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Dedication

To Jenna

Abstract

My dissertation consists of two chapters, which are both centered on the analysis of international economic policy.

In the first chapter, *"Relocation Cost, Time Inconsistency, and the Temptation of Protection"*, I show that important aspects of agricultural support policy across developed economies emerge as features of the optimal policy of a government with a redistribution motive that lacks the ability to commit to its future policies. I document that, in the data, transfers to the agricultural sector are higher and more persistent over time in countries where the gap in productivity between agriculture and the rest of the economy is larger. This evidence is at odds with the benchmark with commitment, which prescribes a decreasing sequence of transfers to the low productivity sector to provide incentives to relocate. Without commitment, the government has a temptation to redistribute ex post, which depends on the gap in productivity between sectors. When the agricultural productivity gap is large, this temptation is strong, and the commitment outcome cannot be sustained. When the gap is small, the policy without commitment mimics the benchmark with commitment. In a quantitative exercise, I show that the policy without commitment can account for roughly 30% of the cross-sectional variance in the persistence of transfers to the agricultural sector over time.

The second chapter, *"Migration and the State"*, joint with Zachary Mahone, studies the interaction between social insurance and migration policy. Governments in many countries help insure citizens against idiosyncratic risk. There is a long recognized tension between the potential gains from opening borders (increasing economic opportunity) and closing them (supporting state insurance). We develop a game-theoretic model of two countries that strategically interact in setting insurance and migration policies. We ask whether limits on mobility are a natural result of insurance provision, how equilibrium policies depend

on the characteristics of the two countries and if these policies are efficient.

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Chapter 1

Relocation Cost, Time Inconsistency, and the Temptation of Protection

1.1 Introduction

Since the late 1980s, support to the agricultural sector has been declining across developed economies. However, there is large heterogeneity across these countries on the terms of this decline. Noticeably, countries with relatively productive agricultural sectors have been more successful in reducing support than countries with relatively unproductive agricultural sectors. The cross country evidence in the last few decades suggests the presence of a redistribution motive behind this class of policies, as we observe a positive relationship between levels of agricultural support and the gap in productivity between agriculture and the rest of the economy. Governments seem to face a trade off between efficiency, which requires reducing support to ease the relocation process out of the agricultural sector, and their concern for inequality across sectors. In modern democracies, policy makers revisit this simple trade off frequently, and don't have binding commitments to implement policies chosen by their predecessors. This lack of commitment will induce the *ex post* temptation by the government to undo previous reforms by raising current transfer to the agricultural sector, a classic time inconsistency problem. These transfer policies, which have an impact on workers' mobility across sectors, are particularly relevant in light of the fact that value added per worker is much higher in the non agricultural sector (see (Gollin, Lagakos, & Waugh, 2014)). The presence of large productivity gaps between agriculture and the rest of the economy suggests the opportunity of large gains in output just by easing the relocation of workers out of agriculture, especially in developing countries. The government's inability to commit to plans that provide incentives to undergo this costly relocation is likely to contribute to the persistence of this misallocation of labor.

Motivated by these considerations, in this paper I study the optimal policy of a government with a redistribution motive and who lacks commitment, in an economy with two sectors with different productivities. In particular, I show how its redistribution policy depends on the severity of its time inconsistency problem, and argue that this dependency can contribute to explain the observed differences across countries and time in agricultural support.

Specifically, I model a simple two sector economy with hidden action. Agents have access to a technology to move to the high productivity sector; this technology uses effort, which is not observed by the government, and time. Agents' current effort influences their probability to move to the high productivity sector in the following period. The government uses transfers contingent on the agents' current location to maximize a utilitarian welfare function, which captures its preference for redistribution. I show that the interaction between lack of commitment and the government's redistribution motive has an important quantitative impact on the size and time profile of its redistributive transfers.

The government's inability to observe or enforce private agents' actions is a friction that is arguably relevant in many actual economic situations - typical examples are search effort for job opportunities, as well as relocation between sectors and investment decisions. The optimal policy problem in this context has been extensively studied (see (Shavell & Weiss, 1979), (Hopenhayn & Nicolini, 1997), among others). Less attention has been given to analyzing this problem when the government is unable to commit, which is what I do in this paper[0]. The time inconsistency problem for the government in my setup arises from the fact that, in order to give incentives to agents to move, the government has to promise to implement future inequality in consumption across sectors. A government who has a desire to redistribute and cannot commit will be tempted to deviate by equalizing consumption across sectors *ex post*, after agents have taken their moving decisions.

I formalize the commitment problem by focusing on equilibria with trigger strategies in a dynamic game between the government and infinitely lived private agents. A deviation by the government triggers reversion to a repeated static equilibrium in which agents in the low productivity sector exert no effort to move and the government chooses full redistribution in every period. The best outcome of this game - which corresponds to a sustainable equilibrium, in the language of (Chari & Kehoe, 1990b) - is the solution to a social planner's problem that includes constraints on the credibility of future policies. In this paper, I characterize numerically the solution of this problem and demonstrate how the transfer policy varies as a function of fundamental characteristics of the economy.

The presence of the above mentioned constraints imposes a limit on the levels of inequality in consumption across sector that the government can promise to implement through transfers in the future. This is in stark contrast with the benchmark with commitment, in which the spread in promised utility between high and low productivity sector is increasing over time. The government carries out this spread choosing a decreasing sequence of transfers to the low productivity sector. Without commitment, on the other hand, redistributive transfers eventually stop falling. The economy without commitment features also lower output, because agents in the low productivity sector exert less effort to move than in the benchmark.

[0]An exception is (Xie & Pei, 2015), who focus on Markov Perfect Equilibria, as in (Klein, Krusell, & Rios-Rull, 2008)

The transition dynamics are characterized by a progressive relocation out of the low productivity sector. As the fraction of agents in the this sector shrinks, the set of spreads in promised utility between sectors that can be credibly promised by the government shrinks as well. The intuition for this result is simple: the static equilibrium that a government's deviation triggers is associated to payoffs that are increasing in the fraction of agents currently in the high productivity sector. As a consequence, the temptation to implement full redistribution in the current period becomes more appealing for the government as the relocation process takes place. In other words, the severity of the time inconsistency problem for the government increases along the equilibrium path of the economy.

This simple mechanism can provide a rationalization of the evidence on agricultural support in developed economies. I document[1] two facts: (a) the level and (b) the persistence of comprehensive support to agriculture are positively correlated with the gap in productivity between agriculture and the rest of the economy. To get a sense of how agricultural support policy varies across countries and time, it is helpful to consider two extreme cases: Japan and Australia. In Japan value added per worker outside of agriculture is roughly 3.5 times higher than the same measure in agriculture. In Australia, value added per worker outside of agriculture is about 1.3 times higher than in agriculture. Japan's total support to the agricultural sector went from being 2.58% of GDP in 1986 to 1.14% in 2014, a little less than one half of the starting level. Australia went from about 0.8% of GDP in 1986 to 0.14% in 2014, which is roughly one sixth of the original support.

This evidence is inconsistent with the optimal transfer policy with commitment, which prescribes that redistributive transfer will be steeply decreasing over time when the gap in productivity between agriculture (the low productivity sector) and the rest of the economy is large. The key feature of the economy without commitment that allows to match the data is how the tightness of the constraint on the credibility of policy varies as a function of the productivity gap between agriculture and the rest of the economy. When this gap

[1] I use data on "Total Support Estimates" provided by (OECD, 2014)

is large, the temptation to redistribute is stronger, in the sense that a deviation triggers an equilibrium with a relatively high continuation payoff. Intuitively, this will make it harder for the government to sustain outcomes that are better than the static equilibrium without movement. This correspond in the data to economies like Japan. On the other hand, countries with a relatively productive agricultural sector, like Australia, display both in the model and in the data a policy that is closer to the benchmark with commitment. Since the productivity gap between sectors is small, deviations are not as attractive, and better outcomes can be sustained. Considerations of this kind are illustrated by the means of simple numerical explorations of the model.

In a final quantitative exercise, I calibrate the model to compute how much of the variation of comprehensive support across countries and time my mechanism can account for. I choose parameters such that the model-generated policy matches the observed level of transfers as a fraction of GDP in 1986 and then use the equilibrium to generate a path of 28 years for each economy in my sample. My results show that the best sustainable equilibrium matches fairly closely the cross-sectional average of levels and persistence of agricultural support, while the benchmark with commitment grossly underestimates both. The best sustainable equilibrium also outperforms the benchmark in reproducing the observed heterogeneity in the persistence of support across countries. While the policy with commitment captures only 1% of the cross-sectional variance of my measure of persistence, in my calibration the best sustainable equilibrium can account for roughly 26% of the observed variation across countries.

Related literature

This paper builds on several strands of literature. The first one is the literature on optimal policy when the government lacks commitment. (Farhi, Sleet, Werning, & Yeltekin, 2012) is closely related to this paper[2]. They analyze the problem of optimal taxation of capital by a government with a redistribution motive who lacks commitment and who can't

[2](Scheuer & Wolitzky, 2014) generalizes (Farhi et al., 2012)'s environment with a utilitarian planner to a setup in which tax policy is under the threat of a more general political reform.

observe private agents' individual ability, as in (Mirrlees, 1971). In my paper, the government can't observe the effort put by agents to relocate, rather than their individual ability. Their model offers a rationalization for the progressivity of capital taxation - a feature that does not emerge naturally in models in which the government has commitment. As in this paper, the focus is on the set of sustainable plans, a concept introduced by (Chari & Kehoe, 1990b). The seminal paper on the dynamic inconsistency of optimal policy rules is (Kydland & Prescott, 1977).

(Dovis, Golosov, & Shourideh, 2015) also study trigger strategy equilibria in an open economy policy game between a redistributive government and overlapping generations of agents with heterogeneous wealth. The government can issue domestic and foreign debt, and can renege on previous debt promises. They show that in their model the optimal policy resembles an extreme austerity measure when wealth inequality is high. An older related paper by (Staiger & Tabellini, 1987) analyzes a one-shot policy game between a redistributive government and private agents in a two sector, small open economy, in which agents can move to close wage differentials between sectors after a terms of trade shock. They restrict the government's set of instruments to an import tariff. In their setup, when the government has commitment, the optimal tariff is equal to zero; however, the time consistent level of tariffs is positive. In my paper, movement happens in a similar fashion, but I consider a setup with infinitely lived agents, in which deviations by the government are deterred by the costs associated with agents' expectations switching to full redistribution. Moreover, I study a closed economy in which the government is restricted to choose sector contingent transfers.

Another literature to which my paper is connected to is the literature on repeated moral hazard, and in particular its application to the problem of optimal unemployment insurance, which started with (Shavell & Weiss, 1979). My paper builds on several aspects of (Hopenhayn & Nicolini, 1997)'s setup. In particular, my moving technology is equivalent to their technology to search for a job opportunity. Their paper studies the cost minimizing way of providing transfers to an unemployed agent when her search effort is hidden, under the assumption that both sides are committed to the contract. My paper considers the case of a utilitarian welfare function and relaxes the assumption of commitment; moreover, I don't allow for history dependent transfers when agents move from the low to the high productivity sector. In general, the optimal policy in these environments features history dependence and both (Hopenhayn & Nicolini, 1997) and this paper use expected promised utility as a state variable to study a recursive formulation for the planning problem, following early work by (Abreu, 1988), (Stephen E. Spear, 1987) and (Phelan & Townsend, 1991).

This paper is also related to the literature on structural change, and on the role of agriculture in explaining cross-country productivity differences.

As in (Hansen & Prescott, 2002) (although in a reduced form in my paper) the transition towards the advanced sector happens because of a persistent productivity differential. Traditional theories of structural change rather emphasize the role of productivity advancements in agriculture and Engel's law to generate movement out of the agricultural sector - see for example (Caselli & Coleman II, 2001). From (Gollin et al., 2014) I am taking the concept of agricultural productivity gap[3] and relate it to agricultural policies across developed countries. Their paper makes the important point that - especially in developing nations - there is a large productivity differential between agriculture and the rest of the economy, even after carefully accounting for differences in human capital, hours worked and labor share. Their work suggest that a reallocation of labor outside of the agriculture might be associated to large efficiency gains. A possible interpretation of my results is that the interaction of the government's redistribution motive and lack of commitment might be an important factor in slowing down this reallocation. A growing literature is trying

[3] The agricultural productivity gap is just the ratio between value added per worker outside of agriculture and value added per worker in agriculture, measured at national prices. There is a literature attempting to establish whether the magnitude of this gap is preserved when value added is calculated using constant international prices - see (Gollin, Parente, & Rogerson, 2004) for a summary. The consensus is that in both cases the agricultural productivity gap is quite large across countries.

to explain cross-country labor productivity differences between agriculture and the rest of the economy[4]. (Lagakos & Waugh, 2013) propose a theory based on selection, combining elements of (Roy, 1951) and (Eaton & Kortum, 2002). Studying the impact of the threat of progressive reforms in an environment with selection based on comparative advantage is a possible interesting extension to my work. Another view - see for example (Restuccia & Santaeulalia-Llopis, 2015) - emphasizes the importance of institutional barriers to land and labour reallocation to rationalize the productivity gap[5].

The reminder of the paper is organized as follows. In section 2, I analyze a simple two period version of the model, which provides straightforward intuition for how the interaction of lack of commitment and redistribution causes the size and the time profile of the transfers to change compared to the benchmark with commitment. Section 3 introduces the full model with infinitely lived agents and illustrates its main properties. Section 4 documents stylized facts on agricultural support across OECD countries. Section 5 contains the main quantitative exercise and Section 6 concludes.

1.2 Two Period Model and Intuition

In this section, I lay out the baseline environment in a 2 period model and characterize the optimal policy with and without commitment. I also show a simple equivalence between my formulation with identical agents exerting unobservable effort to move and an economy with heteogeneous moving costs across agents.

A. Baseline Environment

Time is discrete ($t = 1, 2$). The economy is populated by a mass 1 of agents distributed across two sectors: a and b. Let μ_t denote the mass of agents in sector a at the beginning of time t. Each sector is characterized by a constant endowment y^i, $i \in \{a, b\}$, with $y^a < y^b$.

[4](Caselli, 2005), (Gollin, Parente, & Rogerson, 2002) and (Restuccia, Yang, & Zhu, 2008) make the point that agricultural productivity plays a central role in understanding income differences across countries.

[5]In a related paper, (Tombe, 2015) shows that trade amplifies the effect of labor market distortions of this kind.

Agents consume their endowment, plus a location contingent transfer T_t^i, $i \in \{a, b\}$. I assume no private borrowing and saving[6] . The budget constraint of an agent in location i at time t is just, for $i \in \{a, b\}$,

$$c_t^i = y^i + T_t^i$$

Agents in sector a at the beginning of $t = 1$ have access to a moving technology that uses effort in the current period, e, to move to sector b at $t = 2$:

$$p : \quad e \to [0, 1]$$

$$\frac{\partial p}{\partial e} > 0, \;\; \frac{\partial^2 p}{\partial e^2} < 0$$

$$\lim_{e \to \infty} p(e) = 1$$

Agents enojoy consumption, pay a linear utility cost for effort and discount future utility at rate β. The utility function of an agent in sector a at the beginning of $t = 1$ is

$$u(c_1^a) - e + \beta p(e) u(c_2^b) + \beta[1 - p(e)]u(c_2^a)$$

$$u : \quad c \to \mathscr{R}$$

$$\frac{\partial u}{\partial c} > 0, \;\; \frac{\partial^2 u}{\partial c^2} \leq 0$$

The problem of an agent in a at time $t = 1$, given expectations on the government transfer policy at $t = 2$, is just given by [7]

$$\max_e u\left(c_1^a\right) - e + \beta p(e) u\left(\hat{c}_2^b\right) + \beta[1 - p(e)] u\left(\hat{c}_2^a\right)$$

[6]Introducing private borrowing and saving would require making an assumption on wheter the government can observe private savings and whether the government policy can be made contingent on the level of savings. Problems with moral hazard and hidden savings have been studied by (Kocherlakota, 2004) and (Abraham & Pavoni, 2008) and (Werning, 2002)

[7]The notation with " ˆ " is meant to capture the dependency of the variable of interest on private agents' expectations on government policy

subject to

$$c_1^a = y^a + T_1^a$$

$$\hat{c}_2^i = y^i + \hat{T}_1^i, \forall i \in \{a, b\}$$

The solution can be characterized by the following optimality condition

$$\begin{cases} e = 0 & \text{if } \hat{c}_2^{b,e} \leq \hat{c}_2^{a,e} \\ \beta p'(e) \left[u(\hat{c}_2^{b,e}) - u(\hat{c}_2^{a,e}) \right] = 1 & \textit{otherwise} \end{cases} \tag{1.1}$$

Throughout the rest of the paper I will assume that a condition of this kind is always sufficient to represent agents incentives, an approach known as first order approach to incentive problems[8].

B. Government

The government is benevolent, in the sense that it chooses transfers T_t^i, $\forall i \in \{a, b\}$, $\forall t$, to maximize a utilitarian welfare function U, subject to a present value government budget constraint (GBC), with borrowing and lending at small open economy rate r:

$$U = \mu_1 \left[u(c_1^a) - e \right] + (1 - \mu_1) u(c_1^b) + \beta \mu_2 u(c_2^a) + \beta (1 - \mu_2) u(c_2^b)$$

$$(GBC) \quad \mu_1 T_1^a + (1 - \mu_1) T_1^b + \frac{1}{1+r} \left\{ \mu_2 T_2^a + (1 - \mu_2) T_2^b \right\} = 0$$

Notice that the government can't control e directly: the optimal movement decision by private agents, which is represented by condition 1.1, will be taken as given by the government, who can only influence it through its transfers' choice.

