Employment Insurance and the Business Cycle

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Abstract

This paper quantitatively investigates the scope for improving welfare by making aspects of the unemployment insurance (UI) system depend on the state of the business cycle. A particular focus is the Canadian system of "Employment Insurance" (EI), which is designed in such a way that the generosity of benefits depends on the state of the macroeconomy.

Simulations of a life-cycle model with heterogeneous agents and search frictions confirm the expectation that optimal UI systems may be characterized by a substantial increase in generosity during recessions, when adverse labour market conditions reduce the importance of moral hazard while increasing the need for consumption insurance.

It turns out, however, that the welfare improvements resulting from this sort of temporal differentiation of benefits are extremely small. Quantitatively, the effects of insurance against business cycle effects provided by the Canadian EI system is dominated by the welfare implications of the inter-regional redistribution inherent in the system.

Keywords: unemployment insurance, job search, business cycle.

JEL Classification Numbers: E3, J6.

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1 Introduction

There has been increasing interest recently in the benefits of making the generosity of the unemployment insurance (UI) system depend on the current state of the business cycle and current labour market conditions. The key to designing an efficient UI system is to find the right trade-off between the consumption insurance that a generous system provides and the moral hazard it induces. A wide range of policies that let benefits follow time-dependent profiles have been studied.[1] Tatsiramos and van Ours (2012) provide an up-to-date survey.

The basic idea underlying the time-varying benefits that are the focus of this paper is that during recessions, unemployment is high but the labour market is slow. This means that on the one hand, making benefits more easily available can substantially improve consumption insurance, while at the same time the effect of such a measure on overall unemployment is likely to be lower than during a boom, as the chances of re-employment are low anyway, leaving less scope for moral hazard.

This type of time-varying UI scheme has been proposed by Kiley (2003) and Sánchez (2008) in a repeated moral hazard framework similar to Hopenhayn and Nicolini (1997). Andersen and Svarer (2010) use a Mortensen-Pissarides search model to show that an optimal system would be substantially more generous than the US system during recessions. Kroft and Notowidigdo (2010) find similar results in a model with stochastic wage offers similar to Shimer and Werning (2007). Mitman and Rabinowich (2011) emphasize that optimal benefits may follow more complex paths over the business cycle. They argue that UI systems should become less generous over the course of a recession to speed up recovery and be procyclical overall. Another possible reason for procyclical benefits may be the requirement to balance the government budget every period as discussed in Andersen and Svarer (2011). Determining whether optimal benefits generosity is procyclical or countercyclical has been one focus of this literature. The key contribution of Landais et al. (2010) is to show how the

[1]The aspect that has received the most attentions is how benefits should depend on the duration of the unemployment spell. See Hopenhayn and Nicolini (1997) and the literature that followed.

optimality of benefits can be assessed in any state using an extended Baily-Chetty criterion that accounts for general-equilibrium search externality present in two-sided search models.[2]

Due to the complexity of the policy problem at hand, theoretical models of time-varying unemployment insurance regularly incorporate strong assumptions that may limit applicability of the results in a real-world context. In particular, all the papers mentioned above assume hand-to-mouth consumption and therefore rule out the possibility that households self-insure through saving.[3] It is one of the main contributions of this paper to examine business-cycle dependent UI in a more realistic general-equilibrium setting with fully optimizing agents. Another paper that does this is Kristoffersen (2012), who investigates optimal UI systems in a general equilibrium model similar to Krusell et al. (2010) with fully optimizing, infinitely lived households. The author finds that, in line with the arguments of Landais et al. (2010), either procyclical or countercyclical benefits can be optimal, but that the welfare consequences of allowing for differentiated UI generosity over the business cycle are extremely small.[4]

The Canadian Employment Insurance (EI) program is an interesting example of a system that does implement counter-cyclical generosity, as it includes mechanisms to make benefits more easily available when the unemployment rate is high. Specifically, benefit durations depend on the number of hours worked during a qualifying period. In regions with high unemployment, fewer hours are required to qualify for a given benefit duration and the maximum durations are longer. The replacement ratio does not depend on labour market conditions, though.[5] While these features of the system are often interpreted as a means of

[2]Other contributions to this literature include Ek (2012), Jung and Kuester (2011), Moyen and Stähler (2009) and Schuster (2012).

[3]It should be noted, however, that the criterion developed in Landais et al. likely generalizes to the case of endogenous savings, just as Baily's criterion does.

[4]In contrast to our model, Kristoffersen (2012) employs an infinite horizon setting rather than a life-cycle model. Moreover, he does not allow for moral hazard of any kind.

[5]The UI system in the US also employs a mechanism that can lead to automatic increases in benefit durations during recessions. "Extended Benefits," which increase the benefit duration by 13 or 20 weeks beyond the usual 26 weeks, are triggered by a combination of high unemployment rates and strong increases in unemployment in a state.
Another country where benefit durations depend on the regional unemployment rate is Poland. However, because extended durations are triggered by high unemployment *relative* to the national average and only

interprovincial redistribution, they do have business-cycle implications if the unemployment rate varies enough over time.

There is a growing literature that investigates the effects of extensions to benefit durations during recessions empirically. Farber and Valetta (2013) and Rothstein (2011) use data from the American Current Population Survey (CPS) to show that extended benefit durations lead to small but significant extensions in unemployment durations. Schmieder et al. (2012) find similar results in German data.[6] Using a different approach based on a simulated structural model with fully optimizing households whose productivity depends on their employment history, Nakajima (2012) attributes almost a third of the rise in US unemployment during the 2009-2011 period to extended benefit durations.

This paper investigates the scope for improving welfare by adjusting UI generosity over the business cycle. This is done quantitatively using a general equilibrium model with overlapping generations of heterogeneous agents that is calibrated to resemble the Canadian economy. I consider the efficiency effects of changing replacement ratios and benefit durations over the business cycle. Moreover, I investigate the welfare and distributional implications of the fact that by design, the Canadian EI system varies benefits not only over time, but also across regions.

The plan for this paper is as follows. The following section makes a simple quantitative argument that expected welfare effects of UI differentiation are small. Then I briefly introduce relevant aspects of the Canadian EI system. Sections 4 and 5 describe the model and discuss its calibration and simulation. The main results are presented in section 6. First, the welfare implications of a range of possible UI policies are discussed in the context of the aggregate Canadian economy. Optimal UI policies with and without time-varying benefit schedules are derived for several classes of systems. Then the model is calibrated to match the characteristics of groups of regions that are treated differently under the current EI

with long lags, the Polish system is unlikely to provide particularly effective insurance against business cycle effects. See Sienkiewicz (2011).

[6] Even though benefit durations do not vary with labour market conditions in Germany, the authors are able to exploit the fact that older individuals are entitled to extended benefits.

system to investigate the insurance and distributional properties of the program. Section 7 presents alternative specifications and robustness checks. After a brief discussion of the main findings in part 8, the final section of the paper concludes.

2 Business Cycle Dependent UI and Welfare

Most of the simulation exercises presented in this paper address the question of how UI benefit differentiation over the business cycle affects welfare. To get an idea of the magnitude of the welfare effects to expect, this section presents a simple numerical example that suggests that – as long as the undifferentiated UI system is chosen optimally – switching to the optimal differentiated system is likely to have a very small impact on utilitarian welfare.

Consider an economy that can be in two states, $i = \ell, h$, which occur with probabilities π^i. When in state ℓ, the economy is in a recession. Individuals can be either employed or unemployed. While employed, they enjoy a consumption level of c_e and when unemployed, their consumption level is c_u^i, which may depend on the state i if the UI system is differentiated. Let U^i be the unemployment rate in each state and $\bar{U}$ the average unemployment rate. $u(c)$ is the individuals' utility as a function of consumption.

Assume that the UI system influences households' consumption. It is easy to derive an optimality criteria in the spirit of Baily (1978) for the consumption level of unemployed households under utilitarian welfare. For a differentiated system that controls c_u^ℓ and c_u^h separately, the criteria are

$$\frac{u'(c_u^i)}{u'(c_e)} = 1 + \epsilon^i, \tag{1}$$

where ϵ^i is the elasticity of unemployment duration with respect to c_u^i in each of the state. For an undifferentiated system that results in $c_u = c_u^\ell = c_u^h$, the criterion becomes

$$\frac{u'(c_u)}{u'(c_e)} = 1 + \bar{\epsilon}. \tag{2}$$

$\bar{\epsilon} = \left(\pi^\ell U^\ell \epsilon^\ell + \pi^h U^h l \epsilon^h\right) / \bar{U}$ is the weighted average of the elasticities in the two macro states.

Calibrate the probabilities of the states as $U^\ell = 9\%$, $U^h = 7\%$ and $\pi^\ell = 10\%$ and assume a constant relative risk aversion of 3. Under an undifferentiated system, let $c^h = 1$ and $c^\ell = 0.9$. This is in line with the findings of Gruber (1997), who reports that individuals losing their job experience an initial consumption drop of 6.8%. Now suppose that the underlying UI system is optimal, so that condition (1) is satisfied. This implies that $\bar{\epsilon} = 37.2\%$. Suppose further that in the bad state, there is no moral hazard problem, i.e. $\epsilon^\ell = 0$. Then, ϵ^h must be 42.5%.

What is the effect of switching to the optimal differentiated system? Under this system, individuals must be fully insured in the bad state. It turns out that $c_e = c_u^\ell = 0.9998$, c_u^h slightly drops to 0.8884, and U^h falls to 6.962%. While there is a noticeable differentiation of the consumption levels of unemployed individuals over the business cycle under the optimal policy[7], the resulting welfare improvement of 0.025% is extremely small.

There are two main reasons for this result. Firstly, we implicitly allowed households to self-insure, which led to a moderate consumption drop during unemployment. If one insists that a replacement ratio of 50% is associated with a 50% consumption reduction after job loss, it is possible to find much larger welfare effects. Secondly, we assumed that the generosity of the undifferentiated system was chosen optimally. If this assumption is dropped, it is possible to obtain almost arbitrarily large welfare effects by switching from a very inefficient system to one which at least determines the benefit level in recessions efficiently.

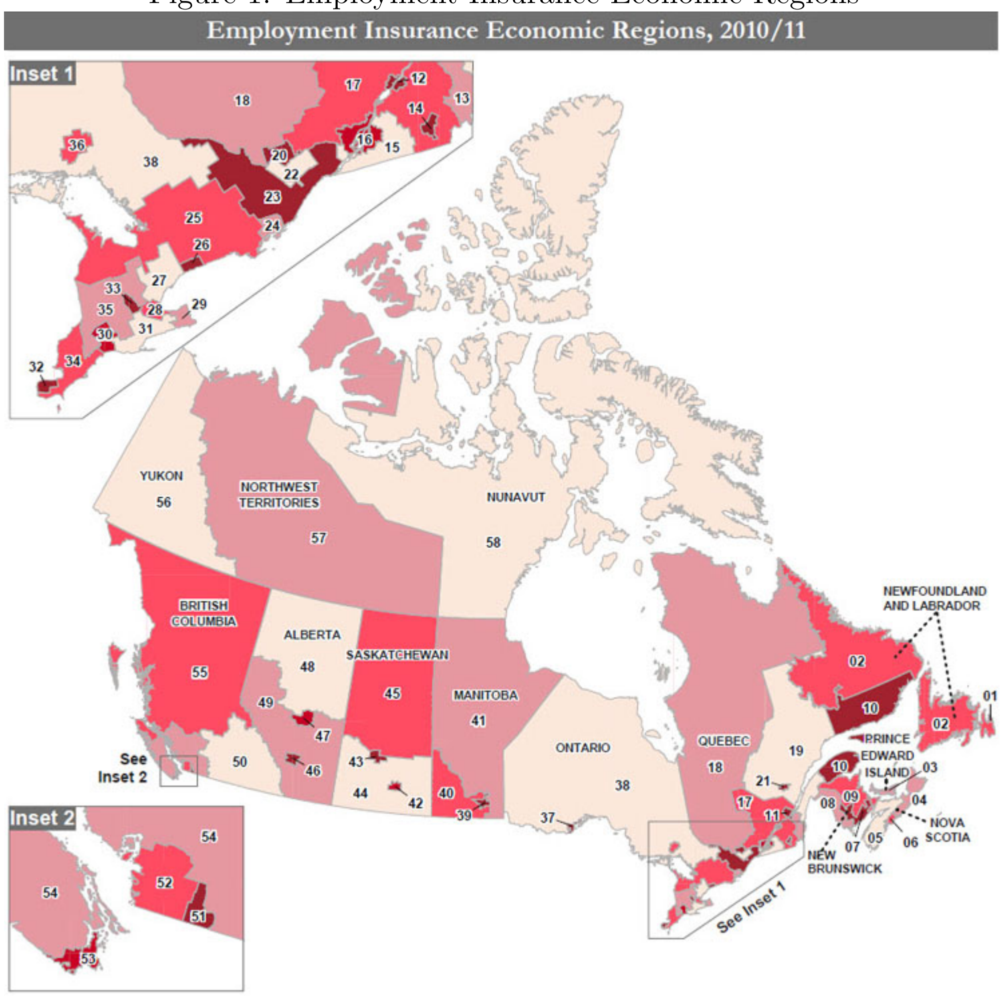
Starting in section 4 below, we will introduce a model in which households' ability to self-insure is determined endogenously in a life-cycle setting. Simulations will show to what extent it is possible to improve welfare by differentiating UI generosity in different settings.

[7]The 11% differentiation of consumption levels would likely be associated with a much larger differentiation of actual UI benefits if households self-insure.

3 The Canadian EI System

For the purpose of administering EI, Canada is divided into 58 "EI Economic Regions," which are chosen to cover individual labour markets or areas with homogenous labour market conditions. The geographical definition of these regions has been changed in the past. Figure 1 shows their current configuration, which has been in place since July 2000.

Figure 1: Employment Insurance Economic Regions



Source: "EI Monitoring and Assessment Report 2011," Human Resources and Skills Development Canada, Annex 7.

