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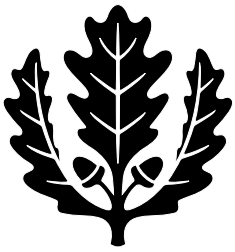

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Abstract

The Canadian unemployment insurance program is designed to reflect the varying risk of joblessness across regions. Regions that are considered low-risk areas subsidize higher risk ones. A region's risk is typically proxied by its relative unemployment rate. We use a dynamic, heterogeneous-agent model calibrated to Canada to analyze voters preferences between a uniformly generous unemployment insurance and the current system with asymmetric generosity. We find that Canada's unusual unemployment insurance system is surprisingly close to what voters would choose in spite of the possibilities of moral hazard and self-insurance through asset build-up.

Journal of Economic Literature Classification: E24, D7, D58, J65

Keywords: Unemployment insurance, moral hazard, shirking, heterogeneous agents, voting, redistribution.

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1 Introduction

The Canadian unemployment insurance program is distinct in several respects. Besides being called an *employment* insurance program, it draws on a commonly financed pool to redistribute asymmetrically on the basis of the severity of the shocks hitting geographical regions. Canada is divided in about sixty regions (see Figure 1), each of which falls in one of twelve categories according to its rate of unemployment. In regions that are hardest hit, the unemployment insurance program entails the highest generosity. While the replacement rate is invariant across regions, the duration of benefits is increasing in the unemployment rate.

Clearly, such a system is prone to generate shirking behavior. As a critic once suggested, 'the Canadian Employment Insurance protects you best against the risk of employment.' If monitoring is not perfect, people in more generous areas may in fact be more tempted to refuse job offers. Those in less generous areas may in turn find it more costly to subsidize the latter. For such system to be sustainable, it must be that regions rotate sufficiently on the riskiness map, so that no region is a constant subsidizer. In this paper, our first goal is to enquire on the political viability of such unemployment insurance arrangement in an economy calibrated to Canada. Would such an insurance scheme arise as a politico-economic equilibrium when compared to the more common uniformly generous system?

Our second goal is to analyze the macro-economic implications of the asymmetric generosity. Workers in less generous regions may rely more on self-insurance than those who feel more protected. As a result, the unemployment insurance policy may stimulate savings in regions that can best afford to save. Compared to a uniformly generous insurance policy, the more redistributive policy has therefore the potential to yield both higher output and higher savings. We wish to quantify this effect.

Our third and final goal is to contrast all of the above with what a benevolent social planner would have chosen under a utilitarian social welfare function.

We work within a general equilibrium model with heterogeneous agents. Agents differ in their geographical area, their assets, their employment status and their eligibility to unemployment insurance. Job offers are drawn from a distribution that matches the characteristics of each region. Agents in the economy are not allowed to migrate, but regions transit from a category to another with probabilities that reflect the transition in the data. Except for some very specific regions, there

is not much persistence in the fate of an area. Abstracting away from migration should therefore not be a significant restriction.[1]

Our research follows a series of recent efforts to revive Baily (1978)'s original attempt to assess the desirability of unemployment insurance regimes using dynamic general equilibrium models parameterized to reflect the key characteristics of various countries. Among the contributors are Hansen & İmrohoroğlu (1992), Wang & Williamson (1996), Andolfatto & Gomme (1996), Hopenhayn & Nicolini (1997), Acemoğlu & Shimer (1999), Pallage & Zimmermann (2001), Gomes, Greenwood, & Rebelo (2001), Wang & Williamson (2002). Progress in computing technologies have made it possible to refine model economies to take into account many important features of actual economies, including moral hazard, precautionary savings, search effort and aggregate shocks. Technology improvements have also made it possible to design and quantify complex unemployment insurance programs with time-varying generosity or experience rating.

The political economy of unemployment insurance compensation was first analyzed by Wright (1986). It has also received much attention in recent years. Authors such as Hassler & Rodr´ıguez Mora (1999) and Pallage & Zimmermann (2001) started to address the responsiveness of voters to moral hazard questions for instance, and the impact of the latter on the majority's choice of unemployment insurance program. The private versus public provision of unemployment insurance has also been analyzed in these papers. Other efforts to analyze the political economy of social programs include Hassler, Rodr´ıguez Mora, Storesletten, & Zilibotti (2003).

