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Identifying Canadian Regional Business Cycles using the Friedman Plucking Model[1]

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Abstract

Following the methodology used by Kim and Nelson (1999b), I find estimates of the permanent and transitory components for Canadian regions based on the Friedman model of business fluctuations. The empirical results support the theoretical predictions that negative transitory shocks hit the economy putting down the real regional output. After that, the regional economy enters in a recovery phase and after this it is operating again near to the trend ceiling level. Using the estimated filtered probabilities, a chronology of the regional business cycles is presented. It shows that there are clear and particular episodes corresponding to the regional dynamics which are not necessarily present at the aggregate level.

Keywords: Business Regional Fluctuations, Markov Switching, Transitory and Permanent Components.

JEL Classification: C22, E32, R00.

Résumé

Suivant la méthodologie utilisée par Kim et Nelson (1999b), j'estime les composantes transitoires et permanentes des cycles économiques des régions canadiennes inspirées par le modèle de Friedman sur les fluctuations des cycles économiques. Les résultats empiriques appuient la théorie qui prédit que les chocs transitoires négatifs sur l'économie entraîne une baisse de la production régionale. Ensuite, l'économie régionale entre dans une phase de récupération pour après tendre à se rapprocher de son niveau maximal. Utilisant des probabilités filtrées, un ordre chronologique des cycles économiques régionaux est présenté. Cet ordre chronologique indique clairement que certains cycles sont directement liés à la dynamique régionale et ne sont pas nécessairement présents à un niveau agrégé.

Mots-clés: Fluctuations économiques régionales, changements de régime de Markov, composantes transitoires et permanentes.

Code JEL: C22, E32, R00

1 Introduction

It was Friedman (1964, 1993) who noted that the amplitude of a recession is strongly correlated with the following expansion, but the amplitude of an expansion is uncorrelated with the amplitude of the succeeding contraction. This striking asymmetry is the basic argument supporting the so named "plucking" model of business cycles[3].

Neftci (1984) presented empirical evidence of the kind of asymmetry advanced by Friedman (1964, 1993), when he found that unemployment rates are characterized by sudden jumps and slower declines. Further evidence was found by Delong and Summers (1986), Falk (1986), and Sichel (1993). As Kim and Nelson (1999b) say, while these kind of asymmetries are consistent with the plucking model, they are also consistent with models where recessions are occasioned by infrequent permanent negative shocks as in the Markov-Switching models of Hamilton (1989) and Lam (1990). According to these authors, what distinguishes the plucking model is the prediction that negative shocks are largely transitory, while positive shocks are largely permanent[4]. Another important fact of the plucking model is the existence of an upper limit to the output, the so named ceiling output, which is set by the resources available in the economy.

The fact that recessions can essentially result from occasional transitory shocks may suggests that a recession, once it begins, will dissipate in a fairly predictable period of time. However, the length of an expansion is not helpful in predicting the next recession. This is what in the literature of business cycles is named duration dependence which was investigated by Diebold and Rudebusch (1990), Diebold, Rudebusch and Sichel (1993), and Durland and McCurdy (1994) in an univariate context; and Kim and Nelson (1998) in a multivariate context. All these references found empirical support of the existence of duration dependence only for recessions times.

Recently a formal econometric specification of the business cycle was suggested by Kim and Nelson (1999b). Their specification allows us to decompose measures from economic activity into a trend component and deviations from the trend that show the types of asymmetries implied by the

[3] Another mention of this kind of evidence was also suggested by Keynes (1936): "the substitution of a downward for an upward tendency often take place suddenly and violently."

[4] In this sense, Sichel (1994) also provides support to this fact by showing that post-war real GDP exhibits "peak-reverting behavior". He also argues the existence of a third, high-growth recovery phase, in addition to the usual recession and expansion phases of the business cycle.

business cycle literature. In this sense, the approach offers more possibilities than standard linear models such as ARIMA models and the unobserved component model of Clark (1987) which cannot account for asymmetries. It may also perform better than other kind of models as the Markov-Switching (Hamilton, 1989; Lam, 1990) where the asymmetric behavior is only accounted in the growth rate or stochastic trend component of real output.

