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Can a Matching Model Explain the Long-Run Increase in Canada's Unemployment Rate?

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Abstract

We construct a simple general equilibrium model of unemployment and calibrate it to the Canadian economy. Job creation and destruction are endogenous. In this model, we consider several potential factors that could contribute to the long-run increase in the Canadian unempoloyment rate: a more generous unemployment insurance system, higher layoff costs, higher discretionary taxes, and a slower rate of productivity growth. We find that in the model economy the impact of all of these factors on the unemployment rate is small.

Résumé

Les auteurs construisent un modèle simple d'équilibre général du chômage qu'ils étalonnent en fonction de l'économie canadienne et dans lequel la création et la suppression d'emplois sont des phénomènes endogènes. Ils examinent plusieurs facteurs susceptibles d'entraîner à long terme une hausse du taux de chômage au Canada : un régime d'assurance-chômage plus généreux, des coûts de licenciement plus élevés, de plus fortes distorsions fiscales et une croissance plus faible de la productivité. D'après le modèle qu'ils utilisent, l'incidence de tous ces facteurs sur le taux de chômage serait faible.

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1 Introduction

The average unemployment rate in Canada has increased substantially in the late 1970s and 1980s, see Figure 1. This increase has been attributed to a variety of factors, the most prominent among them being a more generous unemployment insurance (UI) system. In this paper we try to quantify the contribution of observed changes in the UI system to the increased unemployment rate using a calibrated general equilibrium model of the Canadian economy. We also consider alternative explanations for the higher unemployment rate and thereby evaluate the relative importance of changes in the UI system. In particular we study the role of layoff costs and distortionary taxes, and to put the effects of policy variables in perspective, we study the effects of the slowdown in total factor productivity (TFP) growth.

The Canadian UI program was substantially revised in 1971/1972, and this revision made the UI program more generous in terms of coverage, eligibility and benefits. In 1978/1979 the coverage was reduced and the qualifying requirements were raised. Amendments to the UI system in 1990, 1993 and 1994 have further reduced the generosity of the UI system.[1] We use a summary statistic which reflects the changes in UI generosity along these various dimensions. For this purpose we define the replacement rate as the expected value of unemployment benefits to an unemployed worker, based on the legislated replacement rate, the maximum duration of benefits for a

[1] See HRDC (1995) for a review of the history of the Canadian UI system.

minimally qualified claimant and the coverage rate.[2] Figure 2 documents the substantial changes in the replacement rate during the postwar period.

In 1955 the replacement rate was about 20 percent, and it remained at roughly the same level until the 1971/1972 UI reform. The replacement rate then jumped to 53% in 1972 and declined in 1978/1979 following the restrictions on the UI system. Since the 1980s the average replacement ratio has remained at about 40%, twice its value in the 1950s and 1960s. The replacement rate has increased mainly because UI benefits can be claimed for a longer time period and more unemployed are eligible for UI benefits.

In order to evaluate the relative importance of changes in the UI system, we also study how other policy variables have changed and what the quantitative impact of these changes have been. In particular, we study the effects of layoff costs and other distortionary taxes. To get some perspective on the quantitative importance of changes in these policy variables, we also study the effects of changes in productivity growth rates.

During the time that the UI system has become more generous, changes in labour laws have also increased job protection for workers (Kuhn 1993). This job protection usually takes the form of a mandatory notice requirement or severance pay regulation in lieu, both of which can be interpreted as a layoff tax. Economic theory does not predict unambiguously how such a tax will affect employment. On the one hand, the tax raises the long-run

[2] See Section 3 for a more detailed discussion of our replacement rate. Sargent (1995) reviews other existing measures of UI generosity.

cost of employment, and therefore reduces the number of new hires. On the other hand, a firm will lay off fewer workers because layoffs are more costly. The empirical evidence on layoff costs is also mixed. Lazear (1990) finds that higher severance payments reduce employment in a sample of OECD countries. Jones and Kuhn (1995) find that workers, who receive advance notice, experience somewhat shorter unemployment spells in Canada.

In addition to the UI system and job protection laws, there are other distortionary taxes which potentially affect unemployment and which have increased or decreased over time. For example, Beach and Balfour (1983) and Parker (1995) argue that higher payroll taxes reduce employment in the long run. Figure 3 shows that from the 50s to the 80s the labour income tax rate and the payroll tax rate have both increased, whereas the capital income tax rate has either decreased or remained constant.[3]

Government policy changes, like the UI reforms in the 1970s, may be important for the labour market. During the same time, however, we observe an event of equal or potentially greater importance for the labour market: the productivity growth slowdown. In the mid 1970s TFP growth declined drastically, and growth rates never really recovered to their values in the 1950s and 1960s, see Figure 4. This observation applies to almost all industrialized countries, and almost all of these countries have experienced higher unemployment rates since the mid 1970s. We would like to evaluate the rel-

[3] These tax rates are calculated using the procedure suggested by Mendoza et al. (1994). For a detailed explanation see Appendix D.

ative importance of changes in government policy as compared to changes in productivity growth.

In this paper, we employ a simple calibrated general equilibrium model to quantify the effects of changes in the above mentioned variables on the unemployment rate. Unemployment originates from frictions in the labour market, and the allocation of labour proceeds through a time-consuming matching process, see Mortensen and Pissarides (1994). This matching-type environment is embedded into a standard neoclassical growth model. The model that we present is based on work by Andolfatto (1996), Merz (1995), and Shi and Wen (1994). We extend their work along the lines of Mortensen and Pissarides (1994) and assume that worker-job matches can differ with respect to their productivity. In this environment, worker-job matches are endogenously terminated because their productivity is too low, and we can study the effects of layoff costs on (un)employment. We study the balanced growth path of the economy when there is exogenous labour-augmenting technical change.

Our main findings from the quantitative analysis of the model's balanced growth path are as follows. First, changes in the UI system which double the replacement rate index can explain only a small part of the rise in unemployment. Second, higher layoff costs increase employment and decrease unemployment. This occurs because higher layoff costs reduce job destruction more than they reduce job creation. Since job creation results in high-productivity jobs and job destruction eliminates low-productivity jobs, the higher employment level is associated with a relative increase in low-productivity jobs. Third, the effects of changes in other distortionary taxes on unemployment rates are quantitatively small compared to changes in UI benefits and layoff costs. Fourth, the net-effect on the unemployment rate is small when all observed changes in policy variables are combined, only 7 percent of the 4 percentage point increase that occurred over the reference period. Fifth, lower productivity growth increases the unemployment rate by 0.51 percentage points, and the impact of observed reductions in TFP growth is large compared to the changes induced by policy variables. Lastly, all factors combined account for less than a quarter of the increase in the unemployment rate from the 50s to the 80s.

Our model is described in Section 2. In Section 3 we calibrate the model to the Canadian economy in the 1980s and then study the question as to whether observed differences in policy variables and TFP growth can account for the lower unemployment rates in the 1950s and 1960s. Section 4 concludes.

2 The Model

The model combines the standard representative agent growth model with a matching model of the labour market. There is an infinitely lived representative family with a large number of family members. Some of the family members work and some search for jobs. Workers may receive different wages, and the wage of a worker can change over time. The family takes the wages as given. Over time some workers may lose their job, but at the same time searchers find jobs. A job is created when a searcher is matched with a vacancy which is posted by a representative firm. The firm decides on the number of vacancies to be posted, based on the costs of posting a vacancy and the expected capital value of a job. Wages are determined based on a bargaining process between matched workers and jobs. Time is continuous. We will only study the balanced growth path of the economy.

2.1 The Family Household

The family's preferences are given by the discounted present value of utility

$$\int_0^\infty e^{-\rho t} U\left[c\left(t\right), n\left(t\right), s\left(t\right)\right] dt \tag{1}$$

where instantaneous utility U depends on consumption c, the number of family members employed n, and the number of family members searching for jobs s. The utility function U is of the form

$$U\left(c,n,s\right) = \ln c - \xi_n \frac{n^{\zeta_n}}{\zeta_n} - \xi_s \frac{s^{\zeta_s}}{\zeta_s} \;\; with \;\; \xi_n, \xi_s > 0 \;\; , and \;\; \zeta_n, \zeta_s \geq 1.$$

Future utility is discounted at rate $\rho > 0$.

Employed members of the family, workers, can have two kinds of jobs, low-wage and high-wage jobs. Let n_1 (n_2) denote the number of workers with low-wage (high-wage) jobs, with wages $w_1 < w_2$, and $n = n_1 + n_2$. A family member can obtain a high-wage job by searching, and job offers for a searcher follow a Poisson process with arrival rate ν. High-wage jobs become obsolete over time, and obsolescence follows a Poisson process with arrival rate δ_n. Thus the number of workers with high-wage jobs evolves according to

$$\dot{n}_2 = \nu s - \delta_n n_2. \tag{2}$$

Obsolete high-wage jobs become low-wage jobs. Some of the low-wage jobs are destroyed, and job destruction follows a Poisson process with arrival rate ϕ. The number of workers with low-wage jobs evolves according to

$$\dot{n}_1 = \delta_n n_2 - \phi n_1. \tag{3}$$

The choice of the family that has to be made at each moment of time is how much the representative family should consume, the number of family members searching for jobs, and how much it should add to the capital stock to provide consumption in the future.

The family owns capital k and the net-return on capital is r. The family owns the representative firm and receives profits π. Profits and interest income is taxed at the capital income tax rate τ_k. Employed workers receive wage income, searchers receive an unemployment benefit payment b, and workers who are laid-off receive a lump-sum payment l. The household takes the wage rates of workers as given. The determination of wage rates will be described below. These labour earnings are taxed at the labour income tax rate τ_w. The budget constraint of the family is then

$$\dot{k} = (1 - \tau_k)(rk + \pi) + (1 - \tau_w)(w_1 n_1 + w_2 n_2 + bs + l\phi n_1) + T - c, \tag{4}$$

where T represents a lump-sum transfer payment by the government. The unemployment benefit is proportional to the low-wage with a replacement rate τ_u, $b = \tau_u w_1$. The layoff payment is proportional to the low wage, $l = \sigma_w w_1$.

The first order conditions for an optimal choice are

$$\begin{array}{lcll} U_c & = & \lambda, & (a) \\ -U_s & = & \lambda \tau_u \bar{w}_1 + \mu_2 \nu, & (b) \\ \dot{\mu}_2 & = & \rho\mu_2 - \left[\lambda \bar{w}_2 + U_n - \delta_n \left(\mu_2 - \mu_1\right)\right], & (c) \\ \dot{\mu}_1 & = & \rho\mu_1 - \left[\lambda \left(1 + \sigma_w \phi\right) \bar{w}_1 + U_n - \phi\mu_1\right], & (d) \\ \dot{\lambda} & = & \rho\lambda - \lambda \bar{r}, & (e) \end{array} \quad (5)$$

where λ is the marginal utility of income, μ_i is the capital value of type i workers in utility units, $\bar{w}_i = (1 - \tau_w) w_i$ is the after-tax wage of type i workers, and $\bar{r} = (1 - \tau_k) r$ is the after-tax interest rate. Equation (5.b) states that the utility cost of job search is equated with the benefits from job search which include unemployment benefits and the expected capital gain from a successful match with a high-productivity job. Equation (5.c) [(5.d)] defines the capital value of a high-wage (low-wage) worker. The return to a high-wage (low-wage) job includes wage earnings net of the disutility of work and the expected capital loss from job depreciation (termination).

