Determinants of Aggregate Employment in Canadian Provinces*

James A. Johnson
Department of Economics, Okanagan College
Kelowna, British Columbia V1Y 4X8

Ronald D. Kneebone
Department of Economics, University of Calgary
Calgary, Alberta T2N 1N4

In a study of unemployment rate movements in Canada, Beaudry (1976) concluded that significant regional differences exist in the intensity and time lag with which unemployment reacts to aggregate demand shocks. Thus, some regions of Canada are affected more severely by recessions than other regions. For policy makers interested in using policy-induced output shocks to affect the regional distribution of unemployment in Canada, it is important to have a quantitative measure of these regional differences.

Governments also attempt to influence unemployment rates with supply-side policies aimed at lowering the wage paid by firms (through wage subsidies and employment tax credits, for example) and with training programmes. The effectiveness of such policies depends critically on the magnitude of the wage elasticity of labour demand. Similarly, the effectiveness of policies designed to increase employment by reducing the cost of capital (reducing the corporate income tax rate and accelerating depreciation allowances are two examples) depends on the elasticity of employment with respect to the price of capital. Again, it is important that policy makers be aware of regional differences in the magnitudes of these employment elasticities.

This paper produces estimates of the input price and output elasticities of labour demand for each province. Knowledge of the

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magnitude of these elasticities is a critical first step in evaluating the effectiveness of provincial and regionally differentiated federal employment policies.

The Model

It is assumed that at the aggregate level firm behaviour can be reasonably described as consistent with cost minimization subject to factor prices and an output constraint. Thus, if gross output (Q) can be represented by the following production function:

$$Q = F(L,K,E,M) \tag{1}$$

where L denotes labour, K denotes capital, E represents energy, and M represents raw materials, the minimum achievable cost is given by:

$$C^* = \sum_i P_i X_i^* \qquad \text{with } i = K,L,E,M \tag{2}$$

where P_i is the price of the i^{th} factor and X_i^*, the cost-minimizing factor demand for the i^{th} factor, is a function of factor prices and gross output. Then differentiating C^* with respect to the factor prices (an application of Shephard's lemma) allows one to derive the four cost-minimizing factor demands X_i^*.

If a Cobb-Douglas production function is specified, the cost-minimizing labour demand is derived directly as:

$$X_L^* = \Theta_o + \Theta_Q Q + \sum_i \Theta_i P_i \qquad \text{with } i = K,L,E,M \tag{3}$$

where all variables are measured in logs.

According to equation (3), the equilibrium level of labour input X_L^*, denoted for short as L^*, is a function of output and factor prices and could be estimated directly under the assumption that full adjustment to the optimal level of labour is achieved within each period. But, if adjusting the level of employment is costly, a cost-minimizing firm may not find it optimal to adjust fully to the equilibrium level of employment within each period; see Nickell (1986) for a discussion. The relationship between the equilibrium level of employment and the actual level of employment in any period can be represented by the standard partial adjustment model. Given the theoretical static demand model in equation (3), the partial adjustment model introduces dynamics by assuming that the firm can acquire, in each period, only a fraction (δ) of the difference between the equilibrium level of labour (L_t^*) and the actual level in the preceding period (L_{t-1}):

$$L_t - L_{t-1} = \delta(L_t^* - L_{t-1}) \tag{4}$$

Substituting (4) into (3) yields:

$$L_t = \alpha + \beta_Q Q_t + \sum_i \beta_i P_{it} + \Phi L_{t-1} \qquad \text{with } i = K,L,E,M \tag{5}$$

where $\alpha = \delta\Theta_o$, $\beta_j = \delta\Theta_j$ for j = Q,K,L,E,M, and $\Phi = 1 - \delta$.