Notice also that with this setup I am imposing a restriction on the set of transfers that the goverment has access to. Specifically, I don't allow for transfers at $t = 2$ to depend on the agents' location at $t = 1$. This is motivated informally by the ability of agents to lie

[8]See (Rogerson, 1985a) and (Rogerson, 1985b)

on their past location, but it's not crucial for the results to go through.[9]

C. Timing and Optimal Policy Characterization- Commitment Benchmark

Suppose that the government announces its policy T_t^i $\forall i, t$ the beginning of $t = 1$ and it's not allowed to revise it in the future. Agents in a make their moving effort decision after the announcement. The timing of events is illustrated in Figure 1.1.

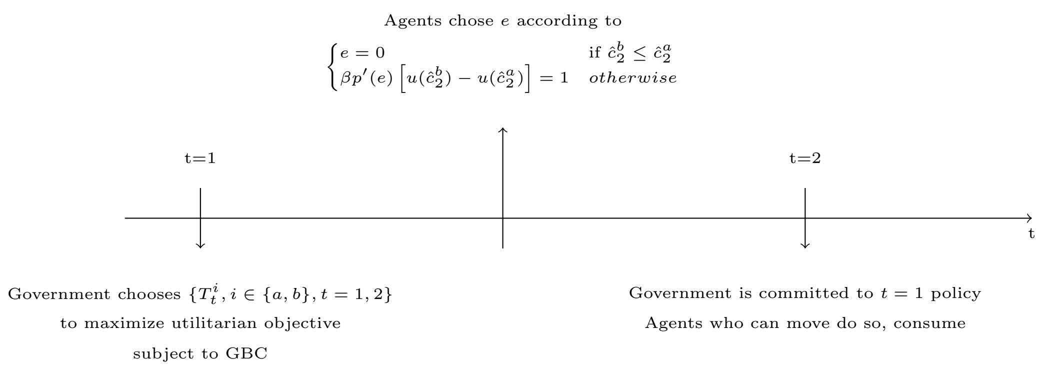

Figure 1.1: Timing with commitment

I focus on symmetric equilibria, in which all agents take the same effort choice e, and in which consequently $\mu_2 = \mu_1[1 - p(e)]$.

The optimal policy with commitment solves the following planning problem:

$$\max_{\left(e, \{c_t^i\}_{\forall i,t}\right)} \mu_1 \left[-e + u(c_1^a)\right] + (1 - \mu_1)u(c_1^b) + \beta\mu_1[1 - p(e)]u(c_2^a) + \beta \left\{1 - \mu_1[1 - p(e)]\right\} u(c_2^b) \tag{1.2}$$

subject to

$$\mu_1(c_1^a - y^a) + (1 - \mu_1)(c_1^b - y^b) + \frac{1}{1+r}\left\{\mu_1[1 - p(e)](c_2^a - y^a) + (1 - \mu_1[1 - p(e)])(c_2^b - y^b)\right\} = 0$$

[9](Shavell & Weiss, 1979) make the same assumption, while (Hopenhayn & Nicolini, 1997) allow for a history dependent transfer when agents leave unemployment

$$\begin{cases} e = 0 & \text{if } c_2^b \leq c_2^a \\ \beta p'(e)\left[u(c_2^b) - u(c_2^a)\right] = 1 & \textit{otherwise} \end{cases}$$

The first constraint is just the resource constraint in the economy, which is obtained by combining the budget constraint of the agents and the government's budget constraint. The second constraint is the incentive compatibilty constraint.

proposition 1.2.1. *Suppose $\beta(1+r) = 1$. In any interior solution of planning problem 1.2, the following inequality holds*

$$\frac{1}{u'(c_2^b)} > \frac{1}{u'(c_1^a)} > \frac{1}{u'(c_2^a)}$$

As a corollary, the sequence T_t^a is decreasing over time.

The proof of this proposition is standard and can be found in the Appendix. The following optimality condition provides intutition for why the sequence of transfers needs to be decreasing:

$$u'(c_1^a) = u'(c_2^a) + \gamma p'(e)$$

γ is the multiplier on the incentive compatibility constraint. If the government could enforce its preferred level of effort, the constraint would be dropped and consumption would be constant over time, given that, since $\beta(1+r) = 1$, perfect consumption smoothing is optimal. However, when the government can't enforce effort directly, it needs $u'(c_2^a) < u'(c_1^a)$ to provide incentives to agents to move. Since the right hand side of the agents' budget constraint is $y^a + T_t^a$, the only way to achieve it is with a decreasing sequence of transfers.

D. Timing and Optimal Policy Characterization- No Commitment

Consider now the case in which the transfer policy is chosen sequentially by two governments with utilitarian objective functions. At the beginning of $t = 2$, the planner takes effort e and the distribution of agents across sectors as given and chooses T_2^i, subject to the budget constraint (which will now include explicitly government debt[10]). The government budget constraint becomes

$$\mu_1 T_1^a + (1-\mu_1)T_1^b + \frac{B}{1+r} = 0$$

$$\mu_2 T_2^a + (1-\mu_2)T_2^b = B$$

The objective function of the planner at $t = 2$ is

$$\mu_2 u(y^a + T_2^a) + (1-\mu_2)u(y^a + T_2^b)$$

Figure 1.2 illustrates the new timing.

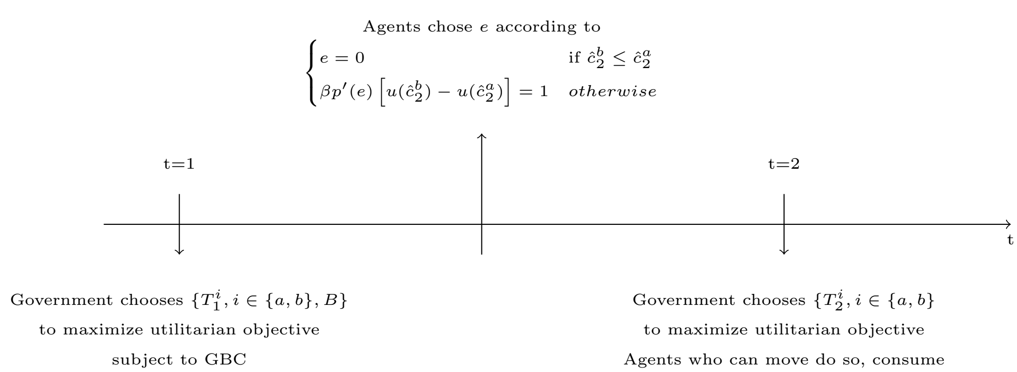

Figure 1.2: Timing without commitment

The optimal policy without commitment can be found by solving the problem of the government at $t = 2$ and then solving backwards. The problem is just

$$\max_{T_2^a, T_2^b} \mu_2 u(y^a + T_2^a) + (1-\mu_2)u(y^a + T_2^b)$$

[10]Here I am ruling out for simplicity default on debt, as in (Persson & Svensson, 1989) and many other papers.

subject to $\mu_2 T_2^a + (1-\mu_2)T_2^b = B$

The following condition needs to hold in the solution:

$$u'(y^a + T_2^a) = u'(y^b + T_2^b)$$

The government, independently of agents' effort or debt, will choose consumption equalization at $t = 2$. Proceeding backwards, it follows immediately that - since the last planner won't accept any consumption inequality - agents will exert no effort:

$$e = 0$$

It is then trivial to show the following:

proposition 1.2.2. *Suppose $\beta(1+r) = 1$. Then, if the government cannot commit to future policy, the time consistent transfers are*

$$T_1^a = T_2^a = (1-\mu_1)(y^b - y^a)$$

$$T_1^b = T_2^b = \mu_1(y^a - y^b)$$

The proof can be found in the Appendix. Notice the stark contrast with the case with commitment: output and transfers are now constant over time and consumption equalization is chosen in both periods. This provides clear intuition for why the interaction of lack of commitment and redistribution motive can produce higher persistence of transfers.

E. Equivalence with economy with heterogeneous moving costs

In this subsection, I show that my moving technology with hidden effort is equivalent to a formulation with heterogeneous and unobservable moving costs[11].

Let agents be indexed by their utility cost of moving between sectors $j \in [0, \infty)$. Let F denote the cumulative distribution function over moving costs. As in the analysis presented

[11]The argument for the proof has been suggested by Matt Greenblatt

so far, moving requires time: agents in a pay their moving cost at $t = 1$ to move to sector b at $t = 2$. The agents solve

$$\max \left\{ \beta u(c_2^b) - j, \beta u(c_2^a) \right\}$$

Clearly there is a cutoff $j^* \in [0, \infty)$ such that any agent with $j < j^*$ is willing to move to b - taking the government policy as given - and for any $j > j^*$, agents will stay in a. So j^* is defined so that the following holds:

$$\beta \left[u(c_2^b) - u(c_2^a) \right] = j^*$$

Consider now the equivalent of planning problem 1.2 with heterogeneous moving costs, and assume for simplicity that $\mu_1 = 1$. The problem can be written as

$$\max_{\{c_t^i, j^*\}\forall i,t} u(c_1^a) - \int_0^{j^*} j dF(j) + \beta F(j^*) u(c_2^b) + \beta [1 - F(j^*)] u(c_2^a)$$

subject to

$(c_1^a - y^a) + \frac{1}{1+r} \left\{ F(j^*)(c_2^b - y^b) + [1 - F(j^*)](c_2^a - y^b) \right\} = 0$

$\beta \left[u(c_2^b) - u(c_2^a) \right] = j^*$

Now it's easy to show that there exist an equivalent economy with hidden effort whose allocations coincide with the one with heterogeneous moving costs. Let $e(j^*) = \int_0^{j^*} j dF(j)$ and define $p(e)$ to be such that

$$p(e(j^*)) = F(j^*)$$

With e and p defined as above, the objective function and the resource constraint of the economy with heterogeneous moving cost and hidden effort are equivalent. What is left to show is that the two economies also have the same incentive constraint.

Notice that $e'(j^*) = j^* dF(j^*)$ and $\frac{\partial p}{\partial j^*} = p'(e(j^*))e'(j^*) = dF(j^*)$. So it follows immediately

$$p'(e(j^*))j^* dF(j^*) = dF(j^*) \Rightarrow p'(e(j^*)) = \frac{1}{j^*}$$

So now take the incentive constraint of the economy with heterogeneous moving costs

$$\beta \left[u(c_2^b) - u(c_2^a) \right] = j^*$$

Using $p'(e(j^*)) = \frac{1}{j^*}$, I can rewrite

$$\beta p'(e) \left[u(c_2^b) - u(c_2^a) \right] = 1$$

F. Intermediate forms of commitment

In this subsection, I study the case in which successive governments have time inconsistent preferences. One interpretation of the results obtained so far is that the optimal policy requires commitment in the future to "high" levels of inequality. When the government can't commit to any future inequality, I have shown that transfers are constant over time. Here I analyze a class of economies that allows for intermediate forms of commitment to future inequality and show what happens to the persistence of transfers in these intermediate cases.

Consider now a government at $t = 2$ with the following preferences

$$\alpha \mu_2 u(c_2^a) + (1 - \alpha)[1 - \mu_2]u(c_2^b)$$

This government takes the distribution of agents and resources as given and maximizes its objective subject to the resource constraint. In optimality, the following condition holds:

$$\frac{u'(c_2^b)}{u'(c_2^a)} = \frac{1 - \alpha}{\alpha}$$

Notice that for $\alpha = \frac{1}{2}$ this government has the same exact preferences as his $t = 1$'s predecessor. This corresponds to the case of complete lack of commitment analyzed in subsection 2.D - in which transfers will be chosen to perfectly equalize consumption between sectors. On the other hand, when α increase, I get an objective function that is "biased" against agents in sector a. Notice that $\frac{1-\alpha}{\alpha}$ is continuous and monotone decreasing in α. Consequenlty $\exists\ \hat{\alpha} > 1/2$ such that the allocation chosen by the $t = 2$'s government is such that $\frac{c_2^b}{c_2^a}$ coincides with the case with commitment.

To ease notation, I define $\chi = \frac{1-\alpha}{\alpha}$. Moreover, to get a sharper characterization of the subgame perfect equilibrium of the game between successive government and private agents, I will consider the case $u(c) = \log(c)$.

proposition 1.2.3. *Suppose $r = 0$ and $\beta = 1$. Let $\mu_1 = 1$ and $u(c) = log(c)$. Then* $\frac{\partial}{\partial \chi}\frac{c_2^a}{c_1^a} = \frac{y^a+T_2^a}{y^a+T_1^a} > 0$

Proof: See Appendix. This proposition simply states that a particular measure of persistence of transfers, $\frac{c_2^a}{c_1^a}$, increases monotonically as I move continuously from the case of preferences for the government at $t = 2$ that implement the commitment benchmark allocation, to the case in which the government at $t = 2$ chooses complete equalization of consumption.

G. Discussion

In this two period model, I have shown that lack of commitment is associated to higher persistence of redistributive transfers. At least two features of this simple formulation[12] motivate the extension to a setup with infinitely lived agents, and both are related to how I can map this model to actual data. First of all, the policy generated by the model in the case in which the government cannot commit is very stark: constant transfers over time. At least for the policies that I analyze (agricultural support), I don't observe in the data examples of transfer policies with perfect persistence. But the main obstacle to use

[12] This critique applies to any finite horizon model in this class, since the only subgame perfect equilibrium in an economy with finite horizon coincides with the static equilibrium described in this section

this formulation for policy analysis is that the degree of severity of the time inconsistency problem is assumed, rather than generated endogenously by fundamental characteristics of the economy. As a consequence, one would need to take an explicit stand on something that is arguaby hard to measure - the ability of the government to commit. In section 4, I document that when the productivity gap between agriculture and and the rest of the economy is large, transfers to the agricultural sector tend to be more persistent. With the formulation of this section, the only way to generate something resembling this feature would be to assume a fundamental difference in the ability to commit across countries that is correlated with this productivity gap. It is hard to argue that across the fairly homogeneous sample of countries that I consider, the institutional differences are such that in some countries the government is able to commit, while in others it can't. In a model with infinitely lived agents and credibility constraints on the policy, on the other hand, the severity of the commitment problem is endogenous. Depending on differences in productivity and other fundamental parameters that can be disciplined by actual data, the time inconsistency problem of the government in the model can become more or less severe.
The cost of adopting the infinite horizon formulation with credibility constraints is the presence of multiple equilibria - which leads to a selection problem. The solution that I adopt is to focus on on the best equilibrium among the defined set of credible policies, as several other papers in the literature.[13],

1.3 The Infinite Horizon Model

In this section, I extend the model of Section 2 to a setup with infinitely lived agents. First of all, it's easy to show that the problem of the agents can be written in a recursive fashion if I define a new variable: the expected utility from being in location $i \in \{a, b\}$ at

[13] For example (Dovis et al., 2015) and (Farhi et al., 2012)

the beginning of time t:

$$w_t^b = u(c_t^b) + \beta \sum_{s=t+1}^{\infty} \beta^{s-t-1} u(c_s^b) = u(c_t^b) + \beta w_{t+1}^b$$

$$w_t^a = u(c_t^a) - e_t + \beta p(e_t) w_{t+1}^b + \beta [1 - p(e_t)] w_{t+1}^b$$

Agents in sector a at the beginning of t consume and choose effort e_t, and with probability $p(e_t)$ they will move to b at $t+1$ with continuation utility w_{t+1}^b; otherwise, with probability $[1-p(e_t)]$ they will be in a at the beginning of $t+1$ and face the same exact problem one period ahead. This consideration allows to rewrite the individual problem of an agent in sector a at the beginning of t - taking the transfer policy as given - as

$$\max_{e_t} u(y^a + T_t^a) - e_t + \beta p(e_t) w_{t+1}^b + \beta [1 - p(e_t)] w_{t+1}^a$$

The optimality condition for e_t is the following:

$$\begin{cases} e = 0 & \text{if } w_{t+1}^b \leq w_{t+1}^a \\ \beta p'(e_t) \left[w_{t+1}^b - w_{t+1}^a \right] = 1 & \textit{otherwise} \end{cases}$$

Notice that the effort decision depends only on the difference in future continuation utility between location b and location a. Notice also that the current *difference* in continuation utilities can be expressed recursively:

$$\Delta_t = w_t^b - w_t^a = u(c_t^b) + \beta w_{t+1}^b - \left\{ u(c_t^a) - e_t + \beta p(e_t) w_{t+1}^b + \beta [1 - p(e_t)] w_{t+1}^b \right\} =$$

$$= u(c_t^b) - [u(c_t^a) - e_t] + \beta [1 - p(e_t)] \left(w_{t+1}^b - w_{t+1}^a \right)$$

$$\downarrow$$

$$\Delta_t = u(c_t^b) - [u(c_t^a) - e_t] + \beta [1 - p(e_t)] \Delta_{t+1}$$

The incentive compatibility constraint can then be rewritten as

$$\begin{cases} e = 0 & \text{if } \Delta_{t+1} \leq 0 \\ \beta p'(e_t)\Delta_{t+1} = 1 & otherwise \end{cases} \tag{1.3}$$

As in the two period version, the government has a utilitarian welfare function:

$$U_0 = \sum_{t=0}^{\infty} \beta^t \mu_t [u(c_t^a) - e_t] + (1 - \mu_t) u(c_t^b)$$

By standard arguments it can be shown that the solution of the government's problem with commitment solves a dynamic programming problem.

proposition 1.3.1. *The optimal policy when the government can commit solves the following Bellman Equation*

$$V(\mu, B, \Delta) = \max_{c^i, e, \Delta'} \mu[u(c^a) - e] + (1 - \mu)u(c^b) + \beta V(\mu', B', \Delta') \tag{1.4}$$

subject to

$$\mu[c^a - y^a] + (1 - \mu)[c^b - y^b] + \tfrac{1}{1+r} B' = B \qquad \textit{Resource Constraint}$$

$$\begin{cases} e = 0 & \textit{if } \Delta' \leq 0 \\ \beta p'(e)\Delta' = 1 & \textit{otherwise} \end{cases} \qquad \textit{Incentive Compatibility Constraint}$$

$$\Delta = u(c^b) - [u(c^a) - e] + \beta[1 - p(e)]\Delta' \qquad \textit{Promise Keeping Constraint}$$

$$\mu' = \mu[1 - p(e)] \qquad \textit{Law of motion for } \mu$$

Sustainable Policies

In this subsection I describe the constraints imposed by the planner's inability to commit not change future policies. In order to do it, I follow (Chari & Kehoe, 1990b) and define the details of a dyanmic policy game in which these constraints emerge as part of the characterization of equilibrium outcomes.