For each of these regions, the 3-months moving average of the seasonally adjusted unemployment rate is used to determine the conditions for the receipt of EI benefits. EI economic regions are clustered into one of 12 groups based on this unemployment figure (no more than

Table 1: Regional Unemployment and Maximum Benefit Duration

hours[a]	unemployment rate less or equal											
	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	–
420-454	0	0	0	0	0	0	0	0	26	28	30	32
455-489	0	0	0	0	0	0	0	24	26	28	30	32
490-524	0	0	0	0	0	0	23	25	27	29	31	33
525-559	0	0	0	0	0	21	23	25	27	29	31	33
560-594	0	0	0	0	20	22	24	26	28	30	32	34
595-629	0	0	0	18	20	22	24	26	28	30	32	34
630-664	0	0	17	19	21	23	25	27	29	31	33	35
665-699	0	15	17	19	21	23	25	27	29	31	33	35
700-734	14	16	18	20	22	24	26	28	30	32	34	36
735-769	14	16	18	20	22	24	26	28	30	32	34	36
						⋮						
1715-1749	33	35	37	39	41	43	45	45	45	45	45	45
1750-1784	34	36	38	40	42	44	45	45	45	45	45	45
1785-1819	35	37	39	41	43	45	45	45	45	45	45	45
1820-	36	38	40	42	44	45	45	45	45	45	45	45

[a] number of insurable hours of work during the qualifying period, which is typically the 52 weeks before job loss

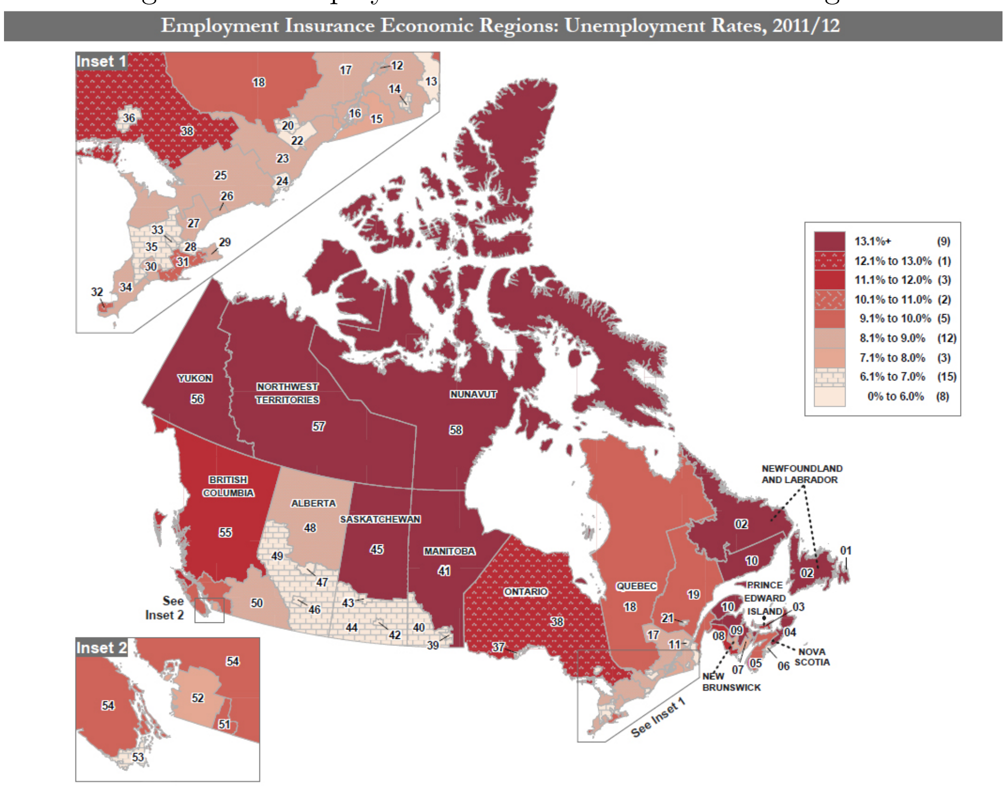
6%, 6% to 7%, 7% to 8%, etc. up to 16% and more).[8] The conditions for the receipt of benefit depends on the unemployment rate in a person's region of residence. The higher this rate, the easier it is to qualify for benefits and the longer is the benefit duration. The required number of hours of work to qualify for benefits ranges from 420 in the 12 months prior to job loss (in regions with an unemployment rate above 13%) to 700 hours (if the unemployment rate is 6% or less). The benefit duration increases with the number of hours

[8] The official unemployment rates reported and used for this purpose by Human Resources and Skill Development Canada (HRSDC), the federal agency administering the unemployment insurance program, differ somewhat from those published by Statistics Canada, even though they are derived from the same survey. The most important difference is that in contrast to Statistics Canada, HRSDC includes aboriginal people living on reserves in their calculations. This leads to higher unemployment measures mostly in the relatively sparsely populated northern parts of the provinces.

worked up to a maximum between 36 weeks in low-unemployment regions and 45 weeks in high-unemployment regions. Table 1 shows the relationship between the regional unemployment rate and maximum benefit duration for a subset of the relevant qualification period brackets.[9]

The aspect of the EI system that is most interesting for our purpose is how maximum benefit durations depend on regional unemployment rates. As can be seen in the last row of table 1, according to this criterion the EI economic regions can be classified into six groups.

Figure 2: Unemployment Rates across Economic Regions



Source: "EI Monitoring and Assessment Report 2012," Human Resources and Skills Development Canada, Annex 1.

[9] Even though the requirements are stated in terms of insurable hours, the underlying idea is to model the system around a 35-hour workweek. The somewhat complicated pattern is as follows: For the same number of qualifying hours, the maximum benefit duration increases by 2 weeks per extra percentage point of regional unemployment. For every additional 70 hours (35 hours) of insurable work, the benefit duration increases by one week if the total number of hours is between 420 and 1,399 (between 1,400 and 1,820). The minimum number of hours required is 420 in regions with more than 13% unemployment. This minimum requirement increases by 35 hours for each one-percentage-point drop of local unemployment. No benefit durations of more than 45 weeks are possible.

Figure 2 reports the official unemployment rates in these regions for 2011-12.[10] Clearly, the wide range of regional unemployment rates over which the generosity of the system varies has been chosen for a reason. Generally, unemployment rates tend to be higher in the four Atlantic Provinces Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick and relatively low in the Prairie Provinces Alberta, Saskatchewan and Manitoba. Within provinces, unemployment rates are typically higher in the northern EI regions.

EI is financed through contributions, which are adjusted annually. In 2013, the total contribution rate was 4.51% on earnings up to the maximum insurable amount of $47,400, which is also adjusted every year.[11] This contribution rate is not an ideal indicator of the cost of UI in Canada, as the EI program does not only provide UI benefits, called regular benefits, but also parental benefits, sickness benefits and benefits to self-employed fishermen, among others. The ratios of regular benefits to insurable earnings and total employment income were 2.70% and 1.71%, respectively, in 2010.[12]

4 The Model

In any given period t, the economy is in one of two possible macro states $s_t \in \{0, 1\}$. In the bad state $s = 0$, which will be identified with periods of recession, total factor productivity (TFP) $p(s_t)$ is lower and the risk of job loss is higher. The sequence of macro states follows a Markov process.

[10]The official unemployment rate in regions 56 to 58, Yukon, the Northwest Territories and Nunavut, is 25%. Even though Statistics Canada measures the unemployment rates in these territories, the corresponding component of the Labour Force Survey is deemed experimental.

[11]The contributions are split between employers and employees. Employers always pay 1.4 times the employees' contributions. Since 2006, Quebec has had a different contribution rate, which is somewhat lower than the federal rate.

[12]See EI Monitoring and Assessment Report 2012, Annexes 2.18 and 2.19.

4.1 Households

The economy is populated by equally large overlapping generations of heterogeneous agents. Each individual has a life span of 60 years, corresponding to ages 20 to 79. Important events include entry into the economy and the labour market at age 20, retirement at age 65 and death at 80 years of age. All agents are identical initially; however, their actual income profiles over their lives differ due to the idiosyncratic nature of labour market opportunities, resulting in different asset levels and consumption possibilities among individuals of the same cohort.

When they first enter the economy, agents are endowed with assets corresponding to three months of labour income[13], but they do not have a job. If an individual is unemployed in period t, she receives job offers at the rate $\omega(s_t)$. These employment opportunities differ in productivity and are therefore characterized by different wages.[14] Once an agent receives an acceptable offer, a job is created and production begins in the following period. Moral hazard arises in the form of individual reservation wages (or equivalently reservation match qualities) that deviate from the social optimum.[15] Jobs last until they are destroyed, which happens at the exogenous state-dependent rate $\lambda(s_t)$, or when the agent reaches her retirement age. After retirement, all agents must rely on assets and interest income for consumption.

Agents maximize the expected utility derived from consumption during the rest of their deterministic lifetime, which is assumed to be time separable.

$$\max E_t \left[\sum_{s=t}^{T_i} \beta^{s-t} u(c_{it}) \right] \tag{3}$$

Here, the index i refers to the individual, T_i is the last period of agent i's life, $\beta > 0$ is a discount factor and $u(c_{it})$ is the agent's instantaneous utility as function of consumption c_{it}.

[13]Three months of the income earned by a 20-year-old agent in a job with match quality one and a reservation wage of zero.

[14]This mechanism is similar to the one used by Shimer and Werning (2007) and Kroft and Notowidigdo (2010.)

[15]Agents who decline jobs are not sanctioned by the government. Pallage and Zimmermann (2005) argue that such sanctions are an important mechanism to control moral hazard in reality.

Agents can save at the prevailing interest rate r, but they are unable to borrow.[16] For every period t of an agent's life, her financial wealth a_{it} therefore evolves according to the budget and borrowing constraint

$$a_{it+1} = (1 + r)(a_{it} + y_{it} - c_{it}) \geq 0, \tag{BC}$$

where y_{it} is any income received during this period, which could be wages or UI benefits.[17]

4.2 Firms and the Labour Market

The labour market is characterized by a Mortensen-Pissarides setting with two-sided search.[18] In order to produce output, firms must first post a vacancy, then wait for a worker to be matched and negotiate a contract. Unfilled vacancies are associated with a flow cost of $kp(s_t)$ that is proportional to TFP. The frequency of matches between workers and firms is determined by an aggregate matching function. Following the literature on job search, I assume that this function is Cobb-Douglas with constant returns to scale, so that the rate of job offers unemployed workers receive can be written as $\omega(s_t) = \bar{\omega}\,(\theta(s_t))^{\eta}$, where $\theta(s_t)$ is the market tightness as a function of the macro state.

Each firm (or job) produces output for a competitive goods market using capital and labour as inputs. The production technology is Cobb-Douglas with a capital share of α. Capital depreciates at the rate δ. The productivity of a worker i on a job j depends on two factors, the worker's inherent productivity q_{it} and the quality of the match m_{ij}. q_{it} increases deterministically over an agent's working life, whereas m_{ij} is a measure of how good the applicant fits the job description. For each match, this match quality m_{ij} is drawn from a lognormal distribution, $\ln m_{ij} \sim N(-\frac{1}{2}\sigma_m^2, \sigma_m^2)$. m_{ij} and q_{it} together determine

[16] I assume that the interest rate is exogenous, which is probably reasonable approximation for a small open economy such as Canada. This assumption also simplifies the model considerably compared to a closed-economy model with time-varying interest rates as in Krusell and Smith (1998).

[17] See appendix A for further details and a formal description of the household's problem.

[18] See Pissarides (2000).

the effective labour supplied by worker i on job j, so that the output produced is given by $Y_{ijt} = p(s_t)\,(m_{ij}q_{it})^{1-\alpha}\,K_{jt}^{\alpha}$. The capital input K_{jt} is adjusted optimally every period, implying $Y_{ijt} = \left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}} p(s_t)^{\frac{1}{1-\alpha}} m_{ij}q_{it}$.

When a firm and a worker meet, Nash bargaining over the part of the labour share $(1-\alpha)Y_{ijt}$ that is paid to the worker as a wage w_{ijt} takes place. Once a job is created, the ratio $\frac{w_{ijt}}{Y_{ijt}}$ stays constant as wages are adjusted to reflect changes in aggregate and individual productivities.[19]

The market tightness in each state is determined by the condition that the expected value of a vacancy be zero. In other words, the aggregate vacancy costs in each state are equal to the rents earned by firms on jobs created in the same state.[20]

4.3 The Capital Market and the Government

Capital is supplied elastically by the world capital market at the interest rate r.

The government runs a UI system. It makes payments to eligible working-age individuals. Moreover, the government provides new agents with their initial asset allocation.[21] To pay for these expenditures, the government levies a proportional tax at a constant rate on all labour income and transfers, i.e. on wages, UI benefits and the agents' initial endowment.[22]

4.4 Long-run Equilibrium

The economy just described is defined to be in a stationary equilibrium if

1. households maximize their utility,

[19] The bargaining is over the present value of income streams rather than utility. The output from the job above the household's reservation wage is split according to the relative bargaining strengths of the two sides. This means that given this reservation wage, in negotiations households act as if they were risk neutral.

[20] I make the simplifying assumption that the market tightness depends on the current state only. This neglects the possibility of using the current distribution of household characteristics to predict time-varying reservation wages more accurately. This simplification is necessary for computational reasons, and is unlikely to be quantitatively important.

[21] Note that this means that the tax rate will be positive even if no UI benefits are paid.

[22] The assumption that all wages and transfers are taxed at the same rate makes it possible to solve the model independent of tax policy in the case of CRRA preferences.

2. firms maximize their profits,
3. given the tightness $\theta_t \in \{\theta(0), \theta(1)\}$ in each macro state $s \in \{0, 1\}$, the total expenditure on vacancies equals the expected rents earned on jobs created in this state,
4. the government budget is balanced on average over the business cycle, and
5. the cross-sectional distribution of the population with respect to individual characteristics is stationary.