The approach of Kim and Nelson (1999b) has been applied to the output of the G-7 countries by Mills and Wang (2002). Interesting performance of this approach has been also noted by Galvao (2002), where this model is one of the three models capable to reproduce the length of the United States (hereafter US) business cycles. In this respect, see the special issue about business cycles published by *Empirical Economics* in 2002.

In this paper, I follow the same methodology of Kim and Nelson (1999b) applied to the logarithm of the real quarterly GDP of Canadian regions covering the period 1961:1 until 2000:1. For the purpose of comparison, estimations using the real quarterly GDP of Canada and the US have also been included.

To my knowledge, at least for Canada, regional data has not been used to identify cycles and/or permanent components or business fluctuations in general. Regional data has been used to analyze predominantly the convergence issue. See, among other references, Coulombe (1999, 2000) and the references mentioned there in. One recent exception is Beine and Coulombe (2002) where regional cycles have been calculated with the goal of determining if Canada can be considered as a monetary zone. However, unlike the present paper, it is important to point that in Beine and Coulombe (2002), the cycles have been calculated using the Hodrick and Prescott (1997) and Baxter and King (1999) filters, which assume symmetry and the absence of a theoretical model supporting the construction of these fluctuations.

As Coulombe (1999) argues, Canada is an interesting case for its density of regional economies, which suggests a different set of economies and possibilities for fluctuations and answers to different shocks. In Beine and Coulombe (2002), for example, one interesting result is the fact that Quebec and Ontario appear to be more linked with the economy of the Great Lakes in comparison with the rest of Canada. In the case of the Atlantic Canada[5], it is relatively poor and dependent of the so called interprovincial redistribution. On the other hand, the region named Prairies (Alberta, Manitoba and Saskatchewan) is based on the extraction of oil and gas with Manitoba appearing relatively more diversified.

[5] Here, this region is denoted as the Maritimes.

In summary, the diversity of regional economies in a wide country such as Canada seems to be a primary element in supporting the interest in fluctuations in these economies. On the other hand, the presence of negative or positive shocks may have a different effect on the aggregate economy than on the regional ones because of their diversity. Consequently, regions should be able to answer differently in presence of shocks. In other words, it is possible to see the total effect observed at the aggregate level (here, Canada) as simply a "complicated" combination of the different regional fluctuations. The knowledge of particular characteristics of fluctuations can also be important from a regional policy perspective. In this context, some relevant questions to be addressed are the following: are the cycles all alike?, are the recessions driven by transitory factors or permanent shocks?, are these fluctuations coincident with those observed using aggregate data for Canada or the US?

Overall, the empirical results support the theoretical predictions made by the plucking specification. In fact, the coefficient associated with the discrete shock in the transitory component is negative and significant for most of the territories analyzed. This means that negative transitory shocks hit the regional economy putting down the real GDP. After that, the regional economy enters in a recovery phase and after this it is operating again near to the trend ceiling level. The chronology of the regional business cycles shows that there are clear and particular episodes corresponding to the regional dynamics which are not present at the aggregate level. There are also recession dates at the aggregate level which are also present at the regional level.

The rest of the paper is organized in the following manner. Section 2 presents the econometric specification of the plucking model. Sections 3 deals with the empirical results. Section 4 presents a chronology of the regional business cycles and the filtered probabilities. Section 5 concludes.