Remark 1. Because the family has a large number of members, it is not affected by idiosyncratic income risk. In this we follow Shi and Wen (1994). Alternatively we could have assumed that there is a representative agent which can obtain insurance against labour income risk, see Andolfatto (1996). Because of the absence of idiosyncratic income risk associated with employment risk, unemployment insurance does not serve any risk sharing role. As in other matching models of the labour market, unemployment insurance acts only as a search subsidy.

Remark 2. In the statement of the household's problem we have not allowed for the possibility that workers may quit their job. We therefore restrict our analysis to balanced growth equilibria where the capital value of a job is non-negative such that there is no incentive for a worker to quit a job.

2.2 The Firm

The homogeneous output good is produced by a representative firm employing capital and labour, and the firm's production function is Cobb-Douglas

$$q = f(k, Zn^e) = k^{\alpha} (Zn^e)^{1-\alpha} \quad with \;\; 0 \leq \alpha \leq 1. \tag{6}$$

Effective labour input n^e is the weighted sum of two types of labour, $n^e = zn_1 + n_2$, and type one labour is less productive than type two labour, $z < 1$. Technical change is of the disembodied labour-augmenting variety, and Z increases at a rate $\varsigma \geq 0$, $Z(t) = e^{\varsigma t}$.

The firm cannot adjust its labour force without cost because there are frictions in the labour market. The number of high-productivity workers can be increased only by posting vacancies o, at a cost of κZ units of output per vacancy posted.[4] These vacancies are matched with workers searching for jobs, and vacancies are filled according to a Poisson process with arrival rate θ. A successful match between a searcher and a vacancy produces a high-productivity job. As discussed above high-productivity jobs become

[4]For a balanced growth path equilibrium to exist, vacancy costs have to increase at the same rate as disembodied technological change.

obsolete, that is become low-productivity jobs at the rate δ_n. Thus the stock of high-productivity jobs evolves according to

$$\dot{n}_2 = \theta o - \delta_n n_2, \tag{7}$$

where we have assumed, that it will never be in the firm's interest to terminate a high-productivity job. The firm will, however, terminate low-productivity jobs over time, at a cost of $\sigma_f w_1$ for each terminated job. This job destruction occurs at a chosen rate ϕ, and the stock of low-productivity jobs evolves over time according to (3).

The firm pays wages, and a pay-roll tax τ_p on its wage bill. The firm can hire capital in a perfectly competitive market and pays a net rate of return r. Flow profits are then defined as

$$\pi = f\left[k, Z\left(zn_1 + n_2\right)\right] - \left(1+\tau_p\right)\left(w_1 n_1 + w_2 n_2\right) - \left(r + \delta_k\right) k - Z\kappa o - \sigma_f w_1 \phi n_1, \tag{8}$$

and the firm discounts future profits at the interest rate $\bar{r}$, $\int_0^\infty e^{-\bar{r}t}\pi\left(t\right)dt$. Analogous to the family household we assume that the firm takes the wage rates for low- and high-productivity jobs as given when it decides on job creation and destruction.

The firm maximizes its profit by choosing the amount of capital to rent, the number of vacancies and the layoff rate. The first order conditions for the maximization of the discounted present value of profits are as follows

$$\begin{array}{lcll} r & = & f_k - \delta_k, & (a) \\ \theta\eta_2 & = & Z\kappa, & (b) \\ \eta_1 & \geq & -\sigma_f w_1 \ \ and \ \ = \ \ if \ \ \phi > 0, & (c) \\ \dot{\eta}_2 & = & \bar{r}\eta_2 - \left[Zf_n - (1+\tau_p)w_2 + \delta_n\left(\eta_1 - \eta_2\right)\right], & (d) \\ \dot{\eta}_1 & = & \bar{r}\eta_1 - \left[zZf_n - (1+\tau_p)w_1 - \phi\left(\eta_1 + \sigma_f w_1\right)\right], & (e) \end{array} \qquad (9)$$

and we can rewrite equations (9.d) and (9.e) as

$$\begin{array}{lcll} \eta_2 & = & \left[Zf_n - (1+\tau_p)w_2 + \delta_n\left(\eta_1 - \eta_2\right) + \dot{\eta}_2\right]/\bar{r}, & (d') \\ \eta_1 & = & \left[zZf_n - (1+\tau_p)w_1 - \phi\left(\eta_1 + \sigma_f w_1\right) + \dot{\eta}_1\right]/\bar{r}. & (e') \end{array} \qquad (10)$$

Equation (9.a) equates the net rate of return on capital with the marginal product of capital after depreciation has been deducted. Equation (9.b) is the free entry condition for vacancies, and it states that with positive entry the cost to create a vacancy is equal to the expected capital gain from a successful match. Equation (10.d′) [(10.e′)] defines the capital value of a high-productivity (low-productivity) job. The return on a high-productivity (low-productivity) job equals the marginal product of high-productivity (low-productivity) labour net of wage payments minus the expected capital loss from job depreciation (termination). Equation (9.c) sets the boundary condition for the capital value of a low-productivity job. If the firm terminates some low-productivity jobs ($\phi > 0$), the firm must be indifferent between keeping the job and terminating the job. The capital value of a low-productivity job is then the negative of the layoff cost.

Remark. The fact that new job-worker matches start out as high-productivity jobs, and decay later to low-productivity jobs, is a simplified version of Mortensen and Pissarides (1994). In future work we plan to investigate the dynamic behavior of job creation and destruction, and a simple two point distribution for the productivity levels considerably simplifies the state space representation of the economy.[5]

2.3 Job Matching and Wage Determination

The labour market in this economy is based on a standard matching model of employment. Labour is not perfectly mobile between employment opportunities, and it takes time for workers and jobs to be matched. Because of this friction in the labour market, wages are not competitively determined. We follow the literature on matching models of unemployment, and assume that the wage rate in a worker-job match splits the surplus between the worker and the job to obtain a Nash bargaining solution. As has been pointed out before, we also assume that the family and the firm take the outcome of this bargaining process as given when they make their decisions.

The rate m at which job searchers and vacancies meet is determined by a matching function,

$$m = M(v, s) = \chi v^{\psi} s^{1-\psi} \ , with \ 0 \leq \psi \leq 1 \ , and \ \chi > 0. \tag{11}$$

The rates at which searchers and jobs are matched are then given by

$$\nu = \frac{m}{s} \ and \ \theta = \frac{m}{o}. \tag{12}$$

[5]There are alternative productivity profiles for the two point support of productivity levels. For example a worker, which is just matched with a job, starts out with the low productivity level, then productivity increases, that is the worker learns, and finally there is obsolescence. This would create a wage profile which is initially increasing with job tenure, and it would reduce the capital value of vacancies, but it would not affect the general properties of the model.

The wage rate is determined to split the capital value surplus from a match. We normalize the capital value of a match for a worker from (5) in terms of the consumption good, $\tilde{\mu}_i = \mu_i/\lambda$, and the capital value of a match for a job is η_i as defined in (10). We assume that the outside option for the firm is a termination of the job match, in which case the firm pays the layoff tax $\sigma_f w_1$. The outside option of a worker is to dissolve the match and search for a new match, in which case the worker does not receive a layoff payment and the capital value of search is zero. The wage then solves the following problem

$$\max_{w_i} \left[\eta_i - (-\sigma_f w_1)\right]^{\gamma} \tilde{\mu}_i^{1-\gamma} \;\; s.t. \;\; \eta_i + \sigma_f w_1 \geq 0 \;\; and \;\; \mu_i \geq 0 \tag{13}$$

where γ denotes the relative bargaining power of the firm, $0 < \gamma < 1$. We now discuss the solution for low and high-productivity matches.

We are interested in a balanced growth path where some low-productivity workers are laid off, that is $\phi > 0$. In this case the firm's first order condition (9.c) implies that $\eta_1 + \sigma_f w_1 = 0$ and the firm is indifferent between keeping or terminating the marginal low-productivity job. This again implies that the capital value of a low-productivity match for a worker must be zero, otherwise we could marginally lower the wage such that the capital value of the match for the firm is greater than the layoff cost and the worker retains a positive capital value. This alternative is preferred by the firm and the worker and no separation would take place.

More formally, according to the solution of the bargaining problem, $\gamma\tilde{\mu}_1 =$

$(1-\gamma)(\eta_1+\sigma_f)=0$. It follows that for low-productivity jobs the equilibrium capital values for jobs and workers are both zero

$$\eta_1 + \sigma_f = \tilde{\mu}_1 = 0. \tag{14}$$

The capital values for jobs and workers in high-productivity matches satisfy

$$\gamma\,(1+\tau_p)\,\tilde{\mu}_2 = (1-\gamma)\,(1-\tau_w)\,(\eta_2 + \sigma_f w_1)\,. \tag{15}$$

Below we will use this to determine the wage rate of high-productivity workers on a balanced growth path.

2.4 A Competitive Equilibrium

To complete the description of the economy we have to specify the government budget constraint and the resource constraint. For the government budget constraint we assume that policy not only determines tax rates, but it also sets a time path for government spending. Since our economy is growing over time, we assume that government spending is a constant fraction $\tilde{g}$ of measured GDP. We define measured GDP as output after deduction of the resource costs incurred for posting vacancies, and government spending is $g = \tilde{g}\,(q - Z\kappa o)$.[6] The government's budget constraint is defined as follows

$$\begin{aligned} g + (1-\tau_w)\,\tau_u w_1 s + T \;\; = \;\; & (\tau_w + \tau_p)\,(w_1 n_1 + w_2 n_2) + \\ & [\sigma_f - (1-\tau_w)\,\sigma_w]\,w_1 \phi n_1 + \tau_k\,(\pi + rk)\,. \end{aligned} \tag{16}$$

Finally the resource constraint for the output good is

$$c + \dot{k} + \delta_k k + g + Z\kappa o = q. \tag{17}$$

[6]For our definition of measured GDP see the discussion in Section 3.2 below.

We are now in a position to define an equilibrium for the economy.

Definition. *An equilibrium is a collection of functions of time* $\{\ c,\ g,\ q,\ k,\ n_1,\ n_2,\ s,\ o,\ m,\ \theta,\ \nu,\ \phi,\ \tilde{\mu}_1,\ \tilde{\mu}_2,\ \eta_1,\ \eta_2,\ w_1,\ w_2,\ r,\ \pi,\ T\ \}$ *such that*

(1) *given* $\{w_1, w_2, r, \pi, T; \nu, \phi\}$, $\{c, k, n_1, n_2, s, \tilde{\mu}_1, \tilde{\mu}_2\}$ *solves the household's problem;*
(2) *given* $\{w_1, w_2, r; \theta\}$, $\{q, k, n_1, n_2, o, \phi, \eta_1, \eta_2\}$ *solves the firm's problem;*
(3) $\{w_1, w_2, \tilde{\mu}_1, \tilde{\mu}_2, \eta_1, \eta_2\}$ *solves the bargaining problem* (13);
(4) $\{s, o, m, \nu, \phi\}$ *is consistent with* (11) *and* (12);
(5) $\{g, n_1, n_2, \phi, w_1, w_2, r, \pi, T\}$ *is consistent with the government budget constraint* (16);
(6) $\{c, g, q, k, o\}$ *satisfies the resource constraint* (17).

