Analysis of institutionnal changes by a macro-economic model of co-integration

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Abstract

A new heterodox model is presented for an open economy based on two approaches: the Regulationist and the Marxist approach. The complete model contains six behavioural equations and two quasi-definition relations for the closure of the system. Sub-systems are also the object of analysis. The first conclusion is that the Canadian quarterly series over more than 50 years show that the specification of a more sophisticated model produces better results than a simple one. The openness of the economy by the interest rate equation gives more credibility to the results and to the institutional changes at the world level. When estimated by sub-period, the value change of parameters confirms the importance of institutional changes which took place between the Fordist period and the post-Fordist period which people identified as a neoliberal regime of accumulation. The most important changes are the change in the exploitation rate or the rate of distribution in favour of capital, the change in the exchange rate regime and the free flow of financial capital, the decrease of the impact of productivity on real wage and final demand, the increase of the importance of the State on productivity through the level of education in general and also of other private and public expenditures such as health and on infrastructure.

Résumé

On présente un nouveau modèle hétérodoxe pour une économie ouverte construit sur les approches régulationiste et marxiste. Le modèle complet comporte six équations de comportement et deux relations de définition pour fermer le système. Des sous-systèmes sont aussi analysés. La première conclusion est que les séries trimestrielles canadiennes sur une période de plus de 50 ans confirment que la spécification d'un modèle plus sophistiqué donne de meilleures résultats qu'un modèle simple. L'ouverture de l'économie par l'équation du taux d'intérêt renforce la crédibilité des résultats et des changements institutionnels à l'échelle mondiale. Lorsqu'estimé par sous période, le changement de la valeur des paramètres confirme l'importance des changements institutionnels qui ont eu cours entre la période fordiste et l'après fordisme que d'aucun ont identifié comme le nouveau régime néolibéral d'accumulation. Les principaux changements institutionnels sont le changement du taux de distribution en faveur du capital, le changement dans le régime du taux de change et la libre circulation du capital financier, la baisse de l'impact de la productivité sur le salaire réel, l'augentation du rôle de l'État sur la productivité et la demande finale via le niveau d'éducation en général et aussi des autres dépenses privées et publiques en santé et en infrastructure.

Introduction

The possibility of measuring institutional changes by an econometric model appears a priori to be a difficult task if not an impossible one. Indeed, if one can make a descriptive analysis of a certain number of institutions such as the state, the markets, the international relations, the social classes, the financial system, how can the analysis of all the interactions between these institutions can be reduced to a model of a few equations the structure of which can change over time? It is a challenge to the economist or to any specialist of social sciences who wants to analyse the reality always very complex by a few simple hypotheses (relations). The usefulness of a model is to simplify the analysis, that is go to the essential and knowingly ignore the secondary aspects. For instance, the analysis of a particular sub-group of institutions such as the labour market through the wage rate relation is enough complicated by itself, but the challenge is still greater when the analysis is extended to a larger group which includes other markets such as financial institutions.

On the other hand, since the purpose is the measurement of institutional changes, it becomes necessary to develop a dynamic analysis of institutions. The model cannot be simply static, even if it has been formulated as such in the first instance. Not only will it be necessary to estimate the parameters of an econometric model from observations over a certain period of time (ex. 10 or 20 years) but also over a long-term period (ex. 50 years) in order to measure the structural changes. The estimation of structural parameters will be made by a particular econometric method called the Error Correction Model which allows the distinction of mid-term (stable) relations from short-term or transitory variations. Structural changes or institutional changes can be observed only in the long-term by comparing two mid-term situations. The Regulation school has already identified a certain number of these changes which characterizes a Fordist accumulation regime over the period 1945 up to mid 70's and a post-Fordist regime from the 80's up to nowadays. This post-Fordist regime, now called by everybody a neoliberal accumulation regime, is associated with a period of intense institutional changes such as the new technology of information and communication (NTIC), world finance (financiarisation) which dominates the real economy, the new division of labour at the world level based on new forms of competition which forces states to develop strategy of deregulation in almost every sectors of the economy.

Our ambition now is to measure these changes with a macro-model of six behavioural equations and with a few definition relations. But what theory or approach should be used for the specification of our equations? As it will be demonstrated in the first section, our model is an heterodox model inspired from two sources: the Regulationist school and the Marxist school. The Regulationist approach has always outlined the importance of the wage rate relation and aggregate demand while the Marxist approach has always given pre-eminence to the profit rate and the mobility of financial capital.

1. Marxism and Regulation

The literature of both schools of thought is so vast that we will be forced in this paper to limit ourselves to refer to only a few well-known economists since the aim of this paper is not to make a survey of the literature but to present a theoretical framework based on both approaches. We will choose the Dumenil-Levy contributions as contemporaneous leaders of the Marxian school and the

Boyer-Billaudot-Aglietta contributions as leaders of the Regulationist school.[1] Dumenil-Levy have contributed to may articles in various radical journals but the essential of their thinking can be found in their book *Economie Marxiste du capitalisme* (2003) and also in the 1996 book *La dynamique du capital*, which was followed in 2000 by *Crise et sortie de crise*, which has been updated and translated in English in 2004 under the title *Capital Resurgent: Roots of the Neoliberal Revolution*. Boyer (2002, 2001, 1995, 1986, 1979), Billaudot (2001, 1976), (Aglietta, 1999, 1997, 1976) and many other authors have contributed to many articles and books on the subject. For eight years, the Association Recherche et Régulation (where R. Boyer had a leading role) published an annual review (*L'Année de la Régulation*) of the most important contributions on the subject.

1.1 Marxist theory

Marx's contribution is greater than a treaty of political economy: it is also a theory of social change (historical materialism) where the history of society and its changes are characterized by the dialectical movement between the development of productive forces (nowadays new technology and productivity) and production relations (built on class structure, state, market, international relations and other institutions such as financial institutions). One can see that Marx's analysis is also characterized by a dynamic approach to institutional changes.

Marx's basis idea is that what matters most is not competition of firms on a particular product market but *competition on the capital market is the main cause of the tendency to the equalization of the profit rate* between the various production branches or industries. The extraordinary development of the financial markets on a world wide basis (or financiarization) is just another confirmation of the relevance of Marx's intuition, which nowadays characterizes neoliberalism and imposes the *domination* of financial capital on the real economy and *competition* between large multinational firms at the world level. Although the political economy of Regulation has some important features of Marxism, such as institutionalism and historicism, Dumenil-Levy strongly dissociate themselves from the Regulationist school by focusing on the importance of the profit rate instead of the wage rate as the engine of growth and depression.

But in addition to competition, there is another force which governs the profit rate: it is the technological change which is assumed exogenous by D-L. This is an important difference with the Regulationist approach where productivity is assumed endogenous. To that extent, Regulationists are closer to mainstream economists like R. Lucas (1988) or P. Romer (1990) who have developed a theory of endogenous technological progress, although from a very different basis.[2]

Therefore, the core of the Marxist approach can be summarized by two key variables: the profit rate and the interest rate (adjusted for a risk premium). These are the two variables which govern the movement of financial and real capital over the world. Financial capital becomes dominant and a major source of instability when the discrepancy between the profit rate expected from the financiers and the profit rate realized in the real world by the firms is increasing at an unsustainable rate. The continual upward push for higher yield in the financial sector due to *the risk factor* forces companies in the real sector to do planning mainly in the short-run in order to boost the value of their yield and their assets[3]. The same upward pressure exists also in the financial sector where, thanks to deregulation, a lot of financial innovations has taken place in order to get a higher yield

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[1] Although Keynes'theory was a short-run explanation, most keynesian and post-keynesian economists have developed a long-term theory and would identify themselves as heterodox economists close to the Regulationist school since aggregate demand is at the core of their approach.

[2] The Regulationist hypothesis of endogenous tecnological change is inspired by various authors such as Young (1928), Kaldor (1966), Verdoorn (1980).

[3] See in particular Artus-Villard (2008), Bonazza (2008), Pastré-Sylvestre (2008).

for fictitious capital. One can observe the exponential development of interbanking loans of all kinds since the mid 90's (Morin, 2006, p. 90). A proxy measure of that pressure is the discrepancy between the interest rate adjusted for a risk premium and the profit rate.