The timing is as follows: at the beginning of each period t, the complete history of past movement across sectors and government policy

$$H_{t-1} = \{\mu_s, B_{s+1}, \{T_s^i\}_{i\in\{a,b\}}\}_{s=0}^{t-1}$$

are publicly known. The government chooses first current transfers and government debt, $\sigma_t(H_{t-1}) = \left(T_t^i(H_{t-1}), B_{t+1}(H_{t-1})\right)$, as well as a complete contingency plan for transfers and government debt for any possible future history. Agents in a, after observing the government's action, take their current action $f_t = \{e_t(H_{t-1})\}$ and choose a contingency plan for any possible future history[14]. Let (σ^t, f^t) be the continuations of the plans for the government policy and agents actions: these are sequences of policy rules from time t onward. Notice that given any H_{t-1}, H_t is induced by $\sigma^t(H_{t-1})$ together with $f^t(H_{t-1})$: given H_{t-1}, $\sigma_t(H_{t-1})$ determines the pair B_{t+1}, $\left(T_t^i\right)_{i\in\{a,b\}}$, while f^t determines e_t, and, in turn, μ_{t+1}. σ^t and f^t generate a continuation utility for the planner given by

$$U^t = \sum_{s=t}^{\infty} \mu_s(H_{s-1})\left[u(y^a + T_s^a(H_{s-1})) - e_s(H_{s-1})\right] + (1-\mu_s(H_{s-1}))\, u\left(y^b + T_s^b(H_{s-1})\right)$$

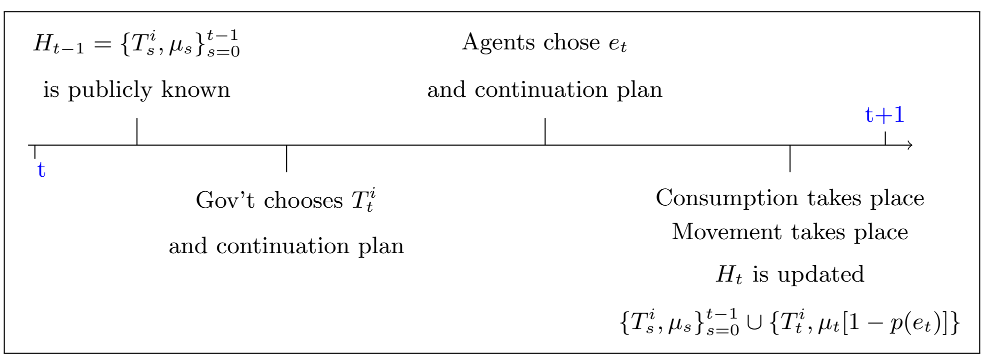

Figure 1.3: Timing of the Game

[14] I focus on situations in which agents are limited to symmetric pure strategies, so that agents in the same sector at a given time t take the same action.

with $\mu_s(H_{s-1}) = \mu_{s-1}\left[1 - p\left(e_{s-1}\left(H_{s-2}\right)\right)\right]$, $\forall s \geq t$.

Expected utilities for agents in a and b after history H_{t-1} can be defined as

$$w_t^a(H_{t-1}) = u(T_t^a(H_{t-1})) - e_t(H_{t-1}) +$$

$$+\beta[1 - p(e_t(H_{t-1}))]w_{t+1}^a(\sigma_t(H_{t-1}), f_t(H_{t-1})) + \beta p(e_t(H_{t-1}))w_{t+1}^b(\sigma_t(H_{t-1}), f_t(H_{t-1}))$$

$$w_t^b(H_{t-1}) = u(T_t^b(H_{t-1})) + \beta w_t^b(\sigma_t(H_{t-1}), f_t(H_{t-1}))$$

Definition 1.3.2. *A sustainable equilibrium is a pair (σ, f) such that the follwing holds:*

- *Given σ, for any history H_{t-1}, f^t solves*

$$\begin{cases} e_t(H_{t-1}) = 0 & \text{if } w_{t+1}^b(H_t) \leq w_{t+1}^a(H_t) \\ \beta p'(e_t(H_{t-1}))\left(w_{t+1}^b(H_t) - w_{t+1}^a(H_t)\right) = 1 & \text{otherwise} \end{cases}$$

- *Given f, σ^t maximizes U^t after any history H_{t-1}, subject to the government budget constraint*

I define allocations and policies to be credible if they are outcomes of a sustainable equilibrium. This set can be characterized using trigger strategies that revert to a certain equilibrium strategy upon deviation. The payoff associated to the latter equilibrium strategy is used to define a set of credibility constraints. The presence of such constraint ensures that the current government prefers the equilibrium outcome to deviating. In this paper, I focus on the following equilibrium strategy pair $(\bar{\sigma}, \bar{f})$:

$$e_t(H_{t-1}) = 0,\ \forall H_{t-1}, t$$

$$T_t^a(H_{t-1}) = (1 - \mu_t)(y^b - y^a),\ \forall H_{t-1}, t$$

$$T_t^b(H_{t-1}) = \mu_t(y^a - y^b),\ \forall H_{t-1}, t$$

$$B_{t+1}(H_{t-1}) = B_t(H_{t-2}),\ \forall H_{t-1}, t$$

Notice that this strategy consist the infinite repetition of the unique Subgame Perfect Nash Equilibrium strategy pair of the one shot game analyzed in Section 1.2, irrespective of history (in this sense, this strategy induces a static equilibrium). The agents exert no effort to move; the government chooses transfers to equalize consumption in every period and sets borrowing and lending to perfectly smooth consumption over time (which corresponds to a constant level of debt if $\beta(1+r)=1$, which is the case I consider).

The associated equilibrium payoff for the government is

$$\bar{U}^t(\mu_t, B_t) = u\left(\mu_t y^a + (1-\mu_t)y^b + B_t \frac{r}{1+r}\right)\frac{1}{1-\beta}$$

What is the value of the government from a deviation? It will consist of the value of the best one period deviation and of the continuation with $(\bar{\sigma}, \bar{f})$:

$$V^d(\mu_t, B_t) = \underbrace{U^d}_{\textit{Best One Period Deviation}} + \beta \underbrace{\bar{U}^{t+1}(\mu_{t+1}, B_{t+1})}_{\textit{Continuation with } (\bar{\sigma}, \bar{f})}$$

It turns out that - since the government maximizes a utilitarian objective - the best one period deviation is just given by consumption equalization in the current period, which yields the following payoff:

$$V^d(\mu_t, B_t) = \max_{B_{t+1}} u\left(\mu_t y^a + (1-\mu_t)y^b - \frac{B_{t+1}}{1+r} + B_t\right) - \mu_t e_t + \beta \bar{U}^{t+1}(\mu_{t+1}, B_{t+1})$$

Note that, given the timing assumptions, which call for the government to move first in the sub-period, agents, after observing the deviation, will immediately revert to $\bar{f}^t$, which prescribes for $e_s = 0\ \forall s \geq t$, irrespective of history. Notice that output in the economy after deviation is constant; the best response for the government in this situation is just to set $B_{t+1} = B_t$, when $\beta(1+r) = 1$. I have at this point all the elements to define the credibility constraint after any hisory H_{t-1} as the following set of inequalities:

$$\forall t, \sum_{s=t}^{\infty} \mu_s \left[u(y^a + T_s^a) - e_s\right] + (1-\mu_s)\, u\left(y^b + T_s^b\right) \geq \frac{1}{1-\beta} u\left(\mu_t y^a + (1-\mu_t) y^b + \frac{B_t}{1+r}\right)$$

A pair of allocations and policies is defined as credible (or sustainable) given $\bar{U}$ if satisfies the sequence of credibility constraints $\forall H_t, t$ and if it satisfies the government budget constraint. The following proposition can be finally estabilished:

proposition 1.3.3. *Let $(\bar{\sigma}, \bar{f})$ be the pair of static equilibrium strategies defined above and $\bar{U}$ its associated set of continuation payoffs. An allocation and policy are sustainable given $\bar{U}$ if and only if they are the outcome of an equilibrium with trigger strategies reverting to $(\bar{\sigma}, \bar{f})$ upon a deviation.*

The proof is omitted, since it follows closely the arguments in (Chari & Kehoe, 1990b). Given this construction, I can study the best equilibrium among the set of sustainable allocations and policies given $\bar{U}$ simply by solving the following constrained programming problem:

$$V(\mu, B, \Delta) = \max_{(c^i)_{i\in\{a,b\}}, e, \Delta'} \mu[u(c^a) - e] + (1-\mu)u(c^b) + \beta V(\mu', B', \Delta') \tag{1.5}$$

subject to

$$\mu[c^a - y^a] + (1-\mu)[c^b - y^b] + \tfrac{1}{1+r} B' = B \qquad \text{Resource Constraint}$$

$$\begin{cases} e = 0 & \text{if } \Delta' \leq 0 \\ \beta p'(e)\Delta' = 1 & \textit{otherwise} \end{cases} \qquad \text{Incentive Compatibility Constraint}$$

$$\Delta = u(c^b) - [u(c^a) - e] + \beta[1 - p(e)]\Delta' \qquad \text{Promise Keeping Constraint}$$

$$\mu' = \mu[1 - p(e)] \qquad \text{Law of motion for } \mu$$

$$\mu[u(c^a) - e] + (1-\mu)u(c^b) + \beta V(\mu', B', \Delta') \geq \qquad \text{Credibility Constraint}$$

$$u\left(\mu y^a + (1-\mu)y^b + B\tfrac{r}{1+r}\right)\tfrac{1}{1-\beta}$$

1.3.1 Properties of the Model

In this section, I lay out the basic properties of the model. I start with a proposition on the timing of transfers for the case in which the government has commitment. This results confirms what I have already shown in the simple two period example of Section 1.2: the sequence of transfers to the low endowment sector is decreasing over time. I then move on to characterize the best sustainable equilibrium with reversion to $(\bar{\sigma}, \bar{f})$. First, I estabilish how the set of sustainable allocations depends on the gap in productivity between sector. I then perform several numerical illustrations of the solution of the dynamic programming problem introduced previously in this Section. The most important property that I show is that the presence of the sustainability constraints imposes an upper bound on the spread in utility between the high and the low productivity sector that the government can promise. Without binding sustainability constraints, the solution displays an increasing sequence for Δ_t. In the best sustainable equilibrium of the dynamic game, this ceases to be true. This in turn impacts on the timing and size of the transfers to the low productivity sector.

proposition 1.3.4. *If $\beta(1+r) = 1$, in the infinite horizon model with commitment, $T^a_{t+1} < T^a_t$, $\forall t$*

The proof can be found in the Appendix. The intuition for the result is the same as in (Shavell & Weiss, 1979) and (Hopenhayn & Nicolini, 1997). If $\beta(1+r) = 1$, absent incentive constraints, the government would set constant consumption over time and sectors. However, when the government can't observe effort and has to provide incentives through its transfer policy, the time profile of transfers is decreasing.

The next proposition attempts to illustrate how the set of sustainable allocations changes as a function of the spread in productivity between sectors. The basic message is that, when μ is sufficiently low (i.e. developed economies, with relatively small agricultural sectors), the sustainability constraint gets tighter as the spread in productivity between sectors gets larger. As a consequence, the set of sustainable allocations shrinks.

proposition 1.3.5. *Let a pair* $y(\epsilon,\bar{y}) = (y_b, y_a)$ *be such that* $y_b = \bar{y} + \frac{\epsilon}{2}$ *and* $y_a = \bar{y} - \frac{\epsilon}{2}$*. Consider a mean preserving spread* $y(\epsilon',\bar{y}) = (y'_a, y'_b)$*, with* $\epsilon' > \epsilon$*. Let* $\mathscr{X}(\epsilon,\bar{y},\mu_0) = \{e_t, \mu_t, T^a_t, T^b_t\}_{t=0}^{\infty}$ *be a set of allocations with* $\mu_0 < \frac{1}{2}$ *and such that* $\forall x \in \mathscr{X}$*,* $U^t(x) \geq \frac{u[\mu_t y_a + (1-\mu_t)y_b]}{1-\beta}$*,* $\forall t$*. Then* $\mathscr{X}(\epsilon',\bar{y},\mu_0) \subset \mathscr{X}(\epsilon,\bar{y},\mu_0)$

Proof. What I want to show is that if $x \in \mathscr{X}(\epsilon',\bar{y},\mu_0)$, then it must be that $x \in \mathscr{X}(\epsilon,\bar{y},\mu_0)$ as well. This is true if the right hand side of the constraint is increasing in the spread ϵ. Suppose this is the case, then $U^t(x) \geq \frac{u\left[\mu_t(\bar{y}-\frac{\epsilon'}{2})+(1-\mu_t)(\bar{y}+\frac{\epsilon'}{2})\right]}{1-\beta} \geq \frac{u\left[\mu_t(\bar{y}-\frac{\epsilon}{2})+(1-\mu_t)(\bar{y}+\frac{\epsilon}{2})\right]}{1-\beta}$. Clearly $u\left[\mu y_a + (1-\mu)y_b\right] = u\left[\mu\left(\bar{y}-\frac{\epsilon}{2}\right) + (1-\mu)\left(\bar{y}+\frac{\epsilon}{2}\right)\right] = u\left[\bar{y} + \frac{\epsilon}{2}(1-2\mu)\right]$, is increasing in $\epsilon = y_b - y_a$ if $\mu < \frac{1}{2}$. □

I will now switch to a numerical characterization of the main properties of best sustainable equilibrium with reversion to $(\bar{\sigma},\bar{f})$. Throughout this subsection I assume the following functional forms

$$u(c,e) = \log(c) - e$$

$$p(e) = \min\{\gamma e^{\nu}, 1\}$$

I also abstract from borrowing and lending[15].

Property 1: The value function V is hump shaped in Δ

This property has an intuitive economic interpretation which can be shown independently of functional forms (but I provide a numerical illustration for it in Figure 4). By combining the promise keeping constraint and incentive constraint, I obtain

$$\Delta = u(c^b) - u(c^a) + e + \frac{[1-p(e)]}{p'(e)}$$

Notice that the right hand side is increasing in e, given that $p(e)$ is a concave function. Suppose that $\Delta = 0$ and fix μ at an arbitrary level $\in (0,1]$. Then the only way the

[15] Computations including borrowing and lending are in progress. The qualitative results presented here and in the reminder of the paper are unchanged

planner can provide incentives for agents to exert effort to move is - mechanically - by setting $c^a > c^b$, which is in general suboptimal. As a consequence, $e = 0$ and output in the economy is set to be forever at $\mu y^a + (1-\mu)y^b$ and $V(\mu, 0) = \frac{1}{1-\beta} u\left(\mu y^a + (1-\mu)y^b\right)$. Consider an arbitrary small level of promised spread in utilities $\Delta = \epsilon > 0$. The marginal benefit from exerting effort is the highest (given μ), by concavity of $p(e)$. For ϵ small enough, the planner won't need to impose much current consumption inequality across sectors in order to deliver the promised $\Delta = \epsilon$, with the net effect being positive. As the Δ grows, the benefit from exerting e is decreasing and the planner must choose higher level of costly current inequality in consumption to deliver the promised spread in utilities. Eventually, for Δ large enough, the marginal net benefit switches sign.