5 Calibration and Computation

The model is calibrated to match the aggregate Canadian economy or groups of EI economic regions as discussed below. Whenever possible, the model economy replicates features of the Canadian economy between July 2000 and December 2012. This time frame is chosen to make use of all available microdata on EI economic regions in their current configuration, which has been in place since July 2000. These $12\frac{1}{2}$ years are a short time for measuring business cycle effects, however. This period only includes one relatively short recession. For this reason, some parameters are calibrated using a longer data period from January 1976 to June 2013.[23] The starting point of this extended period was chosen to match the introduction of the Labour Force Survey (LFS), the main source of labour market statistics in Canada, in its present form.

For the calibration exercise, I use a specification of the unemployment insurance system that resembles the Canadian Employment Insurance. Specifically, benefits are paid after a waiting period of two weeks at a replacement ratio of 55%. In practice, the duration of the benefits depends on the prevailing unemployment rate as well as an individual's number of hours of insurable work during a qualifying period. Since the work requirement is relatively

[23]Note that the this extended period is exactly three times as long as the shorter period – $37\frac{1}{2}$ years or 450 months vs. $12\frac{1}{2}$ years or 150 months. Recessions are occurring more frequently in the extended period, accounting for 10% of all quarters compared to 6% in the shorter period.

low compared to the typical time between two unemployment spells, I assume that everyone is entitled to receive benefits for the maximum duration available to those with about one year of full-time employment. Benefit durations depend on whether the unemployment spell begins during a boom or a recession. For the aggregate economy, average unemployment rates of 7% to 8% in the good state and 9% to 10% during recessions imply benefit durations of 40 and 44 weeks, respectively.

The households' instantaneous utility function u is assumed to exhibit a constant relative risk aversion of $\gamma = 3$. The annual discount rate is 4%. These values are standard in the macroeconomic literature.

The interest rate is set to the average long-term interest rate of 2.4% for the 2000:7 to 2012:12 period.

Individual productivity q_{it} increases deterministically in a piecewise linear fashion with age to generate lifetime income profiles that resemble those found in household panel data.[24] It rises by 60% between ages 20 and 35, and then by another 20 percentage points until retirement.

The transition probabilities between the macro states are chosen to match the average frequency and duration of recessions in Canada between 1976:Q1 and 2013:Q2. The average duration of recessions during this time was $3\frac{3}{4}$ quarters, with recessions accounting for exactly 10% of the periods.

Productivity is set to be 5.1% lower during recessions, which is the average multifactor productivity (MFP) differential for the business sector between 1976 and 2009 as reported by Statistics Canada.[25] Production is characterized by a capital share of $\alpha = \frac{1}{3}$ and a depreciation rate of $\delta = 8\%$ per year.

The matching parameter η is set to $\frac{1}{2}$, in line with the empirical literature. The variance of match qualities of $\sigma_m^2 = 1\%$ is consistent with the estimates reported in Pollak (2013).

The remaining parameters are calibrated such that the simulated model matches certain

[24] See e.g. Rupert and Zanella (2010).

[25] Multifactor productivity is reported at annual frequency, with 2009 being the most recent year available.

aspects of the data. Specifically, for the calibration of the aggregate economy, the matching rate $\omega(1) = 0.323$ per period is chosen to generate an unemployment rate of 7.13% in the good state, equal to the 2000:7-2012:12 average. Market tightness in the high state is normalized to $\theta(1) = 1$. The matching rate in the low state is then implied to be $\omega(0) = 0.306$, given the lower market tightness $\theta(0) = 0.898$ resulting from lower profits during recessions. The job destruction rate during recessions of $\lambda(0) = 1.43\%$ per period implies an average monthly increase of the unemployment rate of 0.25 percentage points, matching the respective value for the Canadian economy between 1976:1 and 2013:6. Finally, setting $\lambda(1) = 0.90\%$ gives an average unemployment duration of 13.8 weeks, equal to the average found in the LFS for the 2000:7 to 2012:12 period.

The household's relative bargaining strength is set to 95%. This relatively high value implies a vacancy cost of $k = 0.58$ in the model calibrated to the aggregate economy. In the simulations reported below, market tightness in the good state is normalized to one. In this case, the vacancy cost is about 5.8% of the average wage. Statistics Canada reports an actual market tightness of only about $\frac{1}{6}$, however.[26] Under this low market tightness, the corresponding vacancy-cost-to-wage ratio of about one third is consistent with the values reported in the empirical literature.[27]

The calibrated parameters for the aggregate scenario are summarized in table 2.[28]

The model is simulated at a period length of $\frac{1}{2}$ month, i.e. at 24 periods per year or 1440 periods in a lifetime. To solve the model for a particular UI system and parameter constellation, it is necessary to determine the market tightness parameters. This is done as follows. First, the household's problem is solved for a given set of tightness parameters. Then the economy is simulated for a large number of periods. The market tightness parameters

[26]See series v65958686 and v65958994 for the number of vacancies and unemployed at monthly frequency. Reliable vacancy data for Canada has only been available since 2011. Please note that the *job vacancy rates* reported by Statistics Canada are based on a narrow definition of unemployment and thus differ from the market tightness concept used in the theoretical literature.

[27]This is essentially the same vacancy cost that has been used by Landais et al. (2010). Empirical studies tend to find values between about 10% and 60%, see Barron et al. (1997), Silva and Toledo (2005) and Hagedorn and Manovskii (2008).

[28]Further details regarding the data used in the calibration can be found in appendix B.

Table 2: Calibration: Aggregate Canadian Economy

parameter		value	
γ	relative risk aversion	3.0	
β	discount rate	0.96[a]	
α	capital share	$\frac{1}{3}$	
δ	depreciation rate	8%[a]	
ϵ	household's bargaining power	0.95	
η	matching parameter	$\frac{1}{2}$	
σ_m^2	variance of match quality	0.01	
			matching parameter to data
r	interest rate	2.41%[a]	10-year avg. yield of government bonds
$p(0)/q(1)$	relative productivity in bad state	0.949	drop in MFP during recessions
$s = 0 \rightarrow s = 0$	probability of remaining in $s = 0$	0.956[b]	avg. duration of recessions
$s = 1 \rightarrow s = 1$	probability of remaining in $s = 1$	0.995[b]	avg. time between recessions
			matching equilibrium outcome
$\omega(1)$	rate of job offers ($s_t = 1$)	0.323[b]	unemployment rate in good state
$\lambda(0)$	job destruction rate ($s_t = 0$)	1.43%[b]	rise in unemployment during recessions
$\lambda(1)$	job destruction rate ($s_t = 1$)	0.90%[b]	unemployment duration
k	vacancy cost	0.581[b]	zero profit for $\theta(1) = 1$

[a] per year

[b] per period ($\frac{1}{24}$ year)

are adjusted based on the simulation results, with the objective to make expected profits in the firm sector zero. This process is repeated until convergence.[29]

The household's problem is solved by recursively finding the value function for each of the 1,440 periods of an agent's lifetime, starting with the last one. The functions are calculated on a multidimensional grid, using linear interpolation between grid points.[30] The periods prior to retirement are much more complex to solve because of the larger number of state

[29] A total of 1,440,000 periods (60,000 years) is simulated with a cohort size of one person and 1,440 overlapping cohorts at any point in time. The convergence criterion used is a deviation of the market tightness from its predicted value by less than 0.1%.

[30] Further details on the numerical solution strategy are provided in appendix C.

variables (assets, employment status, current match quality or benefit level, UI entitlement, aggregate state of the economy).[31]

The finite size of the simulated sample as well the deviation permitted by the convergence criterion lead to noise in the variables obtained in the simulation runs.[32] Table 3 summarizes the implications for some variables of interest.

Table 3: Accuracy of selected equilibrium measurements

variable	coefficient of variation	max. rel. deviation
welfare[a,b]	$1.02 \cdot 10^{-5}$	$2.78 \cdot 10^{-5}$
expected lifetime utility[b]	$5.59 \cdot 10^{-5}$	$4.13 \cdot 10^{-4}$
$\theta(0)$	$3.39 \cdot 10^{-4}$	$1.16 \cdot 10^{-3}$
$\theta(1)$	$9.32 \cdot 10^{-5}$	$2.86 \cdot 10^{-4}$
unemployment rate ($s = 0$)	$1.85 \cdot 10^{-4}$	$4.46 \cdot 10^{-4}$
unemployment rate ($s = 1$)	$5.56 \cdot 10^{-5}$	$1.55 \cdot 10^{-4}$
consumption	$6.60 \cdot 10^{-6}$	$2.39 \cdot 10^{-5}$
tax rate	$5.65 \cdot 10^{-5}$	$2.01 \cdot 10^{-4}$

[a] utilitarian welfare excluding individuals who have never worked

[b] measured in consumption units

Note: Coefficient of variation and maximum relative deviation from the mean found in 200 simulation runs using different starting values.

6 Results

6.1 Efficient Provision of UI over the Business Cycle

Our first objective is to characterize properties of an efficient UI system quantitatively. This is done by using the calibrated model of the aggregate Canadian economy to perform a number of simulations under different UI systems and comparing characteristics of the

[31] The most complex value functions just prior to retirement have far over 100,000 nodes (497 asset states, 18 job match levels, 19 benefit levels, 7 UI entitlement levels, 2 employment states and 2 macro states).

[32] To further improve the accuracy of the simulation, all results are averaged over ten simulation runs with different simulated samples.

resulting equilibria.[33] The UI systems considered in this exercise have the following properties: Agents who lose their job are entitled to receive benefits. The benefit duration is determined at the time of job loss, like in the Canadian system. This duration may be different depending on whether the spell begins during a good or bad state. There is no waiting period. The replacement ratio may also depend on the state of the economy. At any point in time, however, all unemployed individuals receive the same benefit, i.e. the replacement ratio for an individual may change if the state of the economy changes. The UI system is therefore characterized by four parameters, two replacement ratios $\rho(s)$ and two benefit durations $d(s)$.

The welfare criterion used throughout this paper is utilitarian. I exclude agents from the welfare measure who have never had a job and are therefore ineligible to receive benefits.[34] All welfare changes are reported in consumption-equivalent units.[35]

Appendix D gives an overview of the effects of UI by reporting and summarizing the results of simulating a large number of UI policies with replacement ratios ranging from 0% to 100% and benefit durations of up to 18 months. In what follows, we will focus on the implications of implementing benefits that are differentiated based on the state of the business cycle.[36]

The solid line in the top left panel of Figure 3 shows the optimal choice of replacement

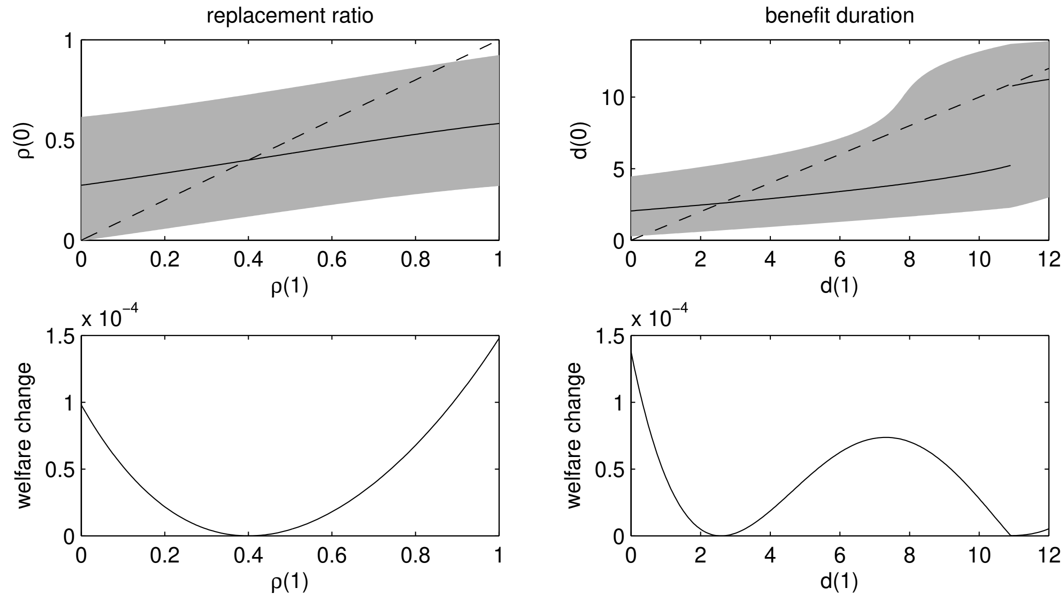
[33] As the focus of this paper is not UI reform, we will be considering steady states only. For the importance of transition paths for the welfare implications of UI policy changes, see Mukoyama (2012).

[34] Agents who have not yet successfully entered the labour market are excluded for simple practical reasons. As these individuals are all unemployed but not eligible to receive UI benefits, their welfare tends to depend strongly on the prevailing market tightness. Generally, these agents favour less generous systems as they imply a higher matching rate and lower taxes on initial wealth. Depending on the assumptions regarding young agents' initial endowment with assets, the impact of the welfare of this group on overall utilitarian welfare may be anywhere from negligible to dominating. In the absence of a serious calibration of the average level and cross-sectional variation of initial financial wealth or access to other means of support - such as social assistance or support from relatives - I decided to remove this group entirely from the welfare calculation. This allows us to focus on the business-cycle properties of UI rather than distributional effects regarding young unemployed.
Note that this issue does not arise in an infinite-horizon setting where everybody has an employment history and is thus potentially eligible to receive UI benefits.

[35] A reported 1% welfare improvement is equivalent to the welfare change that would have resulted from a general 1% increase in consumption.

[36] Given our calibration, particularly with regards to risk aversion, optimal benefit generosity tends to be lower than the existing policy. Experiments in section 7 consider alternative levels of risk aversion.