This paper is organized as follows. The next section lays out the model economy and defines the equilibria. Section 3 tackles the calibration needed to obtain quantitative results. Section 4 presents results for various voting experiments at the federal and provincial levels. Section 5 concludes.

2 The model economy

We carry out our analysis in a dynamic heterogeneous-agent model resembling that of Hansen & İmrohoroğlu (1992) and Pallage & Zimmermann (2001), but with additional dimensions of heterogeneity to reflect the complexities of the Canadian system. The economy is populated by

[1] In fact, if a majority of voters are in favor of the asymmetric regime, the majority should be strengthened if migration from the few persitently hard hit areas was taken into account.

a continuum of agents with infinite lives. Agents live in regions that fall in one of 12 categories j according to their unemployment risk (i.e., their unemployment rate). Individual agents are of measure zero. Besides the riskiness j of their region, agents differ in their asset holdings m, their past employment status η, whether or not they currently have a job offer $s \in \{e, u\}$, and their eligibility to unemployment insurance benefits expressed as a binary variable μ — i.e., $\mu = 1$ if eligible, 0 otherwise. The overall population has unit measure, while the 12 regional groups have invariant measure χ_j. We do not allow movements of population between regions, which would imply that the distribution of agents enter the problem as a state variable. To keep the problem tractable, we model movements as regional shocks: regions transit between categories while preserving their measure. In each period, agents in category j can transit to category j' with probability $T(j'|j)$.

Job offers reach an individual agent i stochastically. At the beginning of each period t, there is a probability $p_j(s_{it}|s_{it-1})$ that agent i's offer status changes from s_{it-1} to s_{it}. The probability depends on the category j of the region in which the agent lives. The economy produces a single good, which can be consumed or stored. The production technology uses labor as its unique input.

Individuals value their consumption c_i and their leisure l_i. If not offered a job, agent i is automatically eligible to unemployment benefits. If offered a job ($s_{it} = e$) at time t, agent i can accept the offer ($\eta_t = 1$), in which case he will work an indivisible number of hours $\hat{h}$, or he can refuse the offer ($\eta_t = 0$). Refusal of an offer would be synonymous with ineligibility to UI benefits if monitoring was perfect. However, in some circumstances, there exists a probability π that an agent refusing an offer may succed in fooling the insurance agency — i.e., pretend not to have received an offer and manage to collect benefits. This probability is positive for those who are currently out of job (job seekers) only. We assume that it is easier to monitor the behavior of currently employed agents (possible quitters).

Agents accepting an offer all produce y units of the unique consumption good, which also constitute their gross income. Agents eligible to UI compensation in risk category j receive a fraction θ_j of a worker's income, while those that are jobless by choice and unsuccessful at fooling the UI agency have zero income. The UI agency is financed by a tax proportional on income. We will denote by τ the tax rate. If the generosity may be asymmetric across regions, the tax rate, however, is the same for all agents. The tax rate is such that the UI agency always balances its budget. Hence

an agent's disposable income is given by:

$$y_{it}^{d}(s_{it},\eta_{it},\mu_{it};\theta_j,\tau) = \begin{cases} y(1-\tau) & \text{if } s_{it}=e \text{ and } \eta_{it}=1 \\ \theta_j y(1-\tau) & \text{if } \mu_{it}=1 \\ 0 & \text{otherwise} \end{cases}$$

Agents can partially smooth out consumption across states of nature using a storage technology, but they are not allowed to lend or borrow. The quantity of the unique consumption good stored at any given time t by agent i represents this agent's asset m_{it}. There is no interest on storage, nor depreciation. This assumption is without loss of generality. Each agent therefore faces the following budget:

$$m_{it+1} + c_{it} = m_{it} + y_{it}^{d}$$

Given the above budget, and the UI policy (θ_j, τ), agent i in risk category j makes a choice of consumption, leisure and asset so as to maximize the following objective function:

$$\mathcal{U}(c_i, l_i; \theta_j, \tau) = E_j \sum_{t=0}^{\infty} \beta^t U(c_{it}, l_{it})$$

where, $U(.,.)$ is a strictly concave and increasing function of consumption and leisure, and β is the agent's discount factor.