Because all variables are measured in logs, equation (5) could be estimated to give direct estimates of the one-period elasticities (β_j) and indirect estimates of the long-run or equilibrium elasticities (Θ_j) since

$$\Theta_j = \beta_j/\delta = \beta_j/(1-\Phi) \qquad \text{for } j = Q,K,L,E,M \tag{6}$$

If the error terms in equation (5) are serially correlated, OLS estimators will be biased and inconsistent because of the lagged dependent variable on the right-hand side. As a consequence, the first difference, $\Delta L_t = L_t - L_{t-1}$, instead of L_t (Hanseman 1986), should be used as the independent variable. Subtracting L_{t-1} from both sides, so that the left-hand side becomes a first difference, and adding a stochastic disturbance term (u_t) and a time trend (T) as a proxy for technical change yields the econometric estimating equation

$$\Delta L_t = \alpha + \beta_Q Q_t + \sum_i \beta_i P_{it} - \delta L_{t-1} + \tau T + u_t \qquad \text{with } i = Q,K,L,E,M \tag{7}$$

Estimation of the Model

Table 1 presents estimation results for equation (7) for all 10 provinces using annual data covering the period 1961-1985 (see the Appendix for data sources and precise operational definitions of input prices).[1] Zellner (SURE) estimation was used to produce these estimates because of the presumed contemporaneous correlation of disturbances across provinces. The degree of efficiency gained from the Zellner approach depends on the actual correlation between disturbances, which in this model is likely to be substantial. In addition, as Schulze (1987) pointed out, use of the Zellner approach allows for the appropriate test of provincial and regional homogeneity. But it provides consistent and efficient estimators only if the lagged dependent variable is uncorrelated with the error term in each equation. As Hanseman (1986) noted, because employment enters the left-hand side as a difference and the right-hand side as a level, the

[1] The limitations to that period were imposed by Statistics Canada's change of definitions regarding most of its industrial price indexes in 1986.

Table 1

ZELLNER (SURE) ESTIMATION

$$L_t - L_{t-1} = \alpha + \beta_Q Q_t + \sum_i \beta_i P_{it} - \delta L_{t-1} + \tau T + u_t$$

Province	β_Q	β_K	β_L	β_E	β_M	δ	τ
Newfoundland	0.1481	0.0100	-0.0976	-0.0247	0.1978**	0.6230**	0.0078**
	(0.0952)	(0.0094)	(0.0855)	(0.0307)	(0.0513)	(0.0774)	(0.0026)
P.E.I.	0.1325	-0.0169	-0.0801	0.1668*	0.2145*	1.0381**	0.0113*
	(0.0964)	(0.0089)	(0.0870)	(0.0584)	(0.0825)	(0.1574)	(0.0048)
Nova Scotia	0.2762**	-0.0002	-0.2631**	0.0009	0.1972**	0.6730**	0.0057
	(0.0780)	(0.0052)	(0.0883)	(0.0234)	(0.0382)	(0.1037)	(0.0040)
New Brunswick	0.0969	0.0120	-0.1257	0.0013	0.2040**	0.7789**	0.0117**
	(0.0527)	(0.0093)	(0.0752)	(0.0219)	(0.0485)	(0.1256)	(0.0032)
Quebec	0.5014**	0.0120	-0.5826**	-0.0921**	0.0466	0.8001**	0.0089**
	(0.0764)	(0.0062)	(0.0870)	(0.0276)	(0.0266)	(0.0752)	(0.0021)
Ontario	0.3909**	0.0104*	-0.2608**	0.0161	0.0512*	0.7599**	0.0083**
	(0.0371)	(0.0043)	(0.0505)	(0.0136)	(0.0190)	(0.0703)	(0.0021)
Manitoba	0.1917**	0.0070*	-0.0899*	0.0309**	0.0996**	1.0967**	0.0120**
	(0.0332)	(0.0033)	(0.0328)	(0.0080)	(0.0187)	(0.0700)	(0.0012)
Saskatchewan	0.0360	0.0382*	0.0554	0.0531	0.0119	0.2342	-0.0007
	(0.0417)	(0.0123)	(0.1109)	(0.0437)	(0.0533)	(0.1316)	(0.0039)
Alberta	0.1567**	0.0243**	-0.0211	0.0265	0.0515	0.2493**	-0.0028
	(0.0536)	(0.0078)	(0.0649)	(0.0204)	(0.0579)	(0.0731)	(0.0033)
British Columbia	0.3658**	0.0126**	-0.1522	-0.0188	0.0114	0.5830**	0.0034
	(0.0642)	(0.0035)	(0.0734)	(0.0231)	(0.0394)	(0.0578)	(0.0025)

Note: The figures in parentheses are standard errors. Starred coefficients are significantly different from zero at the 5 per cent (*) or 1 per cent level (**).

correlation between the lagged variable and the error term is lessened. This was confirmed here by estimating each equation individually with OLS and computing the Durbin (1970) m-statistic (see Appendix Table A-1).[2] In no province were we able to reject the null hypothesis of zero first-order autocorrelation.