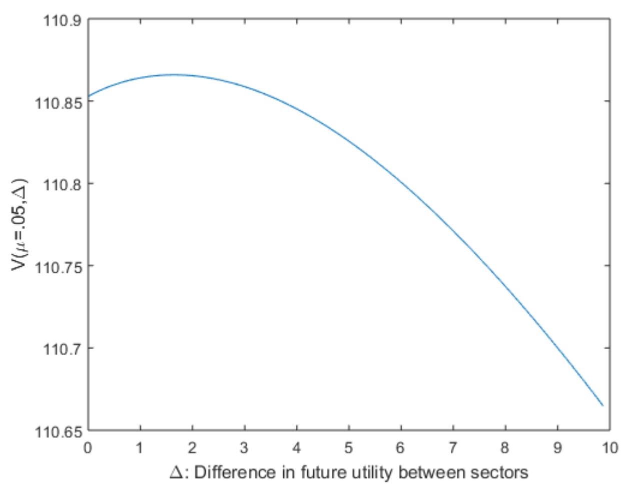

Figure 1.4: Illustration of Property 1

Property 2: The sustainability constraint defines a subset of the state space (μ, Δ) in which the only sustainable strategy is $(\bar{\sigma}, \bar{f})$

Property 2 is also independent of the details of the numerical illustration. Notice that the value of the right hand side of the sustainability constraint for a given history inducing a pair (μ, Δ) coincides with $\frac{1}{1-\beta} u\left(\mu y^a + (1-\mu)y^b\right)$, which is independent of Δ. In general, for β sufficiently small, a Δ^H large enough exists such that

$$V(\mu, \Delta^H) < \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$$

In this situation, the set of incentive feasible choices for the planner that also delivers higher continuation utility than $(\bar{\sigma}^t, \bar{f}^t)$ is empty. The only sustainable equilibrium is the repetition of the static strategy $(\bar{\sigma}, \bar{f})$. Notice that Δ^H must be in the decreasing portion of V as a function of Δ, since I have established in Property 1 that $V(\mu, 0) = \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$ and that $V(\mu, \epsilon) > V(\mu, 0)$, for ϵ small enough. If V is "well behaved" (as it is the case in the numerical illustration that I report here; see Figure 5), then a mapping $\bar{\Delta}(\mu)$: $\mu \to \mathscr{R}_{++}$ can be defined as follows:

$V(\mu, \bar{\Delta}) = \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$, $\forall \mu$

$\forall \Delta < \bar{\Delta}$, $V(\mu, \bar{\Delta}) > \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$, $\forall \mu$

$\forall \Delta > \bar{\Delta}$, $V(\mu, \bar{\Delta}) < \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$, $\forall \mu$

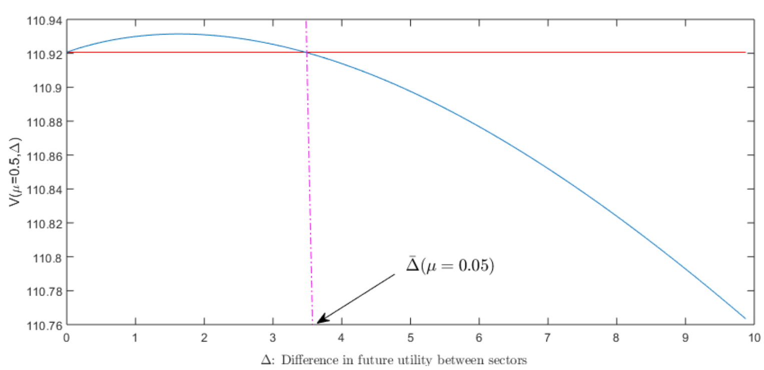

Figure 1.5: Illustration of Property 2

Property 3: For any (μ, Δ), there exist a $\hat{\Delta}(\mu, \Delta)$ such that any $\Delta' > \hat{\Delta}(\mu, \Delta)$ induces a violation of the sustainability constraint in any future period.
Moreover $\hat{\Delta}(\mu, \Delta)$ is decreasing in μ.

Property 3 establishes first that credible promised spread in utility are generally lower than in the case with commitment. This property, which is the most important property to characterize the best sustainable equilibrium, is just a straightforward implication of Property 2 and it defines explicitly a constraint on the choice set of Δ' for any given point in the state space.

Suppose to start from a point (μ, Δ) in the state space such that

$$V(\mu, \Delta) > \frac{1}{1-\beta} u \left(\mu y^a + (1-\mu) y^b \right)$$

Then notice that any choice of Δ' is associated through the incentive constraint and the law of motion for μ to a given $\mu' = \mu[1 - p(e(\Delta'))]$. Now by applying the mapping $\bar{\Delta}$ defined in Property 2 on μ', I can automatically know whether $\bar{\Delta}(\mu'(\mu, \Delta')) > \Delta'$, in which case Δ' is sustainable, or if $\bar{\Delta}(\mu'(\mu, \Delta')) < \Delta'$, in which case the government in the future would choose to deviate (recall that the only sustainable strategy for $\Delta > \bar{\Delta}$ is the static strategy $(\bar{\sigma}, \bar{f})$). In this way, I can define $\hat{\Delta}(\mu, \Delta)$ as the level Δ such that

$$\Delta = \bar{\Delta}(\mu'(\mu, \Delta'))$$

The fact that the value of a government deviation followed by continuation with $(\bar{\sigma}, \bar{f})$ is increasing in μ and independent of Δ determines the second part of Property 3, that is $\hat{\Delta}(\mu, \Delta)$ is decreasing in μ. This has the implication that as the economy goes through its relocation of agents out of the low productivity sector, the choice set of the government shrinks. In a sense, the time inconsistency problem gets more severe.

Illustration of the dynamics

Given these properties, I report in Figure 6 a sample path for the state variables in the commitment benchmark (blue) and the best sustainable equilibrium (red) for the same choice of functional forms and parameters introduced before. Figure 6 is to be read as follows: the economy starts at the upper left corner of the picture, at an initial level

($\mu_0 = .095, \Delta_0 = 4.1$). Increasing levels of spread in future utility Δ' correspond to a movement to the right. Movement towards the bottom of the picture represent a decline in the fraction of agents in the low productivity sector. The dynamics of the benchmark with commitment are clear: the government promises increasing spreads in future utility between sectors to give agents incentives to exert effort. As a consequence, agents progressively relocate out of the low productivity sector over time.

The purple line describes the sustainability constraint: pairs of (μ, Δ) in the region to the right of the pink curve are such that the only sustainable strategy starting from those state variables is $(\bar{\sigma}, \bar{f})$. Notice that the commitment benchmark eventually enters this region.

The best sustainable equilibrium corresponds to the red line. The economy starts at the same point as the economy with commitment. Initially, the evolution of the state variables mimics case with commitment. However, as the economy approaches the sustainability constraint, the credible set of future spread in continuation utilities between sector shrinks. If the government offered the same spread as in the commitment benchmark, private agents would anticipate that future governments would just succumb to the temptation to redistribute, and would not exert effort today. Eventually Δ' becomes a decreasing sequence: future inequality between sectors has to shrink. The reason is implicit in the second part of Property 3: as the relocation takes place, deviations' payoffs are increasing. The final thing to notice is that the benchmark with commitment features greater movement: in the 40 periods that this model simulation illustrates, the benchmark reaches the gray dotted line. The best sustainable equilibrium, which features lower promised inequality between sectors, achieves a smaller relocation.

Finally, Figure 7 illustrates how these dynamics for the state variables translate into a time path for transfers. Notice that after the very initial periods in which the blue line (Commitment Benchmark) and the red line (Best Sustainable) coincide, the transfer policy without commitment initially overshoots below the level of the commitment benchmark, but eventually start growing and gets higher than in the case with commitment.

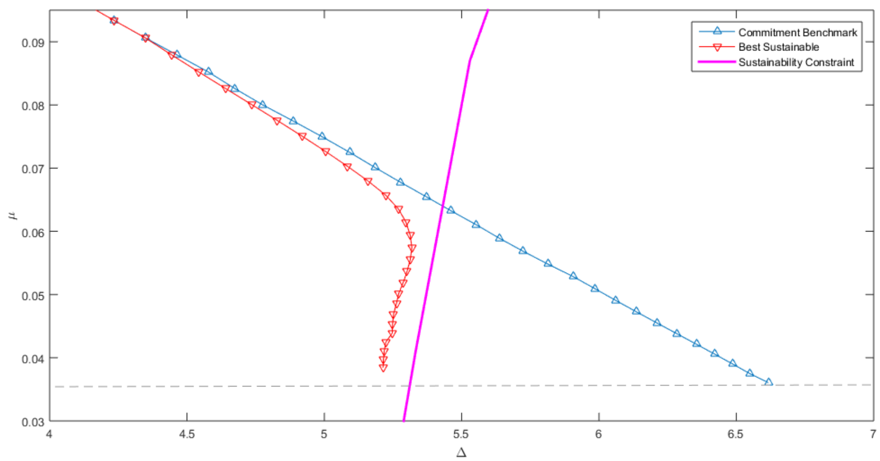

Figure 1.6: Illustration of dynamics for (μ, Δ)

Effect of a mean preserving spread on the aggregate initial endowment

One of the main advantages of studying the best equilibrium with reversion to $(\bar{\sigma}, \bar{f})$ is that the severity of the time inconsistency problem varies as a function of the spread in productivity between sectors. One way to illustrate how this fundamental characteristic of the economy changes both levels and dynamics of endogenous variables is by considering two sample paths of economies with different productivity gaps. Clearly, for any given μ, the sustainability constraint in the economy with higher $y^b - y^a$ will be tighter, since the value of a deviation is increasing in this difference. In order to neutralize effects due to differences in initial output, I impose a different initial μ for the two economies. Figure 8 displays the sample paths for the endogenous state variables of the model for two economies with the following differences in productivity:

$$\text{Large Spread Economy: } y^b = 3.0 \; y^a = 1.0$$
$$\text{Small Spread Economy: } y^b = 2.1 \; y^a = 1.2$$

The horizontal axis of Figure 8 represents the spread in continuation utility Δ, normalized by its maximum value, which correspond to the *laissez faire* economy without any

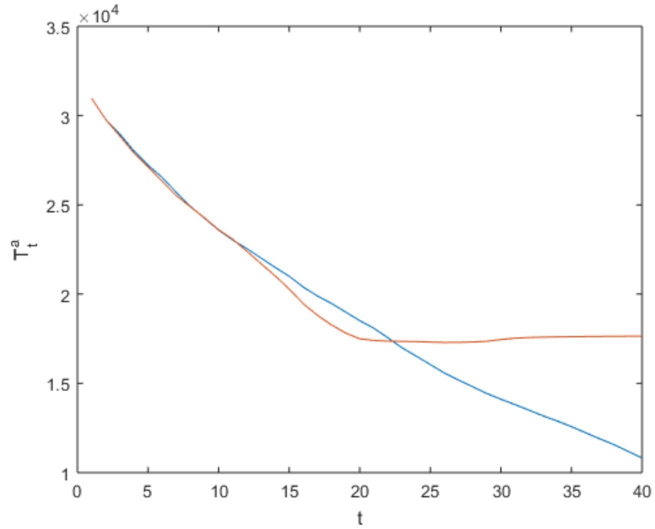

Figure 1.7: Illustration of the dynamics for T^a

transfer. The picture can be explained in the same way as Figure 6. The blue and purple lines represent the sustainability constraint respectively for the economy with Large and Small Spread. Notice that the region in which the only sustainable policy is the static strategy $(\bar{\sigma}, \bar{f})$ is relatively larger in the economy with large spread. Figure 9 and Figure 10 repsectively illustrate the effect of the same mean preserving spread on transfers as a fraction of output per capita, and on their persistence. Notice that the economy with large spread displays also higher transfers - highlighting a stronger redistribution motive. I measure persistence simply by dividing current transfers by the their original level in the first period of the path. The large spread economy features transfers that are relatively more persistent over time.

1.4 Empirical Evidence

This section illustrates some stylized facts about sectoral policy across developed economies. I focus on assistance to the agricultural sector and I document how it varies across several

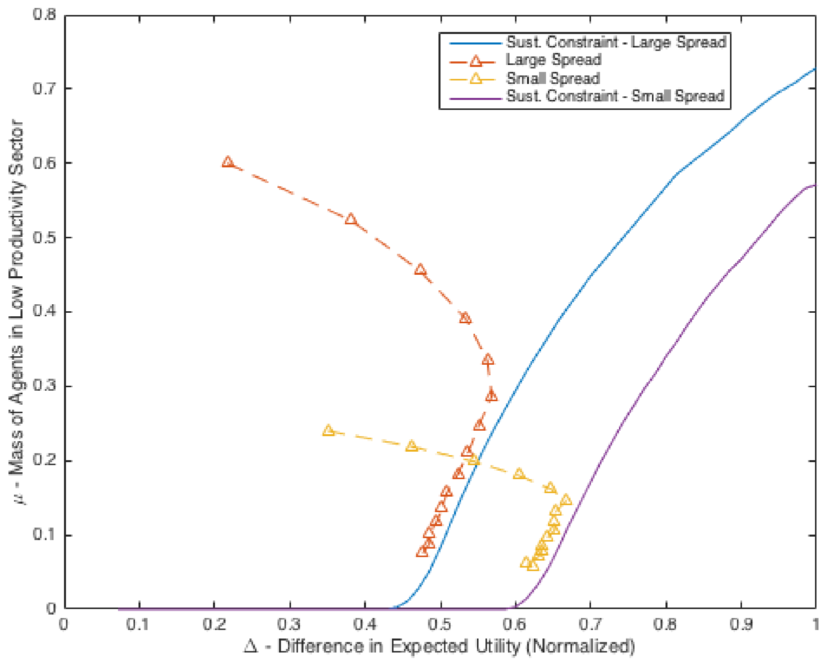

Figure 1.8: Effect of a mean preserving spread: Dynamics

OECD economies over time. The main facts can be synthesized as follows:

1. The level of comprehensive assistance provided to the agricultural sector is positively correlated with the gap in productivity between agriculture and the rest of the economy across countries

2. The persistence over time of this assistance is also positively correlated with the gap in productivity between agriculture and the rest of the economy across countries

I interpret Fact 1 as evidence of a redistribution motive behind agricultural support across countries. In light of this, Fact 2 suggests that reductions to agricultural support are harder to achieve where the redistribution motive for the government is stronger - which is also where the efficiency gains from relocating out of agriculture are the highest.

To measure support to agriculture, I use the Total Support Estimate (TSE), an indicator

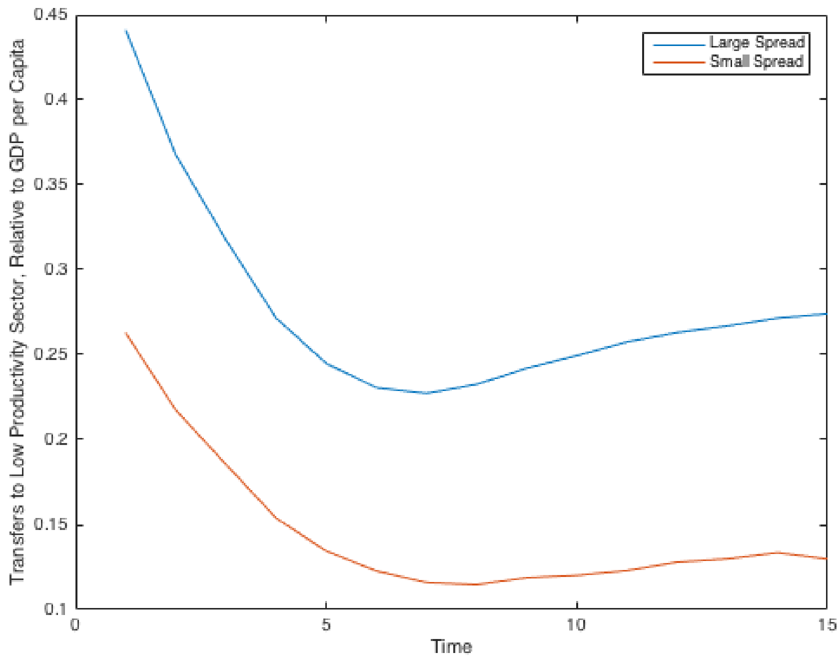

Figure 1.9: Effect of a mean preserving spread: T_t^a as a fraction of output per capita

calculated by the OECD Trade and Agriculture Directorate[16]. TSE is measured as "*the annual monetary value of all gross transfers from taxpayers and consumers arising from policy measures which support agriculture, net of the associated budgetary receipts, regardless of their objectives and impact on farm production and income, or consumption of farm products.*". Detailed time series are publicly available for a cross section of countries from the year 1986 to 2014 on the OECD Statistics website. To allow for a meaningful cross country comparison, I consider the ratio between TSE and GDP (TSE%).

The presence of substantial income differences between the agricultural sector and the rest of the economy has already been pointed out in several papers. (Gollin et al., 2014) provide a simple measure for this differences: the so-called Agricultural Productivity Gap (APG).

[16]See The Producer Support Estimate Manual (2010) -(OECD, 2014) for details on how this indicator is calculated

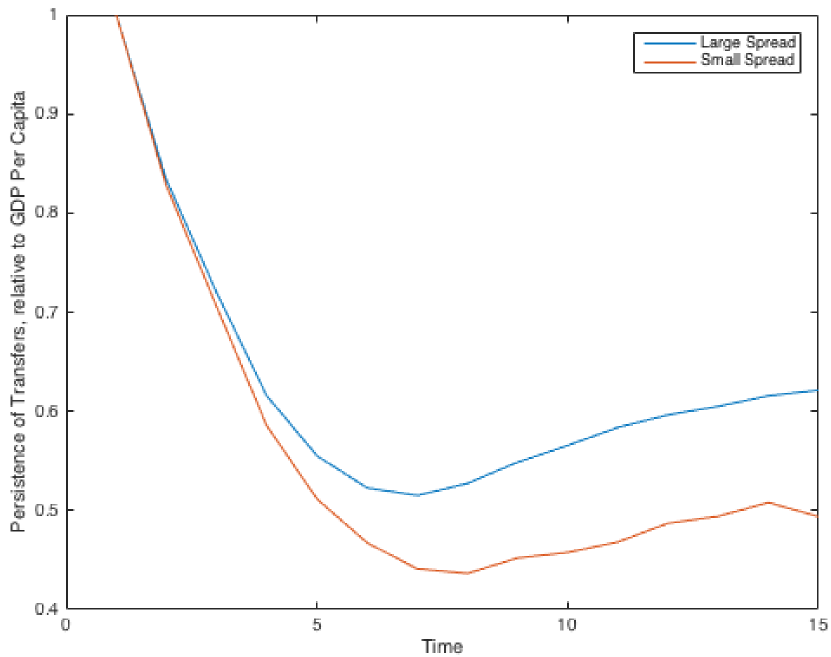

Figure 1.10: Effect of a mean preserving spread: Persistence of T_t^a

The latter is just the ratio between value added per worker outside of agriculture and value added per worker in agriculture. I take the values for APG straight from the Data Appendix of their paper[17] and combine them with part of the evidence collected for TSE% in Table 1.1. Notice that all the countries display a positive agricultural productivity gap. For countries like Japan and Switzerland, where value added per worker outside of agriculture is more than three times higher than its counterpart in agriculture, the evidence suggests potentially large income gains for workers employed in agriculture from switching to a different sector.