1.2 Regulationist theory

Regulation theory is an approach that allows an analysis of the reproduction of the capitalist regime (or its crisis) given that the economic, social, political, cultural, and religious institutions are stable in the mid-term and changing over the long-term. In economics, *regulation theory pertains more to the field of dynamics or growth theory* than the legal or bureaucratic aspect of regulating an economic sector. The capitalist regime is characterized by institutional forms that allow the reproduction or the changes of the partial regulations (relations), whether the latter is a competitive regime or any other type. The Fordist regime which prevailed between 1945 to the mid-seventies has been described by Aglietta (1976) or Boyer(1979) by five institutional forms:

i) A wage relation which is the dominant variable and is based on an acceptable agreement of sharing the productivity gains between capital and labour. Compared to mainstream economics, this leads to a very different characterization of the labour market and its relation with aggregate demand and productivity. A theory of endogenous productivity is at the core of the wage relation.[4]

ii) A form of competition in which firms are evolving. Before World War II, markets were characterized by competition. After the war, oligopolistic and monopolistic competition became dominant (also described as intensive accumulation). This lead to a very different formulation of the price equation and the investment function compared to mainstream economics based on competition. Nowadays with globalization of economies, we are witnessing the return to a form of competition at the national and the world level.

iii) A monetary regime characterized at the national level by credit money which has the virtue of creating money from ex nihilo or *produce liquidity at will* and, at the international level, by a fixed exchange rate until the mid-seventies and a flexible exchange rate regime after. This constitutes the core of the monetary policy where it is assumed that the money supply is endogenous and the monetary policy exogenous, i.e. the central bank has full control over the interest rate thanks to the variable exchange rate. It will be seen that the post-Fordist period will be characterized by a gradual erosion of the control of the central bank over the monetary policy.

iv) A State intervention in the economy which regulates the labour market in the Fordist period and deregulate it in the post-Fordist period. The same type of state intervention occurs in other industrial and financial sectors. The direct intervention of the state in education and health services is very important for productivity since it is now recognized that productivity is linked with the level of these two factors which characterizes the *quality* of the labour force. This is the justification for an active fiscal policy in regulating economic growth.

v) An international insertion in institutions regulating trade (GATT), foreign investments, aid from the World Bank and the IMF. In the post-Fordist period, GATT has been replaced by WTO, the regulation of the exchange rate is done by private financial markets instead of the IMF and the central bank. The *free flow of international capital* (bonds, equity, currencies, futures, derivatives, swaps) is the major change in the international finance (finaciarisation).

Of course, some people might say that mainstream macro economics can also be fitted into this framework. The difference is not at the level of institutions, but at the particular way that one

[4] One should distinguish here the descriptive approach of regulation from the theory itself, the latter being articulated by behavioral relations derived from the descriptive approach. For instance, the wage relation can be described as an institutionnal form and such a form can be specified by one or many behavioral equations.

characterizes the behavioural relations. And it is possible that two different structural approaches lead to the same reduced form model which is estimated by the same set of empirical data. The difference will appear in the interpretation of the results, sometimes with non significant coefficients or coefficient with wrong sign for a specific approach.

According to R. Boyer (2002, p. 185), the essence of the regulation theory (RT) is … « to maintain a clear interest for the analysis of historical processes [of capitalism], beyond the attempts of formalization ». This last quotation means that our heterodox model must not be a simple formal macro model but must be a macro-dynamic model. Therefore, one must choose an econometric methodology which can fit a dynamic structural model. The Error Correction Model (ECM) or the estimation of the parameters of long-term relations specified over a co-integration space will be the core of the empirical analysis in the last part of the paper.

2. The heterodox model

In the fourth part of his book, Billaudot (2001) develops the macroeconomic theory of Fordism, of 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. We have enlarged Billaudot's approach to an open economy model, in particular, by specifying an interest rate equation derived from the balance of payment constraint. The endogenous variables described by seven behavioural equations are consumption, investment, productivity, wage, price, money demand and interest rate. The endogenous variable pertaining to the macro equilibrium condition is that aggregate supply (production) equals the components of the aggregate demand, i.e. there is no inventory variation. Variables pertaining to the definition relations are employment, the profit rate and the financial profitability norm (gap between interest rate and profit rate). Most equations have a non-linear form but are easily adaptable to a log-linear form which is readily suitable for a growth model in an Error Correction Model. In order to reduce the number of co-integration relations, employment, consumption and investment will be substituted into the aggregate demand Price and wage equations will be replaced in many cases by a real wage equation.

2.1 The productivity equation: $Y/E = f_1(Y, K/E, TU, t)$

Productivity in the short-run depends on the scale of the economy (Y), on technical changes embodied in new equipment, in the new division of labour (K/E), and on the degree of capacity utilization (TU). The main justification for an endogenous productivity (or endogenous technological progress) is based on the Kaldor-Verdoorn law or, according to the Lucas-Romer approach, the hypothesis of an increasing-returns-to-scale production function because the level of knowledge is increasing independently from capital and labour. Therefore, the scale of the economy (Y) is an explicit argument of the productivity function. This could be justified by the expenditure of the private and the public sectors spent on research and development. Another justification would be the amount of state expenditures in the education and health sectors. Indeed, the quality of human capital is not only in the level of education but also in the quality of the health services a country has developed. The quality of the infrastructure of a country is now recognized as a major determinant of productivity. Note in passing the *importance of the state as a regulating institution.*

The other determinant of productivity is the capital/labour ratio (K/E) which embodies the Schumpeterian innovation process and a new division of labour. It is assumed endogenous by Regulationists (Petit, 1998, 2002) and exogenous by D-L. However, in the mid-term equilibrium period, if productivity depends solely on the growth rate of potential output and full employment, it is assumed that the degree of capacity utilization (TU) and the unemployment rate are fully adjusted to the desired level and are constant. The existence of a significant coefficient of the unemployment rate would be an indication of a persistent disequilibrium on the labour market in the mid-term or long-term period. The relaxation of the constancy of the degree of capacity utilization would be closer to a Kaleckian equilibrium.[5]

2.2 The employment equation: **E = Y/Y/E = f_2(TU, t)**

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[6]. 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 (TU). 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, and E will be substituted in the consumption function by its definition. The substitution of the employment in the consumption function and the latter in the aggregate demand will make productivity appear in the final demand equation with a negative sign. This is an important divergence with the Fordist approach where a positive sign is assumed for the productivity coefficient in the demand equation. [7]

2.3 The wage rate equation: **w = f_3(p, Y/E, TU, u, t)**

In the Fordist model, the short-run wage is a positive function of price (p), productivity (Y/E) and the degree of capacity utilization (TU) and a negative function of the degree of unemployment (u) according to the Phillips curve. Since the capacity utilization is fully adjusted in mid-term, the equilibrium wage depends only on price, productivity and the unemployment rate. If one assumes that the labour market is fully adjusted in the mid-term, like Billaudot does, then the mid-term equilibrium real wage is growing at the same pace as productivity if prices and wage are growing at the same pace. This is a result which is also arrived at by Dumenil-Levy (1996, p.236). Because of the persistence of a long-term rising tendency of the unemployment rate, the hypothesis of a fully adjusted labour market with a vertical Phillips curve is rejected by most heterodox economists. Therefore, in addition to productivity, our wage equation will contain the unemployment rate (u) as an exogenous variable.

2.4 The price equation: **p = f_4(w, ρ, Y/E, TU, t)**

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 (TU) while the mid-term equilibrium price is constant. The

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[5] See in particular Lavoie-Rodriguez-Seccarecia (2002) Note also that most equations are specified initially with a trend term. When taking the first difference in log with respect to t, the trend term is reduced to a constant.

[6] 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.

[7] Assume that Y is a positive function of E such as $Y = AE^b$, b>0. Substituting E by its definition and taking the log, we have LnY = LnA + b(LnY – Ln(Y/E)) = LnA -b/(1-b)Ln(Y/E). Hence there is a negative relation between Y and Y/E in the demand function unless specified othewise. But if the constant term is replaced by the real wage (w/p), and if the latter is cointegrated with Y/E, then Y can be positively related with Y/E. This is the Regulationist cumulative causation hypothesis.