The coefficients of the input price and output variables shown in Table 1 are one-year elasticities associated with these variables and, using the relation defined in equation (6), lead to indirect point estimates of the corresponding long-run elasticities (see Appendix Table A-2). Consistent estimators of the long-run elasticities, however, can be obtained directly from an equation derived by adding

[2]One benefit of estimating equation (7) with OLS is that it provides a meaningful measure of goodness of fit in each province. This would not be true of equation (5), since regressing a time-series on its own lagged values and a time trend tends to artificially inflate the R^2-statistic (see, for example, Nelson and Kang 1984).

Table 2

3SLS ESTIMATION

$$L_t = \Theta_o + \Theta_Q Q_t + \sum_i \Theta_i P_{it} - [(1-\delta)/\delta\Delta]\, \Delta L_t + (\tau/\delta)T + v_t$$

Province	Θ_Q	Θ_K	Θ_L	Θ_E	Θ_M	$(1-\delta)/\delta$	τ/δ
Newfoundland	0.2038*	0.0222*	-0.1218	0.0424	0.3189**	0.6454**	0.0132**
	(0.0902)	(0.0101)	(0.0847)	(0.0291)	(0.0575)	(0.1325)	(0.0028)
P.E.I.	0.1272	-0.0164	-0.0749	0.1615**	0.2145*	0.0408	0.0109*
	(0.0993)	(0.0097)	(0.0898)	(0.0500)	(0.0737)	(0.1684)	(0.0043)
Nova Scotia	0.4689**	0.0009	-0.4634**	0.0049	0.3194**	0.5945**	0.0072
	(0.1158)	(0.0052)	(0.1275)	(0.0238)	(0.0561)	(0.1886)	(0.0036)
New Brunswick	0.1311*	0.0136	-0.1680	0.0054	0.2608**	0.2939	0.0147**
	(0.0618)	(0.0095)	(0.0840)	(0.0221)	(0.0410)	(0.1669)	(0.0021)
Quebec	0.6522**	0.0159**	-0.7512**	-0.1099**	0.0523	0.2352*	0.0105**
	(0.0662)	(0.0054)	(0.0838)	(0.0272)	(0.0271)	(0.0884)	(0.0019)
Ontario	0.4986**	0.0143**	-0.3245**	0.0208	0.0702**	0.2942**	0.0112**
	(0.0499)	(0.0038)	(0.0592)	(0.0140)	(0.0166)	(0.0861)	(0.0014)
Manitoba	0.1701**	0.0063	-0.0775*	0.0274**	0.0921**	0.0902	0.0111**
	(0.0344)	(0.0032)	(0.0331)	(0.0076)	(0.0177)	(0.0653)	(0.0009)
Saskatchewan	0.2716**	0.0920**	0.0626	0.1877**	-0.0626	2.0924**	-0.0007
	(0.0398)	(0.0135)	(0.1112)	(0.0420)	(0.0510)	(0.3596)	(0.0039)
Alberta	0.6057**	0.0918**	-0.0694	0.1443**	0.2507**	3.1458**	-0.0103*
	(0.0405)	(0.0086)	(0.0632)	(0.0263)	(0.0704)	(0.3064)	(0.0036)
British Columbia	0.6621**	0.0218**	-0.2871**	-0.0276	0.0013	0.6765**	0.0046
	(0.0616)	(0.0036)	(0.0757)	(0.0230)	(0.0391)	(0.0872)	(0.0025)

Note: The figures in parentheses are standard errors. Starred coefficients are significantly different from zero at the 5 per cent (*) or 1 per cent level (**).

a time trend (T) and stochastic error term (v_t) to equation (5) and subtracting $(1-\delta)L_t$ from both sides:

$$L_t = \Theta_o + \Theta_Q Q_t + \sum_i \Theta_i P_{it} - [(1-\delta)/\delta]\Delta L_t + (\tau/\delta)T + v_t \quad \text{with } i = Q,K,L,E,M \qquad (8)$$

where $v_t = u_t/\delta$. With this approach, the coefficients on output and factor prices are direct point estimates of the long-run elasticities. Because ΔL_t is correlated with v_t, Zellner's SURE estimators are inconsistent here. Consequently, the predicted values of ΔL_t were used as instruments in a 3SLS estimation of equation (8). The resulting estimates are presented in Table 2.