2 Econometric Specification of the Plucking Model

Let y_t denotes the logarithm of the real output for a specific province or region at the period t. Following the literature of unobserved components (See Watson, 1986), it is possible to decompose y_t into a trend component and a transitory component, which we denote as τ_t and c_t, respectively. That is,

$$y_t = \tau_t + c_t. \tag{1}$$

Adopting a similar notation as in Kim and Nelson (1999b), we assume that shocks to the transitory component are a mixture of two different types of shocks, which will be denoted as π_{s_t} and u_t, respectively. It allows us to account for regime shifts or asymmetric deviations of y_t from its trend component. In formal terms, the transitory component and the shocks affecting their behavior are specified as follow:

$$\begin{aligned}
c_t &= \phi_1 c_{t-1} + \phi_2 c_{t-2} + u_t^*, && (2)\\
u_t^* &= \pi_{s_t} + u_t, && (3)\\
\pi_{s_t} &= \pi s_t, && (4)\\
u_t &\sim N(0, \sigma^2_{u,s_t}), && (5)\\
\sigma^2_{u,s_t} &= \sigma^2_{u,0}(1 - s_t) + \sigma^2_{u,1} s_t, && (6)\\
s_t &= 0, 1 && (7)
\end{aligned}$$

where $\pi \neq 0$. In the above specification, the term u_t is the usual symmetric shock. The other term π_{s_t} is an asymmetric and discrete shock which is dependent upon an unobserved variable denoted by s_t which is an indicator variable that determines the nature of the shocks to the economy. When the economy is near to the potential or trend output, it can be qualified as normal times. In this case, $s_t = 0$ which implies that $\pi_{s_t} = 0$. In the opposite situation, which could be qualified as a period of recession, the economy is hit by a transitory shock potentially with a negative expected value, that is, $\pi_{s_t} = \pi < 0$. In this case, aggregate or other disturbances are plucking the output down.

Note that in equations (5) and (6) it is allowed for the possibility that the variance of the symmetric shock u_t be different during normal and recession times. In order to account for a persistence of normal periods or periods of recession, it is assumed that s_t evolves according to a first-order Markov-switching process as in Hamilton (1989). It means that

$$\begin{aligned}
\Pr[s_t &= 1 | s_{t-1} = 1] = q && (8)\\
\Pr[s_t &= 0 | s_{t-1} = 0] = p. && (9)
\end{aligned}$$

As it is mentioned by Kim and Nelson (1999b), the above specification for the transitory component of output shares the same idea as in the literature on "stochastic frontier production function", initially motivated by Aigner, Lowell and Schmidt (1977). See also Goodwin and Sweeney (1993).

The model is completed with the specification of τ_t, the permanent component. In this respect, Friedman (1993) suggested that the potential output, or what he named "the ceiling maximum feasible output", can be approximated by a pure random walk. In this case, all possible sorts of shocks can produce disturbances on it. In formal terms, this means that the permanent component can be specified as follows:

$$
\begin{aligned}
\tau_t &= g_{t-1} + \tau_{t-1} + v_t, & (10)\\
g_t &= g_{t-1} + w_t, & (11)\\
w_t &\sim N(0, \sigma_w^2), & (12)\\
v_t &\sim N(0, \sigma_{v,s_t}^2), & (13)\\
\sigma_{v,s_t}^2 &= \sigma_{v,0}^2(1 - s_t) + \sigma_{v,1}^2 s_t, & (14)
\end{aligned}
$$

where, according to (12) and (13), the permanent component τ_t is subject to shocks to the level and shocks to the growth rate. These shocks are given by v_t and w_t, respectively. Note that it is allowed for the possibility that the variance of the shock to the level may be different during normal and recession times. However, variance of the shock to the growth rate is not likely to be systematically different during the normal and the recession times.