The following agents are eligible for UI benefits: those who did not receive a job offer ($s_{it} = u$) but also quitters and job seekers who refused an offer and went unmonitored. Monitoring by the UI agency is imperfect. The probability for a cheater to receive benefits π corresponds to the probability of not being caught when abusing the system. We use π as an indicator of the level of moral hazard. Eligibility to UI compensation is governed by the following binary function:

$$\mu_{it} = \begin{cases} 1 & \begin{cases} \text{with probability 1 if } s_{it}=u \\ \text{with probability } \pi \text{ if } s_{it}=e, \eta_{it-1}=0, \eta_{it}=0 \end{cases} \\ 0 & \text{otherwise.} \end{cases}$$

Let $\vec{\theta}$ denote the vector of replacement ratios $(\theta_j)_{\forall j}$. We denote by x the vector of exogenous variables $(\vec{\theta}, \tau, \pi)$. The problem of the agents is recursive and admits the following Bellman equation:

$$[P] \quad v(m,s,\eta_{-1},j;x) =$$

$$\begin{cases} \max_{m'} U(m+(1-\tau)\theta_j y - m', 1) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|u) v(m', s', 0, j'; x) & \text{if } s = u \\ \max \left\{ \begin{array}{l} \max_{m'} U(m+(1-\tau)y - m', 1-\hat{h}) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|e) v(m', s', 1, j'; x) \ , \\ \pi \left[\max_{m'} U(m+(1-\tau)\theta_j y - m', 1) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|e) v(m', s', 0, j'; x) \right] \\ +(1-\pi) \left[\max_{m'} U(m-m', 1) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|e) v(m', s', 0, j'; x) \right] \end{array} \right\} & \text{if } s = e, \eta_{-1} = 0 \\ \max \left\{ \begin{array}{l} \max_{m'} U(m+(1-\tau)y - m', 1-\hat{h}) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|e) v(m', s', 1, j'; x) \ , \\ \max_{m'} U(m-m', 1) + \beta \sum_{j'} \sum_{s'} T(j'|j) p_{j'}(s'|e) v(m', s', 0, j'; x) \end{array} \right\} & \text{if } s = e, \eta_{-1} = 1 \end{cases}$$

The problem of each agent can be solved using the above Bellman equation for any possible UI policy $(\vec{\theta}, \tau)$. It is then possible to submit various policies to popular vote. We will restrict our attention to voting equilibria of the following helicopter-drop type[2] between a status quo and a unique alternative. We are particularly interested in an experiment in which agents in each risk category are offered the choice to live in a country featuring the Canadian UI system with asymmetric generosity, which we call the *regional system*, and one in which generosity is not differentiated across risk categories, the *uniform system*.

Definition 1 (Voting equilibrium) *A voting equilibrium in this model is a steady-state allocation of work, assets and consumption for all agents, together with a status quo UI policy $(\vec{\theta}, \tau)$ and an alternative $(\vec{\theta}', \tau')$ such that:*

- *agents solve their individual intertemporal problem [P], under both policies;*
- *the UI agency balances its budget under both policies;*
- *one of the policies rallies a majority of votes.*

In the next section, we parameterize this model to Canada and proceed to the numerical solution.

[2]The label 'helicopter-drop' vote suggests the following type of experiment: agents are sent via helicopter at the border of two worlds in which different policies are in effect. They are then asked in which world they would rather be dropped, given that they can maintain their current state in either world. This is possible since every agent is of measure zero.

3 Parameterization to Canada and solution techniques

We need to assign values to all parameters in our model in order to obtain numerical simulations of the voting equilibria. To do so, we follow the literature for several parameters and use figures specific to Canada for others.

We consider the following utility function:

$$U(c_t^{ij}, l_t^{ij}) = \frac{\left(c^{ij}{}_t^{1-\sigma} l^{ij}{}_t^{\sigma}\right)^{1-\rho} - 1}{1-\rho}$$

with $\sigma = 0.67$ and $\rho = 2.5$ as in Hansen & İmrohoroğlu (1992) and Kydland & Prescott (1982). The discount factor β is set to 0.995, which is consistent with a 6% annual discount rate and the fact that we use monthly data. Finally, a worker spends 45% of the time endowment at work. Since it is very difficult to assess the extent of moral hazard empirically, we perform our computations for a wide set of π–values.