(Anderson & Valenzuela, 2008) and others have pointed out a recent tendency by countries to aggressively assisting agriculture relative to other industries. The typical example in

[17]I recomputed the index for all the countries in the sample using data from the World Bank Dataset and found values completely consistent with those of (Gollin et al., 2014). They are available upon request

Table 1.1: TSE % and APG across the OECD

Country	$TSE\%_{1986}$	$TSE\%_{2014}$	$\frac{TSE\%_{2014}}{TSE\%_{1986}}$	APG
Australia	0.84	0.14	0.16	1.33
Canada	1.94	0.37	0.19	1.27
EU	2.69	0.71	0.26	2.23*
Japan	2.58	1.12	0.43	3.55
Korea	8.89	1.8	0.20	3.01
New Zealand	3.06	0.31	0.10	1.32
Norway	3.58	0.86	0.24	2.37
Switzerland	3.74	1.06	0.28	4.13
USA	1.13	0.55	0.48	1.37
Mean	3.16	0.77	0.26	2.28

* Own calculations

this group is Japan, who also displays one of the highest APG in the sample. I build a simple measure of persistence of agricultural aid by taking the ratio $\frac{TSE\%_{2014}}{TSE\%_{1986}}$. I report this indicator in the third column of Table 1.1; this indicator is supposed to show how much countries have cut their agricultural aid relative to the initial level from 1986 to 2014. Notice that over the 28 years covered, Japan has roughly cut in half its aid to agricultural sector as a fraction of GDP, while Australia - a country with one of the lowest APG - has reduced it roughly three times as much. Figure 1.11 documents Fact 1: the levels of TSE% reported in Table 1.1 are positively correlated with APG: as agriculture is relatively less productive compared to the rest of the economy (i.e. high APG), TSE% tends to be higher. As emphasized before, this point towards a redistributive role for transfers to the agricultural sector. Note that this positive correlation is robust to different years in the sample[18].

Finally, Figure 1.12 illustrates Fact 2: $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ is positively correlated with APG. In other words, the less the agricultural sector is productive compared to the rest of the economy, the less aid to the agricultural sector has been reduced over the considered time period. The USA represent an outlier when I look at $\frac{TSE\%_{2014}}{TSE\%_{1986}}$: they display persistent aid even if

[18] Available upon request

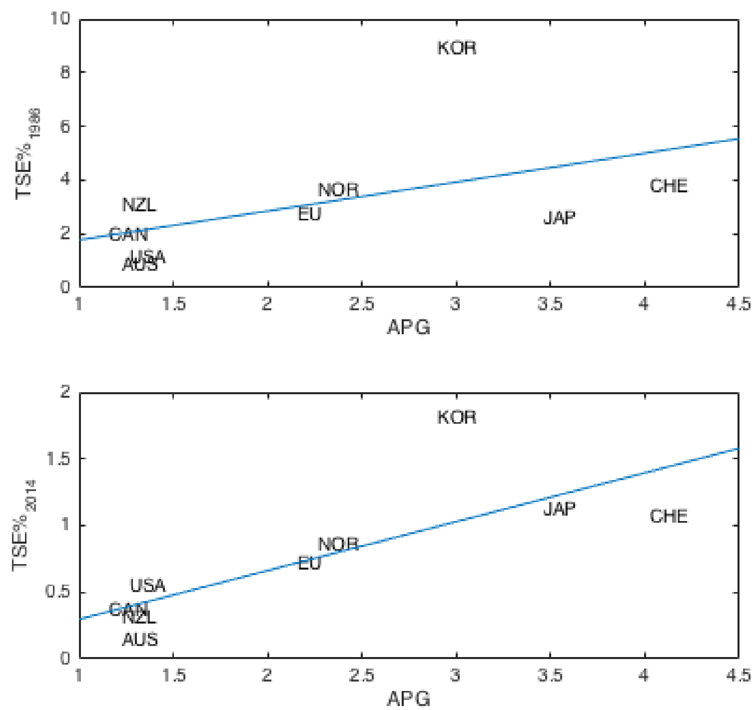

Figure 1.11: TSE% in 1986 and 2014 and APG

their agricultural sector is one of the most productive relatively to the rest of the economy among the countries in the sample. Aside from this case, the relationship between APG and $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ is positive and robust.

1.5 Quantitative Exercise

In this section, I ask how well the mechanism I have described throughout this paper matches the evidence illustrated in Section 4. The spirit of the exercise is to calibrate some of the parameters of the modeled economies to match the observed levels of transfers to the agricultural sector as a fraction of output in 1986. Given these calibrated parameters, I can use the equilibrium of the model to generate sample paths for each economy for 28 years,

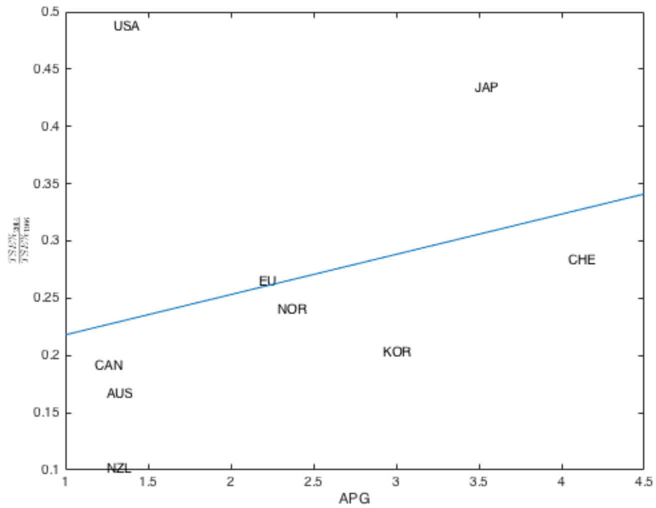

Figure 1.12: $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ and APG

which is the same temporal length as in my data. Using these paths, I compute statistics that are the equivalent to the evidence that I have shown in Section 4: (1) total transfers to the agricultural sector as a fraction of output in the final period, and (2) the ratio between the final period's level of transfers as a fraction of output and the initial one. I perform this exercise both for the benchmark with commitment and for the best sustainable equilibrium, and compare the results. Overall, the best sustainable equilibrium matches fairly closely the average in the cross-section for both (1) and (2), while the benchmark with commitment grossly underestimates both. Finally, the best sustainable equilibrium can account for roughly 26% of the cross sectional variance of (2), while the benchmark captures only slightly more than 1% of the variation.

Table 2 summarizes the calibration. y^a is obtained straight from the data, as the Food and Agriculture Organization provides time series for value added per worker in agriculture across countries at constant 2005 dollars. For each country, I choose y^a to be the average value over the 1986-2014 period. y^b is obtained by multplying y^a by the Agricultural Productivity Gap values reported in (Gollin et al., 2014). μ_0 corresponds to the fraction of

Table 1.2: Calibration

Parameter	Target	Source
y^a	Value Added per worker in agriculture	(Faostat, 2015)
y^b	Value Added per worker outside of agriculture	(Faostat, 2015), (Gollin et al., 2014)
μ_0	Fraction of economically active in agriculture in 1986	(Faostat, 2015)
ν, γ	Average Annual change in μ (Australia)	(Faostat, 2015)
Δ_0	TSE % in 1986	(OECD, 2014)
β	Literature	

people economically active in agriculture over the entire population of economically active in 1986, which is again taken from (Faostat, 2015).

It is important to notice that my exercise requires taking a stand on the parameters of the moving technology and on whether these should be allowed to vary across countries. I assume that the moving technology is homogeneous. The functional form and parameters are as follows:

$$p(e) = \min\{\gamma e^{\nu}, 1\}$$

$$\nu = 0.4, \gamma = 0.1$$

These are chosen so that the model's best sustainable equilibrium for Australia matches the observed average yearly movement out of the agricultural labor force over the time period 1986-2014[19].

Finally, Δ_0 is chosen in each country to match the 1986 level of TSE %, while β is consistent with models for annual frequency data. Notice that neither the evolution of transfers over time, nor the evolution of the share of agents in the agricultural sectors, are targeted[20].

Table 3 and Table 4 summarize the results for each country. The numbers between squared brackets report the data on TSE % from Section 4. Notice first that the average level of

[19]The choice of which country to consider as the "benchmark" to calibrate these parameters is arbitrary. Robustness checks on alternative choices for ν and γ are in progress

[20]With the exception of μ for Australia

Table 1.3: TSE % : Data and Best Sustainable Equilibrium

Country	$TSE\%_{2014}$	$\frac{TSE\%_{2014}}{TSE\%_{1986}}$
Australia	0.162 [0.14]	0.191 [0.16]
Canada	0.241 [0.37]	0.163 [0.19]
EU	0.832 [0.71]	0.309 [0.26]
Japan	0.877 [1.12]	0.339 [0.43]
Korea	2.182 [1.80]	0.245 [0.20]
New Zealand	0.529 [0.31]	0.173 [0.10]
Norway	0.686[0.86]	0.192 [0.24]
Switzerland	0.719 [1.06]	0.192 [0.28]
USA	0.205 [0.55]	0.181 [0.48]
Mean	0.715 [0.769]	0.220 [0.260]
Variance	0.334 [0.233]	0.004 [0.013]

transfer relative to output at the end of the path in the best sustainable equilibrium (0.715%) is fairly close to the one in the data (0.769%). On the contrary, the benchmark with commitment produces an average drop in transfers that is substantially larger (0.587% at the end of the sample path on average across countries).

Notice that this is not an automatic consequence of my chosen calibration: for Switzerland and Norway, for example, the fall in transfers to the agricultural sector is slightly greater *without commitment*, rather than in the benchmark. The reason can be easily understood by looking at Figure 7: the transfers in the best sustainable equilibrium initially *overshoot* the benchmark, and recover later. In the Appendix I provide detailed pictures of the evolution over time of the transfers, and show that this is indeed the case. Note also that the reason why the benchmark fails to match the average level of transfers in the cross section at the end of the sample path is exactly because it over-estimates the drop in transfers for the EU and Japan, two countries with medium to high APG (see also Figure 13 and Figure 14). In terms of cross-sectional variation, the best sustainable equilibrium generates even higher variance than in the data; this is in particular due to one extreme observation in the sample: Korea.

Table 1.4: TSE % : Data and Commitment Benchmark

Country	$TSE\%_{2014}$	$\frac{TSE\%_{2014}}{TSE\%_{1986}}$
Australia	0.160 [0.14]	0.189 [0.16]
Canada	0.240 [0.37]	0.161 [0.19]
EU	0.512 [0.71]	0.190 [0.26]
Japan	0.513 [1.12]	0.169 [0.43]
Korea	1.691 [1.80]	0.190 [0.20]
New Zealand	0.529 [0.31]	0.173 [0.10]
Norway	0.724 [0.86]	0.202 [0.24]
Switzerland	0.719 [1.06]	0.192 [0.28]
USA	0.199 [0.55]	0.176 [0.48]
Mean	0.587 [0.769]	0.182 [0.260]
Variance	0.191 [0.233]	0.000 [0.013]

The analysis of the results for $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ shows that the benchmark with commitment fails in accounting both for the levels and for the heterogeneity of the persistence in support to the agricultural sector. Not only the average for $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ (18%) is again sensibily lower than in the data (26%), but also the benchmark delivers very homogeneous levels in reduction. The variance of $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ generated by the model is only 1.5% of the observed one.

The best sustainable equilibrium performs considerably better. First of all, the average $\frac{TSE\%_{2014}}{TSE\%_{1986}}$ in the cross section (22%) is again sensibly closer to the one observed in the data (26%). Moreover, the model accounts now for roughly 26% of the variance of the data.

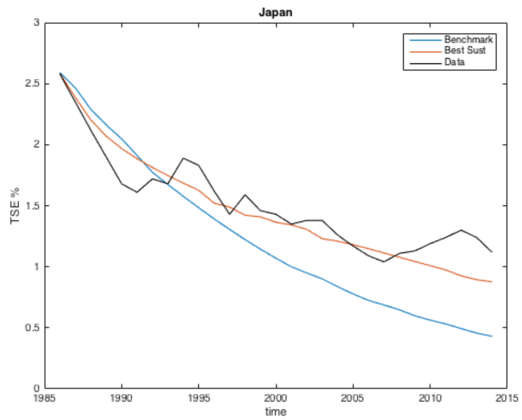

Figure 1.13: Japan

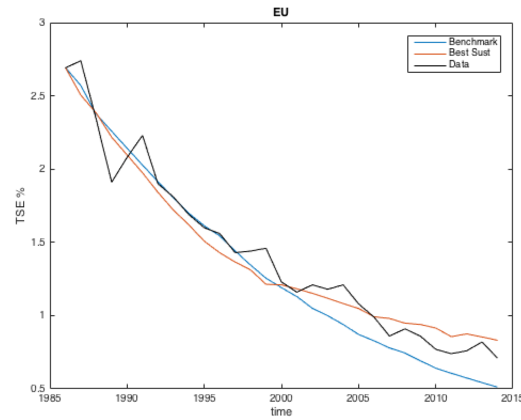

Figure 1.14: European Union

1.6 Conclusion

In this paper I studied the optimal policy problem of a government with a redistribution motive in a simple dynamic economy with hidden action and two sectors. I characterized the outcome of a dynamic policy game corresponding to the best equilibrium with trigger strategies reverting to the infinite repetition of the unique sub-game perfect equilibrium of the associated stage game. Numerical illustrations of the model show how the optimal transfer policy varies as a function of the gap in productivity between sectors. The model can help accounting for differences across countries and time in TSE %, an important measure of support to the agricultural sector for OECD countries. The main finding is that relaxing commitment by studying equilibria with trigger strategies offers a possible way to rationalize the large heterogeneity in agricultural support across countries and time that we observe in developed economies.

Chapter 2

Migration and the State

2.1 Introduction

The decision to migrate is often driven by the search for economic opportunity. In and of itself, this flow of productive factors to their highest return is efficient. However, in a "modern" world where governments help insure their citizens against idiosyncratic risk, the migrants may impose an externality on natives through their claim on state benefits. This tension, perhaps most famously associated with Milton Friedman[0], has long been recognized in many countries.

There are several examples of this. When the Austro-Hungarian Empire relaxed internal migration controls in the 1840s[1], local governments - the providers of these contracts - responded by restricting the requirements for local citizenship. Starting in the 1680s, Massachusetts established the public charge concept, whereby newcomers at risk of becoming a burden on the local government could either be turned away, or admitted conditional on the shipper carrying the individual posting a bond as insurance against such an eventuality

[0] Friedman is often quoted saying, "It is one thing to have free immigration to jobs. It is another to have free immigration to welfare. And you cannot have both." His views were more nuanced than is often implied, but "migration to welfare" is one tension we hope to capture, particularly when countries differ greatly in productivity.

[1] Consent was previously needed to move within the empire

(see (Mau, 2012)). Sometimes countries pose restrictions on the outflow of their own citizens as well, in an apparent attempt to support their social insurance contract. Members of the soviet bloc tended to impose strict controls on the emigration of people in their working age, showing at the same more liberality towards retirees, the former being net contributors to social insurance programs, the latter being net beneficiaries (see (Dowty, 1988)). Home residency requirements of J-1 non-immigrant visa currently issued by the United States can also be interpreted as an example of restrictions of this kind[2].

Motivated by these considerations, we construct a game-theoretic model that focuses attention on the conflict between mobility and state insurance. More precisely, two countries strategically choose mobility and insurance policies to maximize the expected utility of natives. We analyze what inter-country mobility regimes look like in a world where there are gains both from opening borders (increasing economic opportunity) and closing them (supporting the state insurance contract). We ask whether limits on mobility are a natural result of state contracts that provide insurance, and how equilibrium policies depend on the characteristics of the two countries.

We find that equilibrium migration policies depend crucially on the ability of governments to *discriminate* benefits based on the recipients' country of origin.

When governments are constrained to offer the same claims to consumption to both natives and migrants, if any migration happens in equilibrium, it is by high-skilled agents - or net contributors to the government social insurance program. This result seems consistent with the experience of countries that engage in selection of immigrants based on skills[3]. An interesting finding is that, under given parametric conditions, these equilibria feature *lower* levels of insurance than in the autarkic equilibria without migration[4]. Governments

[2]J-1 visas are issued by the United States to - among others - researchers, professors, visiting scholars. When these exchange programs are funded by home governments, or the program was in a field deemed as necessary for the development of the home country, the visitor can be required to return to her home country for at least 2 years after the end of the exchange.

[3]For example, Canada and Australia have adopted a point system based on the characteristics of the immigrant.

[4]It is important to notice that, as we will argue later, these equilibria featuring inequality are associated with higher average utility in both countries compared to the autarkic equilibrium with perfect consumption

in this situation face the benefit of attracting highly productive agents - who can contribute to increase output per capita - at the cost of meeting the outside option that their country of origin offers them. Balancing this trade-off can lead to contracts that increase the consumption spread between high and low skilled agents in the host country. This feature of the equilibrium contracts is reminiscent of a "race to the bottom" effect[5] when governments don't coordinate their migration policies.

When we allow governments in our game to offer contracts to immigrants different than natives, equilibrium migration changes drastically: it is only by low-skilled agents. It is important to notice that the government's ability to restrict agents' emigration plays a crucial role in sustaining this class of equilibria.

A maybe obvious remark is that the policies we characterize are not necessarily efficient[6]. Indeed we show that, in several situations, it is possible to find Pareto improving policies over our non-cooperative equilibrium. Again, the ability of the government to discriminate benefits based on nativity status matters. When the social insurance contract can be customized differently between natives and immigrants, the equilibrium policy with positive migration is always inefficient. When governments have to offer the same contract, we find that the equilibrium policy with migration is *constrained efficient*.