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short-term price in the monopoly sector is far more complicated. It depends positively on the current wage-productivity gap (w/(Y/E)), and on a financial profitability criterion (ρ). The financial profitability criterion ρ=(qi/r) is a ratio between the interest rate (adjusted for a risk factor q) and the profit rate, both variables are measured in nominal terms. If this ratio is too high because of either a thigh monetary policy or an increase in the risk premium, monopolistic firms will try to catch up by rising their price in order to increase their profit rate. This means that a rise in the financial cost will push up the price and, possibly, the profit rate. Therefore, a positive relation between price and the financial profitability criterion is expected. Similarly, a decrease of the profit rate will rise the profitability criterion and will cause a price rise which will feedback on the profit rate. Because of the overwhelming power of financial markets, price and, hence inflation, is positively related to the interest rate and negatively related to the profit rate.

The emergence of the profit rate into the price equation is rather unexpected from the Dumenil-Levy approach since they remain completely silent about the price level and their approach implicitly assumes that inflation is not a problem to be analysed explicitly. Their implicit assumption is that the price movement is well co-integrated with the wage variable and any other nominal variables such as money or the nominal interest rate. The presence of the profitability criterion in the real wage equation, in the consumption equation and in the investment equation will justify the influence of the profit rate and the interest rate in the aggregate demand equation. Therefore, the Marxian approach is well specified in the behavioural equations by these two key variables.

2.5 The consumption equation: **$C = f_5(E, w, p, t)$**

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. In order to minimize the number of (stochastic) exogenous variables, we have chosen to amalgamate credit and transfers with the constant term. This equation constitutes one of the basic tenets of RT: the growth of the system is generated by the growth of demand which is dependent on the growth of the real wage rate and the employment. Therefore, after substituting the determinants of the real wage rate, (Y/E, u and ρ) and the determinants of employment (E=Y/Y/E), consumption can be seen a positive function of the profit rate and productivity and a negative function of the interest rate and the unemployment rate.

2.6 The investment equation: **$I = f_6(C, \rho, TS, TU, t)$**

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 positive function of past profits, with obsolete investment (TS) removed from the gross stock of capital, and of the degree of capacity utilization(TU). Since the last two variables are assumed constant in the mid-term, the competitive equilibrium investment is solely a function of past profits. This is the type of assumption also made by Dumenil-Levy: the rate of investment or the capital stock growth rate is a linear function of the profit rate which is included in the dominator of the profitability criterion.(ρ).

In the Regulationist approach, investment is a positive function of past levels of consumption (C) and the obsolescence rate (TS) of the gross stock of capital. It is a negative function of the financial profitability criterion (ρ). Assuming that TS and TU are constant in the mid-term, the profitability criterion makes the investment function a negative function of the interest rate and a positive function of the profit rate. We therefore obtain the Marxian Dumenil-Levy profit rate relation and the Regulationist demand pull effect with past consumption. Note again the key role played by the profitability criterion: if the profit rate is fully adjusted to the interest rate in the mid-term (a Sraffian equilibrium for instance), then investment becomes a function of consumption alone. However, this last hypothesis is not a realistic one since our heterodox model must also take into consideration the case of competitive firms whose past profits are future investments.

2.7 The money and interest rate equation: $i/i^* = f_7\{(IM/X), (e), (p/p^*)\}$

The money supply is assumed endogenous to the money demand which is a positive function of transactions (i.e. price and output) and a negative function of the interest rate. The interesting question here is why should the interest rate be determined endogenously? The endogenous character of the interest rate is determined directly through price which is a function of i and indirectly through output via the external trade balance.[8] This is different from the mainstream assumption of an exogenous money supply and hence, an exogenous interest rate. The choice of the central bank in 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"*. Until the 90's, the policy rule of the Bank of Canada has been based on a monetary index which is some weighted average of the short-term interest rate and the exchange rate. Therefore, the central bank independence was severely limited. This policy has been abandoned since that period.
- The capital account is positively related to the price differential (p/p*) – inflation increases 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 e_r. Indeed, by definition, $e_r = e(p^*/p)$.[10]

If the capital account function CA or the current account deficit (IM/X) is explicited with respect to the interest rate differential (i/i*), the equation is

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[8] Assuming that imports are a function of output, then there is a simultaneous link between the interest rate and output which is also a function of i through p.

[9] Note in passing that the current account balance will be approximated by the current 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.

[10] One could think that in the mid-term equilibrium our model is based on the purchasing power parity theory with unitary elasticities for the variables e and p/p*. The truth is that these two variables are assumed as common stochastical trend, hence non cointegrated. Moreover, the substitution of the net export balance by the exchange rate in the aggregated demand is another reason which can influence the value of the coefficients of e and p/p* in the interest rate equation.

$$(i/i^*) = A(IM/X)^{\alpha}\,[e(p^*/p)]^{-\beta} = A(IM/X)^{\alpha}\, e^{-\beta}\,(p/p^*)^{\gamma}, \text{ where } \alpha, \beta \text{ and } \gamma > 0.$$

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 (2001b), 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 assumed here is of a rather different type from the one usually specified for a closed economy. The target interest rate taken here is the foreign interest rate. The target inflation rate can be identified with the foreign inflation rate. The target growth rate of output is the growth rate of external demand (imports and exports). *It is the exchange rate flexibility which allows the central bank the possibility of conducting an independent monetary policy*. Therefore, a completely endogenous monetary policy exists if the central bank chooses to regulate the exchange rate.[11]

3.0 Econometric results

The general representation of a dynamic structural model is by a differential equation of the first order (or of a higher order) such as

$$y' = f(y; \beta)$$

where $f(y;\beta)$ is an unknown function. If y is a function of time, then y' measure the rate of change of y over a time period, β is a *structural parameter that is usually assumed constant over a mid-term period*, although it may also be assumed to change (slowly) over a long-run period. In that case, β is also a function of time. The structural stability of the system is not the same concept as the stability of a particular solution of a differential equation. By solving a differential equation, one can look to the conditions which guarantee a stable or convergent solution over time. This depends on the set of particular values of the structural parameters and initial conditions. This may be an interesting exercise achievable with a growth model of one or only a few equations, once the value of parameters have been properly estimated or specified otherwise. One can check the stability of the growth model by verifying if all variables have the same growth rate or converge to different growth rates.

However our main preoccupation here is to estimate the structure before attempting to simulate the inherent stability of the model. The model that is specified and estimated from time series of quarterly Canadian data (1947-1999) is a structural dynamic simultaneous system that has six equations and two definition relations. The model is linear in its parameters, the variables are in log-transform in order that the first difference of a variable measures its rate of growth. Time is measured in discrete periods as its suits a quarterly representation, the order of the difference equations varies between 5 to 8 periods (See table 2 for the choice of the number of lags). Each equation is supplemented with a stochastic term which is related to a stationary condition. The software package CATS/RATS is based on the Hansen-Juselius method of estimating simultaneous co integrated relations of a certain number of endogenous variables. Our model contains 15 variables and 8 co-integration relations are specified and, hence, 7 variables are

[11] It is interesting to note that in times of a big financial crisis such as in the last quarter of 2008, the flight to quality seems to defy any law of gravity or rationnality : despite huge internal as well as external deficits, the US dollar is such a powerful attraction that it forces most other currencies to be brutally depreciated. Unless there is a major change in the international monetary system, these excesses could lead to a return to an exchange rate control.

common stochastic trend variables, i.e. variables that are not specified by a co-integration relation. The number can vary according to certain particular specifications.

Obviously, with a system containing more than one co-integration relation, the problem of identifying a particular co-integration relation to a structural equation becomes very difficult unless some a priori restrictions are specified on the coefficient matrix of the co-integration space. We will proceed with a two equation model before estimating a more complete model. Another hypothesis made here is that all stochastic variables are integrated of order 1 or to a higher order. Finally, the test of a structural break can be done in two ways:

- re-estimate the model for sub-period and analyze the change in the value of the parameters of each equation;
- use a test incorporated in the CATS software based on the significant change of the whole model based on the co-integration matrix Beta. This test does not allow a separate test for a particular equation or subgroup of equations unless each subgroup of equations are estimated separately.