2.5 Balanced Growth Path

We now characterize the balanced growth path of the economy. On a balanced growth path output q, consumption c, investment x, government spending g, capital k, wages w_1 and w_2, the capital values of jobs $\tilde{\mu}_2$, η_1, and η_2, all grow at the constant productivity growth rate $\varsigma \geq 0$. Let an asterisk denote the normalized value of such a variable on the balanced growth path, for example, $k(t) = k^* e^{\varsigma t}$. The interest rate r, the transition rates θ, ν, and ϕ, employment n_1 and n_2, and search activities s and o are constant on the balanced growth path.

Constant employment and search activities imply that the following flow identities apply to the labour market

$$\theta o = \delta_n n_2 = \phi n_1 = \nu s. \tag{18}$$

On the balanced growth path the firm lays off low-productivity workers and using (14) the household's first order conditions (5) simplify to

$$\begin{array}{lcll} 1/\lambda^* & = & c^*, & (a) \\ (1-\tau_k)\, r & = & \rho + \varsigma, & (b) \\ \rho\tilde{\mu}_2^* & = & (1-\tau_w)\, w_2^* + (U_n/\lambda^*) - \delta_n \tilde{\mu}_2^*, & (c) \\ 0 & = & (1-\tau_w)\,(w_1^* + \phi\sigma_w w_1^*) + (U_n/\lambda^*)\,, & (d) \\ 0 & = & (U_s/\lambda^*) + (1-\tau_w)\tau_u w_1^* + \nu\tilde{\mu}_2^*, & (e) \end{array} \tag{19}$$

and from the firm's first order conditions (9) we have

$$\begin{array}{lcll} r & = & f_k\,(k^*, zn_1 + n_2) - \delta_k, & (a) \\ \kappa & = & \theta\eta_2^*, & (b) \\ \rho\eta_2^* & = & f_n\,(k^*, zn_1 + n_2) - (1+\tau_p)\, w_2^* - \delta_n\,(\eta_2^* + \sigma_f w_1^*)\,, & (c) \\ -\rho\sigma_f w_1^* & = & zf_n\,(k^*, zn_1 + n_2) - (1+\tau_p)\, w_1^*. & (d) \end{array} \tag{20}$$

For low-productivity workers the surplus sharing wage rate is

$$w_1^* = \frac{1}{1-\tau_w}\,(-U_n/\lambda^*) - \phi\sigma_w, \tag{21}$$

and for high-productivity workers the wage rate is

$$w_2 = \frac{1-\gamma}{1+\tau_p}\,[f_n\,(k^*, zn_1 + n_2) + \rho\sigma_f w_1^*] + \frac{\gamma}{1-\tau_w}\,(-U_n/\lambda^*)\,. \tag{22}$$

The resource constraint completes the characterization of the balanced growth path

$$c^* + (\delta_k + \varsigma)\, k^* = (1-\tilde{g})\,[f\,(k^*, zn_1 + n_2) - \kappa o]\,. \tag{23}$$

We want to know if changes in policy parameters are quantitatively important for the labour market on a balanced growth path. This analysis will be provided in the next section after we have calibrated our model. To get some intuition for these numerical results we now discuss the qualitative effects of changes in some parameter values for a simplified version with no layoff payments. Without layoff payments the model does have a simple recursive structure, and we can sign the effects of policy changes, see Appendix A. We only discuss the effect of a change in the replacement rate. The analysis of changes in other parameters is straightforward.

An increase in the replacement rate τ_u has no effect on the capital-labour ratio and wages, therefore the capital value of a match to a firm is not affected. Given the free entry condition for the creation of vacancies, the rates at which vacancies and job searchers are matched do not change. Search activity then increases because the replacement rate increases (the capital value of a high-productivity job for a worker has remained unchanged since wages do not change). With a constant job finding rate this means that the share of high-productivity (low-productivity) workers in employment increases (decreases). The share of low-productivity workers declines because the separation rate increases. The effects of changes in the replacement rate and other parameters are summarized in the following result.

Result. *In an economy with no layoff payments* $\sigma_f = \sigma_w = 0$ *and preferences such that the labour and search supply elasticities are equal,* $\zeta_n = \zeta_s$*, an increase in a parameter* x*,* $\Delta x > 0$*, has the following impact on the unemployment rate* $s/(s+n)$*, job finding rate* ν*, job loss rate* ϕ*, relative employment size* n_2/n_1*, and relative wage* w_2/w_1*:*

	$\Delta\tau_u$	$\Delta\tau_p, \Delta\tau_w$	$\Delta\tau_k, \Delta\varsigma$	$\Delta\gamma$	
				$\gamma < \psi$	$\gamma > \psi$
Unemployment Rate ($\Delta(s/(s+n))$)	$+$	0	$-$	$+$	$-$
Job Finding Rate ($\Delta\nu$)	0	0	$-$	$+$	$+$
Job Loss Rate ($\Delta\phi$)	$+$	0	$-$	$+$	$+,-$
Relative Employment ($\Delta(n_2/n_1)$)	$+$	0	$-$	$+$	$+,-$
Relative Wage ($\Delta(w_2/w_1)$)	0	0	0	$-$	$-$

It can be shown that the relationship between the unemployment rate $s/(n+s)$ and the bargaining power of a firm γ depends on the relative magnitudes of γ and the matching elasticity with respect to the vacancy ψ. When $\gamma < \psi$, increasing the bargaining power would increase the unemployment rate; otherwise, the unemployment rate is a decreasing function of the bargaining power. Similarly, the effects of γ on the job loss rate ϕ and the relative employment size n_2/n_1 also depend on the relative magnitudes of γ and ψ; in the case of $\gamma > \psi$, the effects also depend on the other parameters in the model.

3 A Quantitative Analysis

We want to know whether observed changes in policy parameters can account for the observed increase in the long-run Canadian unemployment rate. Previous work has focused on the role of the UI system, for which substantial changes took place in 1971/72 and 1978/79. Following this approach we consider two complete unemployment cycles before and after the reforms, 1956-1966 and 1981-1989. For the quantitative analysis, we parameterize our economy such that the values of a collection of variables on a balanced growth path correspond to the averages of these variables for the Canadian economy over the reference period 1981-1989.[7] With minor modifications, this procedure is the same as the one used for the calibration of the standard growth model, see for example Cooley and Prescott (1995). Finally we obtain the average settings for the policy variables for the period 1956-1966 and recalculate the balanced growth path. The sources of the data used in this analysis are given in Appendix B.

3.1 The Labour Market

We will discuss the parameterization of the labour market first. We start out with a characterization of the degree of turnover in this market, and then consider measures of UI generosity and lay-off costs. We conclude with a remark on labour supply elasticity.

Labour Market Turnover

For the matching function Blanchard and Diamond (1989) estimate the elasticity of matches with respect to vacancies as $\psi = 0.6$. For the purpose of our calibration we interpret the unit time interval as a year. It is dif-

[7] Whenever this is not possible we use evidence reported in other work.

ficult to obtain observations on the average time until a vacancy is filled. We follow Andolfatto (1996) and set this duration to be 45 days, that is $1/\theta = 45/365$.[8] During the reference period the average unemployment rate was $s/(s+n) = 9.5$ percent. The job finding rate ν is set to match the average job tenure, 8 years, estimated by Christofides and McKenna (1993).

We calibrate the economy such that the equilibrium size of the labour force is one, $s + n = 1$. In our economy there are two types of job matches, high and low productivity. Richardson (1994) studies the degree of inequality in labour earnings during the 1980s. Based on Richardson's inequality measures, we consider various partitions of wage earnings into a high-wage and a low-wage group. Figure 5 shows that, for relative sizes between 0.1 and 1.5, the relative wage remains roughly constant at 3.

We choose a relative size of $n_2/n_1 = 0.25$ and a relative wage of $w_2/w_1 = 3$.[9] These numbers imply a layoff rate $\phi = 0.16$. The layoff rate is the rate at which low-wage jobs are terminated, and it implies an average job duration for low-wage workers of 6.4 years. The rate of obsolescence of high productivity jobs is $\delta_n = 0.63$. Our parametrization implies that unemployment incidence, that is the unconditional rate at which workers become unemployed is 0.125 and that the average duration of unemployment is about 44 weeks.

[8] This is the estimate of van Ours and Ridder (1992). Blanchard and Diamond (1989) estimate the average time until a vacancy is filled to be less than a month.

[9] Experiments with different partitions of employment show that for the policy changes we consider, the impact on unemployment is bigger the smaller is the share of high wage employment. We use a relatively small number of n_2/n_1 to get an upper bound estimate.

Empirical work on the Canadian labour market shows that our implied unemployment incidence is too low and our implied unemployment duration is too high. For example, our annual layoff rate corresponds to a monthly layoff rate of 0.013, but Jones (1993) reports an average monthly unemployment incidence of 0.017 for transitions from employment to unemployment, and 0.042 if transitions to non-employment are included. The implied unemployment duration of about 44 weeks is also substantially longer than the 19 weeks reported by Statistics Canada (1991). We cannot avoid this problem since conditional on the unemployment rate unemployment duration and employment duration are not independent on the balanced growth path:

$$\frac{1}{\nu}\left[\frac{1}{s/(n+s)}-1\right]=\frac{1}{\phi}+\frac{1}{\delta_n},$$

where the left-hand side is proportional to the average unemployment duration and the right hand side is average job duration of a completed job spell, which includes high-wage and low-wage employment. Conditional on employment duration, the ratio of high-wage to low-wage earners then determines ϕ and δ_n and thereby unemployment incidence $\phi\delta_n/(\phi+\delta_n)$.

Instead of fixing the employment duration we could have fixed the unemployment duration at 19 weeks. For this parameterization unemployment incidence would be closer to the values reported by Jones (1993), but the average job tenure would be less than 4 years. We could have also chosen a higher ratio of high-wage to low-wage workers. Experiments with such alternative parameterizations show that changes in policies have bigger effects for our chosen parameterization, that is the parameterization provides an upper bound.

The Replacement Rate

Different measures of UI generosity have been constructed in the literature, see Sargent (1995). Usually, these measures consider the following elements of UI benefits: the legislated replacement rate, the percentage of the labour force covered by UI (coverage rate), the maximum number of benefit weeks for a minimally qualified claimant, and the minimum number of working weeks needed to qualify for UI. In our model economy the replacement rate represents UI generosity and we define this replacement rate such that the expected present value of unemployment benefits in the model economy is the same as in the actual economy.

Let π^c be the probability that a worker who has just become unemployed will receive UI benefits. The unemployed worker will receive benefits at the legislated replacement rate τ_u^L for the duration of unemployment up to the maximum duration of UI benefits T^B. Suppose the average duration of unemployment is d, and $1/d$ is the job finding rate. Then the expected discounted present value of UI benefits is

$$\pi^c \int_0^{T^B} e^{-(r+1/d)t} \tau_u^L w_1 dt = \int_0^{\infty} e^{-(r+1/d-\varsigma)t} \tau_u w_1 dt,$$

which we equate with the corresponding capital value of UI benefits in our model. This defines the replacement rate τ_u

$$\tau_u = \pi^c \tau_u^L \left[1 - e^{-(r+1/d)T^B}\right] \left[1 - \varsigma / \left(r + 1/d\right)\right], \qquad (24)$$

and we construct a replacement rate series from annual data on the UI coverage of the labour force (π^c), the legislated replacement rate (τ_u^L), the average unemployment duration (d), and the maximum benefit entitlement (T^B).