We then need to take care of the regional characteristics. First, we establish the transition probabilities of the economic regions used to determine the level of generosity of the unemployment insurance in Canada. These probabilities are obtained using the monthly unemployment rates in each of the regions from 1978 to 2000. As the number and the definitions of the regions has changed over time, we adjusted the data to generate long time series. Each region is weighted by the size of its labor force in 2000. The resulting transition probabilities are displayed in Table 1. The diagonal represents the probabilities of regions to stay in the same category from one month to the next. They are rather low, thereby suggesting a high degree of mobility. The persistence indicators are higher for both extreme categories, reflecting the truncation of the distribution.

Table 2 describes additional characteristics of the regions that are used in the model. The population shares in each category for the invariant distribution are implied from the transition probability matrix. The unemployment rate is obtained from our regional data. Since we do not have regional data on unemployment duration, we assume a uniform average duration of unemployment of 2 periods, the average at the federal level. The replacement rate, θ_j in the model, is computed in the following way. First, we establish its country-wide average at 30%, which is the *effective* replacement rate reported by Hornstein & Yuan (1999) once eligibility requirements are taken into account. This is the rate used in any experiment where UI generosity is uniformly applied across

regions.

With regional generosity, the replacement rates are differentiated in the following way. Under the current Canadian unemployment insurance program, the same benefits are provided to all eligible applicants, but eligibility criteria differ by region along several dimensions: waiting period, benefit period, hours of previous work required. Obviously, taking all these dimensions into account in our model is an impossible task, even with today's computer technology. Thus we want to summarize actual generosity by the effective replacement rate. To do so, we take a "typical" worker in terms of previous work experience, and observe that such a worker would obtain benefits for a period of 23 to 45 weeks, depending on the region. The replacement rate is adjusted proportionally while maintaining an average of 30% across all regions. The resulting unemployment insurance tax rate is 3%, independently of the scheme when there is no successful shirking.

The last remaining parameter π, the probability of success when shirking, is unfortunately unobserved. We thus rely on experimentation with various values to check for the robustness of our results.

To solve each individual's problem, we iterate on the agent value function over a grid of state variables. Our asset space is composed of 301 points between 0 and an upper bound that is never chosen by agents in our computations. An upper bound of 8 proves to be sufficient for all regions. Other state variables include the current region, the current job offer status and previous period employment. Once the value functions and the corresponding optimal decision rules are found, the invariant distribution of the agents is obtained iteratively.

We then compare the value function of each individual agent in our model under the regional and the uniform regimes. A vote in favor of either policy is recorded based on this simple comparison. We then weigh the votes by the distribution of agents in the status quo. We therefore literally count the votes of indiviual agents. In this paper, we cannot identify a median voter and rely on a median voter theorem for the simple reason that we have many dimensions of heterogeneity. While median voter analysis is very convenient, it is an unaffordable luxury in our case.

4 Results

Table 3 provides summary statistics for the two systems, uniform and regional, across various levels of moral hazard π. We will analyze in turn the case without moral hazard, the case with moral hazard and a series of voting experiments.

4.1 No moral hazard

Without opportunities for shirking ($\pi = 0$), everyone works and the regional system is preferred if the maximum average utility criterion is considered. The current regional system is a source of inequality: it leads to a more uneven distribution of assets, the Gini coeffi cient is 0.821 compared to 0.778 under the uniform insurance scheme. It does also lead to a higher average asset holding than the uniform system. Indeed, individual agents in regions with lower unemployment rates feel underinsured and tend to resort more to self-insurance through asset accumulation. They can do this relatively easily, given that they are currently less likely to be unemployed. Individuals living in regions of higher risk categories do not feel as strongly the need to self-insure given the more generous unemployment insurance system in their region. Furthermore, the region overall can actually less afford to self-insure as more agents are unemployed.

Looking at the votes under the no moral hazard case, it is quite striking that voters massively prefer the uniform system. In Pallage & Zimmermann (2001), we already showed that average utility and voting can yield different results when looking at the desirable replacement rate for a uniform system. This appears also to be the case across systems.

Table 4 details the distribution of the votes. Clearly, from Table 4, block voting is the rule at the level of a region. The regions are the most important dimension according to which voters differentiate themselves. Thus one could argue that a "pseudo-median voter" is to be found along the regional dimension, and not by assets or whether he has a job offer. Of course, as we mentioned before, such is not a median voter, since the model features too many dimensions of heterogeneity. But the regional factor is clearly a deciding element in our analysis of the votes.

Note that the voting outcome is exactly the same if we take either system as the status quo.