3.1 The estimated model

After substitution of C and I in the aggregate demand Y and dropping all variables which may be important in the short-term period but are left out of the co-integration space, the model which is finally estimated is a 8 equation system, (6 behavioural equations and 2 definition relations) which implies that one must identify at least 8 co-integration relations:

$Y/E = f_1 (Y, K/E)$

$Y = f_2 (E, w/ p, u, \rho, G, e)$

$w = f_3(Y/E, u,)$

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

$i = f_5\{(i^*, (e), (p/p^*)\}$

$\rho = f_6 (i / r)$

$r = f_7(Y/E, w/p).$

$M1/p = f_8 (Y, i)$

Note that in the demand equation the exchange rate e has replaced the external trade account (X/IM). In certain specifications, the government expenditure variable G is amalgamated with the constant term. A similar substitution has been done in the interest rate equation where the external deficit (IM/X) has been replaced by the exchange rate e. The main purpose of these substitutions is to reduce the number of variables in the co-integration space. One could have reduced the co-integration space to 6 equations by ignoring the two definition relations (ρ and r) whose main role is to close the system. We decided to keep them as a check for identification purpose. If a particular choice of constraints gives the wrong signs in these definition relations, it is an indication that one has to choose a better set of constraints. To make productivity appears in the demand equation and test the Regulationist cumulative causation hypothesis (Boyer-Petit 1991), it becomes necessary to replace E by its definition in the final demand equation. Therefore, the signs of the productivity coefficient, the real wage rate coefficient, the profitability coefficient and the exchange rate coefficient in the demand equation become crucial to watch.

3.2 Preliminary results before estimation

a) Average growth rate of some endogenous variables

Table 1
Quarterly and annual average growth rate

	Average quarterly rate			Average annual rate		
Series	47-75	47-89	47-99	47-75	47-89	47-99
DLY	0.0131	0.0113	0.0102	0.052	0.045	0.041
DL(Y/E)	0.0052	0.0049	0.0047	0.021	0.019	0.019
DL(w/p)	0.0065	0.0054	0.0045	0.026	0.022	0.018
DLi	0.0156	0.0124	0.0056	0.062	0.049	0.022
DLr	-0.0026	-0.0015	-0.0008	-.010	-.006	-.003
DLρ	0.0188	0.0143	0.0067	0.075	0.057	0.027

Table 1 contains the growth rate of the main endogenous variables. Even if these rates are average over three cumulative periods, it is interesting to note the falling tendencies of all of them except for the profit rate. The length of each period is chosen according to the sample estimation in section 3.7.[12]

b) 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 were made: the Dickey-Fuller Augmented test (DFA) and the Phillips-Perron test (PP) for an AR process with a constant and 8 lagged variables, (Loranger-Boismenu, table 4, 2002). Results with the DFA test show that the hypothesis of a unit root is rejected in only one case (TU). Hence all the other variables are I(1).

c) Choice of a constant term

Before determining the co-integration space for each specification, the CATS software 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.

d) Choice of the order of the VAR

[12] For example, the annual productivity growth rate is 2.1% over the 1947-1975 period and 1.9% for the whole period. If one were looking for the average growth rate of the last ten years of our sample, the average growth rate of productivity would be more in the interval of (0, 1) than in the interval of (1, 2).A similar remark applies for the period 1947-1989.

We need also to specify the order of the VAR. Table 1 presents the results for a range of 3 to 7 lag period of a model containing a large number of variables. The minimum according to the HQ criterion is a VAR of 6 lags. Most of our estimation will be done with k = 6.

Table 2

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

3.3 The productivity-demand model

One must now look at a productivity-demand model extended to 5 exogenous variables, forming a system of 7 variables: Y/E, Y; G, X, IM, K/E, H.[13] Although Table 3 gives the rank test at the 10% level, the rank test for two co-integration relations is found at the critical level of 2.5% only.

Table 3

Rank test for the productivity-demand model

Eigenv.	L-max	Trace	H0: r	p-r	L-max90	Trace90
0.2149	49.84	166.87	0	7	28.36	117.73
0.1936	44.32	117.03	1	6	24.63	89.37
0.1191	26.11	72.71	2	5	20.90	64.74
0.1048	22.79	46.60	3	4	17.15	43.84
0.0832	17.91	23.80	4	3	13.39	26.70
0.0272	5.68	5.90	5	2	10.60	13.31
0.0010	0.21	0.21	6	1	2.71	2.71

<u>Important warning for the interpretation of results contained in table 4</u>

For those who are not familiar with Error Correction Model, the results contained in the co-integration matrix presented in table 4 must be read with an opposite sign except for the standardized coefficient equal to 1, because the arguments of the equation are also regrouped on the left hand side of the equation to form a linear combination equal to an error term on the right hand side of the equation (whence the name of Error Correction Model).

The unconstrained estimation gives a negative sign for the demand coefficient (-0.126) in the productivity equation (which is pretty bad) while productivity has a positive elasticity (0.156) in the demand equation. The constrained estimation changes the signs in both equations: the coefficients of aggregate demand in the productivity equation is now positive (0.185). However,

[13] These estimated results were done in 2002 with the inclusion the average length of the labor period H. This variable was dropped out of the cointegration space but included in the constant term in other estimations.

without the specification of the real wage, the productivity coefficient in the demand equation is now negative (-1.741) as already demonstrated in footnote 7. The coefficients of the other components of aggregate demand have the expected sign with relatively high magnitudes. Finally, a positive elasticity (0.853) around unity[14] is observed for the coefficient of the capital/labour ratio in the productivity equation. It is somewhat a surprise that the endogenous technical progress generated by the division of labour appears to be more important than the one caused by the level of education.

Table 4

The productivity-demand model

Unconstrained estimation

LY/E	LY	LK/E	LG	LX	LIM	LH
1.000	0.126	-0.488	-0.106	-0.200	0.077	0.425
-0.156	1.000	1.427	-0.631	0.265	-0.560	1.109

Constrained estimation

LY/E	LY	LK/E	LG	LX	LIM	LH
1.000	-0.185	-0.853	0.000	0.000	0.000	0.690
1.741	1.000	0.000	-0.467	-0.739	0.220	0.000

Standard error of BETA

0.000	0.054	0.111	0.000	0.000	0.000	0.208
0.440	0.000	0.000	0.103	0.146	0.143	0.000

The value of the likelihood ratio calculated from the two types of estimations is a χ^2 (3) equal to 5.32 while the critical value at the 5% level is 7.81. The null hypothesis is accepted and the coefficients of the last four exogenous variables in the unconstrained estimation are not significantly different from 0. Since the results of the constrained estimation appear to be better than those of the unconstrained estimation, we will limit our further analyses to the results of constrained estimation.

3.4 The co-integrated wage-price model

The co-integrated wage-price model is a 5 variable system (p, w; Y/E, u, ρ). According to the trace or lambda-max criterion[15], one could accept 3 co-integration relations. The results in table 5

[14] When the model is exactly identified as it is the case here, the CATS software gives the standard error matrix for Beta and a Wald test can be applied to test whether the coefficient does not differ significantly from 1. The calculated value for the Wald test is $[(.853 - 1)/0.111]^2 = 1.75$ hence a value lower than the 5% critical value of a χ^2 (1) equal to 3.84. The null hypothesis is therefore accepted.

[15] In order to save space, the rank statistics and many other results such as unconstrained estimation will not be published. They are available on demand in Loranger-Boismenu, (2002)

are for two co-integration relations identified to wage and price. By imposing a unit constraint on the price and wage coefficients (+1 or -1) in each equation, the first equation corresponds to the real wage and the second equation to the relative price.

Table 5
The wage price model

LY/E	LW	LP	LU	LRHO	Constant
-1.031	1.000	-1.000	-0.484	0.000	0.271
1.092	-1.000	1.000	0.000	0.231	-0.029
Standard error of beta					Student(t)
0.171	0.000	0.000	0.080	0.000	3.276
0.137	0.000	0.000	0.000	0.041	-1.569

NB the constant term is outside the co-integration space and hence its value does not require to change sign and the calculated Student t value replaces the standard error.

The results in Table 5 are interesting-- the real wage (or the relative price) has a unit elasticity with respect to productivity in both equations with the correct sign. The calculated value of the likelihood ratio is a χ^2 (2) equal to 14.74 while the critical value at the 5% level is 5.99. This implies that the constraints imposed on the coefficients are significant when compared to the free estimation and contribute to the identification of the parameters of the structural model. However, these constraints can also produce biased estimates for the other coefficients.