Remark 1. Our measure of the replacement rate depends not only on exogenous policy variables, but also on the endogenous job finding rate. To see how changes in the job finding rate affect our measure of the replacement rate, we calculate the replacement rate based on the average job finding rate during 1955-1989 in Figure 6(a). This graph shows that variations in the job finding rate do not affect the replacement rate very much. The measure using the fixed average job finding rate smooths out the cyclical components in the replacement rate. For our steady state analysis, the choice of the job finding rate will not make a difference.

Remark 2. Changes in UI eligibility as represented by changes in the coverage rate account for a substantial part of the long term changes of the replacement rate. In Figure 6(b) we plot two replacement rates, one based on the actual coverage rate and one where the coverage rate is fixed at its 1955 value. From this graph we can see that the increase in the coverage rate in the 1970s and 1980s accounts for about half of the increase in the replacement rate. The coverage rate is, however, not the ideal variable for our definition of π^c because a worker who is eligible for UI does not necessarily receive UI when laid off.[10] In our model π^c represents the proportion

[10] The common practice of using the coverage rate in the calculation of UI generosity is also questioned by Sargent (1995).

of the unemployed receiving UI, but Statistics Canada started to construct the number of beneficiaries without earning only in 1976. For the earlier time period we have only data on the total number of beneficiaries, which include regular and special beneficiaries. Special beneficiaries include sickness, maternity, retirement, fishing, training, work sharing, job creation and self-employment assistance, and they are not counted as unemployed. Even some regular beneficiaries without declared earnings would not be counted as unemployed by the Labour Force Survey, see Levesque (1989). Thus the data for total regular beneficiaries and unemployed are not consistent and the proportion of total beneficiaries in unemployment is a poor measure for our π^c. From Figure 6(c) we can see that the coverage rate and the share of all UI beneficiaries in total unemployment behaved very differently over the time period considered. Unlike the coverage rate, we do not observe a dramatic increase from the 1950s to the 1980s in the proportion of beneficiaries in unemployment, only in the 1970s was there a temporary increase in this ratio. We can use the proportion of beneficiaries as our measure of π^c and get another time series for the replacement rate, see Figure 6(d). Relative to the replacement rate which uses the coverage rate, this new series has higher values during 1955-1967 and lower values in the 1980s. For our parameterization of the replacement rate we use the coverage rate, and view the change in the measure τ_u as an upper bound for the generosity of UI.

By using the actual unemployment duration and coverage rate, we obtain an average replacement rate of $\tau_u = 0.41$ for the reference period, 1981-1989, and $\tau_u = 0.22$ for the 1956-1966 period. Another factor we have to consider is that for tax purposes unemployment benefits have been treated differently in the two periods. Before the 1971/72 reform, the benefits were not taxed, but after 1971 benefits have been subject to income taxes. In our model, the benefits are taxed which is consistent with the case in the 1980s. For the 1955-66 period, the replacement rate we use in the model is $\tau_u/(1-\tau_w)$; then the after-tax replacement rate is the actual replacement rate τ_u.

Layoff Costs

Employment protection laws in Canada take mainly the form of notice periods or severance payments in lieu, see Kuhn (1993). Furthermore, not all workers are protected by this legislation, and legislation is not uniform across provinces. The average notice period is about 2 weeks. According to the data from Statistics Canada (1992), permanent layoffs account for 25% of permanent separations and temporary layoffs account for 34% of temporary separations. On average, we assume that 30% of separations are layoffs. For the calibration of the model we set layoff costs for firms and layoff benefits for workers to 1.2 percent ($= 2/52 \times 0.3$) of the annual low-wage income, $\sigma_f = \sigma_w = 0.012$. This amounts to the assumption that during the notice period a worker is not productive. Given that not all workers are eligible for notice periods, this assumption represents an upper bound on the monetary value of layoff costs.

Labour Supply Elasticities

We do not have a good idea on what the work/search elasticities of utility should be. On the one hand, micro studies have estimated labour supply elasticities for men between -0.07 and 0.45 (Pencavel 1986). On the other hand, general equilibrium macroeconomic models tend to work with relatively high labour supply elasticities (Hansen 1985). We follow the macro literature and select a relatively high unitary elasticity, $\zeta_n = \zeta_s = 2.0$, but we also study how the results depend on the particular parameter values within the range $[1.1, 5.0]$. The scale parameters ξ_n and ξ_s are then determined from the first order conditions. We now return to the calibration of the production side of the economy.

3.2 The National Income Accounts

In the standard growth model, the capital income share in GDP is sufficient to determine the capital coefficient in the production function. This is not necessarily true for our economy, since GDP may be an incomplete measure of output. In particular part of gross output is used up in the process of creating vacancies. It is not clear whether or not this output is accounted for in the national income accounts (NIA), for example as part of gross investment. In our calibration we make the extreme assumption that resources used to create vacancies are not measured at all by the NIA, that is measured GDP is $y = q - Z\kappa v = c + x + g$. Appendix C shows that on the income side of GDP we have

$$y = \left[(1+\tau_p)\left(w_1 n_1 + w_2 n_2\right) + \sigma_f w_1 \phi n_1\right] + \left[uk + \rho\left(\eta_1 n_1 + \eta_2 n_2\right)\right].$$

We assume that layoff payments by firms are accounted for as labour income, represented by the first bracket, and interest income on the stock of jobs is accounted for as capital income represented by the second bracket.

For the reference period the average annual capital stock-GDP ratio is $[K/Y] = 3.7$, and the average investment-GDP ratio is $[X/Y] = 0.2$. During this period average annual TFP growth is 0.7 percent.[11] This implies a capital depreciation rate of $\delta_K = 0.044$. The average government consumption-GDP ratio is $[G/Y] = 0.2$. The average capital income-GDP ratio for the same time period is $[P_K K/Y] = 0.41$.[12] Conditional on the vacancy cost-GDP ratio $[Z\kappa o/Y]$, we can express the after-tax interest rate as

$$\bar{r} = \left\{ \left[\frac{P_K K}{Y} \right] - \delta_k \left[\frac{K}{Y} \right] + \frac{\varsigma}{\delta_n} \left[\frac{Z\kappa o}{Y} \right] \right\} / \left\{ \frac{1}{1-\tau_k} \left[\frac{K}{Y} \right] + \frac{1}{\delta_n} \left[\frac{Z\kappa o}{Y} \right] \right\}. \quad (25)$$

The capital income tax rate, labour income tax rate and payroll tax rate are calculated using a method proposed by Mendoza et al. (1994). The computations are based on NIA and government revenue statistics. The method yields estimates of effective tax rates on factor incomes which are consistent with the tax distortions faced by a representative agent in a general equilibrium framework. Appendix D contains a detailed description of the

[11]TFP growth is calculated as the standard Solow residual, that is GDP output growth minus capital and employment growth weighted by their respective factor income shares. TFP growth corresponds to labour augmenting technical change of $\zeta = 0.007/\alpha_n$, where α_n is the labour income share. Our definition of measured GDP excludes resources used for the creation of vacancies, thus this measure of productivity growth does not correspond exactly to the underlying model structure. We expect that the error is not systematic as long as the share of resources devoted to the creation of vacancies is approximately constant, as is assumed for the model.

[12]Cooley and Prescott (1995) estimate similar numbers for the average capital income share in the US.

calculations. During the reference period, the average effective labour income tax rate is $\tau_w = 0.21$, the capital income tax rate is $\tau_k = 0.39$, and the payroll tax rate is $\tau_p = 0.06$.

We can construct an upper bound for the vacancy cost-GDP ratio as follows. Hamermesh (1993) reports that in 1990 average recruitment and training costs in the US represent about one sixth of average annual labour earnings. Based on the UK and German labour market, Bentolila and Bertola (1990) assume that job creation costs are about one month's wages. Based on the gross flow data of Jones (1993) we know that over a year the total number of transitions from unemployment or not in the labour force to employment represents about 50 percent of total employment. Suppose that each one of these transitions will incur the average set-up cost. If we assume that the labour income share in output is about two thirds, the vacancy cost-GDP ratio cannot be higher than five percent, the number we use in our calibration.

Given the vacancy cost-GDP ratio and the capital income tax rate, we obtain the income share of physical capital in gross output. From (25) and $\bar{r} = (1 - \tau_k)(f_k - \delta_k)$ the capital elasticity of gross output is $\alpha = 0.39$. Conditional on the vacancy cost-GDP ratio and the observations on relative wages and relative size of the two wage groups, the bargaining strength of employers is $\gamma = 0.25$ and the relative productivity of low-productivity workers $z = 0.27$.[13]

[13] The bargaining strength parameter is substantially below the value for a symmetric Nash-bargaining solution $\gamma = 0.5$. Also Abowd and Lemieux (1993) estimate the employers

3.3 Can the Model Account for the Increase in the Canadian Unemployment Rate?

We study the quantitative effects of parameter changes based on the calibrated model. We want to know whether changes in policy parameters can account for the observed long run increase in the Canadian unemployment rate. We focus on changes in tax rates, namely changes in the replacement rate τ_u, the pay-roll tax τ_p, the wage income tax τ_w, the capital income tax τ_k, and the layoff payments σ_w and σ_f. To evaluate the importance of changes in these policy parameters we also consider changes in the productivity growth rate ς. In Table 1 we list the responses of a subset of labour market variables to changes in the parameters considered.[14]

The qualitative features of the calibrated model are similar to the ones of the simplified model without layoff payments discussed in Section 2. The introduction of positive layoff payments apparently has only second order effects for changes in parameters other than layoff payments. We observe that higher layoff payments from the firm to workers, $\sigma_f = \sigma_w$, reduce unemployment in the model. The mechanism by which this occurs is as follows. An increase in layoff payments improves the bargaining position of workers

bargaining strength to be $\gamma = 0.80$ using observations on the union wage premium of firms in the Canadian manufacturing industry. They observe that the average wage premium is about 15 percent. In our model the bargaining strength parameter is related to the wage premium of high-skilled over low-skilled workers, and according to our calibration procedure high-skilled workers earn about three times as much as low-skilled workers. If we were to follow Abowd and Lemieux (1993) and used a 15 percent wage premium instead we would obtain a bargaining parameter of $\gamma = 0.7$.

[14]In each cell of Table 1, the value in the first row corresponds to $\zeta_n = \zeta_s = 2.0$; the values in the second and third rows correspond to $\zeta_n, \zeta_s = 1.1$ and 5.0, respectively.

and raises wages for low- and high-productivity workers. Because of higher wages the capital value of a new job for a firm declines, and the rate at which vacancies are filled must increase in order to satisfy the free entry condition for vacancies. The higher exit rate for vacancies implies that the job finding rate for searchers declines. This in turn reduces the benefits from search by more than the increase in wages raises the capital value of a high-wage job, and the number of searchers declines. Since the job finding rate declines, it must be the case that the number of vacancies posted declines by more than the number of searchers. Since both, the number of searchers and the job finding rate of searchers declines, the rate at which new jobs are created declines. This implies that the share of high-productivity jobs is declining. The number of low-productivity jobs is increasing since the firm reduces the layoff rate following the increase in layoff costs. Total employment is then increasing, but employment in efficiency units is decreasing.