4.2 Moral hazard

Of course, it is unlikely that the probability of success at shirking is zero. We therefore want to look at outcomes with higher values of π. In Table 3, we can observe that workers take advantage of these shirking opportunities, and more so under the uniform system. Those who are more prone to shirking are those who can afford the gamble. Clearly, they are more likely to be found in wealthier regions, those that do not face too high a risk of unemployment. Since the uniform system turns out to be more generous than the regional system for those more fortunate regions, it is not surprising that more cheaters are taking their chance under the uniform system. Hence a byproduct of the regional system is that it stimulates overall employment. As we mentioned above, the regional system also stimulates asset accumulation. This remains true in the presence of moral hazard. The macroeconomic effects thus seem to speak in favor of the regional system.

As long as moral hazard is contained at a level π less than 0.2, the regional system would continue to be preferred under the average utility maximization. In another paper, we indirectly measure this parameter for Canada to be in the neighborhood of 0.1 (Pallage & Zimmermann, 2004). If we take this value seriously, we could interpret the fact that the regional system is currently in place as an indication that social preferences in Canada are closely related to the class of utilitarian social preferences.

Passed the $\pi = 0.2$ moral hazard level, however, the average utility criterion would favor the uniform system. This, in spite of the higher proportion of cheaters, lower employment and lower assets in this uniform regime.

Votes stay consistently in favor of the uniform system. Tables 4–9 show how the distribution of the votes evolves as π increases. It further confirms that the region where you live determines how you vote, not your wealth or labor market status. If we stopped our analysis at this point, we would be left with a dilemma: the Canadian unemployment insurance with asymmetric regional generosity does not seem to have the support of the electorate at the federal level. Why then is it in place? Is the Canadian government acting as a utilitarian social planner with the tacit agreement of Canadians? But why would Canadians be tacit and not overwhelmingly claim their discontent? Is our model failing to capture the complexities of Canadian culture? Is our federal election the relevant representation of the Canadian political process?

Clearly, some answers are straightforward. We model here an election on a single issue, the unem-

ployment insurance. Rarely does a party's platform limit itself to that. Voters in Canadian federal elections vote on a package and eventually balance some heart-breaking tradeoffs. Our results then would seem to shed light on a way a party could improve on its platform. But then again, the party itself balances important tradeoffs.

Our model is obviously not capturing the whole picture, but let us keep assuming it does not do too bad a job, and let us work on other dimensions for the moment.

The Canadian political process does not in effect give each Canadian a vote. Some provinces hold more seats in the federal parliament than others on a per capita basis. It turns out that if we weigh the votes within each province by the share of this province's representatives, we get much closer to 50% — and sometimes more — in favor of the regional system. Taking into account the error factor stemming from our simplifications, this may indicate that the regional system may be more robust than what the federal votes above may have suggested. We do this and other experiments in the next subsection.

4.3 The provinces vs. the federation

Experiment 1. (Provincial idiosyncracies) In our first experiment, we acknowledge the fact that Canadians vote for a federal election in their province, which has a given political weight in the federation measured by a pre-assigned number of seats in parliament where smaller provinces get are share of seats that is higher than their population would warrant. Our exercise is thus to record the votes at the provincial level in favor of the regional system of federal unemployment insurance as opposed to the uniform system.

This is not a trivial task. We need to map voters to provinces. To do this, we need to recalibrate the transition probability matrix for the regions in each province, given that not all provinces exhibit the same unemployment patterns over the 1978–2000 period. Next, we need to redo all computations for each province. The calibration for the 11 provinces are available upon request (we agglomerate Yukon, the Northwest Territories and Nunavut into what we call Northern Territories).

A summary of the results for this experiment is given in Table 10. Remarkably, the voting outcomes highlight a clear fracture in the federation: three provinces — Ontario, Alberta and Saskatchewan — stand out against the rest. If the newly founded Conference of Prime Ministers had any say in

the federation, it would likely support the regional system.[3] More realistically, if we weigh the share of provincial voters favoring the regional system by the share of seats held by the provinces (a purely proportional rule), we end up with a much tighter outcome than what the above federal voting results suggested. Without moral hazard, the regional system is still rejected, but only by a margin of 1.2%. In fact, depending on the moral hazard level, the share of agents favoring the regional system lies between 0.47 and 0.54.