The Results

As Wickens and Breusch (1988) pointed out, a comparison of the point estimates of long-run elasticities obtained from the direct and indirect estimators can be regarded as an informal test of the dynamic specification of the model. In an adequately specified dynamic model, the two approaches should yield similar point estimates. In this case, in every province except Saskatchewan the two approaches yield estimates that are very close in absolute value. Of the 45 elasticities reported in Appendix Table A-2 (excluding Saskatchewan), all but one are within a 0.7 standard error of the relevant point estimate in Table 2, and most are within a 0.2 standard error. The one exception is Alberta, where the indirect point estimate of the energy price elasticity is 0.1063—that is, a 1.44 standard error less than the direct point estimate of 0.1443. In the case of Saskatchewan, in addition to quite dissimilar estimates for all five elasticities, a considerably worse "fit" was obtained as can be seen from the R^2-statistics relating to the single-equation OLS estimation reported in Appendix Table A-1. This suggests that the one-period results for Saskatchewan should be regarded with some skepticism.

With the exception of Saskatchewan, however, on the basis of this informal test of dynamic specification and the traditional criteria of goodness of fit, statistical significance, and theoretical plausibility, the results presented in Tables 1 and 2 must be regarded as quite good. For example, the size and statistical significance of the output elasticity should reflect, at least in part, the degree to which industry in a particular province is demand-constrained; this in turn reflects the degree of competition. Thus, one should expect a higher output elasticity in Ontario and Quebec, where manufacturing employment is a far larger fraction of total provincial employment, than in Saskatchewan, Alberta, and Prince Edward Island, where more competitive resource-based industries predominate.[3] Our estimates are consistent with this expectation. Further, the fact that the output elasticity of employment is highest in Quebec conforms to the oft-cited observation that the unemployment rate in Quebec tends to diverge from the unemployment rates in other provinces during recessions.[4]

[3]Using 1986 data, employment in manufacturing as a percentage of total employment is 19 per cent and 16 per cent in Ontario and Quebec respectively, but only 4 per cent, 6 per cent, and 6 per cent in Saskatchewan, Alberta, and Prince Edward Island, respectively.

[4]For a discussion of this "widening hypothesis", see Raynauld (1987). The relative size of output elasticities of labour demand does not, of course, necessarily imply that Quebec's unemployment rate will diverge from the national average during a recession. Given the result that employment is also sensitive to input prices, one must also consider how the recession influences input prices and compare how employment (and the supply of labour) responds to these changes across provinces.

If the underlying aggregate production function is homothetic, then the inverse of the long-run output elasticity provides a measure of returns to scale. Rao (1981) tested for, and firmly rejected, the assumption of homotheticity for all Canadian manufacturing industries. Woodland (1975) also found non-homothetic production functions in all Canadian industries except finance. Thus, this interpretation of the output elasticity does not appear warranted. Our results tend to confirm this finding, as the inverse of long-run output elasticities do not yield reasonable estimates of returns to scale.

The result that employment is generally highly inelastic with respect to the real wage is consistent with the results for Canadian industry found by Rao (1981) and Woodland (1975). The interprovincial variation in this elasticity also conforms generally to prior expectations. The elasticity is insignificant in those provinces where agriculture is a relatively large source of employment—in Prince Edward Island and Saskatchewan, for example, where over 50 per cent of employment is in agriculture versus only 26 per cent in Ontario. Thus, much employment in agriculture is self-employment, which is not strongly sensitive to wage changes. An interesting result is the much higher wage elasticity for Quebec than for Ontario despite the general similarity in the distribution of total employment across different industries. According to 1986 data, 19 per cent of employed workers in Ontario were in manufacturing (versus 16 per cent in Quebec), 26 per cent in agriculture (versus 30 per cent in Quebec), 49 per cent in service industries (versus 49 per cent in Quebec), and the remaining 5-6 per cent in mining, forestry, and construction. Despite these similarities, there are some important differences in the two labour markets. Fortin (1980) noted that in Ontario, businesses invest more in employee training than they do in Quebec, so that Ontario has a relatively more skilled work force. Our result, then, is consistent with a generally found empirical result that the elasticity of employment with respect to wages tends to be greater for unskilled than skilled workers (for examples, see Hamermesh and Grant 1979). It is doubtful, however, that this explains the large difference in the two elasticities. Fortin (1980) also presented evidence that suggested that the many public works projects undertaken in Quebec during the late 1960s to the mid-1970s (Mirabel airport, the James Bay hydroelectric project, the Olympics) drove up wages relative to those in Ontario and produced a legacy of higher wages felt long after the completion of these projects. In part then, the relatively high wage elasticity in Quebec may reflect the relatively non-competitive wage structure in that province.