Overall the quantitative impact of changes in policy parameters on the level of unemployment and the composition of the work force is small. The negligible impact of changes in the pay-roll tax and the wage income tax is not surprising, given that without layoff payments these taxes have no impact on the labour market. The capital income tax rate and the rate at which layoff payments are made have a small impact on the unemployment rate. Among the policy variables, changes in the replacement rate have a noticeable impact on unemployment. To put the effect of changes in policy variables in perspective, a one percentage point increase in the productivity growth rate reduces the unemployment rate by 0.65 percentage points, whereas a 15 percentage point increase in the replacement rate increases the unemployment rate by only 0.21 percentage points.

The discussion up to now suggests that the model can account for only a small portion of the long run increase in the Canadian unemployment rate. For the complete unemployment cycle from 1956-1966 the average unemployment rate was $(s/(s+n))^{old} = 0.053$, the replacement rate was $\tau_u^{old} = 0.25$, the labour-augmented productivity growth rate was $\varsigma^{old} = 0.018$, and the government spending share in GDP was $\tilde{g}^{old} = 0.20$. Since we do not have information on tax rates before 1965, we use the average tax rates for the period 1965-1969: the capital income tax rate was $\tau_k^{old} = 0.41$, the wage income tax rate was $\tau_w^{old} = 0.15$, and the pay-roll tax rate was $\tau_p^{old} = 0.03$. Much of the employment protection legislation was introduced in the seventies, but there also existed some previous legislation (Kuhn 1993). We make an extreme assumption and set layoff costs to zero during this time period, $\sigma_f^{old} = \sigma_w^{old} = 0$. Based on these settings for policy variables and productivity growth we obtain a new balanced growth unemployment rate of 8.6 percent, which means that according to the model, changes in the UI system, layoff costs, tax rates and productivity growth account for only 0.94 percentage points of the four percentage point difference across the two periods.

Table 1 also reports the results of a sensitivity analysis with respect to the labour supply elasticity, the parameters ζ_n and ζ_s. We see that the model can account for an increase of the unemployment rate that lies between 0.24 percentage points (low elasticity) and 6.26 percentage points (high elasticity).[15]

3.4 Related Literature

Our model predicts that the changes in the UI system have had only a limited impact on aggregate unemployment in Canada. This prediction is not an extreme one when compared with other empirical work which has studied the effects of UI reforms on unemployment in Canada. Corak (1994) summarizes the results from these studies.

Macroeconometric studies of the effect of UI reform on the unemployment rate do not provide clear-cut results. Burns (1990) and Bougrine and Seccareccia (1994) find that the 1971/72 UI reforms have had no effect on aggregate unemployment. Fortin (1989) concludes that the UI reforms in the 1970s increased the unemployment rate in the 1980s by 0.6 percentage points, and Fortin, Keil and Symons (1995) estimate that the reforms increased the unemployment rate by 1.9 percentage points.

The microeconometric studies focus on how the replacement rate, entrance requirements and duration of benefits affect the behaviour of workers and firms. A high replacement rate and longer benefit duration are likely to reduce the job finding rate and increase unemployment duration. Less stringent entrance requirements tend to shorten the employment spell and

[15] The findings here are robust to variations in the relative wage ratio w_2/w_1 within the observed range.

increase the job loss rate or unemployment incidence. Ham and Rea (1987) and Corak (1992) find that the replacement rate has no effect on the duration of insured unemployment for males, but affects duration for females; benefit entitlement is, however, an important determinant of unemployment spell length. Green and Riddell (1995) suggest that only 2 to 3 percent of the total number of job terminations are due to the availability and generosity of the UI program.

At this point, work which provides an explicit analysis of the microstructure of UI within a general equilibrium framework is limited. An exception is Andolfatto and Gomme (1995) who incorporate these UI features in a search model and show that the 1971/1972 changes in the UI system may have raised the unemployment rate by 2 percentage points. Further work is clearly desirable, but we conjecture that the impact of changes in the microstructure of UI is limited. See Appendix E for further discussions and some simulation results along these lines.

Our results, concerning the effects of layoff costs, are roughly consistent with results by Mortensen and Millard (1994) and Millard (1994). In theoretical work based on calibrated partial equilibrium models, Bentolila and Bertola (1990) also show that long-run employment increases with higher layoff costs. On the other hand, Hopenhayn and Rogerson (1993) and Veracierto (1995) show for calibrated general equilibrium models that employment is decreasing with layoff costs.[16]

[16] In recent work Alvarez and Veracierto (1997) also discuss the role of UI and layoff

4 Conclusion

We find that in our simple matching model of unemployment, changes in policy variables cannot account for the substantial increase in the average unemployment rate since the mid 1970s. In particular, higher replacement rates which have been the focus of much research recently, do not increase the aggregate unemployment rate by very much. Our results indicate that changes in productivity growth appear to have a bigger impact on unemployment than any of the policy parameters. However, the overall effect of changes in policy variables and productivity growth on the aggregate unemployment rate remains small. If we take our model as a guide this would suggest that the 1996 UI reform will have a limited impact on aggregate unemployment.

On July 1, 1996, the Unemployment Insurance Act and the National Training Act were replaced by a new Employment Insurance (EI) Act. From the perspective of the model the important differences between the old and new system are as follows: income benefits are now based on hours rather than weeks and these benefits are more closely tied to earnings; the basic benefit rate of 55% will now decline by one percentage point for each twenty weeks of benefit use in the past five years and the maximum drop is 5 percentage points. Detailed information is given in HDRC (1996). In our model this policy change represents an approximately 5 percentage point reduction

costs in a general equilibrium framework.

of the replacement rate. If one takes the results from our quantitative analysis at face value, one would have to predict that the impact of these changes on the aggregate unemployment rate will be limited.

Appendix

A. Balanced Growth without Layoff Costs/Benefits

From the optimality of capital accumulation (19.b) and (20.a) we determine the capital-labour ratio $\tilde{k}^* = k^*/n^e$,

$$\rho + \varsigma = (1 - \tau_k) \left[\alpha \left(\tilde{k}^* \right)^{\alpha - 1} - \delta_k \right], \tag{26}$$

and from the first order condition for low-productivity labour (20.d) we determine the wage rate for low-productivity workers w_1^*,

$$(1 + \tau_p) \, w_1^* = z \, (1 - \alpha) \left(\tilde{k}^* \right)^{\alpha}. \tag{27}$$

¿From the first-order condition for the optimal supply of low-productivity labour (19.d) we obtain the marginal rate of substitution between worktime and consumption,

$$-\frac{U_n}{\lambda^*} = (1 - \tau_w) \, w_1^*. \tag{28}$$

Substituting (27) and (28) in the expression for the surplus sharing wage of high-productivity labour (22) we obtain w_2^*,

$$w_2^* = (1 - \alpha) \left(\tilde{k}^* \right)^{\alpha} [1 - (1 - z) \, \gamma] \, / \, (1 + \tau_p), \tag{29}$$

and the relative wage of high-productivity workers is

$$\frac{w_2^*}{w_1^*} = \frac{1 - (1 - z) \, \gamma}{z}.$$

Based on the wage rates we can determine the capital values of high-productivity job matches. First, we determine the capital value for a firm. From expression (20.c) we obtain η_2^*,

$$(\rho + \delta_n)\,\eta_2^* = (1-\alpha)\left(\tilde{k}^*\right)^\alpha (1-z)\,\gamma. \tag{30}$$

The free entry condition (20.d) for vacancies then determines the rate at which vacancies are filled θ,

$$\theta = \kappa/\eta_2^*, \tag{31}$$

and from the matching function we obtain the job finding rate for job seekers

$$\nu = \left(\chi\theta^{-\psi}\right)^{1/(1-\psi)}. \tag{32}$$

Now we obtain the capital value of a high-productivity job for a worker $\tilde{\mu}_2^*$

$$(\rho + \delta_n)\,\tilde{\mu}_2^* = \frac{1-\tau_w}{1+\tau_p}(1-z)(1-\gamma)(1-\alpha)\left(\tilde{k}^*\right)^\alpha. \tag{33}$$

¿From the first order condition for the optimal allocation of search time we obtain the marginal cost of search in terms of consumption goods,

$$-\frac{U_s}{\lambda^*} = \frac{1-\tau_w}{1+\tau_p}(1-\alpha)\left(\tilde{k}^*\right)^\alpha \left[\frac{\nu(1-z)(1-\gamma)}{\rho+\delta_n} + \tau_u z\right]. \tag{34}$$

In our work we assume that the work and search time elasticities are the same

$$\zeta_n = \zeta_s = \zeta.$$

This assumption, together with (28) and (34), determines the search-employment ratio $s/(n_1+n_2)$,

$$\frac{\xi_s}{\xi_n}\left(\frac{s}{n_1+n_2}\right)^\zeta = \frac{\nu(1-z)(1-\gamma)}{z(\rho+\delta_n)} + \tau_u. \tag{35}$$

¿From the fact that on a balanced growth path the number of unemployed agents, and the number of low-productivity and high-productivity job matches remain constant it follows that

$$\nu\left[\frac{s}{n}\right]=\theta\left[\frac{o}{n}\right]=\delta_n\left[\frac{n_2}{n}\right]=\phi\left[\frac{n_1}{n}\right], \tag{36}$$

and we obtain o/n, n_2/n, ϕ, and n_1/n. From the resource constraint (23) and the definition of U_n/λ^* we can determine the level of employment and consumption,

$$\left[\frac{c^*}{n^e}\right]+(\varsigma+\delta_k)\,\tilde{k}^*+g+\kappa\frac{o}{n^e}=\left(\tilde{k}^*\right)^{\alpha}, \tag{37}$$

and

$$\xi_n n^{\zeta-1}c^*=(1-\tau_w)\,w_1^*. \tag{38}$$

B. Data Source and Description

I. National Accounts, Cansim, Statistics Canada

1. Expenditure Accounts, Cansim Matrix 6628, Current Dollars, Annual Data

- c: Personal expenditure on consumer goods and services. It includes durable goods, semi-durable goods, non-durable goods and services. The services cover gross imputed rent, gross rent paid and other lodging.

- g: Government current expenditure on goods and services, including defence expenditure.

2. Income Accounts, Cansim Matrix 6627, Current Dollars, Annual Data

(2a) $(1+\tau_p)(w_1 n_1 + w_2 n_2)$: Wages, salaries and supplementary labour income. Supplementary labour income includes mandatory employer contributions to workers compensation and social insurance (such as unemployment insurance, the Canada and Quebec Pension Plans and the provincial health insurance plans) and nonmandatory employer contributions on behalf of employees to pension funds and private and public insurance plans (such as life, health and dental care, short and long-term disability).

(2b) Net income of farm operators from farm production.

(2c) Net income of non-farm unincorporated business.

3. We assume that the wage income share for farm production and non-farm unincorporated business is the same as in the rest of the economy and calculate the capital-income share in GDP as 1-2a/(GDP-2b-2c) where we define GDP= $c+g+i$ and i is defined in II.3.