Literature Review

This work is related to several strands of literature. Both topically and conceptually it is most closely linked to (Razin & Sadka, 2010), who quantitatively analyze a game between a host and source country with forward looking voters. Redistribution policy is modeled as a non-targeted lump sum transfer to all agents, financed by a proportional labor tax. Their model, like ours, is designed to examine how state benefits and limits on mobility arise endogenously from underlying assumptions on the native population and technology. In

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equalization.

[5]See (Mendoza & Tesar, 2005).

[6]It has long been recognized that when governments act in a non-cooperative fashion and to maximize their own country's welfare, the equilibrium is likely to be inefficient. See (Chari & Kehoe, 1990a) for an analysis of this issue in limiting economies.

(Razin & Sadka, 2010)'s formulation, only the host-country regulates directly immigration, and restrictions to the emigration of agents are excluded from the policy set. In contrast, in this paper each country can set both immigration and emigration restrictions, jointly with a social insurance contract. As already mentioned, in (Razin & Sadka, 2010) policies are determined by majority voting, while we model the desire of the government to provide agents with insurance using a utilitarian welfare function[7]. Another paper studying how welfare benefits influence migration is (Borjas, 1999), which analyzes the geographic clustering of immigrants in US states as a function of the generosity of their welfare benefits. Our work also shares conceptual inspiration from part of the literature on local public goods exploring how different preference aggregation concepts give rise to different endogenous limits on mobility ((Jehiel & Scotchmer, 2001), for example). The welfare improving role of mobility, while simpler in our model, is explored in papers such as (Benhabib & Jovanovic, 2012). Our paper is also closely related to the literature on strategic fiscal policy interactions of countries ((Chari & Kehoe, 1990a) or (Mendoza & Tesar, 2005)) in which policy formation is modeled as a game between countries with various types of productive linkages. A potential cost of mobility, that by effecting outside options it may tighten participation constraints and reduce the provision of insurance, is explored in the context of local risk-sharing networks in (Morten, 2013).

The reminder of the paper is organized as follows: Section 2 illustrates the economic environment and introduces our two-country policy game. In Section 3 we derive the main results for the case in which the governments are constrained to offering the same policy to agents independently of their nativity status. In Section 3 we also provide a numerical illustration of equilibria in which allowing high-skilled immigration is paired a reduction in risk sharing in the host economy. In Section 4 we analyze the environment in which discrimination between native and immigrant agents is allowed. Section 5 discusses the efficiency of the Nash equilibria of these games. Section 6 concludes.

[7]It is worth mentioning that our setup can also be given a political economy interpretation, as its policies can also emerge in a setup with *probabilistic voting*, as shown in (Lindbeck & Weibull, 1987)

2.2 Economic Environment

There are two countries, indexed by $j \in \{1, 2\}$. Each country is populated by two types of agents: high and low skilled. For simplicity, we assume that each type is endowed with $\theta(i) > 0$ units of output, with $i \in \{H, L\}$ and $\theta(H) > \theta(L)$. Let $\pi(i, j)$ be the measure of agents with endowment $\theta(i)$, born in Country $j \in \{1, 2\}$. Without migration, total output in Country j is simply given by

$$y_j = A_j \{\pi(L, j)\theta(L) + \pi(H, j)\theta(H)\}$$

Notice that we are allowing for countries to differ in their Hicks-Neutral technology parameter A_j.

Agents consume the output good, and their utility function u is assumed to be strictly increasing and strictly concave.

Timing and Policy

At the beginning of time, agents in country j are uncertain about their endowment realization (or, equivalently, their type). They know however that with probability $\pi(i, j)$, they will be assigned an endowment $\theta(i)$. Aside from this, agents are identical. We assume that there is no private market to insure agents against the risk of the realization of a low endowment. Once realized, $\theta(i)$ is publicly observable.

In each country there is a government that offers *ex-ante* the following contract

$$G_j = \left\{\alpha_j^c(i, j), m_j(i, j)\right\}_{\forall i,j}$$

In this notation, the subscript $j \in \{1, 2\}$ always denotes the "name" of the Country whose government is enacting the policy, while the arguments of the policy functions between parenthesis are used to identify the agents which are subject to the policy.

$\alpha_j^c(i, j)$ represents the share of total output y_j allocated to the consumption of agents of type i, born in Country j, enacted by the government of Country j. Notice that the government is specifying a consumption policy not only for its native agents, but also for any foreign born agent that is present in Country j.

$m_j(i,j) \in \{0,1\}$ denotes the migration policy enacted in Country j. $m_j(i,j) = 1$ means that agents of type i born in Country j are allowed to move: the government of Country j is giving its $i - type$ agents the right to *emigrate* to Country j'. Conversely, $m_j(i,j) = 0$ implies that $i - type$ agents born in Country j cannot emigrate to Country j'. $m_j(i,j')$ is the *immigration* policy of Country j's government: with $m_j(i,j') = 1$ $i - type$ agents from Country j' are allowed to enter Country j, while with $m_j(i,j') = 0$ they are blocked. The government of Country j maximizes a utilitarian welfare function

$$\sum_i \pi(i,j)u(\alpha_j^c(i,j)y_j)$$

Notice that immigrants don't enter the government's objective. The usual interpretation that the government is providing *ex-ante* insurance against the realization of idiosyncratic risk applies here.

Autarky Problem

It is useful consider first the autarky case, that is the situation in which we exclude both immigration and emigration of any type of agent. The government is just maximizing its welfare function, subject to a resource constraint for the economy. The notation for this case can be simplified, and the government problem reads

$$V^a = \max_{\alpha^c(i)} \sum_{i \in \{L,H\}} \pi(i)u(\alpha^c(i)y)$$

subject to

$\sum \pi(i)\alpha^c(i) \leq 1$ (resource constraint)

$\alpha^c(i) \geq 0$

$y = A\left\{\pi(L)\theta(L) + \pi(H)\theta(H)\right\}$

Let λ be the multiplier on the resource constraint. An interior solution is characterized by the first order necessary conditions

$$\frac{\partial}{\partial \alpha^c(i)}: \quad u'(\alpha^c(i)y)y = \lambda, \forall i \in \{L, H\}$$

together with the complementary slackness condition

$$\lambda\left\{1 - \sum \pi(i)\alpha^c(i)\right\} = 0$$

$\frac{\partial}{\partial \alpha^c(i)}$ implies that $\alpha^c(i)$ is constant across types: $\alpha^c(L) = \alpha^c(H)$. This leads to an autarkic value, in which the government offers full insurance to its native agents:

$$V^a = u\left(A\frac{\pi(L)\theta(L) + \pi(H)\theta(H)}{\pi(L) + \pi(H)}\right)$$

Migration decisions and policy game

In order to properly define the policy game between the governments of Country 1 and 2, we need to take a stand on the timing of the agents migration decisions, which is as follows

1. $G = \{G_1, G_2\}$ are announced simultaneously
2. $\theta(i)$ is realized
3. Agents make their moving decisions
4. Movement takes place and agents consume

$i - type$ agents born in Country j solve, after seeing their $\theta(i)$ and taking G as given, the following

$$W(i, j; G) = \max_{\delta \in \{0,1\}} (1 - \delta)w_j(i, j) + \delta w_{j' \neq j}(i, j)$$

$w_j(i,j)$ represents the value associated with being in Country j, being an $i - type$ and being born in Country j. To give an example, $w_2(L,1)$ is the value of an $L - type$ agent born in Country 1 achieved by moving to Country 2. Notice that, for a $i - type$ agent from Country j, if either $m_j(i,j) = 0$ or $m_{j' \neq j}(i,j) = 0$, the moving decision is irrelevant, since G is prescribing that either emigration from j or immigration into j' is restricted.
Let $\delta^*(i,j;G)$ denote the optimal moving choice of a $i - type$ agent born in Country j. The resource constraint in Country j (dropping from the notation the dependence of δ^* on G) is the following

$$\sum_i \left\{\pi(i,j)[1-\delta^*(i,j)m_j(i,j)m_{j'}(i,j)]\alpha_j^c(i,j) + \pi(i,j')[\delta^*(i,j')m_j(i,j')m_{j'}(i,j')]\alpha_j^c(i,j')\right\} \leq 1$$

The problem of the government in Country j, taking $G_{j'}$ as given, is to select G_j to solve

$$V_j(G_{j'}) = \max_{G_j} \sum_{i \in \{L,H\}} \pi(i,j)u(\alpha_j^c(i,j)y_j)$$

subject to the resource constraint and the optimal moving decisions of the agents $\delta^*(i,j;G)$. Now that players, actions and payoffs are specified, we can turn to the definition of the equilibrium concept. As previously anticipated, we focus on non-cooperative equilibria with pure strategies of the policy game between Country 1 and 2's governments.

Definition 2.2.1. *A Nash Equilibrium with pure strategies is a set of government policies* $G^* = \{G_j^*, G_{j'}^*\}$ *and agents' moving decisions* $\delta^*(i,j;G), \delta^*(i,j';G)$ *such that*

- G_j^* *solves* $V_j(G_{j'}^*;\delta^*)$ *and* $G_{j'}^*$ *solves* $V_{j'}(G_j^*;\delta^*)$
- $\delta^*(i,j;G)$ *solves* $W(i,j;G)$, $\forall i,j$, *taking* G *as given*

It is immediate to show that, independently from the ability of the governments to discriminate α_j^c based on nativity status, Autarky is a Nash Equilibrium of this game. Moreover, Autarky is also the worst Nash Equilibrium.

lemma 2.2.2. *The minimum level of utility achievable in any Nash Equilibrium by Country* j*'s government is the autarkic utility level*

Proof. First, we establish that autarky is a Nash Equilibrium. Suppose Country j's government offers the autarkic contract to its citizens and blocks the entry and exit of any agent. The best response by Country j''s government is to set also the autarkic policy for consumption, since this contract solves the maximization problem of the government when there is no immigration or emigration. Country j''s government is also indifferent among opening or closing borders - so closing borders (both for immigrants and emigrants) is best response. The symmetric argument applies for j's, which trivially establishes that autarky is a pure strategy Nash Equilibrium.

Since the payoff from autarky for both governments is *independent* of the other government's strategy, it follows immediately that any payoff, in order to be an equilibrium payoff, needs to yield utility at least as high as autarky. □

2.3 Policy ***without*** discrimination

We start from the case in which the governments cannot discriminate their consumption allocation based on the nativity status of the agents. This is equivalent to assuming $\alpha^c_j(i,j) = \alpha^c_j(i,j') = \alpha^c_j(i)$, $\forall i$.

The next set of results aims to characterize conditions for the existence of equilibria with positive migration between countries. We start from establishing that accepting $L - type$ immigrants is always a dominated strategy. The intuition is simple: given that the government has to offer immigrant agents the same consumption share of output that it provides to natives, accepting $L - type$ agents means increasing the mass of net beneficiaries of redistributive transfers. This implies that the amount of resources that the government can allocate to native agents is lower than in autarky. As a corollary, if any equilibrium migration exists, it must be by $H - type$ agents.

proposition 2.3.1. $m_j(L, j') = 1$ *is never best response*

Proof. Suppose not. Notice first that admitting $L-type$ agents - ceteris paribus - decreases

average output. If $\alpha_j^c(L) = \alpha_j^c(H)$ a contradiction follows immediately, since consumption in this case is constant across types and equal to average output. This establishes that $m_j(L,j') = 1$ can't be the best response combined with strategies that call for equal consumption shares across types. Suppose then that $m_j(L,j) = 1$ is the best response combined with $\alpha_j^c(L) \neq \alpha_j^c(H)$. We will assume for simplicity that $\pi(H,j') = 0$, but the argument carries through for any $\pi(H,j') > 0$. Consider the case in which $\alpha_j^c(L) < \alpha_j^c(H)$. It is useful to define $\forall i,j$ the shares $\bar{\alpha}_j^c(i)$ of *average* output that correspond to $\alpha_j^c(i)$. We can obtain them just by dividing both sides of the resource constraint by the total population size:
$\left\{\frac{\alpha(L)}{\pi(H,j)+\pi(L,j)+\pi(L,j')}\left[\pi(L,j)+\pi(L,j')\right]+\frac{\alpha(H)}{\pi(H,j)+\pi(L,j)+\pi(L,j')}\pi(H,j)]\right\} y_j \leq$
$\frac{y_j}{\pi(L,j)+\pi(L,j')+\pi(H,j)}$. The right hand side of the expression is just average output, while $\bar{\alpha}_j^c(i) = \frac{\alpha(i)}{\pi(H,j)+\pi(L,j)+\pi(L,j')}$ is the consumption share of average output of type $i \in \{L,H\}$. Notice that a vector $\bar{\alpha}(i)$ is feasible if $\sum_i \left[\bar{\alpha}(i)\left(\sum_j \pi(i,j)\right)\right] \leq \frac{1}{\sum_{i,j}\pi(i,j)}$. Let average output with $m_j(L,j') = 1$ be $\hat{y}_j$ and average output with $m_j(L,j') = 0$ be $\bar{y}_j$. The total value for the government with migration of $L - type$ agents from j' will be $\pi(L,j)u((\bar{\alpha}_j^c - \frac{\epsilon}{2})\hat{y}_j) + \pi_j(H,j)u((\bar{\alpha}_j^c + \frac{\epsilon}{2})\hat{y}_j)$, with $\epsilon = \bar{\alpha}_j^c(H) - \bar{\alpha}_j^c(L)$ and $\bar{\alpha}_j^c = \frac{\bar{\alpha}_j^c(H)+\bar{\alpha}_j^c(L)}{2}$. But then consider the plan with the same shares of consumption out of average output, but $m_j(L,j') = 0$. Notice that this is feasible, since $\frac{1}{\pi(L,j)+\pi(H,j)} > \frac{1}{\pi(L,j)+\pi(H,j)+\pi(L,j')}$, while the left hand side of the feasibility constraint is $\bar{\alpha}(L)\pi(L,j) + \bar{\alpha}(H)\pi(H,j) < \bar{\alpha}(L)[\pi(L,j)+\pi(L,j')] + \bar{\alpha}(H)\pi(H,j)$. Since $\hat{y}_j < \bar{y}_j$, this plan provides the government with higher utility: $\pi(L,j)u((\bar{\alpha}_j^c(L) - \epsilon)\bar{y}_j) + \pi_j(H,j)u((\bar{\alpha}_j^c(L) + \epsilon)\bar{y}_j) > \pi(L,j)u((\bar{\alpha}_j^c(L,j) - \epsilon)\hat{y}_j) + \pi_j(H,j)u((\bar{\alpha}_j^c(L,j) + \epsilon)\hat{y}_j)$. This contradicts $m_j(L,j') = 1$ being best response. A symmetric argument can be applied for the case $\alpha_j^c(H) < \alpha_j^c(L)$. □

Two corollaries follow from proposition 2.3.1. One is simply that free migration can't be an equilibrium. Second, equilibrium migration is not possible if $A_1 = A_2$, that is if the host and source country are equally productive. In other words, for any migration to be possible in equilibrium, there must be a productivity differential between countries.

Corollary 2.3.2. *Free migration, i.e.* $m_j(i,j) = 1$, $\forall i, j$, *is not an equilibrium*

Proof. Follows immediately from the fact that $m_j(L, j') = 1$ is never best response □

Corollary 2.3.3. *If* $A_1 = A_2$, *Autarky, i.e.* $m_j(i,j) = 0, \forall i, j$ *and* $\alpha_j^c(L) = \alpha^c(H)$, *is the unique equilibrium.*

Proof. Suppose not. Then there must be an equilibrium with some movement, and by proposition 2.3.1 it must be that $H - types$ agents move. Without loss of generality, suppose that migration is from Country 1 to Country 2. It useful to consider again shares of consumption $\bar{\alpha}_j^c(i)$ of *average* output which correspond to a contract $\alpha_j^c(i)$. It must be the case that the contract offered in Country 2 is such that $u\left(A_1\frac{\theta(L)\pi(L,1)+\theta(H)\pi(H,1)}{\pi(L,1)+\pi(H,1)}\right) \leq \pi(L,1)u(\theta(L)A_1) + \pi(H,1)u(\bar{\alpha}_2^c y_2^*)$, where y_2^* is average output in Country 2. Notice in particular that it must be the case that $\bar{\alpha}_2^c y_2^* > \theta(H)A_2$, since u is strictly concave and $A_2 = A_1$. Using the budget constraint for the government in Country 2, $\bar{\alpha}_2^c(L)y_2^* < \theta(L)A_2$ is implied. Such contract is clearly suboptimal by Country 2's perspective, since consumption plans that provide insurance are strictly preferred to plans that offer no insurance by the planner. □

The following proposition identifies sufficient conditions for migration to exist in equilibrium. The idea is that if the host Country is sufficiently more productive, the "talent" of $H - type$ agents born in the source country is more efficiently allocated abroad. The cost for the source Country is loosing its ability to offer any insurance to $L - type$ agents. However, if the productivity differential is large enough, the gain from the greater economic opportunity accessed by the $H - type$ agents, whose contribution to output is now $A_2\theta(H) > A_1\theta(H)$, offsets the cost.

proposition 2.3.4. *If* $A_2 - A_1$ *is sufficiently large,* $m_j(H,1) = 1$ *and* $m_j(L,1) = 0$ $\forall j$ *is a Nash Equilibrium migration policy with* $\alpha_2^c(H) = \alpha_2^c(L)$

Proof. Proposition 2.3.1 established that $m_j(L,1) = 1$ can't be the best response policy, so it must be the case that in any Nash Equilibrium $m_j(L,1) = 0$. Now fix A_1 to some arbitrary level. In order for the candidate policy to be part of a Nash Equilibrium, it must be the case that letting $H-types$ emigrate is the best response for Country 1's government, i.e. $\pi(L,1)u(A_1\theta(L)) + \pi(H,1)u(\alpha_2^c(H)y_2^*) \geq \max_{\alpha_1^c(i)} \pi(L,1)u(\alpha_1^c(L)y_1) + \pi(H,1)u(\alpha_1^c(H)y_1)$ with y_2^* being output in Country 2 under the candidate policy, and y_1 a feasible output level in Country 1 under any different migration policy. Notice that - conditional on the proposed Country 2's policy - output in Country 1 is bounded above: $y_1 \leq \bar{y}_1 = A_1\{\theta(L)\pi(L,1) + \theta(H)[\pi(H,1)]\}$. Consequently, $\max_{\alpha_1^c(i)} \pi(L,1)u(\alpha_1^c(L)y_1) + \pi(H,1)u(\alpha_1^c(H)y_1) = u(\bar{y}_1) = u\left(A_1\frac{\theta(L)\pi(L,1)+\theta(H)[\pi(H,1)]}{\pi(L,1)+\pi(H,1)}\right)$. It is now possible to define the minimum level of consumption in Country 2 $c_2^*(H,1)$ offered to $H-type$ agents migrating from Country 1 for which Country 1 is willing to choose $m_1(H,1) = 1$. $c_2^*(H,1)$ in particular solves the following:

$u\left(A_1\frac{\theta(L)\pi(L,1)+\theta(H)[\pi(H,1)]}{\pi(L,1)+\pi(H,1)}\right) = \pi(L,1)u(A_1\theta(L)) + \pi(H,1)u(c_2^*(H,1))$

As long as Country 2 offers a contract $\alpha_2^c(H,1)$ such that $c_2(H,1) = \alpha_2^c(H)y_2^* \geq c_2^*(H,1)$, $m_1(H,1) = 1$ is the best response for Country 1.