Many of the cross price elasticities are significantly different from zero, indicating that the input mix is sensitive to changes in relative input prices. This, and the fact that these elasticities are generally small, agree with the industry results of Rao and Preston (1984) and Woodland (1975). The signs of these coefficients are generally the same across provinces, with raw materials, capital, and energy mainly found to be substitutes for labour. There are some exceptions, however. For example, energy is a complement to labour in Quebec, possibly reflecting the location in that province of labour-intensive, energy-reliant industries such as textiles.

The speed-of-adjustment coefficient (δ) is significantly less than unity in every province except Prince Edward Island, New Brunswick, and Manitoba. Thus, in every province except these three the hypothesis that full adjustment takes place within one year is rejected by the data. In addition, differences among provinces in the size of this coefficient suggest that the time lags determining when demand shocks are felt differ among provinces. This result is reflected in a comparison of the one-period elasticities in Table 1 to the long-run elasticities in Table 2. For example, while the long-run output elasticities are very similar for Quebec, Alberta, and British Columbia, Quebec's one-period output elasticity is noticeably higher than that of British Columbia and twice that of Alberta.

The linear time trend is included in the regressions as a substitute for an index of technology, and it represents the behaviour of employment per unit of output over time, after accounting for the influence of output and input prices. Woodland's (1975) study of Canadian industry found significantly negative time trends for the agriculture, forestry, and transportation sectors, significantly positive time trends in the finance and services sectors, and insignificant time trends in the other sectors. Because the service industry accounts for approximately 50 per cent of total employment in all provinces except Prince Edward Island (where it accounts for 37 per cent), a positive time trend for aggregated data was to be expected. Our finding of a significantly positive time trend in six of the ten provinces is generally consistent with that expectation.

Implications of the Results

To investigate the homogeneity of provincial labour markets, we tested the null hypothesis of equal elasticities across provinces for each of the five one-period elasticities and the corresponding five long-run elasticities. The relevant Wald chi-square test statistics are

presented in the first column of Table 3. Not surprisingly, in every case the null hypothesis is rejected by the data. Thus, exogenous shocks and nationally applied employment policies can be expected to have significantly different effects on employment across provinces.

Table 3

WALD CHI-SQUARE STATISTICS FOR THE NULL HYPOTHESIS OF EQUAL ELASTICITIES WITHIN REGIONS

	Canada	Atlantic Region	Prairie Region
Short Run			
β_Q	69.50^b	4.99	8.75^a
β_K	30.00^b	6.60	11.67^b
β_L	57.99^b	3.05	3.01
β_E	41.88^b	8.78^a	0.30
β_M	47.18^b	0.05	4.12
Long Run			
Θ_Q	123.54^b	8.57^a	72.74^b
Θ_K	195.60^b	8.56^a	154.29^b
Θ_L	93.01^b	7.26	1.60
Θ_E	113.02^b	12.41^b	35.43^b
Θ_M	94.72^b	2.66	12.19^b

[a]Reject at $\alpha = 0.05$.
[b]Reject at $\alpha = 0.01$.

We also tested whether the practice of using the five traditional regions—and thus implicitly treating them as homogeneous—is reasonable when discussing employment policies. The results of testing the null hypothesis of equal elasticities within regions are presented in the second and third columns of Table 3. Somewhat surprisingly, the hypothesis that wage elasticities are identical for every province within either the Atlantic Region or the Prairie Region cannot be rejected, and this is true of both one-period and long-run elasticities. In fact, within the Atlantic Region the only one-period elasticity that shows significant provincial variation is the energy price elasticity, reflecting the much higher point estimate for Prince Edward Island than for the other three Atlantic provinces. Less evidence of homogeneity is exhibited in the long run where three of the five elasticities show significant provincial variation. The Prairie Region exhibits less evidence of homogeneity than does the Atlantic Region, although in the case of three one-period and one long-run elasticities, the null hypothesis cannot be rejected. These results suggest that for some employment policies it makes sense to treat the Canadian labour market as diverse regionally but as homogeneous within regions. This would seem to be the case for policies directed toward altering the real wage. For other policies designed to affect other input prices, this treatment is clearly not appropriate.