4. Government Transfers to Person, Cansim Matrix No. 577, Current Dollars, Annual Data

- sb: Unemployment insurance benefits

II. Fixed Capital Flows and Stocks, 1961-1994, historical, Statistics Canada

1. Non-residential fixed capital flows and stock, Annual, Current Dollars

(1a) Gross fixed capital formation

(1b) End-year net stock using delayed depreciation method

2. Residential fixed capital flows and stocks

(2a) Gross fixed capital formation

(2b) End-year net stock using delayed depreciation method

3. i and k: Investment and capital stock calculated as:

$$\begin{aligned} i &= 1a + 2a \\ k &= 1b + 2b \end{aligned}$$

III. Labour Force Survey, Cansim Matrix 2074

- d: Average duration of unemployment

III. Canadian Labour Force, Cansim Matrix 600, Annual

1. Total civilian labour force

2. Total civilian labour force - employed

3. Total civilian labour force - unemployed

4. Civilian non-institutional population 15 and over

5. Unemployment rate calculated by (series 2 / series 1)

IV. Data Used in Calculations of Effective Tax Rates

1. National Accounts, Volume II: Detailed Tables, OECD, Annual, Different Issues

(a) Cost components of GDP

OP = total operating surplus of the economy

(b) Accounts for households and private unincorporated enterprises

W = wages and salaries

OSPUE = operating surplus of private unincorporated enterprises

PEI = property and entrepreneurial income

2. Revenue Statistics, OECD, Annual, Different Issues

1100 = taxes on income, profits and capital gains of individuals

1200 = taxes on income, profits and capital gains of corporations

2000 = social security contribution

2200 = employers' social security contribution

4100 = recurrent taxes on immovable property

V. Richardson (1994), Wage Distribution, Annual

We use Lorenz curve ordinates to calculate the ratio of high wage jobs to low wage jobs n_2/n_1 and the ratio of high wage rate to low wage rate w_2/w_1.

VI. Consumer Price Index, Cansim Matrix 2231, Annual Average, All Items (86=100)

VII. Unemployment Insurance Statistics

1. Statutory Replace Rate, Beneficiaries, Minimum Weeks of Work to Qualify, Maximum Weeks of Benefits for a Minimally Qualified Claimant, Statistics Canada, cat. no. 73s-202S

2. Person Covered by UI, Cansim Matrix 26, monthly averages

C. National Accounts

Our definition of measured GDP y is gross output q minus the cost of posting vacancies

$$\begin{aligned} y &= q - Z\kappa o \\ &= (1+\tau_p)\left[w_1 n_1 + w_2 n_2\right] + uk + \sigma_f w_1 \phi n_1 + \pi. \end{aligned} \tag{39}$$

¿From the budget constraints of family household and government,

$$\begin{aligned} c + x + g &= (1+\tau_p)\left[w_1 n_1 + w_2 n_2\right] + uk + \sigma_f w_1 \phi n_1 + \pi \\ &= \{(1+\tau_p)\left[w_1 n_1 + w_2 n_2\right] + \sigma_f w_1 \phi n_1\} + (r+\delta_k)k + \pi \\ &= \ wage,\ salary,\ and\ supplementary\ labour\ income + interest \\ &\quad + \ capital\ consumption\ allowance + corporation\ profits. \end{aligned}$$

¿From (9.d,e) and the assumption of constant returns to scale of production function,

$$\pi = \rho(\eta_1 n_1 + \eta_2 n_2).$$

D. Calculation of Effective Tax Rates

The following calculations are based on the method proposed in Mendoza, Razin and Tesar (1994). The notation and data sources are given in Appendix B.

- *Household's average tax rate on total income* (τ_h):

$$\tau_h = \frac{1100}{OSPUE + PEI + W}$$

- *Effective labour income tax rate* (τ_w):

$$\tau_w = \frac{\tau_h W + 2000}{W}$$

- *Effective capital income tax rate (τ_k):*

$$\tau_k = \frac{\tau_h(OSPUE + PEI) + 1200 + 4100}{OS}$$

- *Effective payroll tax rate (τ_p):*

$$\tau_p = \frac{2200}{W}$$

E. Micro-Structure of the UI System

Macroeconomic studies of the change in the Canadian unemployment rate usually represent the UI system through one summary variable or index, for example our replacement index. An exception to be discussed below is the work of Andolfatto and Gomme (1995). Microeconometric studies usually consider the incentive effects of institutional details of the UI system for one particular element of this system. This includes the actual replacement rates, the duration of UI benefits and the minimum requirements to receive UI benefits, for a survey see Corak (1994). At this point we only conjecture on how the institutional setup of UI affects aggregate unemployment.

One would expect that higher replacement rates and UI benefits which are received for a longer time raise the average length of an unemployment spell. Basically higher benefits raise the reservation wage of unemployed workers and lower the exit rate from unemployment. In particular, once UI benefits have run out or are about to run out, one would expect that the exit rate from unemployment increases. Meyer (1990) in a study of twelve US states finds that exit rates from unemployment triple during the last four weeks before UI benefits expire. Corak (1994) argues that work with Canadian data does indicate some increase in exit rates from unemployment before UI benefits expire, the increase, however, does not appear to be quantitatively important. Crémieux et al. (1995) also suggest that the expected termination of UI payments does not affect the exit rates from unemployment in any important way.

One can also make an argument that, if a worker has to work a minimum period of time in order to qualify for the receipt of UI benefits, a higher minimum work time may imply longer employment spells and less unemployment. This argument assumes that there are some workers who only work in order to claim UI benefits later on, that is workers quit after they qualify for UI benefits. An extension of this argument implies that workers work until they have accumulated enough work experience in order to qualify for the maximum duration of UI benefits. Green and Riddell (1995) find that for some high unemployment regions job loss rates almost double at the time an entrance requirement for UI benefits is met. This kind of behaviour is probably limited to low wage jobs with no career opportunities and to explicit seasonal jobs. Green and Sargent (1995) indeed observe a quantitatively important increase in job loss rates only for seasonal workers. This means that even if this effect is quantitatively important for some workers, it will apply only to a limited number of workers, see also Corak (1994).

We conjecture that the impact of changes in the microstructure of the UI system on aggregate unemployment is limited. This conjecture is based on the following argument. Assume a discrete-time partial equilibrium variation of our model. A period represents a week. All unemployed workers receive UI benefits, but only for a limited time, T^U weeks, and only if they have worked for T^R weeks. Suppose that exit rates from unemployment are not constant, but depend on how many weeks n a worker has been unemployed.

In particular

$$\nu_n = \begin{cases} \nu & \text{for } n \leq T^U - 4, \\ 3\nu & \text{for } n > T^U - 4, \end{cases}$$

that is about four weeks before UI benefits expire the job finding rate triples. Suppose that there are some workers who work only until they qualify for UI benefits, that is the job-loss rate also depends on how many weeks a worker has been working. In particular

$$\phi_n = \begin{cases} \phi & \text{for } n < T^R, \\ 2\phi & \text{for } T^R \leq n \leq T^R + 3, \\ \phi & \text{for } n > T^R + 3, \end{cases}$$

that is the aggregate job loss rate doubles for four weeks after workers meet the minimum entrance requirement for UI benefits. Given the evidence discussed above this parameterization appears to be an upper bound on the effect of UI benefits expiration and minimum entrance requirements.

Assuming a fixed labour force we can calculate the unemployment rate implied by these job loss and job finding rates. In our calibration exercise we have used the observation that during the reference period in the 1980s the average duration of unemployment was about 16 weeks (4 months) and the average unemployment rate was about 10 percent. This implies a base job finding rate of $\nu = 0.049$ and a base job loss rate $\phi = 0.007$. During this time period the average maximum duration of UI benefits, T^U, was about 26 weeks, and the average minium entrance requirement for UI, T^R, was about 12 weeks.[17]

[17] Maximum durations and minimum entrance requirements differ across provinces according to the local labour market conditions.

Consider the following experiment. Change the maximum duration UI benefits can be collected and the minimum entrance requirement for UI benefits to their values during the 1960s, and do not change the base rates ν and ϕ. That is T^R is increased to 30 weeks, and T^U is reduced to 15 weeks. This will imply a reduction of the unemployment rate to 8.1 percent, and almost all of this reduction is due to the shorter duration that UI benefits can be collected. We consider this to be a first order approximation for the upper bound of the effects of the change in the micro structure of the UI system.

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Figure 1. Unemployment Rate, 1950–1994.

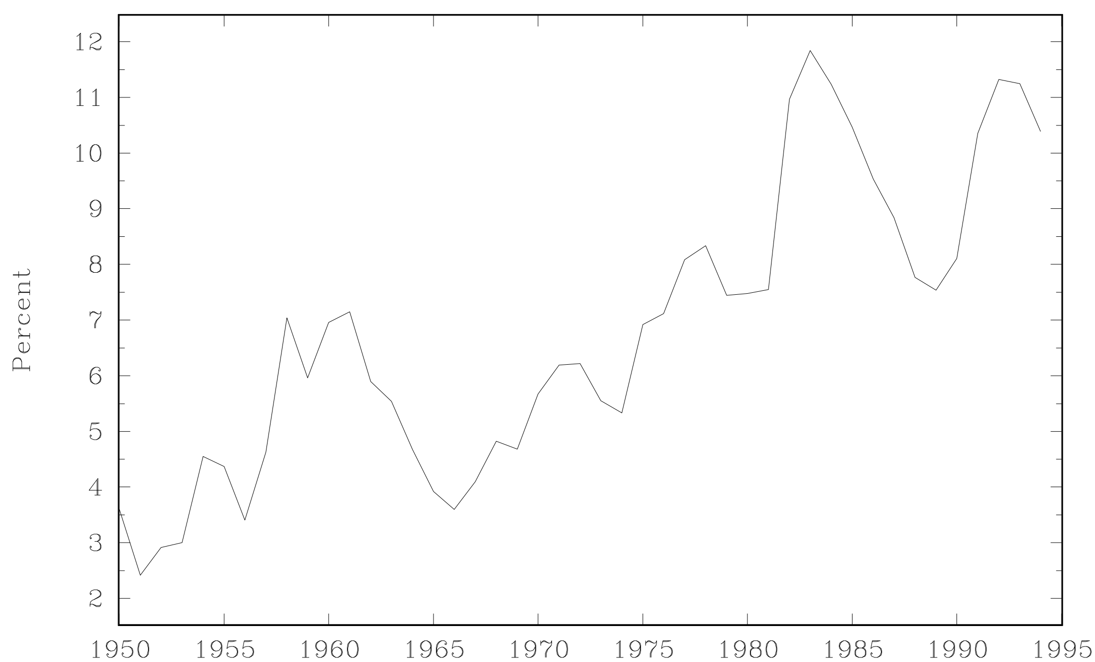

Figure 2. Replacement Rate, 1955–1989.