The real wage is growing with the unemployment rate (0.484). But if the co-integration relation is better identified as the unemployment rate than the real wage, the sentence can be reversed and one could say that it is the unemployment rate which is a function of the real wage. The unemployment rate would be explained by the growing number of unqualified employees who are pushed into Marx's reserve army. The well paid jobs are for those who are better skilled workers of have achieved a higher level of education. The positive and significant constant term (0.271) which represents a mid-term deterministic trend adds some weight to this interpretation.

The coefficient of the ρ variable has a negative sign, an unexpected result in the price equation. Either the interest rate has no influence on price or the falling tendency of the profit rate has a negative effect on the relative price. This last interpretation is in accordance with the negative relation between the profit rate and the wage rate: w/p is increasing because the profit rate is falling. Finally, it should be outlined that the constant term is not different from 0 in the price equation.

3.5 Estimated results of a productivity-demand-wage-price model

A four equation system is now formed with 4 endogenous variables (Y/E, Y, w, p) and 6 exogenous variables (G, X, IM, K/E, u, ρ) which are common stochastic trends or shocks on equilibrium of the system. Therefore**,** a 10 variable system is freely estimated in the first instance and then a new constrained estimation is estimated. Following the 10% trace or lambda-max criterion, there is a possibility to accept 9 co-integration relations. Only the first four co-integration relations will be analysed. Although the 10 variables enter in each unrestricted co-integration relation, comments on the results of Table 6 will be limited to variables restricted in the constrained model.[16]

Table 6

The productivity-demand-wage-price model

LY/E	LY	LW	LP	LK/E	LU	LRHO	LG	LX	LIM
1.000	-0.437	0.000	0.000	-0.061	0.000	0.000	0.000	0.000	0.000
-1.636	0.000	1.000	-0.817	0.000	-0.166	0.000	0.000	0.000	0.000
0.661	0.000	-0.901	1.000	0.000	0.000	0.084	0.000	0.000	0.000
-1.640	1.000	-0.586	0.551	0.000	0.000	0.057	0.03	-0.076	0.106

Demand (last line of table 6) has a strong positive relation with productivity (1.64) and is also a positive function of wages (.586). Although these coefficients may be biased, the novelty here is the upward biased positive coefficient of productivity combined with the downward biased positive coefficient of wage which gives some strength to the cumulative causation hypothesis of the Regulationist approach. One should note the importance of the wage specification in the aggregate demand equation as it has been already outlined in footnote 7. A negative relation is also noted between demand and the profitability criterion (-0.057) which validates the negative relation between investment and the interest rate on one hand and the increase of the profit rate (or past profits) on the other hand. Note finally that final demand is positively linked to the external demand.

Productivity (line 1, table 6) is strongly linked to demand (.437) and shows a weak positive link with capital-labour ratio(.061). This result is the opposite of the one already observed with the simple productivity-demand model. This shows that a more complete model can improve significantly the estimation of the structural parameters.

The results of the wage-price equations (lines 2 and 3, table 6) do not differ substantially from those already observed in table 5 except that the relaxation of the real wage constraint influences the magnitude of some coefficients.

3.6 The interest rate equation based on a money-price-wage model

The wage-price model has already been successfully estimated. The next step is to enlarge the model in order to include 4 new equations, two of which are identity relations--the profit rate and the financial profitability norm. The third equation is the money demand, given that the money supply is endogenous. The fourth equation is the interest rate equation which transforms the model into an open economy with the free flows of financial capital. Therefore, the monetary-financial system is made up of 6 endogenous variables (w, p, r, ρ, i and M1) and 9 exogenous variables (u, q, K/E, G, i*, p*, e, Y, Y/E). In a complete model, integrating the productivity-demand model and the money variables, the last two variables would be considered as endogenous.

[16] Since the rank tests, the likelihood ratio tests and the results of unconstrained estimation have already been commented elsewhere (Loranger-Boismenu, 2002), we abstain to discuss them here.

Many estimations were made. Only one final result will be published here in table 7 of Appendix B. Since it is not easy to read and interpret the value of all the coefficients in table 7, we will examine each equation separately into a more explicit form. There is no interest to comment about the results of our two definition relations (the profit rate Lr and the profitability criterion Lρ) except to notice that the estimated results have the expected signs (lines 4 and 2 in table 7).

a) The wage price equations (lines 1 and 3, table 7)

$$Lw = .894\ p + 1.154\ L(Y/E) + .077\ Lu + \text{constant}$$

$$Lp = .995\ w - 1.031\ L(Y/E) - .116\ L\rho + \text{constant}$$

Assuming that the coefficients of w and p are not significantly different from 1, one can see that real wage changes at the same rate as productivity with a unit elasticity coefficient in both equations. The positive sign of the u coefficient and the negative sign of the ρ coefficient have the same interpretation already done in section 3.4.

b) The money demand (line 5, table 7)

$$L(M1/p) = 1.855\ LY + .322\ Li + \text{constant}$$

The real balance of money is a positive function of output (and hence demand), but its coefficient is biased upward. One would expect an elasticity close to unity. Again, the absence of demand as an additional endogenous variable may be responsible for such a bias. Similarly for the interest rate : one would expect a negative sign while our results show a positive sign. A better specification is required.

c) The interest rate equation (line 6, table7)

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

Note that the interest rate differential has a unit elasticity (1.058) with respect to the current account deficit, and strongly reacts to a domestic inflation greater than a foreign inflation (5.247). The hypothesis of an independent monetary policy is validated with a significant negative coefficient (-0.705) for the exchange rate: a devaluation (de>0) does not require that the central bank raises its interest rate.

3.7 Monetary and financial model of an open economy

We proceed now to the estimation a more complete model including productivity and aggregate demand as endogenous variables. The system includes 8 endogenous variables (Y,Y/E, w, p, r, ρ, i, M1) and 7 exogenous stochastic variables (u, K/E, q, G, i*, p*, e) where q is the risk premium associated with i. The results are contained in table 8 in Appendix B. As in the previous section, results are presented for each particular equation in an explicit form.

a) The wage equation (lines 1 and 3, table8)

$$Lw = Lp + .368L(Y/E) - .292Lu + \text{constant}$$

$$Lp = Lw - 1.049\ L(Y/E) - .124L\rho + \text{constant}$$

The imposition of a unit constraint on the coefficients of wage and price in order to specify real wage as an endogenous variable (or the relative price) causes an important change for the coefficients in the wage equation but does not disturb those of the relative price equation. The unemployment rate coefficient is now negative, which validates the hypothesis of a Phillips curve but with a serious downward bias for the productivity coefficient (0.368).[17]

b) The money demand (line 5, table8)

$$L(M1/p) = 0.662\ LY - 1.766\ Li + \text{constant}$$

The results for the money demand are much better than in the previous section with a negative elasticity (-1.766) for the interest rate and a less biased positive elasticity for production (0.662 instead of 1.855)). This illustrates again that a more complete model gives better results than a simple one.

c) The interest rate equation (line 6, table8)

$$L(i/i^*) = 6.097\ L(p/p^*) - 1.328\ L(e) + \text{constant}$$

The replacement of the current deficit balance (IM/X) by the exchange rate e in the interest rate equation almost doubles the value of the exchange rate coefficient (-1.328 instead of -0.705). This illustrates the important link between the interest rate and the exchange rate in an open economy based on the free flow of financial capital. It also increases the impact of the relative (external) prices on the interest rate differential.

d) The productivity equation (line8, table8)

$$L(Y/E) = .395LY + .122\ L(K/E) + \text{constant}$$

Theses results validate those already observed in section 3.5: productivity is mainly caused by the level of knowledge in the economy and, hence, the quality of the labour force expressed by the scale of the economy. The impact of the labour division measured by the K/E coefficient is three times less.

e)The demand equation (line7, table8)

$$LY = 1.075L(Y/E) + 1.110L(w/p) - .141\ L\rho + .012Le + \text{constant}$$

The results of this equation are the best that one can imagine especially if they are compared with those already observed in section 3.5:

a unitary positive elasticity for productivity;

a unitary positive elasticity for real wage;

a negative impact of the profitability criterion on demand: an interest rate increase lowers demand and a profit rate increase pushes demand upward;

a devaluation has a weak positive impact on demand.

Note that the two variables that have the greatest impact are the real wage and productivity. In time of severe economic crisis, it is wise that governments spend more on health, education and infrastructure because it feeds back on productivity, but they should also encourage the private sector to increase real wage instead of depressing it.