The model can be written in state-space form. The observation equation is

$$
\begin{aligned}
y_t &= \begin{bmatrix} 1 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} \tau_t \\ c_t \\ c_{t-1} \\ g_t \end{bmatrix} \\
&= H\xi_t, & (15)
\end{aligned}
$$

while the state equation is

$$
\begin{aligned}
\xi_t &= \begin{bmatrix} 0 \\ \pi_{s_t} \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & \phi_1 & \phi_2 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \xi_{t-1} + \begin{bmatrix} v_t \\ u_t \\ 0 \\ w_t \end{bmatrix} \\
&= \overline{\mu}_{s_t} + F\xi_{t-1} + V_t & (16)
\end{aligned}
$$

where $E(V_t V_t') = Q_{s_t}$ and

$$
Q_{s_t} = \begin{bmatrix} \sigma_{v,s_t}^2 & 0 & 0 & 1 \\ 0 & \sigma_{u,s_t}^2 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \sigma_w^2 \end{bmatrix}.
$$

3 Empirical Results

The model presented in the last section was estimated using the logarithm of the quarterly GDP of the Canadian regions covering the period 1966:1 until 2000:1. The regions analyzed are British Columbia, Maritimes, Ontario, Prairies and Quebec. The region labeled here as the Maritimes includes the provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland. On the other hand, the region noted as the Prairies is conformed by Alberta, Manitoba and Saskatchewan. As it is apparent, this region covers very different provincial economies. In my opinion, Alberta has a different dynamics than the other two provinces and consequently, I am considering another region, denoted as the Prairies-ex, which is conformed only by Manitoba and Saskatchewan. Hence, Alberta is also considered separately in the subsequent analysis[6]. Finally, for goals of comparison, I also include estimations using the logarithm of the quarterly GDP of Canada and the US.

The results of the estimations are presented in Table 1, where values in parenthesis indicate the standard errors[7]. There are some observations to point out. One important issue is concerned with the value of the sum of the autoregressive coefficients of the transitory component (ϕ_1 and ϕ_2). The highest value is 0.95 corresponding to Quebec. After that, we find Canada, the US and Ontario. On another and, Alberta, the Prairies and the Prairies-ex show lower levels of persistence (around 0.77) while the regions of the Maritimes and British Columbia present the smallest levels of persistence. In these cases, the results suggest that there is no subsequent effects on the series originated by the transitory shock.

Observing the roots associated with the AR(2) polynomial of the transitory component, only three territories present pseudo-cyclical behavior[8]. Such are the cases of the Maritimes, the Prairies and the Prairies-ex, which

[6] Of course, other opinions may suggest that Saskatchewan also constitutes a very different economic structure and it should be analyzed separately. While I accept some degree of arbitrariness in the decision to analyze separately the province of Alberta, my support is the fact that this province is essentially dedicated to the extraction of oil and gas while Saskatchewan is principally a region based on agriculture like Manitoba, even when this last province presents some more degree of diversification.

[7] All estimations have been performed using the Gauss code supplied by Kim and Nelson (1999a). Note that, unlike Kim and Nelson (1999b), no regularity conditions were violated regarding the estimates of the variances as mentioned in the note (b), Table 1 of Kim and Nelson (1999b).

[8] It is useful to remmber that complex roots may be represented by $a + bi$, where $i = \sqrt{-1}$. The modulus is then calculated as $r = \sqrt{a^2 + b^2}$ and the frequency ω is defined by $arccos(1/r)$. The period is then calculated as $2\pi/\omega$.

present periods of 5.6, 12.9 and 14.6 quarters, respectively.

Another important issue is related to the estimates of π, the coefficient associated with the discrete shock of the transitory component. According to the results, this coefficient is always significant with the only exception of the region labeled the Prairies-ex. Notice that the significance levels of this coefficient for the cases of Prairies and the US is borderline at the 10.0%. In all of these cases, this coefficient is negative suggesting widely support for the plucking model.

The transitory component is also subject to a symmetric continuous shock, denoted by u_t. It is interesting to note that the volatility of the transitory shocks in recession and normal times appears to be insignificant. The exceptions are the Prairies (recession times), Maritimes and Ontario (normal times). All this suggests that the discrete shock (π_{s_t}) explains most of the dynamics in the transitory component. In the other cases there exists some importance of the symmetric shock.