The elasticity estimates presented in Tables 1 and 2 suggest some interesting interprovincial comparisons and some important policy implications. A *ceteris paribus* output shock, for example, will have, according to our results, a much larger effect on employment in some provinces than in others; however, the ranking of which provinces are most affected by such a shock changes over time because of differences in the speed of adjustment. Thus, although after one year employment in Ontario would be slightly more responsive to an output shock than employment in British Columbia, after three years the response in British Columbia would be 15 per cent greater and after five years 20 per cent greater than the response in Ontario. Quebec would be hard hit by such an output shock, since not only would its long-run response be large, but 80 per cent of that response would be felt in the first year, making Quebec's one-year response the largest of any province. By contrast, Alberta would show a small (but significant) response after one year and a slow speed of adjustment. For Alberta then, only the most prolonged output contraction would affect employment significantly, whereas for Quebec the response would be large even for the most short-lived output shock. An interesting implication of these differences in output elasticities is that employment in Quebec would therefore be the major beneficiary of federal stabilization policies undertaken during periods of excess capacity (when input prices would not be greatly affected).

Similar differences exist in the response of provincial employment to input price shocks, and these too have some interesting policy implications. For example, the larger the wage elasticity, the more effective would be wage subsidy schemes and government job training programmes aimed at increasing employment. Once again, the results suggest that Quebec would be the biggest beneficiary of any such nation-wide employment policy both after one year and in the long run, with Nova Scotia and Ontario the second most strongly affected provinces in both periods. This is, in part, an attractive result for policy makers because Quebec and Nova Scotia's unemployment rates historically have been higher than the national average. It is also true, however, that Ontario would benefit equally with these provinces and that many historically high-unemployment provinces (Newfoundland, New Brunswick, Prince Edward Island, and British Columbia), which have relatively low wage elasticities, would be relatively unaffected by such employment policies.

Indeed, for all provinces except Quebec the highly inelastic demand for labour means that a very large wage reduction would be

necessary to reduce unemployment significantly within one year. This suggests that, in general, wage subsidy schemes are not likely to be very effective.

Efforts to reduce unemployment using investment tax credits or accelerated depreciation allowances (both of which reduce the cost of capital) would seem to be a potentially effective policy in all provinces, since the cross price elasticity is either insignificantly different from zero or, when it is significantly positive, very small in value. Thus, reducing the cost of capital would appear to cause little substitution away from labour, implying that the effect of such a policy on employment would be felt almost exclusively by capital acquisitions and output.

Conclusion

This paper has demonstrated that the demand for labour is significantly sensitive to variations in input prices and output and that this sensitivity differs significantly across provinces. These results have important implications for the success of employment policies in general and regionally targeted employment policies in particular.

This study is one of the very few of labour demand at the provincial level. This scarcity of studies is curious, since the regional distribution of the impact of a nationally applied employment policy (or other type of shock) appears to be an important question in a country often concerned about regional disparities. Furthermore, the provincial governments in Canada control a very large portion of the total government budget and thus have the potential to influence employment within their own jurisdiction. Whether they can in fact do so depends not only on the magnitude of interprovincial "leakages"—a question that has received considerable attention (see, for example, Miller and Wallace 1983)—but also on whether changes in provincial aggregate supply and demand have a large or small effect on provincial employment. The results in this paper suggest that even if aggregate supply and demand were affected equally in all provinces, employment would change much more in some provinces than in others. Estimates of the effect of policy on provincial output—even adjusted to account for interprovincial leakages—do not in and of themselves provide conclusive evidence of the effect of policy on provincial employment. Needed as well are measures of interprovincial differences in the sensitivity of aggregate employment to changes in the determinants of labour demand. This study is an effort to provide such measures. Moreover, it has demonstrated significant interprovincial variation in the degree of employment sensitivity.

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Appendix: Data Construction and Sources

Q — Gross output, defined as provincial gross domestic product. Taken from: Statistics Canada, *Provincial Income and Expenditure Accounts, 1961-86*, Cat. No. 13-213S.