Another representation of provincial political power is one in which provinces vote as a block: Indeed, if we adopted the view that all representatives of a province take the position of the majority of voters in their province (a winner-takes-all rule like in the US electoral college), the regional system would have an approval rate of 52% regardless of moral hazard levels. It is likely that the truth lies between those two extreme representations of democracy in Canada.

Hence, it appears that the regional system might be politically much more robust than we would have originally thought. There may be a lot of discontent about the unemployment insurance system currently offered, as measured in our federal vote, the regional system is supported by close to 50% if not more of the provincial votes. Since the regional system is also better from a social welfare point of view, for low levels of moral hazard, voters and the social planner are in fact quite close.

Experiment 2. (Decentralization) Using the setup of our model economy, it is possible to look at other unemployment insurance schemes and verify how voters would choose among them. Table 11 compares the current federal system of regional generosity to one in which each province offers and finances its own system with uniform generosity. In this case, voting outcomes show that the provinces are split in a way that can easily be predicted by the tax rate that applies in the province. Indeed this is the only dimension in which the two proposals differ. Thus, provinces with above average mean unemployment rates unanimously favor the current federal system, the others unanimously want to go provincial. Again, the fracture isolates Ontario, Alberta and Saskatchewan from the rest of the provinces. In this vote, the tax rate overwhelms any effect coming from the current labor market situation in the region, with few small exceptions when π is high.

Table 12 presents a slightly different type of vote. Provincial voters still compare the federally-

[3]The Conference of Prime Ministers is an assembly of all provincial Prime Ministers. At the moment, it is nothing more than a lobby trying to influence federal policies.

run regional system to a provincially-run unemployment insurance, but the provincial alternative now features a regional instead of a uniform generosity. The same results apply. The tax rate is still overwhelmingly decisive, thereby showing how some provinces currently benefit from the subsidies distributed through a federal system compared to a provincial system.

Finally, Table 13 compares both regional and uniform systems when offered at the provincial level. The results are not clearcut at all, as the tax rates are now much closer to each other and the regional dynamics become more important. Unlike for the other votes, there are some important vote reversals as moral hazard is increased. This can happen because the regions of the smaller provinces typically visit only few risk categories, thus the probability of being in the "pseudo-median voter category" is high, and small changes can make this category tip one way or another, much like the American electoral college in presidential elections. Note that the Northern Territories are indifferent, given that their unique economic region has always been in the highest risk category.

One striking result with this last experiment is that all three provinces that disliked the regional system at the federal level for reasonable moral hazard now would adopt it at the provincial level. Thus Ontario, Saskatchewan and Alberta are not against the system itself but dislike subsidizing provinces with higher average unemployment rates. Conversely, some earlier approvers now oppose it, as they would not benefit from the cross-provincial subsidies anymore, like Manitoba, New Foundland or New Brunswick. The choice of unemployment insurance regime now depends only on the distribution agents.

5 Conclusions

Canada has a unique unemployment insurance program, which extends a more generous hand to regions that have higher unemployment rates. To an economist, this is awkward and seems to contradict many results in the asymmetric information literature. We show in this paper that this system can make a lot of sense at the macroeconomic level. We also show that in spite of the possibility of cheating, it can be the optimal alternative to the more common uniformly generous system.

While Canadians speak loud and clear against their unemployment insurance system, if we account for the peculiarities of the Canadian political process, we do not find much evidence that it would

be rejected if solely submitted to popular vote. In fact, the current system would receive a support quite close to 50% in our computerized replica of the Canadian parliament.

Beyond this point, the present paper has several other messages. First, it offers a methodology to perform social experiments within a general equilibrium model with heterogeneous agents. Economists and political economists know the price of running social experiments. We offer interesting affordable alternatives. We show, in particular, that it is possible to impose quantitative discipline to such voting experiments. Second, political economy has the power to account for many dimensions of heterogenity. The current computer technology allows us to build dynamic models with as many agents as we need to properly represent a society. Understanding heterogeneity may be key in the understanding of many real-world elections. Our paper shows that it is indeed possible to work in such environments.