On another hand, the estimates of the variances associated to the level of the permanent component (σ_{v_0} and σ_{v_1}), are significant in most of territories. The exceptions are the Maritimes and Ontario for the estimate of σ_{v_1} and Canada for the estimate of σ_{v_0}.

The variance of the growth rate of the permanent component (σ_w^2) is not significant for the Maritimes and for the Prairies-ex although a rejection using a significance level of 10.0% is possible in the case of the estimate of the US. Then, it is concluded that the trend growth has been constant in these territories.

Summarizing, the estimates suggest that during normal times ($s_t = 0$), most of the regional economies are subject principally to permanent disturbances and they operate near the trend ceiling. In the other case, during recessions and the recovery periods that follow, the transitory component plays a principal role in regional output fluctuations. At the same time, given the magnitude of the sum of the autoregressive coefficients, when regional economies are near to the end of a period of recession, and there are no other negative shocks, the fast-decaying negative shocks give origin to a third phase, which Sichel (1994) named high-recovery phase.

Another conclusion is related to the territories of the Maritimes and the Prairies-ex which appear to be dominated by transitory shocks. In fact, the estimates related to the permanent components are not significant. In the case of Ontario presents a similar behavior although some estimates of the permanent component are significant. On another hand, unlike the behavior of the Prairies-ex, Alberta seems to be affected by long term effects and transitory shocks. It supports the argument that its dynamics is different from the other two provinces conforming the Prairies-ex. All other territories appear affected for both kind of shocks.

Figures 1 and 2 visually summarize the preceding discussions. Notice that all estimates presented in the graphs represent filtered estimates, that is, they are estimates based on information until time t. Figure 1 shows the evolution of the logarithm of the real GDP and its trend component for each region ($\tau_{t|t}$) while Figure 2 shows the estimates of the transitory components for each region ($c_{t|t}$).

Essentially, Figure 1 indicates that most of the time the regional economies are operating on or near the trend ceiling component. In periods of recession, the economy is operating below the trend ceiling component. Notice that there are some cases where the economy is notably below the ceiling component. Such are the cases of British Columbia (1980-1992), Alberta (1974-1989), Canada (1981-1984), the US (1971-1973, 1981-1983), Ontario (1989-1993), Quebec (1974-1979, 1981-1983, 1990-1993) and Prairies (1974-1978, 1981-1989). All these issues can be appreciated more clearly in Figure 2. It is possible to observe that after a through, the negative transitory shocks are deteriorating, restoring the economy back to the trend ceiling, or the normal level.

In conclusion, once a series of negative transitory shocks hit regional economies, it plucks output down, their effects decay relatively fast as implied by $\phi_1+\phi_2$, especially in the cases of the Maritimes and British Columbia. In other words, the negative shocks are relatively short-lived. Near the end of the recession, with no further new negative shocks, the fast decaying negative shocks give rise to a third, high recovery phase. Then by the time the effects of these negative shocks are all gone, the economies are again operating near the trend ceiling component. We have, in consequence, three distinctive phases of the business cycle fluctuations, as implied by Sichel (1994).

4 A Chronology of the Regional Business Cycles

Using estimate probabilities (p and q) it is possible to calculate the expected durations of a recession and of normal times defined by $1/(1-q)$ and $1/(1-p)$, respectively. The estimates suggest that the regions presenting higher expected durations of normal times are the Maritimes, Quebec, Alberta and the US. In the opposite case, that is the regions presenting higher values of the expected duration of a recession time, are the Prairies, the Maritimes and British Columbia. The other regions present expected duration values smaller than one year[9].

Figure 3 represents the probabilities of negative shocks to the transitory component ($Pr[s_t = 1|\Psi(.)]$). Using these probabilities, Table 2 presents a chronology of the Canadian regional business fluctuations. I consider the last quarter before a recession as a peak and the last quarter of a recession as a trough where a recession should last at least for two quarters. I use the practical rule proposed by Hamilton (1989), where a probability larger than 0.5 indicates (in this case) that there is a recession.