Figure 3: Optimal differentiation of benefits over the business cycle



Note: Upper panels: Optimal policy parameter in recessions as a function of policy parameter during non-recessions (solid line) compared to no differentiation over the business cycle (dashed line). The shaded area shows the range of policy parameters that yield welfare within $\frac{1}{100}\%$ of the optimal choice.
Lower panels: Relative welfare improvement from choosing optimal differentiation over no differentiation as a function of the policy parameter during non-recessions.
Left: Varying replacement ratio for a fixed benefit duration of 3 months.
Right: Varying benefit duration for a fixed replacement ratio of 30%.
Values obtained for a 4^{th}-order polynomial approximation of simulated welfare function.

ratios during recessions, $\rho(0)$, as a function of replacement ratios in normal times, $\rho(1)$ for a constant benefit duration $d(s) = 3$. The dashed line corresponds to undifferentiated replacement ratios, $\rho(0) = \rho(1)$. The optimal level of $\rho(0)$ rises monotonically with $\rho(1)$ and is above $\rho(1)$ for replacement ratios below 40%. In this range, countercyclical UI generosity is desirable. For $\rho(1) > 40\%$ generosity should be procyclical. As pointed out by Landais et al. (2010), the two factors determining the optimal benefit generosity at the margin are its effect on the insurance-cost trade-off as summarized by the Baily-Chetty condition[37] and its general-equilibrium effect on the search externality. Given our calibration, the second effect always works towards countercyclical generosity. The optimal undifferentiated policy is $\rho(0) = \rho(1) = 24\%$ while the optimal differentiated policy is $\rho(0) = 34\%$ and $\rho(1) = 23\%$.[38]

[37] Baily (1978) and Chetty (2006)

[38] These results coincide with the optimal policies reported in the $\rho(s) \geq 20\%$ and $d(s) \geq 3$ scenario in table 4 below.

Clearly, there is a benefit to a differentiated policy that outweighs its costs well beyond the optimal level of generosity. For $\rho(1) > 40\%$, however, the high moral-hazard costs of of procyclical replacement ratios make them unattractive from a welfare perspective.

Even though the optimal level of $\rho(0)$ may differ substantially from $\rho(1)$, the welfare cost of choosing an undifferentiated system over the policy involving the optimal replacement ratio during recessions is very low. The gray area in the figure shows the range of $\rho(0)$ that involves a welfare reduction of less than $\frac{1}{100}\%$ compared to the optimal choice of $\rho(0)$. Note that the dashed line representing $\rho(0) = \rho(1)$ lies within this range for $\rho(1) < 90\%$, which means that the cost of the undifferentiated system compared to the optimally differentiated system is small. The lower left panel of figure 3 explicitly shows this welfare cost.

The two panels on the right of figure 3 show the corresponding effects of varying benefit durations instead of replacement ratios. For a fixed replacement ratio of $\rho(0) = \rho(1) = 30\%$ the optimal benefit duration $d(0)$ is shown as a function of $d(1)$ in the upper panel. In this scenario, countercyclical generosity is desirable for benefit durations of up $2\frac{1}{2}$ months. An interesting feature of the optimal benefit duration is that it is not a continuous function of $d(1)$. The discontinuity results from the fact that the welfare function is generally non-concave in $d(0)$.[39] Again, the welfare costs of choosing an undifferentiated policy $d(0) = d(1)$ over the optimal differentiated one for any level of $d(1)$ is very small.[40]

In both of the above scenarios that vary either replacement ratios or benefit durations taking the other policy variable as given, it may be optimal to implement a considerable differentiation of UI over the business cycle. Under our parametrization, benefit generosity should be procyclical in the vicinity of the optimal non-recession parameter value.

[39]Note that the discontinuity occurs for a rather high value of $d(1)$, more than five times the optimum.

[40]In this scenario, the optimal undifferentiated policy is $d(0) = d(1) = 2.0$ months and the optimal differentiated policy is $d(0) = 2.4$ months and $d(1) = 1.9$ months.

Table 4: Optimal UI

	Canadian EI	$d(s) = \infty$		$d(s) \to 0$		$\rho(s) \geq 20\%$ and $d(s) \geq 3$	
		optimal	constr. optimal	optimal	constr. optimal	optimal	constr. optimal
$\rho(0)$	55%	5.1%	4.7%	255%	162%	34%	24%
$\rho(1)$	55%	4.6%	4.7%	148%	162%	23%	24%
$d(0)$ (months)	10.1	∞	∞	$\frac{1}{2}$	$\frac{1}{2}$	3	3
$d(1)$ (months)	9.2	∞	∞	$\frac{1}{2}$	$\frac{1}{2}$	3	3
welfare change (total)	–	0.785%	0.784%	0.687%	0.684%	0.643%	0.642%
welfare change ($s = 0$)	–	0.536%	0.501%	0.968%	0.474%	0.581%	0.349%
unemployment[a]	9.87%/7.13%	7.22%/5.17%	7.20%/5.18%	7.35%/5.14%	7.19%/5.16%	7.48%/5.24%	7.32%/5.25%
market tightness[a]	0.90/1.00	1.36/1.43	1.36/1.43	1.32/1.46	1.38/1.45	1.29/1.42	1.34/1.41
consumption	7.68	7.84	7.84	7.94	7.94	7.90	7.90
tax rate	4.05%	0.59%	0.59%	1.84%	1.84%	1.25%	1.24%
match quality	1.08	1.07	1.07	1.07	1.07	1.07	1.07

Note: Optimal policies and all values reported are based on a 4^{th}-order polynomial approximation of welfare and other outcomes as functions of $\rho(s)$ calculated on a grid. The minimum spacing of this grid is is: 0.5% in the $d(s) = \infty$ cases, 1% for the $\rho(s) \geq 20\%$ and $d(s) \geq 3$ cases and 5% for the $d(s) \to 0$ cases.

[a] bad state/good state

It is tempting to search for the welfare-maximizing combination of the UI parameters $\rho(s)$ and $d(s)$. However, allowing both replacement ratios and benefit durations to vary at the same time yields one of two degenerate, albeit perfectly sensible, solutions to the optimization problem.

One possibility is that it is optimal to choose a very low replacement ratio to reduce the adverse effects on the rate of job acceptance. Once the moral hazard problem is dealt with in this way, however, there is no need to restrict the benefit duration any more. As a consequence, a system under which households can receive a very low benefit indefinitely may be optimal.[41]

The other possibility is given by the opposite limiting case along the duration dimension. As the negative incentive effects of effectively paying agents for being unemployed can be reduced for any given level of generosity by reducing the benefit duration and increasing the replacement ratio accordingly, it may be optimal to choose a fixed one-time payment at the time of separation.[42] In the case of our discrete-time model, the best benefit duration would therefore be one period. In this scenario, moral hazard effects are so strong that agents are willing to give up insurance against unexpectedly long unemployment durations in favour of a mechanism that merely compensates them for the expected cost of job loss.

Table 4 compares Canadian EI to six alternative systems. These six systems are categorized as belonging to three classes. For each class, the optimal system is listed along with a "constrained optimal" one, meaning the optimal system under the additional constraint that there is no differentiation based on the state of the economy.

The first class of UI systems does not limit benefit duration, $d(s) = \infty$. It turns out that this class contains the global optimum for all UI systems considered. The second class,

[41]Pollak (2007) argues that it would be preferable to provide these benefits in the form of fixed social assistance payments that are independent of previous earnings.

[42]Another effect that works towards making a one-time payment preferable is a discounting or interest effect. Everything else equal, households prefer to get payments earlier. To the government it does not matter whether it pays households today or tomorrow, because in either case it is just redistributing from one group to another. This effect arises in part because we are comparing steady states without taking into account the one-time expenditure or revenue resulting from the introduction of the system.

labelled $d(s) \to 0$, sets the benefit duration to the lowest possible value of one period, practically converting UI into a severance-pay-like system with a one-time payment in the first period after job loss. This class contains a local optimum. Finally, the third class requires benefit durations of at least three months and replacement ratios of at least 20%. There is nothing special about these threshold values, except that the lower bounds imposed exclude corner cases like the first two classes and limit the set of UI systems to those that look like and have the trade-offs of the majority of actual UI systems.

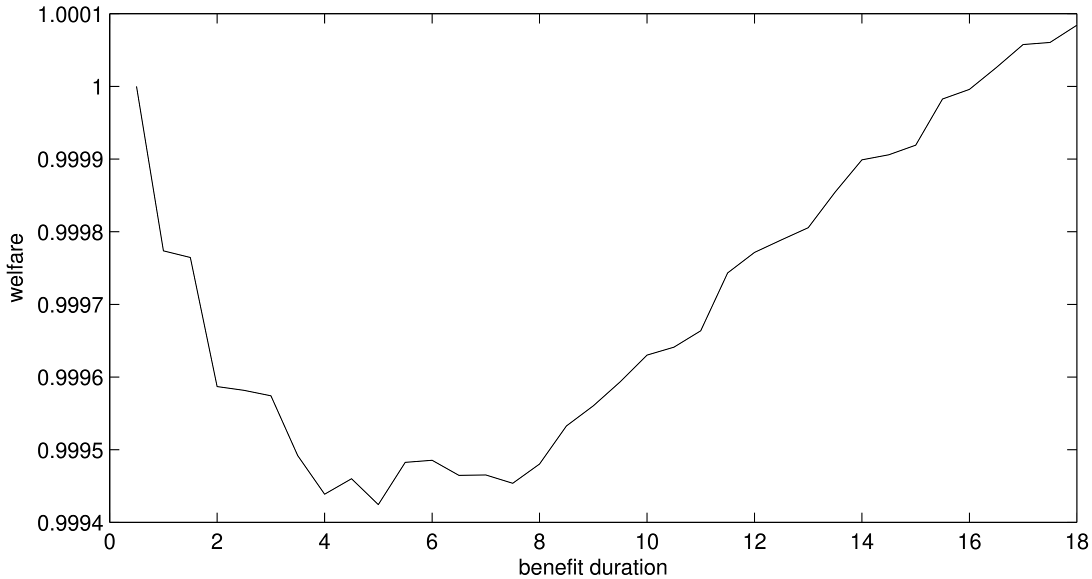
Some of the optimal UI systems show substantial differentiation in benefits depending on the state of the economy, which is in line with the findings in the theoretical literature, including Landais et al. (2010) and Kroft and Notowidigdo (2011). In the three scenarios, payments that occur during recessions are, respectively, 11%, 72% and 48% higher than in the good state. The fact that none of the optimal systems shown in table 4 shows differentiation along the duration dimensions does not mean that such a feature is never desirable for a UI system, as was shown in figure 3 above.

Figure 4 shows the relationship between benefit duration and welfare for a given level of generosity $\Gamma(s) = \rho(s)d(s)$ for an unconstrained UI system. Starting at the constrained optimal system in the $d(s) \to 0$ class, benefit duration is expanded up to a maximum of 18 months while the replacement ratios are reduced proportionally. The resulting U-shaped relationship clearly shows that the most efficient systems are associated with either very short benefit durations or very low replacement ratios.[43]

A striking observation that can be made in table 4 is how little the efficient response of UI generosity to the state of the economy actually matters for welfare. While it is possible to improve welfare significantly over the status quo in the steady state – by as much as 0.785% when choosing the globally optimal policy – allowing for state-dependent benefits leads to improvements of less than a hundredth of a percent compared to the optimal constrained

[43]Figure 4 is not as smooth as one might expect. The reason for this is solely the welfare criterion used. Alternative welfare measure such as utilitarian welfare of the whole population or average expected lifetime utility produce much smoother curves.

Figure 4: Welfare as a Function of Benefit Duration for Constant Generosity



Note: Generosity $\Gamma(s) = \rho(s)d(s) = 0.8$ for $s \in \{0, 1\}$. The system with the lowest possible benefit duration of $d(0) = d(1) = \frac{1}{2}$ is the constrained optimum on the $d(s) \to 0$ class in table 4, the welfare of which is normalized to unity in the figure. The system with the longest benefit duration under consideration (18 months) and the corresponding replacement ratio of $\rho(0) = \rho(1) = 4.4\%$ is comparable to the constrained optimum in the $d(s) = \infty$ class.

policy. Efficiency gains of this order of magnitude are almost certainly unnoticeable, and they are dwarfed by the effects of other choices regarding the design of the UI system.

When only the welfare changes in the bad state are considered, the cost of going with the constrained optimum depends on how big the foregone differentiation actually is. Part of the reason for this result is the choice of a constant tax rate over time. Most of the additional costs of more generous benefits during recessions are paid for when when the economy is in the more prosperous state.

While these calculations qualitatively confirm the results of Andersen and Svarer (2010), Landais et al. (2010) and others that varying UI generosity over the cycle is desirable in principle, they also suggest that given the limited impact of this feature of the UI system, it may be better to look elsewhere for efficiency improvements. These findings are in line with the results obtained by Kristoffersen (2012), who reports that in a model with self-insurance calibrated to the US, the welfare improvements possible by adjusting UI generosity over the cycle are of the order of hundreds of percent.

6.2 A Region-Based Model of the Canadian Economy

This subsection is concerned with modelling regional differences in labour markets. For the purpose of assessing the properties of EI, this is important for two reasons. The first reason is that EI conditions benefits on regional unemployment rates; consequently, considering only aggregate unemployment rates and one uniform UI policy is likely to give a distorted picture of the implications of existing EI rules. Secondly, unemployment rates differ substantially across regions. Official regional unemployment rates in January 2013 ranged from 3.9% in Central Quebec to 31.3% in Northern Manitoba. Since any UI system is likely to have very different effects across these highly heterogeneous regions, it is crucial to consider unemployment levels and dynamics at the regional level to get a more accurate picture of the EI system overall.

Our goal is to assess the implications of the EI system for welfare and inter-regional redistribution considering business cycle effects. The results can shed light on political economy issues related to the design of the system, as highlighted by Pallage and Zimmermann (2005b).

The model is calibrated to match EI economic regions 1 to 55.[44] Using monthly data on regional unemployment rates since July 2000,[45] each observation is classified into one of six groups corresponding to the six unemployment rate brackets associated with different maximum benefit durations. This classification is based only on unemployment rates during the good state. During the bad state, unemployment rates are typically higher, putting the same set of regions into a different EI bracket with different benefit conditions. The labour market variables for the six groups of EI economic regions are then calibrated analogously to the aggregate simulation discussed above. The necessary data on regional unemployment rates, unemployment durations and labour market sizes is generated from the microdata

[44] This excludes the three territories with a combined population of less than 120,000.