4. Test for structural changes

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[17] One should not take that bias too seriously since if the relative price is inverted, the productivity coefficient remains with a unitary elasticity as in section 3.6.

4.1 Test with a simple productivity-demand model

The first graph in the appendix A is a test of constancy of the co-integration space of the productivity-demand model over the period 1976 to 1999. The choice of this period is dictated by the Fordist crisis which causes a radical change in the monetary policy in Canada in September 1975 and a radical change at the international level by a generalisation of the floating exchange rate (The Jamaica Agreement 1976). The null hypothesis (i.e there is no structural break) is accepted at the 5% level if the statistics for the co-integration matrix is less than unity. The model is estimated for the whole period 1947-1999 and then re-estimated for a sub-period 1976-1999. The software CATS gives two calculations for this statistics in each quarter: one is based on the value of the variables including short-term variations (BETA_Z) and a second one based on the value of variables purged of their short-term variations (BETA _R). Since the statistic is well above unity for the whole period with observations from 1975, it can be safely concluded that major structural breaks (or institutional changes) occurred between the whole period for which β has been estimated and the last sub-period 76-99. This break marks the end of the Fordist period. Note also another structural break shown in the graph from 1982 to 1999. This structural change corresponds to the Reaganomic period of deregulation. If the 1976-1982 period can be identified as a post-Fordist transition period, the new regime which starts in 1983 is qualified as a neoliberal regime.

4.2 Test with a complete model

The second graph is a test conducted with the complete model as specified in table 8. Since it is somewhat arbitrary to decide the particular year of the occurrence of a structural break, we picked the break point in 1985 instead of 1982. The result is about the same: each statistics (BETA_Z and BETA_R) is above unity for the period 1985-1999. The null hypothesis is rejected at the 5% level and we also notice that a new structural break seems to occur from the 1988-90 period. The period 1990-1999 is a period of intensification of deregulation with a lot of financial innovations, in particular the exponential growth of credit swaps by banks, the emergence of exotic derivatives and other financial products. It is impossible with these global tests to identify which particular institutional change has caused these structural breaks. It is all of them (change in the state regulation, change in the money and financial regulation, change in the form of competition, change in the international relations) but it is not possible to identify the particular influence of any of them. A more refined analysis by each equation would give a closer picture of those changes. This is the object of the next section.

4.3 Estimation by sub-period

The complete model of section 3.8 has been re-estimated for two other sub-periods: 1947-1975 and 1947-1989. The first sub-period corresponds to the Fordist period. The second sub-period corresponds to the post-Fordist period which constitutes a transition between the Fordist period and the neoliberal regime.[18] Indeed, the last decade of our sample (1990-1999) is characterized by the accelerated institutional changes in the financial sectors and the accrued importance of the openness of the Canadian economy. The results for each equation comes from tables 8, 9 and 10 in appendix B. As it can be observed from these tables, the last two sub-periods have been estimated with a model of 15 variables and 8 co-integration relations. But for the first period, the number of variables was reduced to 13 (elimination of LG and Lq) and the number of co-

[18] It is always somewhat risky to pinpoint a precise date to these structural changes. That is why we chose a transition period which overlap both regimes (Fordist and neo-liberal)

integration relations was also reduced to 5 by eliminating the two definition relations and one of the relative price equations. Only the price/wage relation entered into the co-integration space. These change became necessary to avoid the problem of a non-invertible generalized matrix.

The wage eq. (w/p)	LY/E	Lu	Lρ
1947-1975	4.106	0.567	-0.570
1947-1989	1.134	0.187	-0.036
1947-1999	0.368	-0.292	0.124

There are major changes in the coefficients of the three explanatory variables: the impact of productivity has decreased substantially over time; the unemployment rate is responding more to the flexibility of the labour market in the last decade with a sign change from positive to negative, and the change of sign of the profitability criterion in the last period from negative to positive. These changes illustrate without any doubt that the institution "labour market" is marked by an important change: the market has evolved from a closely regulated market to a flexible one over time. The positive coefficient for the first two sub-periods is an indication that the labour market was regulated quite differently: profits and wages were evolving in the same direction. But the coefficient of the last period (which is by the way the whole period) is significantly negative (-0.292) and validates the hypothesis of a Phillips curve.[19]

A similar situation is observed for the evolution of the profitability criterion coefficient: it is negative in the first two periods and positive in the last period. The positive coefficient illustrates a major shift in the exploitation rate (or the distribution coefficient) between labour and capital: an increase of the profit rate will lower the real wage rate. We are far from the Fordist compromise of sharing the productivity gains. Finally, concerning the evolution of productivity, we observe that it has not only diminished over time (see table 1) but it impact on the real wage has diminished very substantially (-75% between 1947-75 and 1999).[20]

The money demand L(M1/p)	LY	Li
1947-1975	0.866	-0.183
1947-1989	0.324	0.036
1947-1999	0.662	-1.766

The estimated coefficients of the second period are somewhat bizarre: income has a small elasticity with respect to the money real balance, the interest rate sign is contrary to expectation and the value of its coefficient is most likely not different from 0. While in the second period the demand for money was rather independent from the interest rate, it appears that by adding the data of the last ten years, there has been a major change in the interest rate coefficient which reflects the dominant influence of financial markets with an elasticity coefficient almost three times the one of aggregate demand. This also illustrates that the central bank policy is much more

[19] The statistical significance is indirectly validated by the standard error matrix of the Beta coefficients for the period of 1947-1975 (table 10). As already mentionned, the CATS software calculates the Standard error matrix only when the rank of the matrix is compatible with the number of restrictions.

[20] The result for the last period 1947-1999 are biased as mentionned in footnote 17. The more likely value is unity. Therefore, the decrease of the productivity coefficient is from 4 to 1 which is 75%.

influenced by the financial markets during the last decade. Therefore, these results validate the change in the financial institutions at the national level as well as at the international level.

The int. rate eq. L(i/i*)	L(p/p*)	Le
1947-1975	4.264	-1.668
1947-1989	3.902	-2.931
1947-1999	6.097	-1.328

The change in the value of these structural coefficients is more remarkable in the last decade than in the 40 years before. On one hand, the increase of the importance of the relative price between home and abroad in the last decade (more than 50%) is a consequence of the openness of the Canadian economy. It illustrates another institutional change in the international relations. On the other hand, the reduction of the influence of the exchange rate by 50% in the last decade is perhaps an indication that the central bank has stopped its dirty float practice since1990.

The productivity eq. L(Y/E)	LY	LK/E
1947-1975	0.235	0.381
1947-1989	0.376	0.175
1947-1999	0.395	0.122

The most significant change in the value of the structural coefficients of the productivity equation is the steady growth of the influence of the level of education and qualification of the labour force over the fifty year period followed by a similar steady decrease of the influence of the division of labour (68%). If the regulation of the K/E ratio pertains more to the private sector, education and health is primarily a matter of concern for the public sector and, hence, the evolution of the aggregate demand coefficient shows an important institutional change of the role of the State in regulating productivity.

The demand LY	LY/E	Lw/p	Lρ	Le
194791975	2.436	1.008	-0.347	-0.352
1947-1989	1.038	1.386	-0.069	0.002
1947-1999	1.075	1.110	-0.141	0.012

The most surprising fact is that the Regulationist cumulative causation hypothesis is validated in all three periods. However, there is an important loss of influence of productivity on demand: the productivity coefficient decreases by 56% between the first period and the last period which includes the last ten years.[21] The influence of the real wage is steady over the 50 year period. The influence of the profitability criterion has declined substantially (-59%) over the same period. Does that mean that demand would be influenced more by the profit rate than the interest rate? According to a previous research, (Loranger-Boismenu, 2002) the falling tendency of the profit rate has been reversed since 1983 in Canada. If a part of profits is invested a broad, it does not

[21] In fact, because of the cumulative information contained in the last period which is the whole period (1947-99), the decrease of the impact of productivity on demand would be greater if the estimated results for the last period had been based on the last ten years of the sample.

stimulate demand as much as if it had been reinvested in the domestic economy. The delocalisation of production in emerging countries constitutes another striking institutional change in the international relations. Finally, the negative value of the exchange rate coefficient in the Fordist period is the most striking result. Under a fixed exchange regime, devaluation was not a stimulant of aggregate demand: it had an opposite effect. The small value (near 0) of the exchange rate coefficient in the first post-Fordist period marks a transition between the two periods. It is only in the last decade that the incidence of a devaluation can have a small influence over aggregate demand.