First of all, take into consideration the case of the US. It is clear that the model reproduces almost the same business cycles dates as found in Kim and Nelson (1999b). Of course, they are not directly comparable because of the different sample sizes and because the data is not the same. Notice that the current estimation reproduces the peaks and troughs obtained for the periods of 1971:2-1972:1, 1980:2-1980:4 and 1981:4-1983:4. The picture shows probabilities around 0.45 for 1991:1-1991:2 possibly related to the Gulf war and the corresponding oil price shock. Summarizing the US case, what pictures suggest is that the US economy has been working close to the ceiling output since 1985. This is consistent with the view that it represents the longest period of sustained expansion in the US economic history. As it is mentioned by Mills and Wang (2002), following Romer (1999), this issue is associated with the fact that authorities kept inflation under control.

For Canada, the model establishes the following periods of recession: 1974:4-1975:3, 1981:3-1983:1 and 1990:4-1991:2. Interestingly enough, recessions in Canada are not coincident with those experienced in the US but rather they always occur after a recession in the US. In fact, for example, the oil crisis appears to have affected the US economy immediately but Canada is not affected until some quarters after. However, note that the oil crisis is detected immediately in the province of Alberta. Similar observations are possible to be inferred from the recession that occurred in 1980:2-1980:4. The last two recession periods identified for Canada are normally found in other studies; see Bodman and Crosby (2000), Goodwin (1993) and Mills and Wang (2002). As it is known, in the 1980s Canada was affected by two shocks. The first shock was a shift in the international patterns; while the second shock was associated with the presence of labor rigidities coming from structural differences among the ten provinces.

It is very apparent from Table 2 that recession dates for Ontario and

[9] Notice that the estimate of the expected duration of a recession time for the US is extremely high. Although many different sets of starting values were tried, the estimates were always the same. On another hand, these results are not similar to those found in the other investigations and thus, they should be taken with caution.

Quebec are closely related. Compared to the aggregate (i.e., Canada), both regions show similar dates. The recession period of 1990:4-1991:2, detected for Canada, appears longer in Quebec and in Ontario. On the other hand, the recession period occurring during 1976:3-1978:2 appears to be also a recession only in Quebec. Overall, it is observed that the recession that arrived in 1981:3-1983:1 seems to be common to most of the regions with the only exception taking place in the region of the Prairies-ex.

Finally, I observe that the aggregate recession (1990:4-1991:2) is only observed in Ontario, Quebec, and the Prairies-ex. In the case of British Columbia it is possible to observe a frequent period of short recessions and normal times between 1983:3 and 1990:4, which may be associated to the movements in the price of gas.

5 Conclusions

The principal goal of this paper is to proportionate empirical evidence on regional business fluctuations using Canadian regional data. To do this, I used the econometric specification of the plucking model of Friedman (1964, 1993) proposed by Kim and Nelson (1999b). This model, after imposing an asymmetric discrete shock in the transitory component of the series, allows to estimate the permanent and the transitory components of the series.

While most of the business cycles research has been focused on the use of aggregate data at the international level, no study has been dedicated to the regional data. Given that Canada represents an interesting example of the density of regional economies, this paper represents a first attempt at identifying recessions at this level. Among the many reasons to justify the interest in regional business fluctuation, the variety and the different dynamics and possible answers to the presence of a shock are of most importance.

The results confirm the relevance of the plucking model using Canadian regional data. The estimates indicate the importance of the asymmetric discrete coefficient in most of these economies. Permanent and transitory components are identified and the evidence suggests that regional economies are working near the ceiling level until a shock is strikes the economy and this lowers the output. After that, recovery starts again until another shock appears. Different answers can be inferred when the probabilities of being in a recession have been calculated. There are some *"common"* periods of recession in the sense that they are observed at the aggregate level and also at the regional level. But there also exist *"regional"* recessions which are observed only at the regional level.