[45] In July 2000, EI economic regions were redefined and their number was increased slightly.

set of the Labour Force Survey, on which the official provincial and regional unemployment figures reported by Statistics Canada and HRSDC are based as well.[46] The details of the calibration, to the extent that they differ from the calibration of the aggregate model discussed above, are summarized in table 5.[47]

Table 5: Calibration: Groups of EI Economic Regions

parameter	value[a]					
	$< 6\%$	$6-7\%$	$7-8\%$	$8-9\%$	$9-10\%$	$> 10\%$
$\omega(1)$	2.784	0.415	0.279	0.203	0.196	0.184
$\lambda(0)$	1.37%	1.39%	1.42%	1.45%	1.62%	2.36%
$\lambda(1)$	0.73%	0.85%	0.92%	0.95%	1.10%	1.77%
k	0.463	0.555	0.609	0.644	0.582	0.432

[a] per period ($\frac{1}{24}$ year)

Using these calibrated regional models, the effects of alternative benefit durations on welfare are analyzed as follows. A UI system with a constant (i.e. time and region invariant) benefit duration of 36 weeks, corresponding to the lowest duration actually used in Canada, is taken as the base scenario. Three alternative scenarios are considered. A "business cycle only" scenario only allows for an increase of benefit durations from 36 to 40 weeks during recessions. A "region only" scenario introduces the regional differentiation of benefit duration found in the EI system without allowing the generosity of UI to vary over time with the business cycle. Finally, a scenario labelled "actual EI" combines both regional and temporal variation of benefit durations, resembling the policy actually in place. For each of these three alternative scenarios, the welfare effect of switching to it from the base scenario is reported for each type of economic region.

[46] The calibration is based only on the microdata available in the Labour Force Survey. As a consequence, the unemployment figures used are consistent with those reported by Statistics Canada, not those used by HRSDC, which, as mentioned in footnote 8 above, differ slightly in their definition.

[47] The only difference in the calibration of the six groups of regions compared to the aggregate calibration is the use of regional average unemployment rates and unemployment durations. The size of the labour force in each region is used to aggregate the 55 regions into the six groups. The unemployment rates in the good state for the six groups are 4.86%, 6.50% 7.50%, 8.50% 9.50% and 13.2%. The unemployment durations are 10.8, 13.2, 14.3, 15.7, 15.5, and 14.3 weeks.

Most centrally administered UI systems redistribute income from low-unemployment to high-unemployment regions, simply because they offer the same insurance for the same price (i.e. contributions or payroll taxes) to people exposed to different unemployment risk due to different regional labour market conditions. The Canadian system is even more redistributional, as it offers *better* insurance for the same price to those living in high-risk regions.

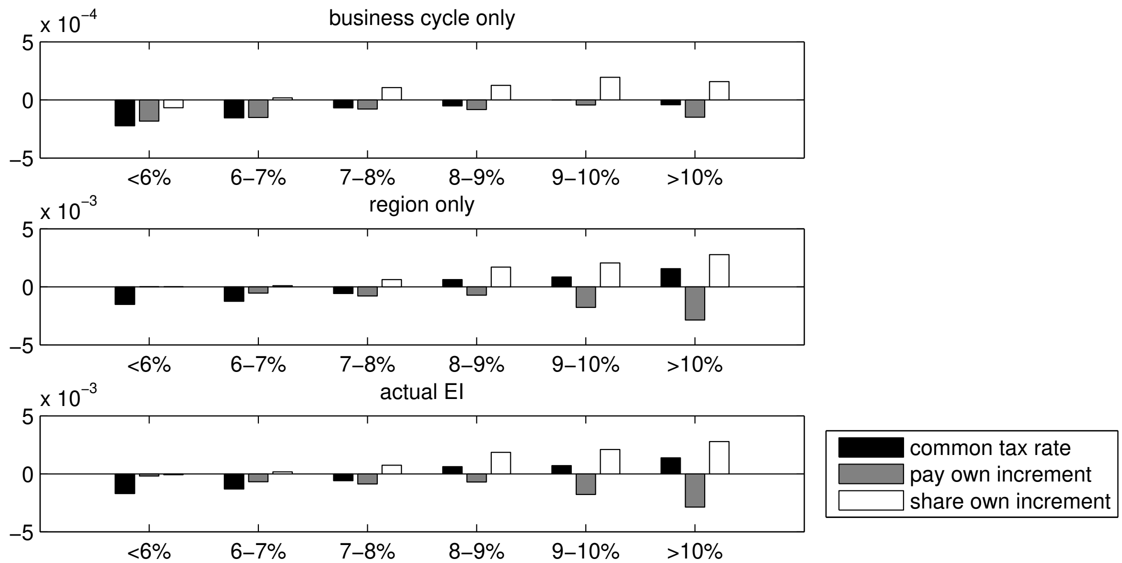
To highlight the oft-discussed distributional nature of the EI system, the welfare changes explained above are reported for three different cases: The first case, termed "common tax rate," assumes that when switching from the base scenario to an alternative, UI tax rates are adjusted equally in all regions to make sure the government budget remains balanced. The case "pay own increment" refers to an experiment where each region adjusts its individual tax rate to individually finance the extra cost of changing the UI system. This case eliminates the distributional effect entirely. Finally, in the case "share own increment" the global tax rate is adjusted uniformly to share the cost of changing the policy in one group of regions at a time. This case differs from the first one by essentially letting each group of regions decide on their own UI system, taking the behaviour of the others as given, instead of looking at the changes in all regions as a package.[48]

Figure 5 reports the results by scenario, region and case. The first panel shows the welfare effects of increasing the benefit duration by four weeks during recessions. Clearly, from an efficiency perspective this is not desirable. The reason is simply that the benefits are too generous already even under the base scenario, as suggested by figure 3. Only if the regions with higher unemployment rates could implement the policy independently while sharing the cost of the policy change with the rest of the county, they would find it attractive to implement countercyclical benefits at the base level of generosity.

The other two panels show the welfare effects of switching to the regionally differentiated system and the actual EI system with both regional and temporal differentiation. Even

[48]Note that the values reported for the first and the third of these cases depend, among other things, on the relative sizes of these groups of regions as well as their tax bases.

Figure 5: Welfare Effects of Changing UI Policy, by Group of EI Economic Regions



though the last scenario combines the first two, it looks almost identical to the region-only scenario. This is because the welfare effects associated with varying generosity over the business cycle are an order of magnitude smaller than the distributional effects.[49] The findings regarding the welfare effects of the regional differentiation of EI are what one would expect. Under a common tax rate, high-unemployment regions favour the existing system while low-unemployment regions pay the cost. If each group of regions had to pay for increasing UI generosity to the current level, all regions would prefer the base scenario. This should not be surprising as even the base scenario is rather generous compared to the optimum, as seen in the previous subsection. Finally, when faced with the option of increasing the generosity of their own UI while sharing the costs countrywide, all groups of regions will do this. What is perhaps most surprising about these results is the scale of the welfare effect. The costs or benefits of choosing the actual EI system over the baseline scenario are between -0.2% and 0.2%, likely too small to notice. Consistent with the findings reported in the previous section, the business cycle component of the welfare effect is small enough to be considered irrelevant.

[49]Notice the different scales on the three panels.

Figure 6 compares the same scenarios as figure 5, aggregating by province instead of groups of regions.[50] As before, qualitatively the findings are what one would expect: The welfare effect of temporal differentiation is negative but very small.[51] The Atlantic Provinces and Quebec prefer EI to the baseline system, the western provinces do not, and Ontario is highly representative of the whole country. A measure of the welfare-relevant distribution inherent in the system is the difference between the welfare effects in the "common tax rate" case and the "pay own increment" case[52], i.e. the difference between the black and the grey bars in figures 5 and 6. This distributional effect is positive for all provinces east of Ontario, and negative for the rest of the country. Still, the effect is rather small in absolute terms, and also small compared to the total distribution brought about by the system.[53]

7 Robustness

This section highlights some important properties of our model and presents alternative specifications.

Figure 7 demonstrates the importance of life-cycle effects for the evaluation of UI. The top left panel shows the welfare change by age that results from raising the replacement ratio from $\rho(0) = \rho(1) = 30\%$ to 40% for a fixed duration of 3 months. Agents up to age 35 tend to benefit from the change, while those older than that suffer a welfare reduction. The reason for this pattern is that borrowing constraints affect younger households, while

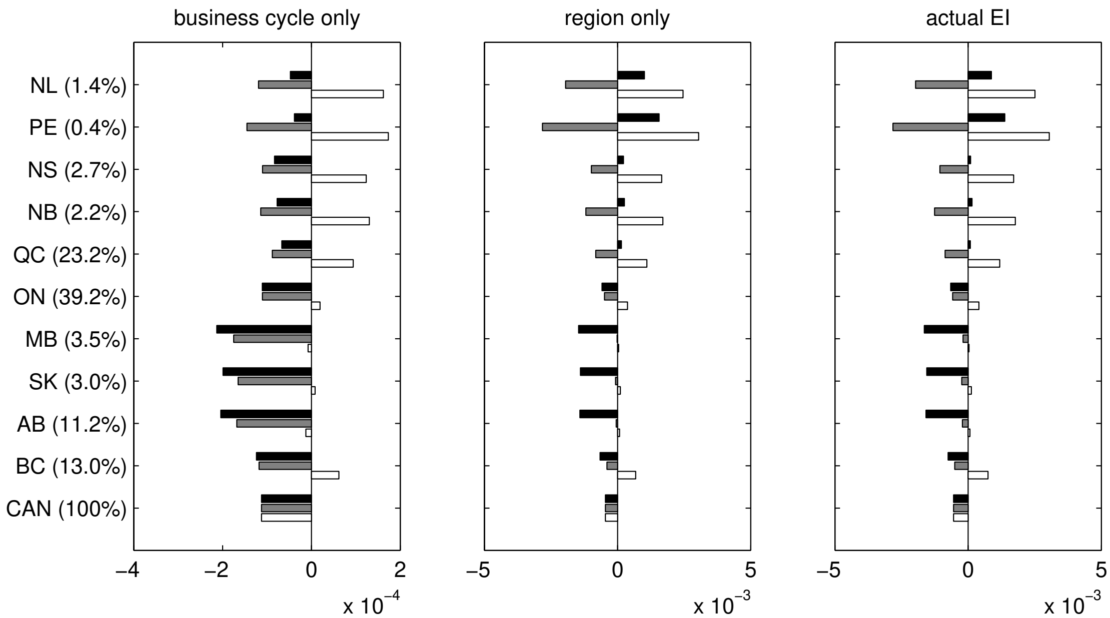
[50] Note that the provincial results are not merely convex combinations of the results reported by group of region. For example, the proper interpretation of the "share own increment" case is now: "What happened if province X switched to the differentiated EI system, sharing the cost of the change countrywide?"

[51] In response to the 2008-09 recession, the federal government uniformly extended benefit durations by five weeks for all eligible individuals as a discretionary and temporary measure. (This basically added five weeks to all non-zero values in table 1.) The measure, which extended a local policy experiment to the whole country, was effective for 18 months starting in March 2009. Our results suggest that the welfare effect of this measure was likely positive and almost certainly tiny.

[52] The difference between the actual welfare cost of the differentiated system under a shared tax burden and the welfare change that would result if provinces implemented the system without any change in transfers.

[53] Balancing the EI budget on a per-province basis instead of partly sharing the cost though a common tax rate would change welfare in the provinces by between -3.32% (Prince Edward Island) and 1.02% (Manitoba). The effects that can be attributed to the regional differentiation of the system are less than $\frac{1}{10}$ of this in magnitude.

Figure 6: Welfare Effects of Changing UI Policy, by Province



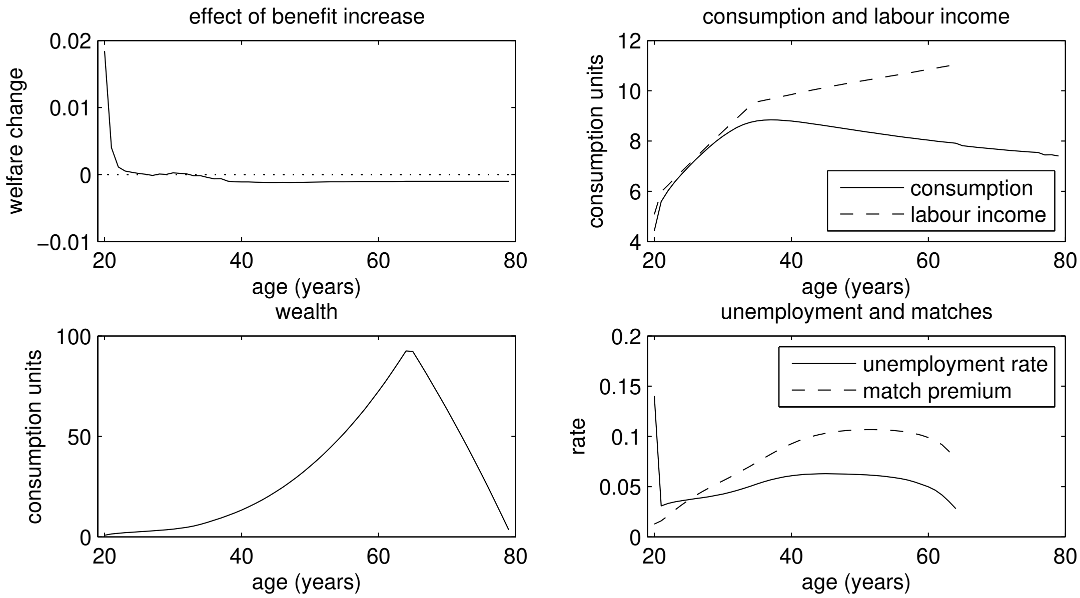
Note: For each province, its weight based on the size of its labour market is reported.

those above age 40 are effectively unconstrained. This can be seen in the top right panel, which shows that consumption peaks at around age 40 and declines thereafter, which is to be expected for well-insured households given that the interest rate is below the discount rate. The bottom right panel shows how the liquidity constraints affect labour market outcomes. Unemployment rates rise with age up to 40 years, which reflects older households' choice for longer job search. This results in a better matches for older individuals - the average match quality is about 10% better at age 50 than at age 20.