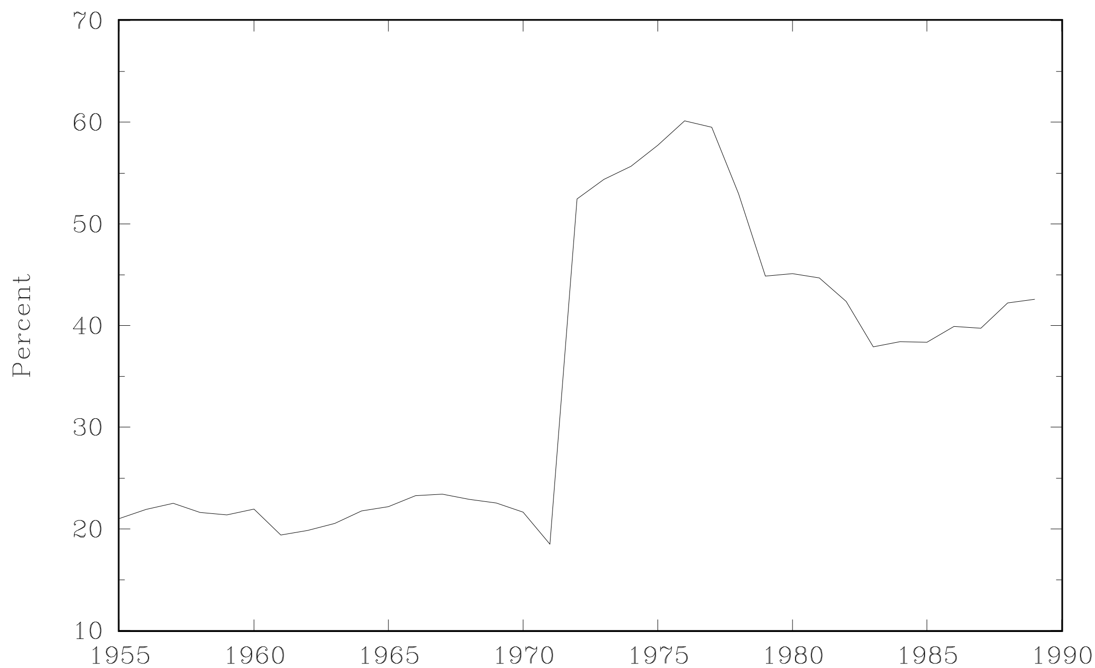

Figure 3. Tax Rates and Government Spending.

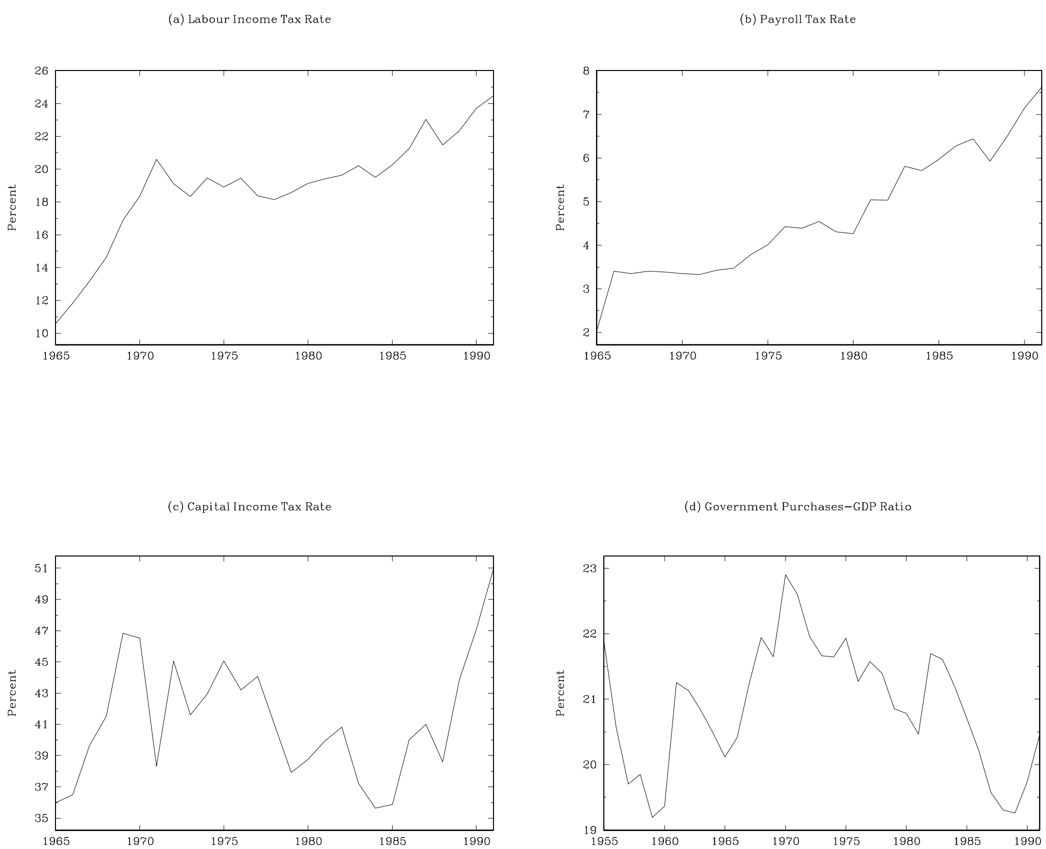

Figure 4. Total Factor Productivity Growth, 1956–1991.

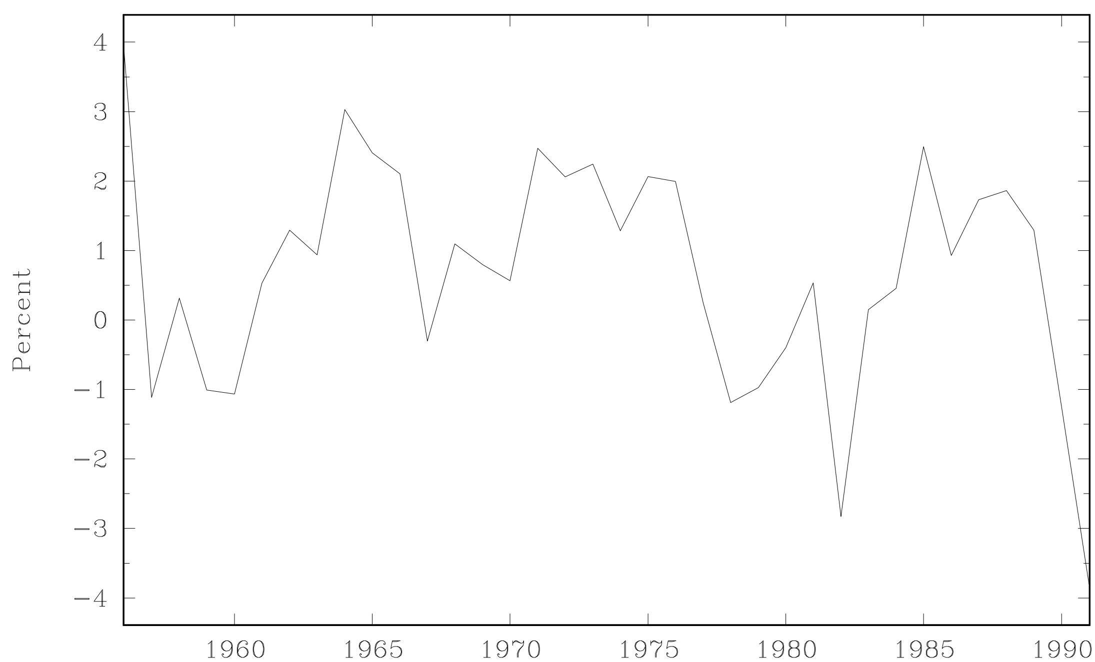

Figure 5. Relative Wage Rate.

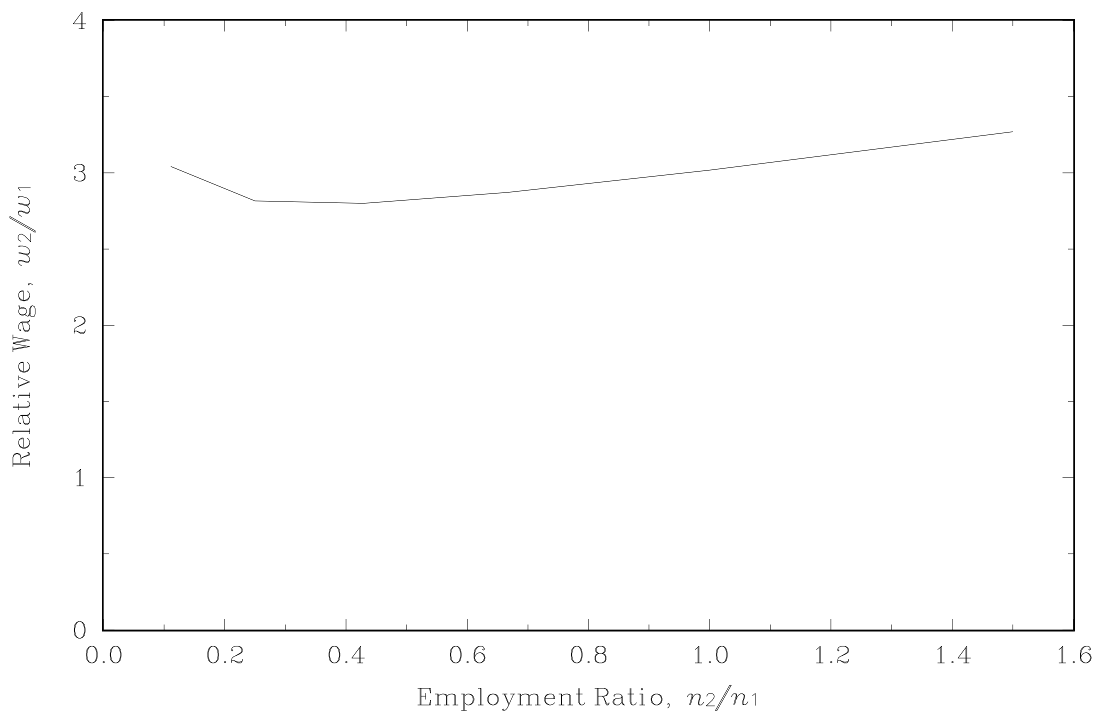

Figure 6(a). Unemployment Duration and the Replacement Rate.

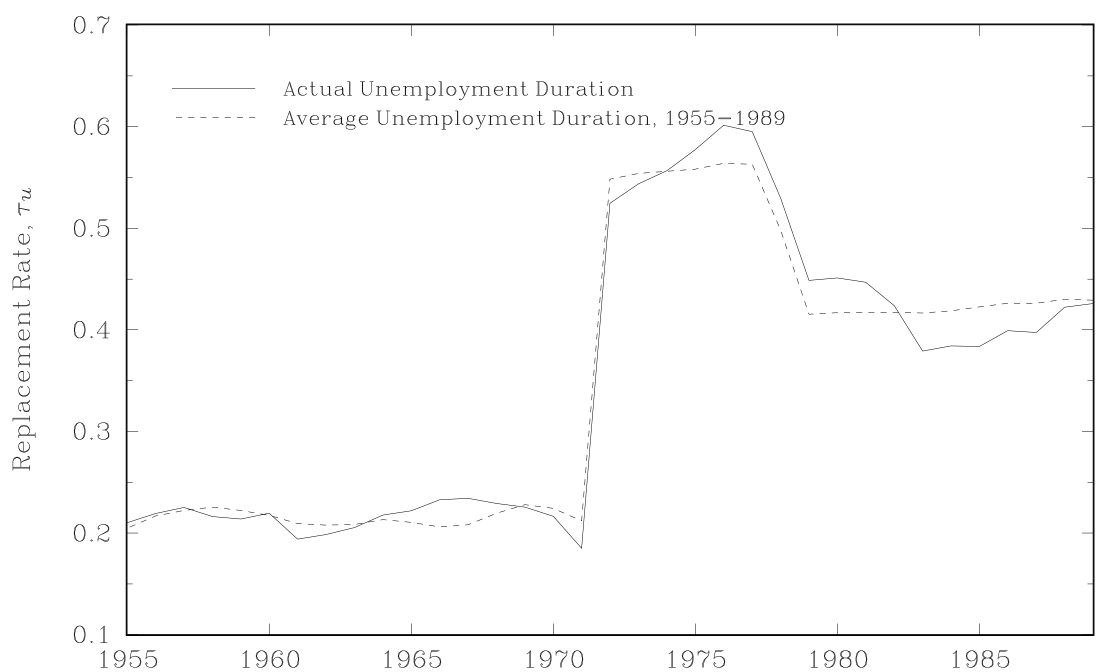

Figure 6(b). Coverage Rate and the Replacement Rate.