L — Total employment by province. Taken from: Statistics Canada, *The Labour Force*, Cat. No. 71-001.

P_L — Price of labour by province, defined as average weekly wages and salaries of all employees. Taken from: Statistics Canada, *Employment, Earnings and Hours*, Cat. No. 72-002.

P_L — Price of energy by province, proxied by the price of electricity rather than by the price of fossil fuels because the latter might better be regarded as an output price for some provinces with large fossil fuel industries (such as Alberta). In any case, when we estimated the model using the price of fossil fuels instead of electricity, there was very little effect on the estimated parameters. Taken from: Statistics Canada, *Industry Price Indexes*, Cat. No. 62-011.

P_M — Price of raw material, constructed from price indexes in *Industry Price Indexes*, Cat. No. 62-011. Although Statistics Canada provides no consistent time-series on raw material prices for the whole of the estimation period, it defines the weights it attaches to various types of industrial inputs when constructing its raw materials price index (this index begins only in 1977). This same weighting scheme is employed here in the construction of a consistent series, using price indexes of industrial outputs that are as unprocessed as possible and that correspond as closely as possible to the types of inputs listed by Statistics Canada as entering their raw materials price index. The price index is a weighted average of eight industry price indexes and, when compared to the Statistics Canada index for the years 1977-1985, performs well in picking up all the turning points in the nominal price of raw materials.

P_K — Price of capital, constructed using the standard Jorgenson-type approach. The basic formula for the nominal cost of capital (C_{Ki}) in province i is:

$$C_{Ki} = q_i[r_i + \delta_i - (q/p)_i](1 - \Phi_i)(1 - u_iZ_i)[1/(1 - u_i)]$$

where: $q_i = (ME_i PME + NRC_i PNRC)/(ME_i + NRC_i)$

$r_i = \beta[MYW(1 - u_i)] + (1 - \beta)\tau - \pi$

$\delta_i = [(.13)(ME_i) + (.07)(NCR_i)]/(ME_i + NRC_i)$

ME_i, NRC_i Total business investment in machinery and equipment and in non-residential construction, respectively. Taken from: *Provincial Income and Expenditure Accounts*, Cat. No. 13-213S.

PME, PNRC National implicit price indexes for ME and NRC, respectively. Thus, qi is a weighted average of the price index for machinery and equipment and non-residential construction, where the weights vary from province to province, depending on the province's investment mix in a given year. Taken from: *Industry Price Indexes*, Cat. No. 62-011.

β Ratio of debt to total financing. Following Clark and Freeman (1980), β was set equal to 0.55.

MYW McLeod, Young and Weir 10 industrial corporate bond price index.

u_i Corporate income tax rate (federal and provincial) in province i. Taken from: Statistics Canada, *Corporation Taxation Statistics*, Cat. No. 61-208.

τ Equity financing cost, which was assumed to be equal to the interest rate on safe assets (the treasury bill rate) plus a risk premium. The risk premium was set at 7 per cent (see Boadway et al. 1987).

π_i Expected inflation rate in province i, calculated as the five-year ARMA (1,1) forecast of provincial inflation rates.

Φ_i Investment tax credit, set at 20 per cent for the Atlantic provinces and 7 per cent for all the other provinces.

δ_i Weighted average of depreciation rates for machinery and equipment and for non-residential construction. Following Clark and Freeman (1980), Field and Grebenstein (1980), and others, these were set at 13 per cent and 7 per cent, respectively.

Z_i Current value of the capital cost allowance (CCA) in province i. It depends on the CCA rate for the relevant class of capital, the tax depreciation scheme used during a particular year (declining balance or straight-line

accelerated depreciation), and the province's investment mix. The weighting schemes and the depreciation formulae used are available from the authors on request.

All of the Statistics Canada and constructed input price indexes and gross output figures are nominal values. These values should have been deflated by the product price, but wholesale price indexes were not available at the provincial level. As a proxy, therefore, they were deflated using the Consumer Price Index, which is available from: Statistics Canada, *Prices and Price Indexes*, Cat. No. 62-002, and *Consumer Prices and Price Indexes*, Cat. No. 62-010, for major cities. In provinces where only one city index is published, it constitutes the provincial deflator. In those provinces where more than one city index is published, a weighted average (by population) of the city indexes is used to generate the provincial deflator.