As explained above, the welfare criterion used is utilitarian welfare of the part of the population that has had a job at some point in their lives. This is the whole simulated population excluding entrants into the labour market who have not yet found work. The reason is that the welfare of this particular group can have a substantial impact on the overall welfare measure, which is not robust to small changes in the calibration of the model.

Figure 8 shows the welfare impact of the same policy change as in figure 7, using an inclusive utilitarian measure as well as the welfare measure that excludes entrants. The top panels show welfare changes by age for different levels of initial endowments, which

Figure 7: Age profiles



Note: The "match premium" is defined as difference between the average match quality and the average match quality of all job offers, which is unity.

are measured in months of income.[54] The two welfare measures yield virtually identical results for household aged 21 and above. Only for 20 year old households, there is a stark difference. While those who are already employed enjoy a large welfare improvement due to higher benefits, those who are still unemployed suffer a strong negative effect. The reason is that the first group is comprised of liquidity constrained individuals who are entitled to insurance, whereas the second group has no entitlement but suffers from the reduced market tightness under more generous benefits. The two lower panels show the overall welfare effect of the policy change for different levels of endowment. While the welfare measure that excludes entrants yields rather predictable results – higher endowments mean less liquidity constraints and hence less appetite for UI – the inclusive welfare measure exhibits a non-monotonic relationship between benefit generosity and welfare.

The choice of the welfare measure does not affect the result that the welfare effects of business cycle dependent UI are small. An alternative experiment that increases the

[54] As before, "income" refers to the income of an agent with productivity one on a job characterized by the average match quality of unity outside of a recession. This measure is very close to the average starting wage of individuals first entering the labour market.

Figure 8: Welfare effects of increasing UI generosity by age for different initial endowments

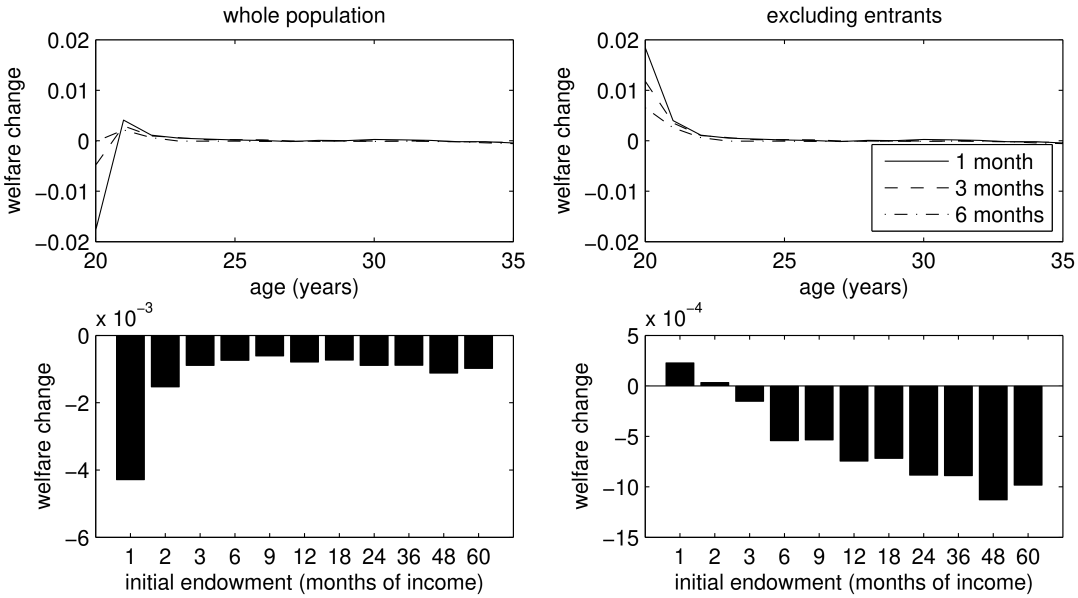
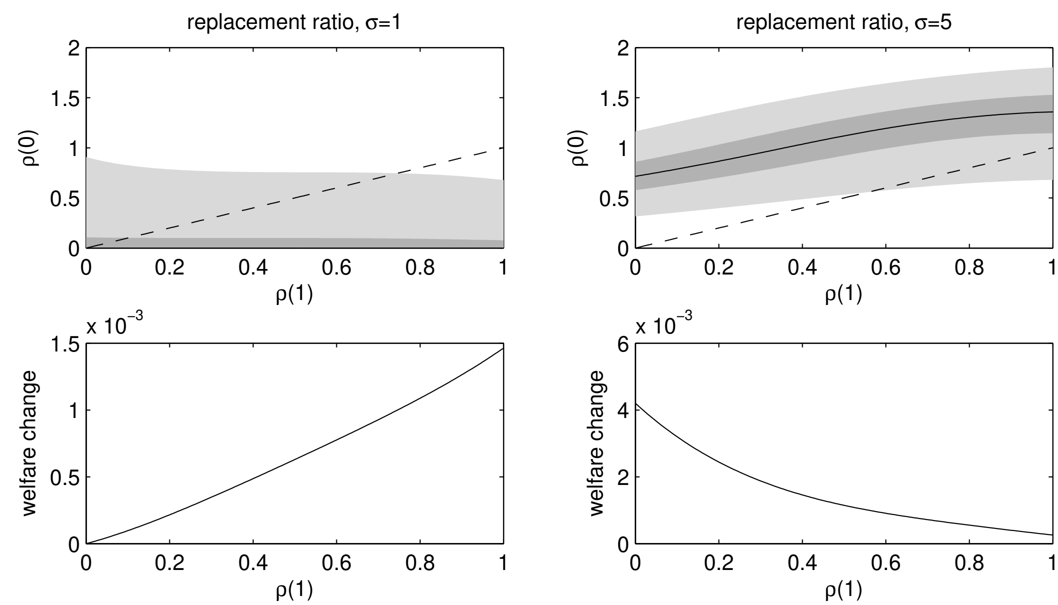


Figure 9: Optimal policy and the benefit of differentiation for alternative degrees of risk aversion



Note: The "match premium" is defined as difference between the average match quality and the average match quality of all job offers, which is unity.

replacement ratio from 30% to 40% in recessions only rather than in both states as above produces almost exactly the same welfare patterns as those reported in figure 8, except that all effects are a muted by a factor 10.

Figure 9 shows how the optimal replacement ratios in recessions depends on the replacement ratio in normal times for risk aversions of $\sigma = 1, 5$. The results are presented in the same way as those for $\sigma = 3$ in figure 3 above. As before, the dark gray bands cover policy parameters that are within $\frac{1}{100}\%$ of the optimum in terms of welfare. The light gray areas cover the $\frac{1}{10}\%$ range. Benefit duration is fixed at 3 months for this exercise.

Clearly, optimal benefit generosity varies significantly with the households' risk aversion. For log utility, the optimal policy is $\rho(0) = 0$ for any level of $\rho(1)$. In the high risk aversion case $\sigma = 5$, optimal levels of $\rho(0)$ lie between 72% and 135%.

In both of these cases, there are levels of $\rho(0)$ for which choosing the optimal replacement ratio during recessions over an undifferentiated policy leads to welfare improvements of more than 0.1%. Yet, such gains are hardly a matter of fine tuning the UI system, as they are only possible if $\rho(1)$ is grossly suboptimal. In such a situation, it would be most effective to adjust $\rho(1)$.[55]

In the $\sigma = 1$ case, the optimal differentiated and undifferentiated policies coincide at a corner result, $\rho(0) = \rho(1) = 0$. In the high risk aversion scenario, the optimal undifferentiated policy is $\rho(0) = \rho(1) = 93\%$. Switching to the optimal differentiated policy of $\rho(0) = 134\%$ and $\rho(1) = 91\%$ yields a welfare improvement of 0.037%.

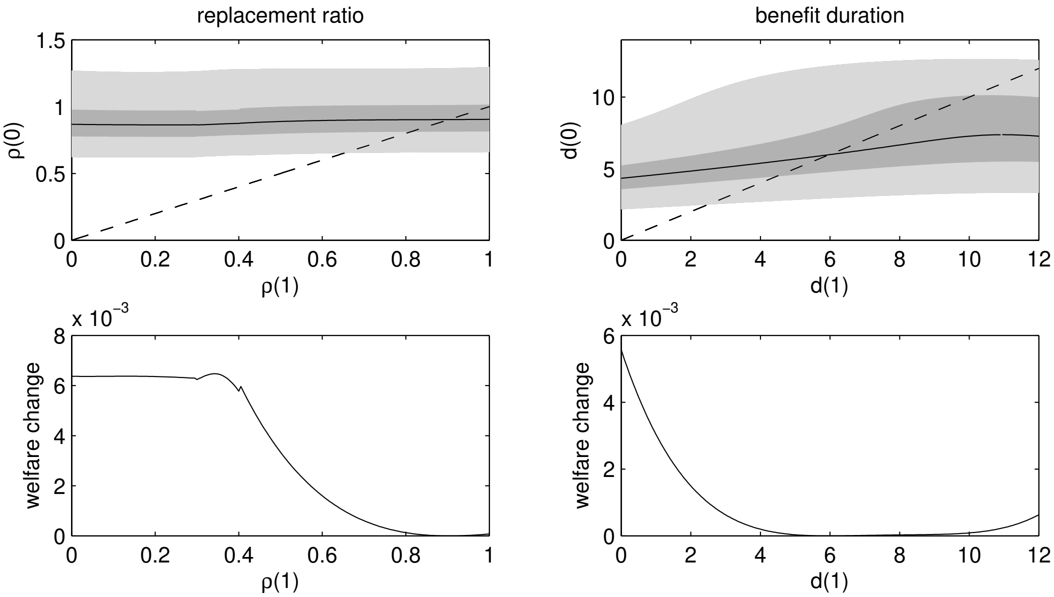
While the optimal generosity of UI systems depends strongly on households preferences[56], the result that only small welfare improvements are possible by introducing business-cycle dependent benefits into an otherwise reasonably efficient system does not.

Finally, figure 10 shows optimal replacement ratios and benefit durations in a scenario where households are not allowed to save, so that UI benefits equal their consumption levels during unemployment. This scenario introduces welfare payments that guarantee a minimum income corresponding to 50% of the typical income of a 20-year-old household as well as

[55] Consider for example a situation where $\rho(0) = \rho(1) = 20\%$ in the $\sigma = 5$ case. Raising $rho(0)$ to its optimal value of 87% for this level of $\rho(1)$ results in a welfare improvement of 0.24%. The same improvement can be achieved by adjusting both $\rho(0)$ and $\rho(1)$ to 25%.

[56] In fact, disregarding its properties regarding inter-regional redistribution, the Canadian EI system could be reasonably close to the optimum for some level of risk aversion above 3

Figure 10: Optimal policy and the benefit of differentiation for hand-to-mouth consumers



pensions of 70% of the typical income of households before retirement. These benefits ensure that consumption is always positive.[57]

Notice that without savings, the link between UI generosity in the good state and optimal benefits in the bad state almost disappears. In previous scenarios, the precautionary savings accumulated in the good state partly determined the need for insurance in the bad state; this is not the case in this scenario.

The welfare improvement resulting form replacing the constrained optimal replacement ratio of $\rho(0) = \rho(1) = 85.4\%$ with the unconstrained optimum of $\rho(0) = 90.3\%$ and $\rho(1) = 84.6\%$ is 0.003%. The effect of switching to a differentiated policy when varying benefit durations is even smaller.[58] Generally, there is little scope for improving welfare by differentiating benefits in the neighbourhood of the constrained optimal policy. If the base policy is not chosen efficiently, however, adjusting UI generosity in the bad state can have a stronger positive effect on welfare, up to 0.64% in this scenario. This welfare improvement

[57] In this scenario, benefit duration is fixed at $d(0) = d(1) = 6$ when replacement ratios are varied and replacement ratios are set to $\rho(0) = \rho(1) = 60\%$ when optimal durations are analysed.

[58] In this case, optimal differentiation is very small, with $d(0) = 5.97$ and $d(1) = 5.96$.

can be even larger under a less generous welfare system.[59]

8 Discussion

The main finding of this paper is that potential gains from allowing benefit generosity to be differentiated over the business cycle are small. They are small in absolute terms as long as the UI system is reasonably efficient otherwise. They are small relative to the efficiency improvements that can be achieved by other, more conventional means such as adjusting general replacement ratios and benefit durations for systems that are further away from the optimum. And, in the case of the Canadian system, the business cycle effects that result from the unique features of the system are small compared to the welfare effects resulting from inter-regional redistribution that also follows from this very design.

On the one hand, this means that fine-tuning a UI system for optimal intertemporal patterns of generosity may not be worth it. On the other hand, even implementing inefficient business-cycle dependent policies is *per se* unlikely to do much damage.

As pointed out in the introduction, most of the existing literature on this particular feature of UI systems is based on models that do not allow for saving and self-insurance. This can lead to an exaggeration of the positive effects of UI, which may be quite strong even for low levels of risk aversion. Moreover, it may result in an emphasis of the fine tuning of subtile aspects of the system that can strongly affect individual behaviour when household consumption and thus indirectly behaviour is well controlled by policy; in more realistic settings, where the policy maker has substantially less control over households who can protect themselves effectively against the potential adverse effects of sophisticated incentive schemes, the implementation details of a system may be less important.[60]

[59] In the lower left panel of figure 10 shows a plateau for replacement ratios below 30%. This is because the UI system becomes irrelevant if UI benefits are typically below welfare payments. The welfare benefits of 50% of young individuals' typical income, which were used in this simulation, are higher than what single households can actually receive in the form of social assistance and housing benefits. Cutting maximum welfare payments in half makes the welfare plateau smaller and increases the maximum possible welfare improvement from UI benefit differentiation to as much as 2.2% for values of $\rho(1) < 20\%$.