Conclusion

Our aim as declared in introduction was to specify a macro-economic model based on the Regulationist and the Marxist approaches in order to show how changes in the structure of the model are explained by major institutional changes such as change in the state regulation, change in the forms of competition, change in the international relations, in particular changes in the production and in the financial markets at the world level, change of the rate of exploitation or the wage/profit distribution. In order to achieve this aim, it was necessary to specify a certain number of behavioural equations whose number after substitution was reduced to six behavioural equations and two definition relations.

The parameter estimation has been realized in various steps by first working with a simple two equation model and then extend the procedure to an open economy model of six behavioural equations. The econometric results show a certain robustness of the model over the whole period of fifty years of observations but remain sensitive to the choice of a particular specification and a particular set of observations. These results have led us to pinpoint in many instances the major institutional changes that occurred over time and caused these major structural breaks. This is particularly true with the tests conducted in the last two sections of the paper. But what about certain central hypotheses in the Regulationist and Marxist approaches?

The Regulationist cumulative causation hypothesis

The test of this hypothesis is through the sign of the productivity coefficient in the productivity-demand model. With the productivity-demand model unrelated to the wage-price variable, the productivity coefficient is negative. However, with the productivity-demand-wage/price model, in a closed economy as well as in an open economy, the productivity coefficient in the demand equation is positive, which validates the Regulationist cumulative causation hypothesis. However, estimated results by sub-periods show that there is a significant decline of the productivity coefficient between the Fordist and the post-Fordist period. This observation has been outlined by many empirical studies in various countries. One possible causes among many others is the rapid extension of the financial sector at the expense of the real sector: speculation does not create value added.

Economies of scale and the endogenous technological progress

The estimated value of the coefficients in the productivity equation changes radically depending whether the w/p variable is included or excluded from the demand equation. One can see the importance of using a simultaneous equation system. For instance, in the simple two equation productivity-demand model, the value of the K/E coefficient is rather high (.853) and the value of the demand coefficient is rather low (.185). But in a more complete model (closed or open economy) where the real wage variable is included in the demand equation, the results are completely reversed: the Y coefficient is dominant (.437 and .395) while the capital/labour ratio coefficient is weak (.061 and .076). The conclusion that can be drawn is that the level of education or the quality of the labour force has a greater influence on productivity than the division of labour expressed by the capital/labour ratio K/E.

The real wage-productivity relation

In all the specifications, there is a strong link between real wage and productivity with an elasticity coefficient around unity. Results by sub period show an accelerated decline of the impact of productivity on real wage (-75%). If labour does not get any longer its fair share of productivity, this phenomenon constitutes a good illustration of an important shift in the wage/profit distribution or an increase of the exploitation rate. This is perhaps one of the most important institutional change in the post-Fordist period.

The profitability criterion

The profitability criterion defined as the ratio between the interest rate (adjusted for a risk premium) and the profit rate is the key variable in the Marxist approach. It appears in the demand equation and the real wage equation. It significance is validated in the demand equation for any specified sub period. Demand reacts negatively to an increase of the interest rate and positively to an increase of the profit rate. Concerning the real wage equation, the value of the estimated coefficient varies according to a particular period. For instance, for the whole period 1947-1999, the coefficient is positive and, hence, an increase of the profit rate will pull down the real wage, which is not the case in the two previous sub periods. Again, one can see here the change at the institutional level: the labour market moved from rigidity to flexibility and, at the same time, the exploitation rate shifted in favour of capital.

The openness of the economy

Most Regulationist and Marxist researchers use closed economy models. At the era of globalisation, such an approach is insufficient. Our approach consisted to introduce the exchange rate in the demand and in the interest rate equations. The specification of the interest rate as an endogenous variable led us to add two more foreign exogenous variables: the foreign interest rate and the foreign prices. Our results indicate that the domestic interest rate is well co-integrated with the foreign rate, is highly elastic with the relative prices (domestic/foreign) and elastic with respect to the exchange rate. The specification of an open economy model gives better estimated results with a more complex simultaneous equation system, since the interaction of the interest rate is made with other equations of the model.

All in all, the structural model seems rather robust for the whole period of 50 years. Tests of structural change and the estimation of the model by sub periods validate the institutional changes that occurred over that long period. These changes are observed on the labour market, on the financial markets, on the exchange rate regime and the monetary policy, on the role of the State concerning productivity and production at the world level.

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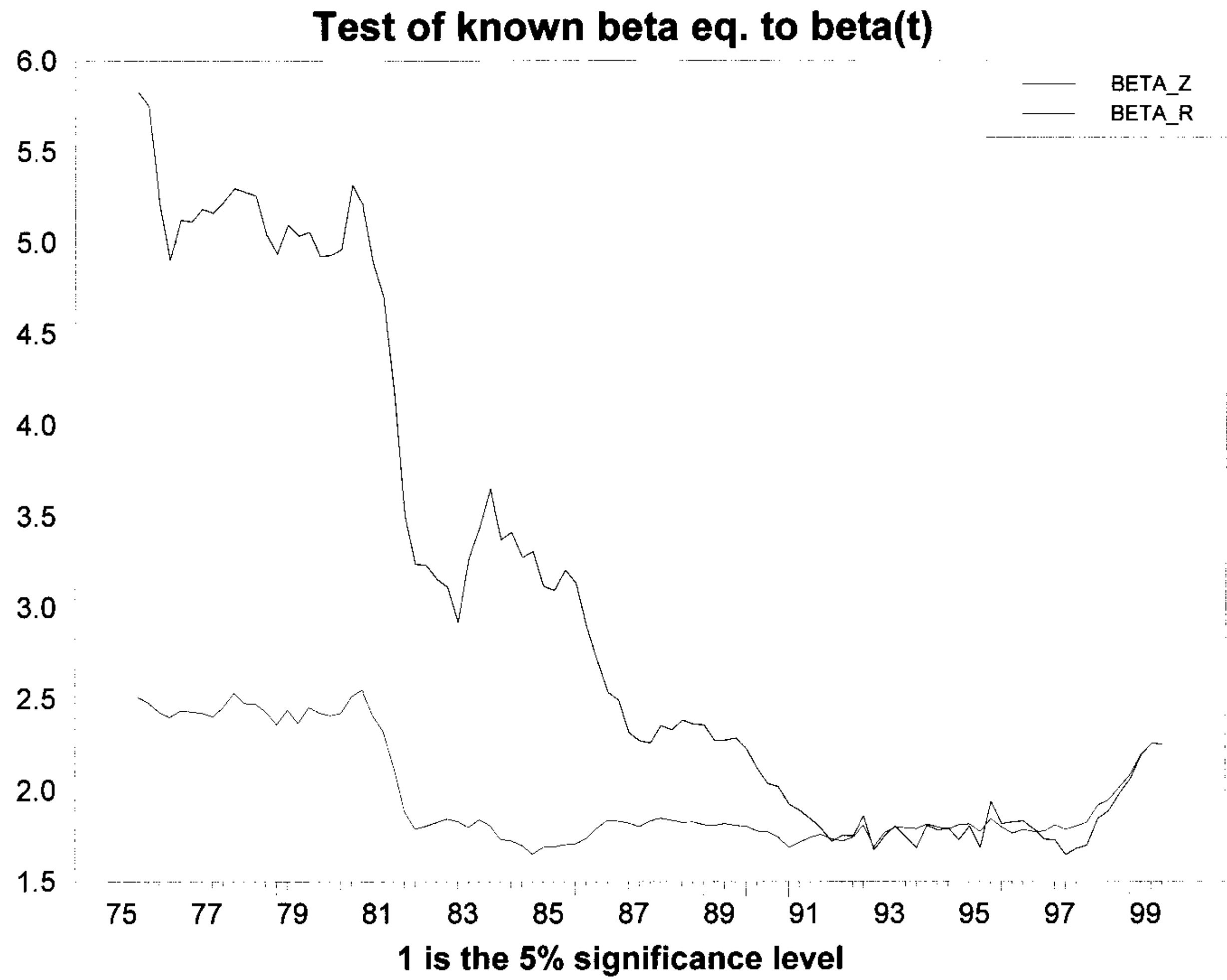
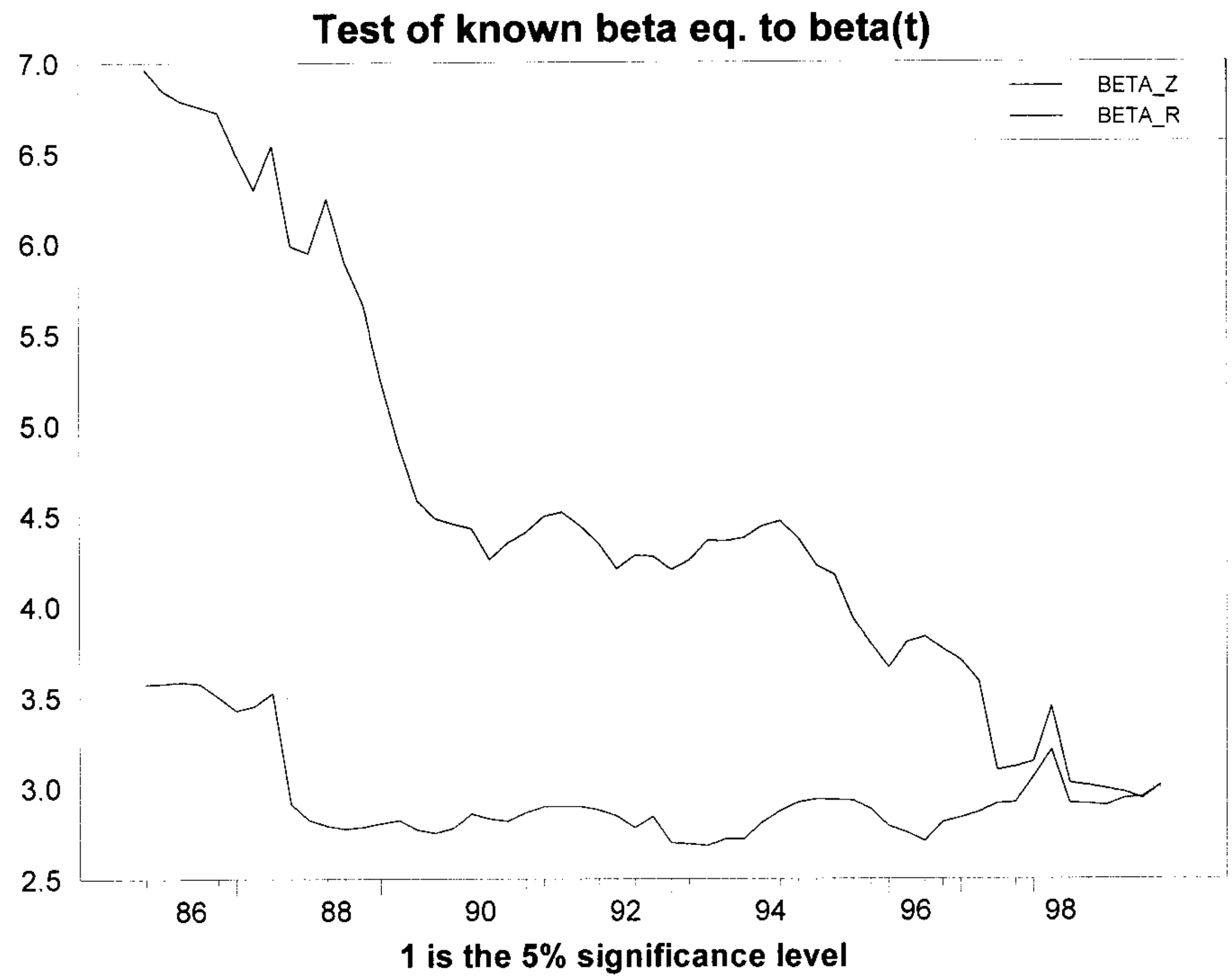
Appendix A