Consider the following candidate: $\alpha_2^c(H) = \alpha_2^c(L)$. In this case, consumption for any type in Country 2 is exactly equal to average output $\bar{y}_2^* = A_2\frac{\theta(L)\pi(L,2)+\theta(H)[\pi(H,1)+\pi(H,2)]}{\pi(L,2)+\pi(H,1)+\pi(H,2)}$. A_2 can be made arbitrarily large so that $\bar{y}_2^* > c_2^*(H,1)$, confirming that $m_1(H,1) = 1$ is the best response. Notice also that $\bar{y}_2^*$ is increasing in $\theta(H)$, which automatically establishes that $m_2(H,1) = 1$ is the best response for Country 2 as well. Finally, notice that moving from Country 1 to Country 2 for $H-type$ agents is individually rational, since $\bar{y}_2^* > \bar{y}_1$. □

Notice that proposition 2.3.4 identifies a sufficient condition for a specific type of equilibrium: one in which Country 2 offers a full insurance contract to its citizen. This is not the only equilibrium with migration that can emerge in this setup. It is possible in particular that - for some combination of parameters $[A_2,\pi(H,1),\pi(H,2)]$, Country 2's optimal strategy will be to offer a contract with $\alpha_2^c(H) > \alpha_2^c(L)$. The benefit for Country 2 is higher output, while the cost is inequality, or spreading consumption across types. We offer a numerical characterization of these equilibria in the next subsection.

2.3.1 A race to the bottom

Proposition 2.3.4 describes equilibria in which Country 1 is willing to let its $H - type$ agents to emigrate to Country 2, as long as the contract offered to them is such that total utility is at least as high as in Autarky: $\pi(L,1)u(A_1\theta(L)) + \pi(H,1)u(\alpha_2^c(H)y_2) \geq u\left(A_1[\pi(L,1)\theta(L) + \pi(H,1)\theta(H)]\right)$. This condition implicitly defines $H - type$ agents' *outside option* that Country 2 has to pay to in order to get Country 1 to set $m_1(H,1) = 1$:

$$c_2^*(H) = \alpha_2^c y_2 = u^{-1}\left(\frac{u\left(A_1[\pi(L,1)\theta(L) + \pi(H,1)\theta(H)]\right) - \pi(L,1)u(A_1\theta(L))}{\pi(H,1)}\right)$$

In this subsection we illustrate numerically that there exist situations in which meeting $c_2^*(H)$ would require moving away from full insurance in Country 2, and in which it is also optimal to do so. We argue that these equilibria offer an interesting example of how migration policy contributes to shaping the social insurance contract. Absent the possibility to attract $H - type$ agents, there would be no consumption inequality, or perfect redistribution, in Country 2. Opening borders together with non-discrimination can have the indirect effect of providing $H - type$ agents with a more remunerative outside option, forcing the host Country to provide a larger consumption spread between types.

Throughout this subsection, we assume the familiar constant relative risk aversion functional form

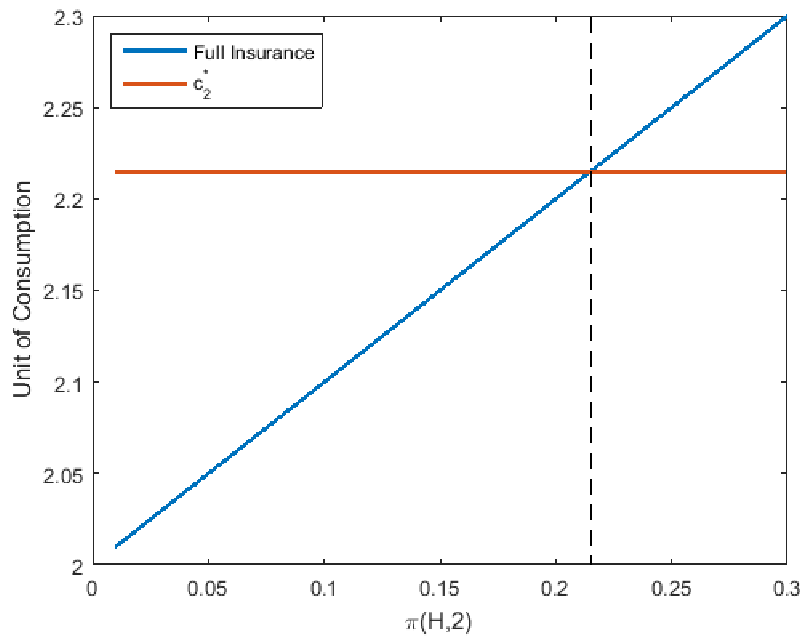
$$u = \frac{c^{1-\sigma}}{1-\sigma}$$

Moreover, we normalize $A_1 = 1$, fix the share of $i - type$ agents in Country 1 to be $\pi(L,1) = \pi(H,1) = \frac{1}{2}$, and assume $\theta(H) = 2$, $\theta(L) = 1$. We can now investigate under which parametric combinations of $(A_2, \pi(L,2), \pi(H,2))$ we obtain a "race to the bottom" in equilibrium, in the sense that $\alpha_2^c(H) > \alpha_2^c(L)$ if $m_2(H,1) = 1$.

First, we set $\sigma = \frac{9}{10}$ and $A_2 = 1.5$. With these parameters, Figure 1 shows the value of the outside option c_2^* together with the consumption allocation with full insurance in Country 2 with $H - type$ from Country 1 allowed to immigrate, as a function of $\pi(H,2)$.

For values of $\pi(H,2)$ to the left of the vertical dotted line, the outside option is higher than the consumption allocation achievable with full risk sharing. As a consequence, in this region Country 2 can't offer a full insurance contract, if it wants to convince Country 1's government to let its $H-type$ agents migrate. Figure 2 compares the value for the Government of Country 2 of providing $H-type$ agents with their outside option (leaving $L-type$ agents with whatever resources are left over) with the value of full insurance (with $H-type$ agents migrating), and Autarky. Notice that both contracts with $H-type$ agents migrating dominate Autarky, confirming that opening borders to $H-type$ agents is an optimal strategy. Clearly Country 2's government would rather set full insurance, which leads a higher payoff. However, for any $\pi(H,2)$ to the left of the dotted line, it is necessary to spread consumption across types in order to meet the outside option of $H-type$ agents. Figure 3 illustrates the type of equilibria we obtain when we let $(A_2, \pi(H,2))$ vary. Notice that when A_2 is close to $A_1 = 1$ (at the bottom left corner of Figure 3, dark blue area), Autarky emerges as the unique equilibrium, in line with Corollary 3.3. As we move from south to north in Figure 3, we notice that the Autarky set gets larger. The intuition is the following: when A_2 is relatively small, c_2^* is larger than the full insurance level of consumption. As a consequence, in order to convince Country 1's government to let $H-type$ agents migrate, Country 2 has to create a spread in consumption between types. For a given A_2, the larger is the initial share of $H-type$ agents in Country 2, the lower is the incentive for the Country 2's government to increase its output (since utility is strictly concave), consequently the benefit of attracting $H-type$ immigrants is relatively low, and closing borders is optimal. The green area represents race to the bottom kind of equilibria. For any given level of $\pi(H,2)$, there is a region where A_2 is large enough that the output benefit of admitting $H-type$ agents is greater than the cost of introducing inequality in Country 2; however, A_2 is not large enough to beat the outside option offered in Country 1. Finally the yellow region is the area where $A_2 - A_1$ is large enough that proposition 2.3.4 applies.

Figure 2.1: Outside option fro $H - type$ agents and full insurance consumption



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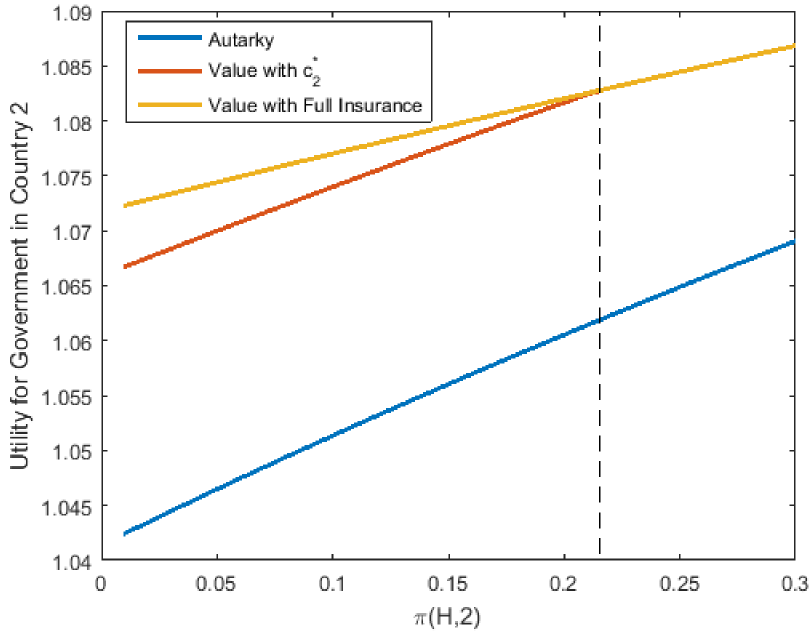
2.4 Policy *with* discrimination

Suppose now that governments are allowed to set $\alpha^c_j(i,j) \neq \alpha^c_j(i,j')$. In this section, we are again trying to characterize conditions for the existence of equilibria with migration. The following lemma establishes that migration will always be from the unproductive to the productive Country.

lemma 2.4.1. *Suppose $A_2 > A_1$. Then there is no migration from Country 2 to Country 1.*

Proof. Suppose not. Then, notice that in order for movement to be individually rational, Country 1 must offer a contract $\alpha^c_1(i,2)$ $\forall i$ such that the resulting consumption $c_1(i,2) = \alpha^c_1(i,2)y_1 \geq \alpha^c_2(i,2)y_2 = c_2(i,2)$, for each $i - type$ agent that is allowed to move. Notice that Country 1, in any best response, will offer only ϵ (with ϵ arbitrarily small) more than their consumption contract in Country 2. Suppose only $H - type$ agents move. But

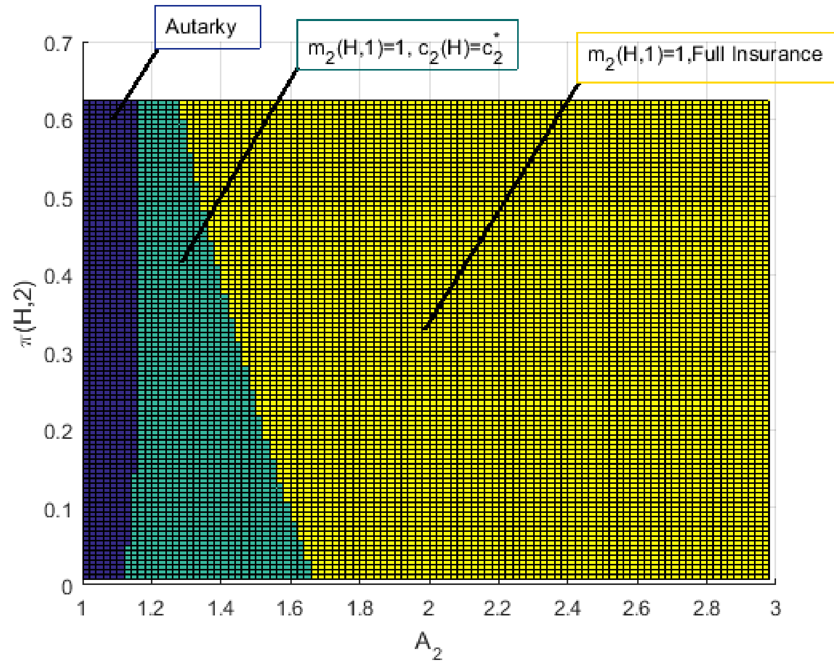
Figure 2.2: Country 2's Government Value



then Country 2 would not be able to provide any insurance, and would be forced to give $L - type$ agents only their endowment. This strategy is strictly dominated by one that sets $m_2(H,2) = 0$ and $\alpha_2^c(i,2) = 1, \forall i$ (full insurance), so having only $H - type$ agents moving from Country 2 to Country 1 is not an equilibrium. When $L - type$ agents move from Country 2 to Country 1, notice that the total gain in output in Country 1 is either $\pi(L,2)A_1\theta(L)$ or $A_1(\pi(L,2)\theta(L)+\pi(H,2)\theta(H))$, depending on whether $H-type$ agents also move or not. However, total resources to be allocated to these agents' consumption must be no less than either $\pi(L,2)A_2\theta(L)$ or $A_2(\pi(L,2)\theta(L)+\pi(H)\theta(H,2))$ to make movement individually rational. However, both quantities are larger than the output contribution of the migrating agents in Country 1. Clearly Country 1 would be better off in autarky. $\square$

We now turn to excluding the existence of equilibria in which *all* agents migrate from the unproductive to the productive Country. This result is due to the non-cooperative nature

Figure 2.3: Equilibrium policies in $(A_2, \pi(H,2))$-space



of the equilibrium concept. If the agents' contribution to output in Country 2 is larger than in Country 1, and Country 2 is not forced to offer $L-type$ agents from Country 1 the same consumption as its own, then migration of any $i-type$ agent can be associated with a net output gain in Country 2. Under this scenario, there are many consumption contracts that make moving individually rational for agents and optimal for both Countries.

However, if Country 2 takes the policy of Country 1 as given, which is at the base of the concept of best response, the optimal reaction to any policy allowing for emigration in Country 1 is to minimize the cost of making immigration individually rational. This behavior nullifies the gains from opening borders for agents from Country 1.

proposition 2.4.2. *Suppose $A_2 > A_1$. Free mobility - or $m_j(i,j) = 1, \forall i, j$ - from Country 1 to Country 2 is not an equilibrium.*

Proof. Suppose not. By lemma 2.4.1 movement will be from Country 1 to Country 2. It must be optimal for Country 1 to set $m_1(i,1) = 1$, $\forall i$. In addition, Country 1 must be offering some budget feasible contract which delivers utility higher than the case in which agents consume their individual endowment, i.e. $\alpha_1^c(L,1) \in \left[\frac{\theta(L)}{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)}, 1\right]$ and $\alpha_1^c(H,1) \in \left[1, \frac{\theta(H)}{\pi(H,1)\theta(H)+\pi(L)\theta(L)}\right]$ with $\pi(L,1)\alpha_1^c(L,1) + \pi(H,1)\alpha_1^c(H,1) = 1$. The best response by Country 2 to this strategy is to offer, $\forall i$, $m_2(i,2) = 1$, and a consumption contract $\alpha_2^c(i,1) = \alpha_1^c(i,1)\frac{A_1\{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)\}+\epsilon}{y_2}$, with y_2 being output in Country 2 *post* migration and ϵ arbitrarily small. Notice that the resulting consumption for $i - type$ agents from Country 1 is exactly the same that they would be getting in Country 1, augmented by an arbitrarily small ϵ. Note that Country 2's best interest will always be offering a contract $\alpha_2^c(i,1)$ that minimizes the cost of making migration for agents in Country 1 individually rational, independently of how large $A_2 - A_1$ is. The reason is that these agents' total contribution to Country 2's output is $A_2 \sum \pi(i,1)\theta(i)$, which is larger than the total amount of resources to allocated to their consumption $A_1 \sum \pi(i,1)\theta(i)$ needed to make migrants indifferent between moving and staying. Country 2's government can take all the resources in excess of the latter amount and redistribute them to its native agents, whose share of consumption can be computed residually from the budget constraint. Given this optimal response by Country 2, notice however that Country 1 can set $m_1(H,1) = 0$, $m_1(L,1) = 1$, $\alpha_1^c(i,1) = 1$ $\forall i$, which leads to utility $\pi(L,1)u(\bar{y}_1) + \pi(H,1)u(\theta(H)A_1)$[8], with $\bar{y}_1 = \frac{A_1\{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)\}}{\pi(L,1)+\pi(H,1)}$. This payoff is higher than what Country 1 could achieve with free mobility with *any* feasible consumption policy, whose respective payoff is bounded above by $\pi(L,1)u(\bar{y}_1) + \pi(H,1)u(\bar{y}_1)$. This contradicts the hypothesis that $m_j(i,j) = 1, \forall i$ is an equilibrium. □

One of the main insights of the proof of proposition 2.4.2 is that the best response to the productive Country "poaching" agents for the lowest possible price is, for the unproductive

[8]Country 1 is promising an equal share of consumption out of total output to any $i - type$ agent. $L - type$ agents know that, if they stay, they will consume $\bar{y}_1$, and marginally more if they migrate, so it is individually rational for them to do so. As a consequence, output in Country 1 will just be $\pi(H,1)A_1\theta(H)$, which will be completely allocated to a mass $\pi(H,1)$ of agents.