[60] An example is Werning (2002), who shows that the result that benefits should decline with the duration

Another aspect of model design that can be relevant when quantifying the welfare effects of UI is the choice between life-cycle and infinite-horizon models. It is important to note that in an infinite-horizon setting even with carefully calibrated, realistic income processes, there is no reason to expect that the resulting stationary wealth distribution bears much resemblance to the one that results under life-cycle behaviour. While it is possible to include features that help obtain a more realistic distribution[61], simulating an actual life-cycle model appears to be the most straightforward and robust way to account for the different behavioural and welfare effects that policy has on different groups of the population.[62] We have seen in section 7 that policy changes affect different age groups very differently. Modelling these groups explicitly therefore seems important for quantitative exercises.

As discussed above, young individuals who have not successfully entered the labour market yet are excluded from the welfare measure. This is done for reasons of robustness, and it seems justifiable in our context. However, when it comes to making policy recommendations regarding UI, this particular group is of great importance for overall welfare outcomes. This is because by definition, the share of these households that have to find a job is 100%, which makes them extremely sensitive to changes labour market conditions. Moreover, under many UI systems, these individuals are not eligible to receive benefits, which means they only feel the effects of UI changes indirectly. Interestingly, the welfare of this groups depends on the very general equilibrium externalities that have been discussed in the context of benefit extensions and business-cycle dependent UI policies; see for example Landais et al (2010) and Lalive et al (2013). The problem of realistically calibrating the endowment of this group[63] does not arise in infinite-horizon settings, and to my knowledge it has received little attention in the theoretical literature so far.

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of an unemployment spell are not robust to allowing for hidden savings.

[61]See Krusell and Smith (1998) for a classic example.

[62]While it is straightforward to model realistic life-cycle income profiles with all their implications for consumption and saving behaviour in life-cycle models, this is more of a challenge in infinite-horizon settings.

[63]This includes initial wealth, but also access to insurance from family and other welfare programs.

9 Summary and Conclusions

This paper presented a general equilibrium model of life cycle behaviour under labour market frictions calibrated to resemble the Canadian economy.

Simulations of a wide range of UI policies have shown that optimal systems may exhibit large changes in generosity with the business cycle and the state of the labour market. The variation of the benefit duration as opposed to the replacement ratio as seen in the EI system can be an adequate way of providing better insurance during downturns; the actual change in benefit durations over the business cycle possible under the Canadian system is not particularly aggressive, however.

Even though our simulations confirm the theoretical prediction that adjusting UI generosity during recessions generally improves welfare, they also show that the quantitative importance of responding efficiently to the state of the economy is typically extremely small. Both for optimal systems and the actual EI system, the welfare improvement from varying benefit generosity over time is measured in hundredths of percent at most, two orders of magnitude smaller than the efficiency improvements that can be achieved by much simpler policy changes such as adjusting replacement ratios or benefit durations without any conditioning on the current state of the economy.

We also used the model to assess the distributional implications of the model both across groups of similar regions and across provinces in terms of welfare. The patterns that emerge match very closely what one would expect simply based on the benefits-to-contributions ratios reported by HRSDC:[64] The Atlantic Provinces and Quebec benefit from the more generous treatment of high-unemployment regions, whereas Ontario and the western provinces suffer a reduction in welfare. Even though the distributional effects of the system are more important than the insurance they provide against business cycle effects, they are still quite small - none of the net payers among the provinces suffers a welfare reduction of more than 0.15% and none of the net recipients gains more than 0.18% from regional differentiation.

[64] See EI Monitoring and Assessment Report 2012, Annex 2.19.

Appendix

A The Household's Problem

The Bellman equation characterizing a the problem of an unemployed household of age g in period t that has at least one more period in the labour market left is given by

$$V_g^u(a_{it}, b_{it}, d_{it}, s_t) = \max_{a_{it+1}, \underline{m}} \Bigg(u(a_{it} + y^u(b_{it}, d_{it}) - \frac{a_{it+1}}{1+r}) + \beta F(\underline{m}) E_t[V_{g+1}^u(a_{it+1}, b_{it}, d_{it+1}, s_{t+1})] + \beta \int_{\underline{m}}^{\infty} E_t[V_{g+1}^e(a_{it+1}, \tilde{m}(m, \underline{m}), s_{t+1})] dF(m) \Bigg). \tag{A.1}$$

Here b_{it} is the individual's benefit amount or last wage, which is determined upon job loss.[65] d_{it} encodes the remaining benefit duration.[66] Given these two variables, it is possible to determine the actual benefit payment $y^u(b, d)$. The reservation match quality an agent chooses given her current situation is $\underline{m}$. $F(m)$ is the distribution function of the best match quality offered per period.

If the agent receives a job offer with an acceptable match quality $m \geq \underline{m}$, Nash bargaining takes place over the share of the output that is paid as a wage. Given the agent's bargaining power ϵ, the value $\tilde{m}(m, \underline{m}) = \underline{m} + \epsilon(m - \underline{m})$ could be interpreted as the job's effective match quality from the agent's perspective, a measure that accounts for the fact that part of the labour share will go to the firm.

The maximization problem of an employed agent of age g who is not yet about to retire

[65] $b_{it} = 0$ for agents who have never had a job and are therefore not entitled to receive benefits.

[66] This variable may, however, also be used to determine whether the agent is in his waiting period.

is

$$V^e_g(a_{it}, \tilde{m}_{it}, s_t) = \max_{a_{it+1}} \Bigg(u(a_{it} + y^e(\tilde{m}_{it}, s_t, g) - \frac{a_{it+1}}{1+r}) + \beta(1-\lambda)E_t[V^e_{g+1}(a_{it+1}, \tilde{m}_{it}, s_{t+1})] + \beta\lambda E_t[V^u_{g+1}(a_{it+1}, b(\tilde{m}_{it}, s_t, g), d(s_t), s_{t+1})] \Bigg). \tag{A.2}$$

The household's labour income is $y^e(\tilde{m}_{it}, s_t, g) = (1-\alpha)\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}} p(s_t)^{\frac{1}{1-\alpha}} \tilde{m} q(g)$, where $q(g) = q_{it}$ is the agent's age-dependent productivity. If the job is destroyed at the end of the period, the agent's entitlement to UI benefits is determined as a function of her current income and the macro state, $b_{it+1} = b(\tilde{m}_{it}, s_t, g)$ and $d_{it} = d(s_t)$.

A retired individual's problem is simple and deterministic.

$$V_g(a_{it}) = \max_{a_{it+1}} \Bigg(u(a_{it} - \frac{a_{it+1}}{1+r}) + \beta V_{g+1}(a_{it+1}) \Bigg), \tag{A.3}$$

where $V_g(a_{it}) \equiv 0$ if the age g exceeds the agent's life span.

B Calibration

All data on the Canadian economy used in the calibration comes from Statistics Canada.

The real interest rate was calculated as the average 10-year yield of Government of Canada marketable bonds from 2000:7 to 2012:12 minus CPI inflation.[67]

Recession quarters since 1976 were determined using chain-weighted seasonally adjusted GDP[68] data as periods with at least two consecutive drops in GDP. This procedure identified four recessions[69] accounting for 15 out of the 150 quarters under consideration.

The average increase in the national unemployment rate during months that fall into recession quarters was 0.25%. In all scenarios under consideration, $\lambda(0)$ was chosen to match this value. The matching rate $\omega(1)$ was calibrated to make the model match the

[67]series v122487 and v41690914

[68]series v1992067 and v62305752

[69]1980:Q2-1980:Q3, 1981:Q3-1982:Q4, 1990:Q2-1991:Q1 and 2008:Q4-2009:Q2

average unemployment rate in non-recession months between 2000:7 and 2012:12, either at the national level or for groups of regions.

The productivity drop during recessions was calculated based on annual multifactor productivity (MFP) estimates[70] using the following regression:

$$\ln MFP_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 RQ_t,$$

where $RQ_t \in \{0, 0.25, 0.5, 0.75, 1\}$ is the share of recession quarters in year t. The value $\exp(\beta_3) = 0.949$ is the relative productivity during recessions.

Statistics Canada does not publish employment-related data by EI economic region,[71] so some time series had to be constructed directly from the Labour Force Survey (LFS) microdata set.[72] Labour force size, unemployment rate and unemployment duration series were constructed by region and month for EI regions 1 to 55 and 2000:7 to 2012:12. All series were seasonally adjusted. The labour force size was used for aggregating the regions into six groups and to compute national averages. The unemployment rates and durations by group of regions were used to calibrate the regional models. The national average of unemployment duration was also used in the calibration of the model to the aggregate Canadian economy.

C Model Solution and Simulation

The household's problem is solved by numerical dynamic programming, starting at the final period (number 1,440) and proceeding backward to the first. Value functions are represented on a multi-dimensional grid, using linear interpolation.[73]

[70] series v41712881

[71] There are data by "economic region," but the definition of regions used by Statistics Canada does not match EI economic regions.

[72] The public-use file of the LFS does not contain geographic information that is more detailed than provinces. Access to the full dataset I used is restricted.

[73] An exception to this rule are intervals in which the value function reaches its infimum, $-\infty$ for our parametrization. In this case, a non-linear function with the proper asymptotic behaviour is used. Even though linear interpolation may appear inferior to more sophisticated interpolation techniques such as higher order splines, its simplicity makes it so much faster that it becomes possible to use much finer grids in the computation, resulting improved accuracy.

These grids are given by $AG \times MG \times SG$ for employed agents, $AG \times BG \times UG \times SG$ for unemployed agents and just AG for retired agents. The possible macro states are represented by $SG \in \{0, 1\}$. AG is the asset grid for values of $a_{it} \geq 0$. It is composed of a linearly spaced section close to zero and a geometrically spaced section for higher asset levels. It has up to 497 nodes, although the grids for younger agents omit some of the higher nodes that cannot be reached to save space and computation time. MG represents levels of match quality. It has 15 nodes at the midpoints of their respective quantiles plus three extra nodes at 50% and 75% of the lowest and 150% of the highest quantile nodes. The benefit grid BG is a 19-point grid derived from MG, but adjusted to cover the whole relevant range of wages across age groups. Finally, UG represents the remaining benefit duration as well as special states such as being in the waiting period. Its size depends on the maximum benefit duration and the complexity of the rules, but it is typically 7 nodes or less.

To solve the optimization problem of unemployed households, it is necessary to calculate the expectation over the continuous match quality variable m as shown in equation A.1 in appendix A. This is done using a quadrature-like approach, based on the grid points MG chosen along this dimension and using the appropriate probability weights.

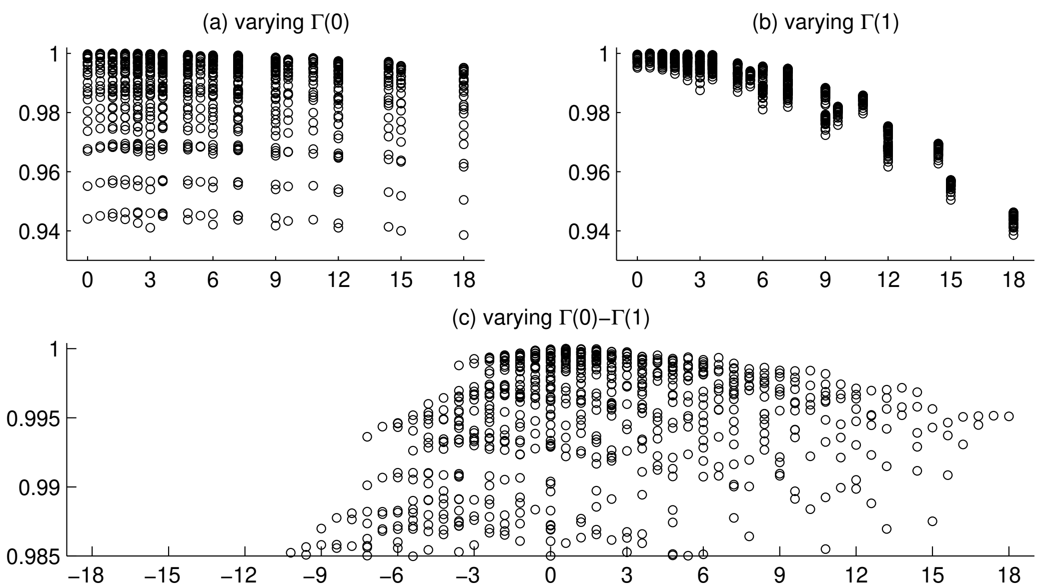
Solving the general equilibrium problem involves finding the levels of market tightness $\theta(0)$, $\theta(1)$ that yield zero expected profits for jobs created in the bad and the good state, respectively. It also requires finding the tax rate that balances the government's budget. To solve for the market tightness, I start from a reasonable guess, solve the household's problem for the implied job offer rates $\omega(s)$, and then simulate the economy for a large number of periods to calculate aggregate variables, including the firms' profits. If the zero-profit condition is not met with the required accuracy, I update my guesses of $\theta(s)$ and start over. In most scenarios, it takes about 5-10 of these iterations to determine market tightness.

All these computations are done for a tax rate of zero. Once the equilibrium market tightness has been determined, it is straightforward to calculate the tax rate required to balance the government budget based on measured expenditures and the tax base. All that needs to be done at this point is to adjust some of the results, including consumption and welfare measures, for the tax rate. This can be done so easily because the preferences are CRRA and the tax base includes all sources of household income except interest.

Solving the household's problem for a typical set of parameters takes about 1-2 minutes (on one processor core) and requires approximately 2GB of memory. Given the large extent of the history simulated based on the household's behaviour (see footnote 29), this part of the computation takes much longer, approximately 10-20 minutes. It thus takes about 1-2 hours to solve the full general equilibrium model for one set of policy parameters.[74]

D Simulated UI Scenarios

Figure 11: UI Generosity and Welfare



Note: Highest welfare normalized to 1. Generosity $\Gamma(s)$ is given by replacement ratio times benefit duration.

Figure 11 summarizes the results obtained in a large number of policy simulations using scatter plots. In these simulations, the replacement ratios and benefit durations were varied between 0 and 100% and 0 and 18 months, respectively, for both states of the economy.