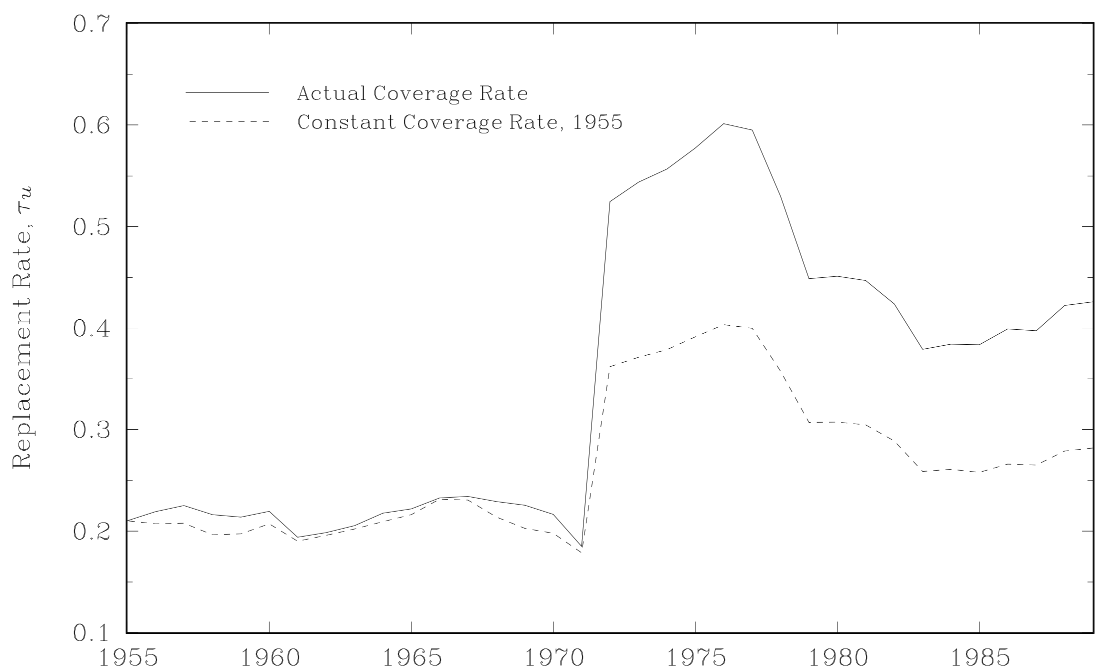

Figure 6(c). Definition of UI Eligibility.

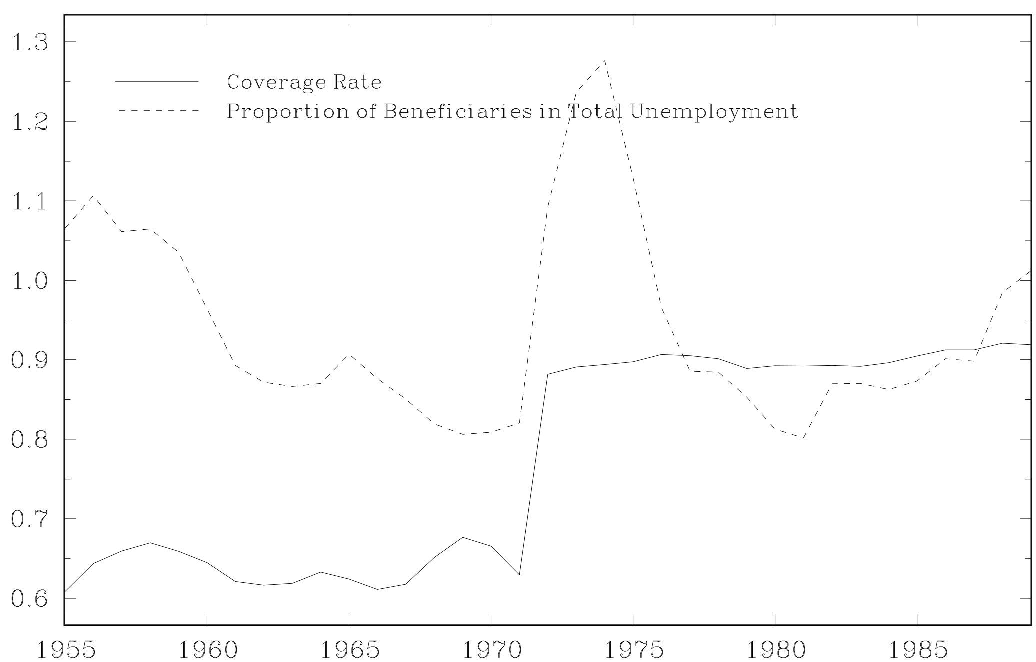

Figure 6(d). UI Eligibility Definition and the Replacement Rate.

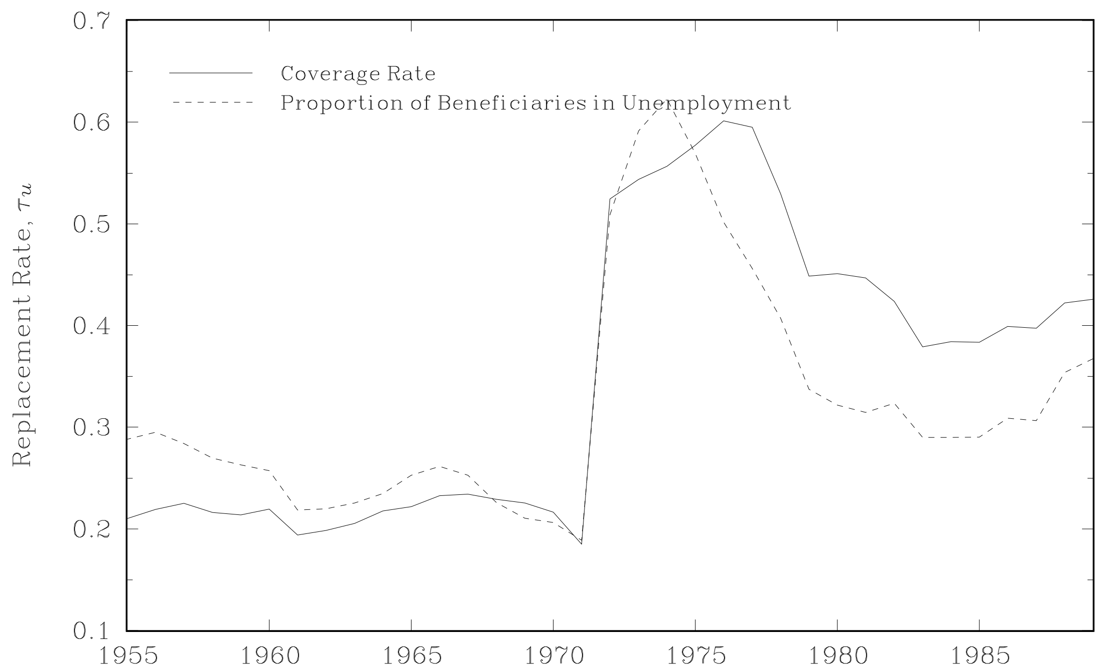

Table 1: The Responses of Labour Market Variables

Absolute Change (*100) Given Actual Changes in Parameters

Parameters	$\Delta(s+n)$	$\Delta s/(s+n)$	$\Delta n_1/n$	$\Delta w_2/w_1$	Δinc	Δd
$\Delta\tau_u$=-0.1541	0.3016	-0.3272	0.7582	-0.0021	-0.4735	-0.0041
	6.4519	-2.7762	6.2633	-0.0162	-3.9132	-0.0313
	-0.0189	-0.0830	0.1910	-0.0005	-0.1202	-0.0010
$\Delta\tau_p$=-0.0290	1.2036	-0.0036	0.0179	-0.0018	-0.0110	0.0386
	2.0386	-0.0347	0.0929	-0.0020	-0.0565	0.0382
	0.5240	-0.0009	0.0115	-0.0018	-0.0071	0.0387
$\Delta\tau_w$=-0.0580	3.0695	-0.0000	-0.0000	0.0000	0.0000	0.0000
	5.0539	-0.0000	-0.0000	0.0000	0.0000	0.0000
	1.3319	0.0000	0.0000	-0.0000	-0.0000	-0.0000
$\Delta\tau_k$=0.0180	0.3247	-0.1316	0.6461	-0.0018	-0.4020	1.4611
	2.9868	-1.2077	3.0649	-0.0083	-1.9154	1.4484
	0.0822	-0.0332	0.4196	-0.0012	-0.2615	1.4623
Δg=-0.0049	-0.2878	-0.0000	-0.0000	0.0000	0.0000	0.0000
	-0.4676	-0.0000	-0.0000	0.0000	0.0000	0.0000
	-0.1261	0.0000	-0.0000	-0.0000	0.0000	-0.0000
$\Delta\sigma_w$=-0.0115	-0.1186	0.0287	-0.0874	-0.0448	0.0547	-0.0863
	-0.7759	0.2907	-0.6969	-0.0448	0.4370	-0.0863
	-0.0389	0.0072	-0.0373	-0.0448	0.0233	-0.0863
$\Delta\sigma_f$=-0.0115	-0.3703	0.1281	-0.6281	0.0646	0.3939	-1.3529
	-3.1246	1.2927	-3.4061	0.0728	2.1372	-1.3374
	-0.1045	0.0320	-0.4023	0.0639	0.2520	-1.3541
Policy Effect	4.1384	-0.3057	0.6983	0.0180	-0.4416	-0.0007
	12.9951	-2.6813	6.0409	0.0180	-3.7846	-0.0007
	1.6539	-0.0773	0.1889	0.0180	-0.1133	-0.0007
$\Delta\varsigma$=0.0062	3.0573	-0.6143	2.8941	-0.0078	-1.8086	7.2372
	14.8228	-4.6472	11.0486	-0.0272	-6.9059	7.1967
	1.0730	-0.1575	1.9246	-0.0053	-1.2028	7.2426
Total Effect	7.2710	-0.9375	3.5923	0.0180	-2.2452	7.3384
	26.6553	-6.2583	14.1319	0.0180	-8.8312	7.3384
	2.7227	-0.2427	2.1242	0.0180	-1.3280	7.3384

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