Graph 1 The productivity-demand model



Graph 3 The open economy model



Appendix B

Table 7

Estimation of a monetary-financial model (productivity and demand exogenous), rank = 6

Lw	Lp	Lr	LRHO	LM1	Lu	Li	Lq	LY/E	LKE	LY	LM/X	Li*	Lp*	Le
1.000	-0.894	0.000	0.000	0.000	-0.077	0.000	0.000	-1.154	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	2.900	1.000	0.000	0.000	-0.385	-.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-0.995	1.000	0.000	0.116	0.000	0.000	0.000	0.000	1.031	0.000	0.000	0.000	0.000	0.000	0.000
1.995	-1.995	1.000	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	-1.000	0.000	0.000	1.000	0.000	-0.322	0.000	0.000	0.000	-1.855	0.000	0.000	0.000	0.000
0.000	-5.247	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	-1.058	-1.000	5.247	0.705

Table 8

Estimation of a complete model with productivity and wage in the demand equation (constraints on w/p, M/p, i/r)

Period **1947-1999**, rank of beta matrix = 8

LW	LP	LRHO	Lr	LM1	Li	LY	LY/E	Lu	LK/E	LQ	LG	Li*	Lp*	Le
1.000	-1.000	0.000	0.000	0.000	0.000	0.000	-0.368	0.292	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	1.000	0.906	0.000	-0.906	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
-1.000	1.000	0.124	0.000	0.000	0.000	0.000	1.049	0.0 00	0.000	0.000	0.000	0.000	0.000	0.000

1.235	-1.235	0.000	1.000	0.000	0.000	0.000	-3.629	0.000	2.602	0.000	0.000	0.000	0.000	0.000
0.000	-1.000	0.000	0.000	1.000	1.766	-0.662	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	-6.097	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000	6.097	1.328
-1.110	1.110	0.141	0.000	0.000	0.000	1.000	-1.075	0.000	0.000	0.000	-0.010	0.000	0.000	-0.012
0.000	0.000	0.000	0.000	0.000	0.000	-0.395	1.000	0.000	-0.122	0.000	0.000	0.000	0.000	0.000

Table 9

Estimation of a complete model with productivity and wage in the demand equation (constraints on w/p, M/p, i/r)

Period **1947-1989**, rank of beta matrix = 8

LW	LP	LRHO	LTXR	LM1	LR	LY	LPRE	LU	LKN	LQ	LG	LRUS	LPUS	LE
1.000	-1.000	0.000	0.000	0.000	0.000	0.000	-1.134	-0.187	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	1.000	0.997	0.000	-0.997	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000
-1.000	1.000	-0.036	0.000	0.000	0.000	0.000	1.334	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-0.644	0.644	0.000	1.000	0.000	0.000	0.000	0.719	0.000	0.398	0.000	0.000	0.000	0.000	0.000
0.000	-1.000	0.000	0.000	1.000	-0.036	-0.324	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	-3.902	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.000	3.902	2.931
-1.386	1.386	0.069	0.000	0.000	0.000	1.000	-1.038	0.000	0.000	0.000	0.194	0.000	0.000	-0.002
0.000	0.000	0.000	0.000	0.000	0.000	-0.376	1.000	0.000	-0.175	0.000	0.000	0.000	0.000	0.000

Table 10

Estimation of a complete model with productivity and wage in the demand equation (constraints on w/p, M/p, i/r)

Period **1947-1975**, rank of beta matrix = 5

LW	LP	LRHO	LTXR	LM1	LR	LY	LPRE	LU	LKN	LRUS	LPUS	LE
-1.000	1.000	-0.570	0.000	0.000	0.000	0.000	4.106	0.567	0.000	0.000	0.000	0.000
0.000	-1.000	0.000	0.000	1.000	0.183	-0.866	0.000	0.000	0.000	0.000	0.000	0.000
0.000	-4.264	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	-1.000	4.264	1.668
-1.008	1.008	0.347	0.000	0.000	0.000	1.000	-2.436	0.000	0.000	0.000	0.000	0.352
0.000	0.000	0.000	0.000	0.000	0.000	-0.235	1.000	0.000	-0.381	0.000	0.000	0.000

"STANDARD ERRORS" FOR BETA (transposed)

0.000	0.000	0.115	0.000	0.000	0.000	0.000	0.364	0.035	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.026	0.028	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.425	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.425	0.141
0.082	0.082	0.051	0.000	0.000	0.000	0.000	0.187	0.000	0.000	0.000	0.000	0.051
0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.012	0.000	0.000	0.000