[74]Combined, all calculations performed for this version of the paper took about $4\frac{1}{2}$ core-years to complete.

The policy variants chosen here are on a grid with intervals of 20 percentage points for replacement ratios and 3 months for durations.[75] Note that this choice of grid implicitly imposes the constraint that if there is a positive benefit, it is paid at a rate of at least 20% for at least three months. While this restriction is consistent with typical real-world implementations of UI, it excludes some interesting policies, as will be seen later. For the purpose of visualizing the welfare patterns that arise, for each state s the replacement ratio $\rho(s)$ and the benefit duration $d(s)$ are combined into a compound generosity measure $\Gamma(s) = \rho(s)d(s)$.[76]

Figure 11 (b) shows that $\Gamma(1)$ is actually a rather good predictor of the efficiency of a UI system. In fact, the upper envelope of the graph suggests that a low to moderate level of generosity - in our case approximately $\Gamma(1) < 4$ - is a necessary condition for attaining high welfare. Panel (a) of the figure, which shows $\Gamma(0)$, gives a similar picture, although varying generosity in the bad state has a quantitatively much smaller effect on welfare, so that looking at this statistic alone reveals rather little about the likely welfare properties of a UI scheme.

Finally, panel (c) of figure 11 plots welfare levels by the difference in generosity between the two states, $\Gamma(0) - \Gamma(1)$. The best outcomes are achieved for $\Gamma(0) \geq \Gamma(1)$, which is consistent with the expectation that it is optimal to provide more generous insurance during recessions. Note, however, that the quantitative importance of following this rule is really small.[77]

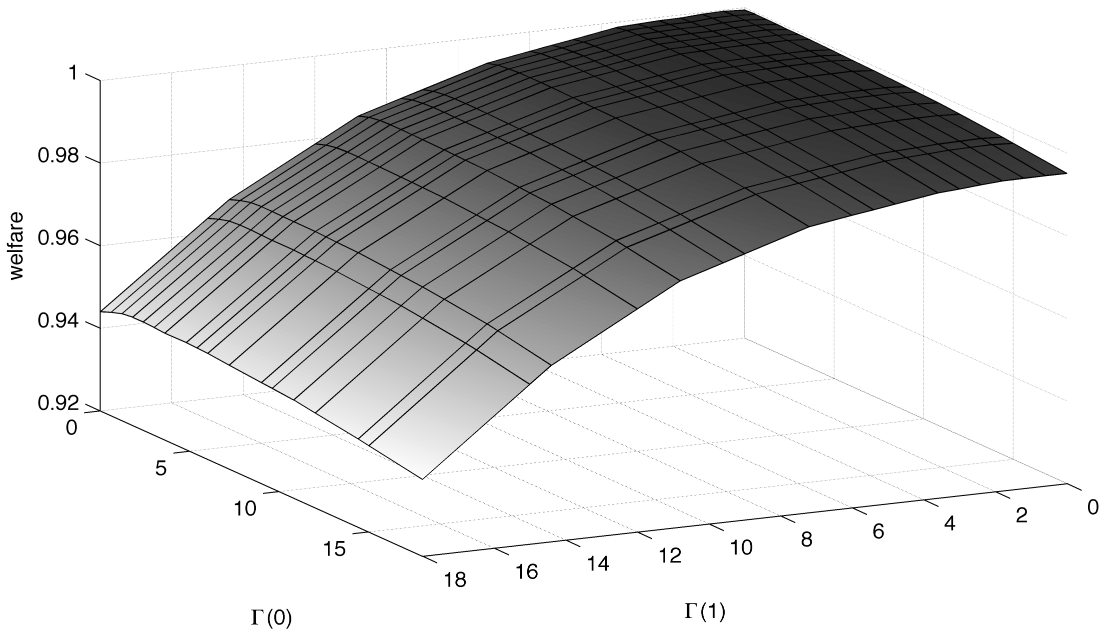
Figure 12 presents this information differently, showing the highest levels of efficiency attainable as a function of $\Gamma(0)$ and $\Gamma(1)$. Interestingly, this function has a plateau for lower levels of generosity. For $\Gamma(0) \leq 9$ and $\Gamma(1) \leq 4.8$, welfare levels within 0.5% of the optimum

[75] All distinct scenarios on the grid $(\rho(0), \rho(1), d(0), d(1)) \in \{0, 0.2, 0.4, 0.6, 0.8, 1\}^2 \times \{0, 3, 6, 9, 12, 15, 18\}^2$ are simulated. Some of the 1,764 combinations are redundant, because for a replacement ratio of zero the benefit duration is irrelevant and vice versa. In total, 961 distinct UI policies are considered.

[76] A generosity of $\Gamma(s) = 9$ could, for example, correspond to a 100% replacement ratio for nine months or a 50% replacement ratio for 18 months. This is a simple *ad-hoc* way of measuring UI generosity. For a more general and principled approach see Pallage et al. (2013).

[77] The vertical axis in panel (c) is scaled differently to make this effect visible.

Figure 12: Maximum Welfare as a Function of UI Generosity



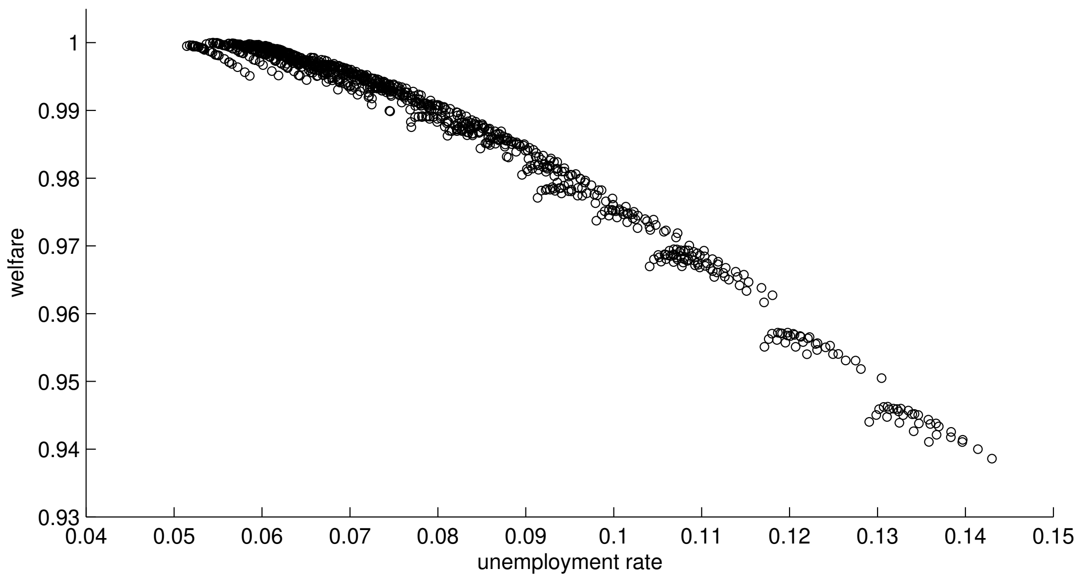
Note: Highest welfare normalized to 1. Generosity $\Gamma(s)$ is given by replacement ratio times benefit duration. The figure shows the upper convex envelope for the welfare levels obtained in the 961 policy experiments described in footnote 75.

are attainable. Many actual UI systems fall into this area, and the Canadian EI system with generosities between 4.5 and 5.7 is not far off.[78]

Another interesting observation that can be made based on the simulations presented in this section is that there appears to be a tight relationship between the unemployment rate and welfare over a range of policy parameters. While this close and over a wide range nearly linear relationship must break down in the neighbourhood of an interior optimum, it still appears that the unemployment rate is a good indicator for the quality of a UI system at the levels of generosity typically implemented.

[78]This does not imply, of course, that EI *does* lead to welfare close to the optimum. It just means that potential efficiency is not made impossible by excessive generosity.

Figure 13: Welfare vs. Unemployment for a Range of UI Policies



Note: Welfare and unemployment outcomes for the 961 UI policies described in footnote 75.

References

Andersen, T.M. and M. Svarer (2010): "Business Cycle Dependent Unemployment Insurance," IZA Discussion Paper 5196, September 2010.

Andersen, T.M. and M. Svarer (2011): "State Dependent Unemployment Benefits," *Journal of Risk and Insurance*, Vol. 78(2), 325-344.

Baily, M.N. (1978)" "Some Aspects of Optimal Unemployment Insurance," *Journal of Public Economics*, Vol. 10(3), 379-420.

Barron, J.M., M.C. Berger, and D.A. Black (1997): "Employer Search, Training, and Vacancy Duration," *Economic Inquiry*, Vol. 35(1), 167-92.

Chetty, R. (2006): "A General Formula for the Optimal Level of Social Insurance," *Journal of Public Economics*, Vol. 90(10-11), 1879-1901.

Ek, S. (2012): "Unemployment Benefits and Taxes: How Should Policy Makers Redistribute Income over the Business Cycle?" IZA Discussion Paper 6308, January 2012.

Farber, H.S. and R.G. Valletta (2013): "Do Extended Unemployment Benefits Lengthen Unemployment Spells? Evidence from Recent Cycles in the U.S. Labor Market," Federal Reserve Bank of San Francisco working paper 2013-09.

Gruber, J. (1997): "The Consumption Smoothing Benefits of Unemployment Insurance," *American Economic Review*, Vol. 97(1), 192-295.

Hagedorn, M. and I. Manovskii (2008): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *American Economic Review*, vol. 98(4), 1692-1706.

Hopenhayn, H.A. and J.P. Nicolini (1997): "Optimal Unemployment Insurance," *Journal of Political Economy* 105(2), 412-438.

Jung, P. and K. Kuester (2011): "Optimal Labor-Market Policy in Recessions," Federal Reserve Bank of Philadelphia working paper 11-48.

Kiley, M.T. (2003): "How Should Unemployment Benefits Respond to the Business Cycle?" *The B.E. Journal of Economic Analysis & Policy*, 3(1), 1-20.

Kristoffersen, M.S. (2012): "Business Cycle Dependent Unemployment Benefits with Wealth Heterogeneity and Precautionary Savings," Economics Working Papers 2012-19.

Kroft, K and M.J. Notowidigdo (2011): "Should Unemployment Insurance Vary With The Local Unemployment Rate? Theory And Evidence," working paper, November 2010.

Krusell, P., T. Mukoyama and A. Şahin (2010) "Labor-Market MAtching with Precautionary Savings and Aggregate Fluctuations," *Review of Economic Studies*, Vol. 77(4), 1477-1507.

Krusell, P. and A.A. Smith (1998): "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, Vol. 106(5), 867-896.

Lalive, R., C. Landais and J. Zweimüller (2013): "Market Externalities of Large Unemployment Insurance Extension Programs," CESifo Working Paper Series 4414.

Landais, C., P. Michaillat and E. Saez (2010): "Optimal Unemployment Insurance over the Business Cycle," NBER Working Paper 16525, November 2010.

Mitman, K. and S. Rabinovich (2011): "Pro-cyclical unemployment benefits? Optimal policy in an equilibrium business cycle model," PIER Working Paper 11-010.

Moyen, S. and N. Stähler (2009): "Unemployment Insurance and the Business Cycle: Prolong Benefit Entitlements in Bad Times?" Deutsche Bundesbank Discussion Paper Series 1: Economic Studies No 2009,30.

Mukoyama, T. (2012): "Understanding the Welfare Effects of Unemployment Insurance Policy in General Equilibrium," mimeo.

Nakajima, M. (2012): "A Quantitative Analysis of Unemployment Benefit Extensions," *Journal of Monetary Economics*, Vol. 59, 686-702.

Pallage, S., L. Scruggs and C. Zimmermann (2013): " Measuring Unemployment Insurance Generosity," *Political Analysis*, forthcoming.

Pallage, S. and C. Zimmermann (2005): "Heterogeneous labor markets and generosity towards the unemployed: an international perspective," *Journal of Comparative Economics* 33(1), 88-106.

Pallage, S. and C. Zimmermann (2005b): "On Voters' Attitudes towards Unemployment Insurance Subsidies across Regions: A Canadian Simulation," *Journal of Population Economics*, Vol. 19, 391-410.

Pissarides, C.A. (2000): *Equilibrium Unemployment Theory*, MIT Press, Cambridge (MA) and London.

Pollak, A. (2007): "Optimal unemployment insurance with heterogeneous agents," *European Economic Review*, vol. 51(8), 2029-2053.

Pollak, A. (2013): "Unemployment, Human Capital Depreciation, and Unemployment Insurance Policy," *Journal of Applied Econometrics*, forthcoming.

Rothstein, J. (2011)" "Unemployment Insurance and Job Search in the Great Recession," Institute for Research on Labor and Employment, UC Berkeley, working paper.

Rupert, P. and G. Zanella (2010): "Revisiting Wage, Earnings, and Hours Profiles," mimeo.

Schmieder, J.F., T.M von Wachter and S. Bender (2012): "The Effects of Extended Unemployment Insurance over the Business Cycle: Evidence from Regression Discontinuity Estimates over Twenty Years," NBER working paper 17813.

Schuster, P. (2012):"Cyclical unemployment benefits and non-constant returns to matching," mimeo.

Sánchez, J.M. (2008): "Optimal state-contingent unemployment insurance," *Economics Letters*, 98(3), 348-357.

Shimer, R. and I. Werning (2007): "Reservation Wages and Unemployment Insurance," *The Quarterly Journal of Economics*, Vol. 122(3), 1145-1185.

Sienkiewicz, Ł. (2011): "EEO Review: Adapting unemployment benefit systems to the economic cycle, 2011 - Poland," European Employment Observatory.

Silva, J.I. and M. Toledo (2005): "Labor Turnover Costs and the Behavior of Vacancies and Unemployment," Society for Economic Dynamics 2005 Meeting Papers 775.

Tatsiramos, K. and J.C. van Ours (2012): "Labor Market Effects of Unemployment Insurance Design," CentER discussion paper 2012-082.

Werning, I. (2002) "Optimal Unemployment Insurance with Unobservable Savings," mimeo.