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Table 1. Estimates of the Plucking Model*

Parameters	British Columbia	Maritimes	Ontario	Prairies
q	0.9100	0.9386	0.6742	0.9784
	(0.0914)	(0.0772)	(0.1662)	(0.0188)
p	0.9591	0.9903	0.9646	0.9715
	(0.0232)	(0.010)	(0.0202)	(0.0353)
ϕ_1	-0.0043	0.5201	0.8665	1.7327
	(0.0513)	(0.2383)	(0.0981)	(0.0243)
ϕ_2	0.0018	-0.3517	0.0185	-0.9614
	(0.0137)	(0.1744)	(0.0874)	(0.0300)
σ_{u_0}	0.0000	0.0034	0.0000	0.0014
	(0.0000)	(0.0021)	(0.0000)	(0.0009)
σ_{u_1}	0.0000	0.0102	0.0076	0.0000
	(0.0011)	(0.0022)	(0.0022)	(0.0000)
σ_{v_0}	0.0087	0.0090	0.0077	0.0045
	(0.0009)	(0.0015)	(0.0006)	(0.0008)
σ_{v1}	0.0196	0.0000	0.0000	0.0120
	(0.0030)	(0.0009)	(0.0014)	(0.0009)
σ_w	0.0005	0.0006	0.0011	0.0006
	(0.0002)	(0.0004)	(0.0004)	(0.0003)
π	-0.0387	-0.0258	-0.0218	-0.0017
	(0.0063)	(0.0105)	(0.0035)	(0.0010)
Log Lik	392.7437	420.1951	440.6662	430.8740

* Standard errors in parenthesis.

Table 1 (continued). Estimates of the Plucking Model*

Parameters	Quebec	Alberta	Prairies-ex	Canada	United States
q	0.5334	0.6949	0.8391	0.6472	0.9933
	(0.0204)	(0.1720)	(0.0972)	(0.1563)	(0.0076)
p	0.9868	0.9844	0.9683	0.9495	0.9955
	(0.0118)	(0.0111)	(0.0234)	(0.0593)	(0.0073)
ϕ_1	1.5028	0.1923	1.7172	1.2990	1.3936
	(0.1061)	(0.1126)	(0.0505)	(0.2059)	(0.1786)
ϕ_2	-0.5494	0.5542	-0.8960	-0.3777	-0.4807
	(0.1046)	(0.1313)	(0.0569)	(0.2101)	(0.1669)
σ_{u_0}	0.0017	0.0000	0.0015	0.0048	0.0026
	(0.0016)	(0.0000)	(0.0017)	(0.0031)	(0.0010)
σ_{u_1}	0.0000	0.0000	0.0000	0.0000	0.0063
	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0023)
σ_{v_0}	0.0072	0.0119	0.0078	0.0025	0.0033
	(0.0006)	(0.0008)	(0.0007)	(0.0051)	(0.0008)
σ_{v1}	0.0019	0.0091	0.0238	0.0043	0.0073
	(0.0010)	(0.0029)	(0.0043)	(0.0013)	(0.0019)
σ_w	0.0006	0.0010	0.0005	0.0008	0.0005
	(0.0003)	(0.0005)	(0.0003)	(0.0004)	(0.0003)
π	-0.0178	-0.0408	-0.0034	-0.0108	-0.0071
	(0.0026)	(0.0055)	(0.0022)	(0.0037)	(0.0040)
Log Lik	461.9813	393.8828	416.9099	488.9813	475.4593

* Standard errors in parenthesis.