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Figure 1: Canadian employment regions (Source: Canada Employment Insurance website)

Table 1: Transition probability matrix for risk categories

Unemp. rate	$\leq$ 6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	>16%
$\leq$6%	.936	.062	.001	0	.001	0	0	0	0	0	0	0
7%	.118	.728	.151	.003	0	0	0	0	0	0	0	0
8%	.001	.135	.680	.179	.005	0	0	0	0	0	0	0
9%	.001	.005	.146	.692	.149	.007	0	0	0	0	0	0
10%	0	0	.001	.186	.663	.145	.005	0	0	0	0	0
11%	0	0	0	.009	.182	.647	.151	.011	0	0	0	0
12%	0	0	0	0	.007	.189	.653	.145	.005	0	0	.001
13%	0	0	0	0	0	.013	.194	.602	.178	.013	0	0
14%	0	0	0	0	0	.003	.019	.194	.621	.156	.006	.001
15%	0	0	0	0	0	0	0	.008	.265	.544	.166	.017
16%	0	0	0	0	0	0	0	.014	.026	.241	.507	.212
>16%	0	0	.001	0	0	0	0	0	.002	.016	.086	.895

Table 2: Characteristics of risk categories (all figures in %)

Risk category	$\leq$ 6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	>16%	Aggreg.
Population	18.95	10.07	11.08	13.64	11.31	9.10	7.36	5.33	4.69	2.79	1.69	3.98	100
Unemp. rate	4.94	6.60	7.57	8.56	9.52	1.53	11.52	12.52	13.53	14.50	15.55	19.18	9.22
Repl. rate	22.72	24.69	26.67	28.64	30.62	32.59	34.57	36.54	38.52	40.49	42.47	44.45	30

Table 3: Aggregate characteristics, federal votes

	Avg. utility		Workers		Avg. assets		Tax rate		Asset Gini		Votes	
π	Unif	Reg	Unif	Reg	Unif	Reg	Unif	Reg	Unif	Reg	Unif	Reg
0.0	-.5542	-.5540	.908	.908	0.852	0.923	.0296	.0295	.778	.821	.65	.35
0.1	-.5541	-.5540	.907	.907	0.852	0.932	.0296	.0295	.771	.809	.65	.35
0.2	-.5538	-.5539	.888	.892	0.880	0.972	.0312	.0309	.692	.697	.74	.26
0.3	-.5552	-.5563	.847	.855	1.011	1.054	.0368	.0357	.595	.583	.82	.18
0.4	-.5595	-.5598	.798	.812	1.139	1.173	.0470	.0446	.505	.502	.65	.35
0.5	-.5664	-.5664	.744	.761	1.265	1.285	.0631	.0588	.443	.426	.65	.35

Table 4: Voting outcomes with $\pi = 0$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.6506	0.3494	0.3494	0.6506
with offers	0.6034	0.3043	0.3043	0.6034
without offers	0.0472	0.0451	0.0451	0.0472
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0	0.0910	0.0910	0
7	0	0.0736	0.0736	0
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 5: Voting outcomes with $\pi = 0.1$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.6506	0.3494	0.3494	0.6506
with offers	0.6034	0.3043	0.3043	0.6034
without offers	0.0472	0.0451	0.0451	0.0472
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0	0.0910	0.0910	0
7	0	0.0736	0.0736	0
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 6: Voting outcomes with $\pi = 0.2$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.7415	0.2585	0.2585	0.7415
with offers	0.6848	0.2229	0.2229	0.6848
without offers	0.0568	0.0355	0.0355	0.0568
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0.0910	0	0	0.0910
7	0	0.0736	0.0736	0
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 7: Voting outcomes with $\pi = 0.3$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.8151	0.1849	0.1849	0.8151
with offers	0.7500	0.1578	0.1578	0.7500
without offers	0.0652	0.0271	0.0271	0.0652
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0.0910	0	0	0.0910
7	0.0736	0	0	0.0736
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 8: Voting outcomes with $\pi = 0.4$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.6506	0.3494	0.3494	0.6506
with offers	0.6034	0.3043	0.3043	0.6034
without offers	0.0472	0.0451	0.0451	0.0472
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0	0.0910	0.0910	0
7	0	0.0736	0.0736	0
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 9: Voting outcome with $\pi = 0.5$, federal vote