Table A-1—SINGLE EQUATION OLS ESTIMATION

$$L_t - L_{t-1} = \alpha + \beta_Q Q_t + \sum_i \beta_i P_{it} - \delta L_{t-1} + \tau T + u_t$$

Province	β_Q	β_K	β_L	β_E	β_M	δ	τ	R^2	Durbin m-stat
Nfld.	0.0862 (0.1843)	0.0189 (0.0193)	-0.0376 (0.1504)	-0.0275 (0.0627)	0.1877** (0.0725)	0.5841** (0.1460)	0.0083 (0.0054)	0.6989	1.06
P.E.I.	0.1288 (0.1691)	-0.0106 (0.0150)	-0.1278 (0.1384)	0.1293 (0.0950)	0.2200 (0.1116)	0.9347** (0.2700)	0.0111 (0.0080)	0.5735	-1.28
Nova Scotia	0.3241* (0.1227)	0.0019 (0.0086)	-0.3368* (0.1309)	0.0067 (0.0377)	0.2055** (0.0515)	0.5500** (0.1639)	0.0025 (0.0064)	0.7274	-0.33
N.B.	0.1163 (0.0926)	0.0054 (0.0148)	-0.1441 (0.1125)	0.0141 (0.0324)	0.1934* (0.0676)	0.7524** (0.2117)	0.0105 (0.0054)	0.6003	-0.73
Quebec	0.6414** (0.1422)	0.0166 (0.0128)	-0.7168** (0.1500)	-0.0758 (0.0552)	0.0242 (0.0362)	0.8501** (0.1382)	0.0040 (0.0040)	0.8226	-0.93
Ontario	0.3660** (0.0848)	0.0132 (0.0069)	-0.2165** (0.0723)	0.0161 (0.0211)	0.0645* (0.0261)	0.8162** (0.1086)	0.0101** (0.0032)	0.8916	-0.62
Manitoba	0.2395** (0.0536)	0.0087 (0.0055)	-0.1373* (0.0500)	0.0387* (0.0144)	0.0832** (0.0257)	1.0719** (0.1325)	0.0106** (0.0021)	0.8392	-0.79
Sask.	0.1126 (0.0829)	0.0257 (0.0216)	0.0035 (0.1740)	0.0644 (0.0884)	-0.0356 (0.0794)	0.3660 (0.2550)	-0.00002 (0.0063)	0.2615	-1.89
Alberta	0.1427 (0.0899)	0.0215 (0.0128)	-0.0153 (0.0922)	0.0374 (0.0347)	0.0633 (0.0889)	0.2387* (0.1128)	-0.0024 (0.0052)	0.7877	-0.85
B.C.	0.4380** (0.1391)	0.0136 (0.0075)	-0.1994 (0.1431)	-0.0130 (0.0479)	-0.0150 (0.0709)	0.6164** (0.0992)	0.0018 (0.0051)	0.8667	-0.03

Note: The figures in parentheses are standard errors. Starred coefficients are significantly different from zero at the 5 per cent (*) or 1 per cent level (**). The Durbin m-statistic has a t distribution under the null hypothesis of no first-order autocorrelation. For no province could the null be rejected at $\alpha = 0.05$.

Table A-2—INDIRECT ESTIMATES OF LONG-RUN ELASTICITIES

Province	Θ_Q	Θ_K	Θ_L	Θ_E	Θ_M
Nfld.	0.2377	0.0161	-0.1566	-0.0396	0.3175
P.E.I.	0.1276	-0.0163	-0.0772	0.1607	0.2066
Nova Scotia	0.4104	-0.0003	-0.3909	0.0013	0.2930
N.B.	0.1244	0.0154	-0.1614	0.0017	0.2619
Quebec	0.6267	0.0150	-0.7282	-0.1151	0.0582
Ontario	0.5144	0.0137	-0.3432	0.0212	0.0674
Manitoba	0.1748	0.0064	-0.0820	0.0282	0.0908
Sask.	0.1537	0.1631	0.2366	0.2267	0.0508
Alberta	0.6286	0.0975	-0.0846	0.1063	0.2066
B.C.	0.6274	0.0216	-0.2611	-0.0322	0.0196

Note: These indirect estimates of long run elasticities were obtained by dividing the estimated one-period elasticities reported in Table 1 by the estimated speed-of-adjustment coefficient reported in Table 1.