Table 2. Business Cycle Chronologies using the Plucking Model

British Columbia		Ontario		Prairies		Quebec	
Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
67:3	20:3	75:1	75:3	67:1	67:3	74:2	75:4
82:1	83:2	80:1	80:3	69:2	70:4	76:3	78:2
83:3	84:2	81:3	83:2	71:4	72:2	81:4	83:2
84:3	87:1	90:2	91:2	74:2	75:1	90:4	92:2
87:4	88:2	91:4	93:4	76:3	77:3		
88:3	90:4			81:3	83:3		
				83:4	84:2		
				86:2	87:1		

Table 2 (continuation) . Business Cycle Chronologies using the Plucking Model

Maritimes		Alberta		Prairies-ex		Canada		United States	
Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
67:1	69:3	71:4	72:2	66:3	68:1	74:4	75:3	71:2	72:1
70:4	71:2	74:2	75:1	69:2	69:4	81:3	83:1	80:2	80:4
80:2	81:1	76:2	84:4	70:1	70:3	90:4	91:2	81:4	83:4
81:2	82:2	85:2	85:4	71:1	71:3				
86:3	87:3	86:1	87:2	71:4	72:2				
		94:2	96:1	87:2	89:4				
				90:4	91:3				

Figure 1. Current Output and Trend Component

Figure 2. Regional Cycles

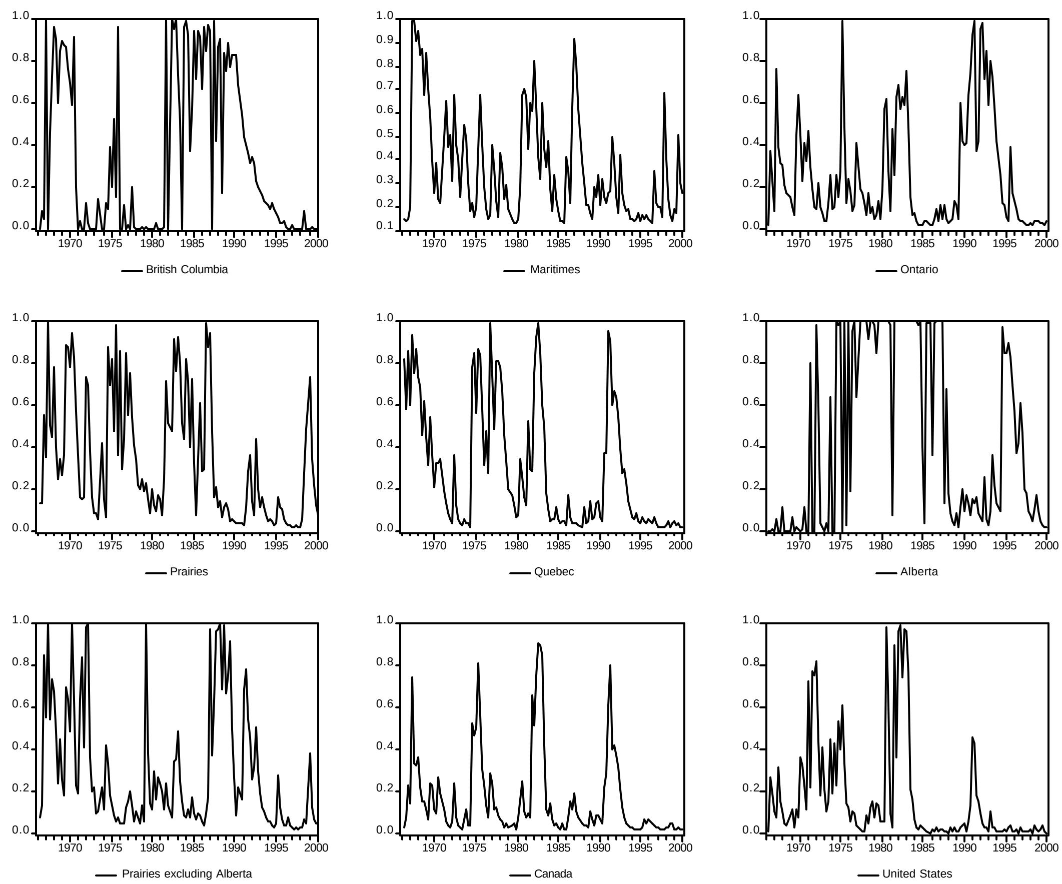

Figure 3. Probabilities to be in Recession Times ($s_t = 1$)