Status quo:	Uniform		Regional	
Votes for status quo:	Yes	No	Yes	No
Overall votes	0.6506	0.3494	0.3494	0.6506
with offers	0.6034	0.3043	0.3043	0.6034
without offers	0.0472	0.0451	0.0451	0.0472
By region 1	0.1895	0	0	0.1895
2	0.1007	0	0	0.1007
3	0.1108	0	0	0.1108
4	0.1364	0	0	0.1364
5	0.1131	0	0	0.1131
6	0	0.0910	0.0910	0
7	0	0.0736	0.0736	0
8	0	0.0533	0.0533	0
9	0	0.0469	0.0469	0
10	0	0.0279	0.0279	0
11	0	0.0169	0.0169	0
12	0	0.0398	0.0398	0

Table 10: Provincial voting outcomes: share of voters within each province favoring current federal system of regional generosity over uniform generosity at federal level

π	0.0	0.1	0.2	0.3	0.4	0.5	Seats
New Foundland	1.	1.	1.	1.	1.	1.	7
Nova Scotia	1.	1.	1.	1.	1.	1.	11
New Brunswick	1.	1.	1.	1.	1.	1.	10
Pr. Edward Isl.	1.	1.	1.	1.	1.	1.	4
Quebec	1.	1.	1.	1.	1.	1.	75
Ontario	.10	.06	.02	.01	.02	.04	106
Saskatchewan	.04	.04	.07	.11	.15	.15	14
Manitoba	.51	.51	.51	.51	.51	.51	14
Alberta	.06	.06	.06	.08	.14	.26	28
Brit. Columbia	.56	.55	.72	.83	.96	1.	36
Northern Terr.	1.	1.	1.	1.	1.	1.	3
Federal parliament	Proportional rule						
Seats	150.1	145.5	147.8	151.9	159.8	166.8	308
Seat share	.488	.473	.480	.493	.519	.541	
Federal parliament	Winner-takes-all rule						
Seats	160	160	160	160	160	160	308
Seat share	.520	.520	.520	.520	.520	.520	

Table 11: Provincial voting outcomes: share of voters within each province favoring current federal system of regional generosity over uniform generosity at provincial level

π	0.0	0.1	0.2	0.3	0.4	0.5
New Foundland	1.	1.	1.	1.	1.	1.
Nova Scotia	1.	1.	1.	1.	1.	1.
New Brunswick	1.	1.	1.	1.	1.	1.
Pr. Edward Isl.	1.	1.	1.	1.	1.	1.
Quebec	1.	1.	1.	1.	1.	1.
Ontario	.0	.0	.0	.0	.0	.0
Saskatchewan	.0	.0	.0	.0	.01	.09
Manitoba	1.	1.	1.	1.	1.	1.
Alberta	.0	.0	.0	.01	.04	.06
Brit. Columbia	1.	1.	1.	1.	1.	1.
Northern Terr.	1.	1.	1.	1.	1.	1.

Table 12: Provincial voting outcomes: share of voters within each province favoring current federal system of regional generosity over regional generosity at provincial level

π	0.0	0.1	0.2	0.3	0.4	0.5
New Foundland	1.	1.	1.	1.	1.	1.
Nova Scotia	1.	1.	1.	1.	1.	1.
New Brunswick	1.	1.	1.	1.	1.	1.
Pr. Edward Isl.	1.	1.	1.	1.	1.	1.
Quebec	1.	1.	1.	1.	1.	1.
Ontario	.0	.0	.0	.0	.0	.0
Saskatchewan	.0	.0	.0	.0	.0	.0
Manitoba	1.	1.	1.	1.	1.	1.
Alberta	.0	.0	.0	.0	.0	.0
Brit. Columbia	1.	1.	1.	1.	1.	1.
Northern Terr.	1.	1.	1.	1.	1.	1.

Table 13: Provincial voting outcomes: share of voters within each province favoring provincial system of regional generosity over uniform generosity at provincial level

π	0.0	0.1	0.2	0.3	0.4	0.5
New Foundland	.45	.45	.44	.24	.51	.15
Nova Scotia	.76	.76	.75	.58	.41	.10
New Brunswick	.49	.49	.49	.40	.39	.39
Pr. Edward Isl.	.70	.70	.70	.36	.70	.07
Quebec	.62	.62	.62	.49	.49	.62
Ontario	.73	.73	.73	.57	.35	.04
Saskatchewan	.79	.79	.78	51	.44	.28
Manitoba	.32	.32	.32	.32	.32	.32
Alberta	.74	.74	.74	.64	.28	.17
Brit. Columbia	.69	.69	.69	.59	.49	.23
Northern Terr.	.50	.50	.50	.50	.50	.50