Country, to block the exit of $H - type$ agents. When the productive Country allows the entry of $L - type$ agents, in a sense, the burden of financing the social insurance contract is lifted from $H - type$ agents in the unproductive Country. In this situation, $H - type$ agents can consume their endowment, which makes them strictly better off than in any situation in which they are contributing to social insurance.

This logic is exploited in the following lemma, which settles that if any migration can happen in equilibrium, it must be by $L - types$. The lemma illustrates how discrimination based on nativity status plays a role in shaping migration policy. In Section 3 we have established that admitting $L - types$ means - in a sense - allowing migration to welfare. Any non-altruistic government would block such an attempt, since it distracts resources from the social insurance contract for native agents. This results is reversed with discrimination.

lemma 2.4.3. *Suppose $A_2 > A_1$ and that an equilibrium with movement exist. Then it must be that $m_1(H,1) = 0$ and $m_j(L,1) = 1, \forall j$.*

Proof. An immediate corollary to proposition 2.4.2 is that at most one group of agents will move. Suppose for contradiction that $m_1(H,1) = 1$ and $m_j(L,1) = 0$, $\forall j$. Following the same logic as on proposition 2.4.2, any budget feasible consumption contract with some insurance offered in Country 1 will be such that $\alpha_1^c(L,1) \in \left[\frac{\theta(L)}{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)}, 1\right]$ and $\alpha_1^c(H,1) \in \left[1, \frac{\theta(H)}{\pi(H,1)\theta(H)+\pi(L)\theta(L)}\right]$ with $\pi(L,1)\alpha_1^c(L,1) + \pi(H,1)\alpha_1^c(H,1) = 1$. Country 2 best response is to offer $\alpha_2^c(i,1) = \alpha_1^c(i,1)\frac{y_1+\epsilon}{y_2}$, $\forall i$, with $y_1 = A_1 \{\pi(L,1)\theta(L) + \pi(H,1)\theta(H)\}$, y_2 output in Country 2 *post* migration, and ϵ arbitrarily small. Notice that with this contract it is individually rational for $H - type$ agents to migrate, and Country 1 can't offer any insurance to $L - type$ agents. But then notice that the payoff for Country 1 from this strategy is bounded above by $\pi(L,1)u(\theta(L)A_1) + \pi(H,1)u(\theta(H)A_1)$, which is strictly dominated by the autarkic payoff. □

Proposition 2.4.4 is the main result of this section and characterizes an equilibrium with migration when government can discriminate the social insurance policy based on nativity status.

proposition 2.4.4. *Suppose $A_2 > A_1$. Then $m_j(L, j) = 1, \forall j$, $m_1(H, 1) = 0$ is an equilibrium with $\alpha_1^c(i, 1) = 1, \forall i$ and $\alpha_2^c(i, 2) = \alpha_1^c(i, 1)\frac{\bar{y}_1}{y_2}, \forall i$, where y_2 is output in Country 2* post *migration, and $\bar{y}_1 = A_1\{\pi(L, 1)\theta(L) + \pi(H, 1)\theta(H)\}$*

Proof. Consider the following consumption contract for Country 1: $\alpha_1^c(H, 1) = \alpha_1^c(L, 1) = 1$. Country 1 is committing to offer the same share of total output to both types, or perfect consumption sharing.

Following the logic of proposition 2.4.2, if $A_2 > A_1$, the best response by Country 2 is always to attract both $L - type$ and $H - type$ agents offering them just a small ϵ more than their outside option, or $\alpha_2^c(i, 2) = \alpha_1^c(i, 1)\frac{A_1\{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)\}+\epsilon}{y_2}$, $\forall i$, where y_2 is output in Country 2 *post* migration, and ϵ arbitrarily small. Notice that moving is individually rational for both types. By setting $m_1(i, 1) = 1, \forall i$, Country 1's government would achieve in equilibrium $u\left(\frac{A_1\{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)\}}{\pi(L,1)+\pi(H,1)}\right)$.

But if $H - type$ agents were blocked, then its payoff would become $\pi(H, 1)u(\theta(H)A_1) + \pi(L, 1)u\left(\frac{A_1\{\pi(L,1)\theta(L)+\pi(H,1)\theta(H)\}}{\pi(L,1)+\pi(H,1)}\right)$. Since there is no other feasible contract that delivers a higher payoff, $\alpha_1^c(i, 1) = 1, \forall i$, $m_1(L, 1) = 1$, $m_1(H, 1) = 0$ is the best response by Country 1. □

2.5 Constrained efficiency

We finally show what we had informally stated at the end of Section 1, that is the non-cooperative equilibria with migration[9] of this game are not necessarily constrained efficient. The surprising result is that when we consider governments restricted to offer $\alpha_j^c(i, j) = \alpha^c(i, j')$, $\forall i$, equilibrium migration is *constrained efficient*, in the sense that we cannot find any contract that can make any player (either the governments or private agents)

[9] There is a large variety of situations in which the autarkic equilibrium is not a Pareto Efficient either. We decided to focus on the equilibria with migration.

better off without making someone else worse off, considering the same contract space that governments have access to in our game.

proposition 2.5.1. *Suppose $A_2 > A_1$. Then the equilibrium with migration by $H - type$ agents from Country 1 to Country 2 and $\alpha^c(L) = \alpha^c(H)$ characterized in proposition 2.3.4 is Pareto Efficient.*

Proof. Notice first that there is no alternative consumption policy that pareto dominates the one offered under the scenario that only $H - type$ agents move from Country 1 to Country 2. Indeed in Country 1 $L - type$ agents can at best consume their endowment. In Country 2, since there is no change in output (we are keeping the migration policy unchanged), and since the original allocation is non-wasteful, any feasible change in the consumption policy will make necessarily one type worse off. We can now consider all alternative migration policies and check whether they offer a Pareto improvement under *some* insurance policy. We can immediately exclude Autarky, since we have established that Autarky is the worst Nash Equilibrium, so both governments would be worse off when an equilibrium with migration is possible. Suppose then to allow $L - type$ agents to move from Country 1 to Country 2, in addition to $H - type$ agents. Whatever the consumption policy chosen in Country 2 (partial or full insurance), this will correspond to a reduction in average output in Country 2. This implies that either $L - type$ or $H - type$ agents will need to reduce their consumption in Country 2, compared to the scenario without $L - type$ agents migrating. Suppose now that $L - type$ agents migrate without $H - type$ agents towards Country 2: then average output is even lower than in the case just considered, and the same reasoning goes through. The only polices left are the ones in which agents also move from Country 2 to Country 1. Clearly $L - type$ agents can't be moving alone: if they did, then they would be getting *at most* $A_1 \frac{\pi(H,1)\theta(H)+\pi(L,2)\theta(L)}{\pi(H,1)+\pi(L,2)}$. Notice that this is strictly lower than $A_2 \frac{[\pi(H,1)+\pi(H,2)]\theta(H)+\pi(L,2)\theta(L)}{\pi(H,1)+\pi(L,2)+\pi(H,2)}$, which is the consumption they would get in the equilibrium candidate. If $H - type$ agents moved alone from Country 2 to Country 1, then $L - type$ agents would be consuming their endowment in Country 2, and would be worse off. We have then to consider the cases in which both $H-type$ and $L-type$ agents moved from Country 2 to Country 1. The highest value that the government in Country 2 would achieve from this situation is $u\left(A_1\frac{[\pi(H,1)+\pi(H,2)]\theta(H)+\pi(L,2)\theta(L)}{\pi(H,1)+\pi(L,2)+\pi(H,2)}\right)$. This is strictly lower than $u\left(A_2\frac{[\pi(H,1)+\pi(H,2)]\theta(H)+\pi(L,2)\theta(L)}{\pi(H,1)+\pi(L,2)+\pi(H,2)}\right)$, which is the value for Country 2's government under the proposed equilibrium. □

In stark contrast to this result, when governments are allowed to set $\alpha_j^c(i,j) \neq \alpha_j^c(i,j')$, under no parametric condition the equilibrium with movement that we have described in Section 4 is efficient.

proposition 2.5.2. *The equilibrium with movement described in proposition 2.4.4 is not Pareto Efficient.*

Proof. Consider a pair of policies G' identical to the ones described in proposition 4, with the exception that $m_1(H,1)=1$ and $\alpha_2^c(H,1)=\alpha_1^c(H,1)\frac{A_2\theta(H)-\delta}{\bar{y}_2}$, with δ being a small positive number such that $A_2\theta(H)-\delta > A_1\theta(H)$, and $\bar{y}_2$ being output post migration. Notice that $H-type$ agents from Country 1 are still receiving less than the value of their individual endowment, allowing Country 2 to allocate the extra resources to its native agents[10]. Since $L-type$ agents from Country 1's consumption is unchanged, Country 1 is better off as well. □

2.6 Conclusion

In this paper we have studied a game between two governments that set both migration policy (including the possibility of restricting the *emigration* of native agents) and social insurance to maximize the well-being of their native citizens. We have characterized the Nash equilibria of this game, first under the assumption that governments cannot discriminate the social insurance contract based on nativity status, and finally allowing for such possibility. We have found that this change in the contract space is associated with

[10]Any non-wasteful allocation will make Country 2 agents and government strictly better off.

markedly different equilibrium migration policies. When discrimination is possible, *low skilled* agents move from the country that we identify as relatively unproductive towards the productive one. In contrast, when governments are not allowed to offer different benefits to immigrants, migration is by *high skilled* agents. A conjecture we make is that world consumption inequality will be lower - under a large range of parametric configurations - in the former situation. Imposing a non-discriminatory social insurance policy implies that movement by *low skilled* agents is always blocked by the host country in equilibrium, limiting their quest for economic opportunity. We hope this study represents a step forward a deeper understanding of the forces behind the large degree of variation in migration policy that we observe across developed economies.

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Appendix A

Proofs

Proof of **Proposition 1.2.1**

Consider any interior solution to the planning problem 1.2, $\left\{\hat{c}_t^i, \hat{e}\right\}_{\forall t,i}$ and the level of utility $\hat{U}$ associated to it. This allocation in particular is incentive compatible and it is the resource minimizing allocation that provides utility $\hat{U}$. Notice also that, in any solution of the planning problem, a necessary condition for optimality is

$$u'\left(\hat{c}_1^a\right) = u'(\hat{c}_1^b)$$

Now, consider the following perturbation $\forall i$:

$$u(\bar{c}_1^i) = u(\hat{c}_1^i) - \beta\delta$$

$$u(\bar{c}_2^i) = u(\hat{c}_2^i) + \delta$$

Let $\mathscr{C}$ be a function that maps the perturbed utility level into consumption (namely the inverse u^{-1} of the utility function). Notice that the perturbed allocation achieves the total level of utility $\hat{U}$ of the optimal allocation:

$$\mu_1 \left(u(\hat{c}_1^a) - \beta\delta\right) + (1-\mu_1)\left(u(\hat{c}_1^i) - \beta\delta\right) + \beta\mu_1[1-p(e)]\left(u(\hat{c}_2^a) + \delta\right) + \beta\left(1-\mu_1[1-p(e)]\right)\left(u(\hat{c}_2^b) + \delta\right) =$$

$$-\beta\delta + \beta\delta + \mu_1 \left(u(\hat{c}_1^a)\right) + (1-\mu_1)\left(u(\hat{c}_1^i)\right) + \beta\mu_1[1-p(e)]\left(u(\hat{c}_2^a)\right) + \beta\left(1-\mu_1[1-p(e)]\right)\left(u(\hat{c}_2^b)\right) = \hat{U}$$

Moreover, the allocation is also defined to implement the same level of effort $\hat{e}$, since $u(\bar{c}_2^b) - u(\bar{c}_2^a) = u(\hat{c}_2^b) + \delta - u(\hat{c}_2^a) - \delta = u(\hat{c}_2^b) - u(\hat{c}_2^a)$. At $\delta = 0$, the perturbed allocation coincides with the solution of the planning problem. It must then be that at $\delta = 0$, the perturbed allocation indeed minimizes the resources to provide $\hat{U}$, solving

$$\min_{\delta} \mu_1 \mathscr{C}\left(u(\hat{c}_1^a) - \beta\delta\right) + (1-\mu_1)\mathscr{C}\left(u(\hat{c}_1^b) - \beta\delta\right) + \mu_1[1-p(e)]\mathscr{C}\left(u(\hat{c}_2^a) + \delta\right) + \left(1-\mu_1[1-p(e)]\right)\mathscr{C}\left(u(\hat{c}_2^b) + \delta\right)$$

From the first order conditions, using $\beta(1+r) = 1$, I obtain

$$\frac{\mu_1}{u'(\hat{c}_1^a)} + \frac{1-\mu_1}{u'(\hat{c}_1^b)} = \frac{\mu_1[1-p(e)]}{u'(\hat{c}_2^a)} + \frac{1-\mu_1[1-p(e)]}{u'(\hat{c}_2^b)}$$

Notice that in optimality $u'(\hat{c}_1^a) = u'(\hat{c}_1^b)$, so the condition becomes

$$\frac{1}{u'(\hat{c}_1)} = \frac{\mu_1[1-p(e)]}{u'(\hat{c}_2^a)} + \frac{1-\mu_1[1-p(e)]}{u'(\hat{c}_2^b)}$$

In any interior solution, $\hat{c}_2^b > \hat{c}_2^a$. But then notice that $\frac{1}{u'(\hat{c}_1)}$ is just the weighted average of the two terms on the right hand side of the equation. Then, it follows immediately that

$$\frac{1}{u'(\hat{c}_2^b)} > \frac{1}{u'(\hat{c}_1)} > \frac{1}{u'(\hat{c}_2^a)}$$

To show the corollary, notice that

$$c_t^a = y^a + T_t^a$$

Then using the concavity assumption on u, I get

$$\frac{1}{u'(y^a + T_1^a)} > \frac{1}{u'(y^a + T_2^a)} \rightarrow u'(y^a + T_1^a) < u'(y^a + T_2^a) \rightarrow$$

$$y^a + T_1^a > y^a + T_2^a \rightarrow$$

$$T_1^a > T_2^a \quad \square$$

Proof of **Proposition 1.2.2**

Notice that since $e = 0$, $\mu_1 = \mu_2$. Also, since the government at $t = 2$ is equalizing consumption across locations, the problem of the government at $t = 1$ can be written as

$$\max_{T_1^i, B} \mu_1 u(y^a + T_1^a) + (1 - \mu_1) u(y^b + T_1^b) + \beta u \left(\mu_1 y^a + (1 - \mu_1) y^b - B \right)$$

subject to $\mu_1 T_1^a + (1 - \mu_1) T_1^b + \frac{1}{1+r} B = 0$

By taking first order conditions with respect to T_1^i, one obtains

$$T_1^a - T_1^b = y^b - y^a$$

The government is equalizing consumption at $t = 1$, too. The problem can then be rewritten as

$$\max_{B} u \left(\mu_1 y^a + (1 - \mu_1) y^b + \frac{B}{1 + r} \right) + \beta u \left(\mu_1 y^a + (1 - \mu_1) y^b - B \right)$$

Since $\beta(1+r) = 1$, it must be that that $B = 0$ and then the proposition follows immediately by plugging the optimality condition derived above for transfers into the government budget constraint with $B = 0$. $\square$

Proof of **Proposition 1.2.3**

First, define $\theta = \frac{c_2^a}{c_1^a}$. Notice first that, given χ and the log utility assumption, the optimal level of effort chosen by agents solves

$$\beta p'(e)\left[\log(c_2^b) - \log(\chi c_2^b)\right] = 1$$

$$e(\chi) = p'^{-1}\left(\frac{1}{\beta}\frac{1}{\log\frac{1}{\chi}}\right)$$

Thanks to the log-utility assumption, e is just a decreasing function of χ and it doesn't depend directly on the allocation at $t = 2$. Now by using the $t = 2$'s budget constraint I get

$$c_2^b(\chi, B) = \frac{p(e(\chi))y_b + [1 - p(e(\chi))]y_a + B}{p(e(\chi)) + [1 - p(e(\chi))]\chi}$$

This latter function represents the best reponse of the $t = 2$'s planner to e and B only as a function of the preference parameter χ. Notice now that the problem of the government at $t = 1$, by using $c_{a2} = \chi c_{b2}$ and that e depends only on χ, simplifies to[1]

$$\max_B \log\left(y_a - \frac{B}{1+r}\right) + \beta\log\left(\frac{p(e(\chi))y_b + [1 - p(e(\chi))]y_a + B}{p(e(\chi)) + [1 - p(e(\chi))]\chi}\right)$$

The policy function for B can be derived just by taking first conditions:

$$B(\chi) = \frac{1}{1+\beta}\left\{\beta(1+r)y_a - p(e(\chi))y_b - [1 - p(e(\chi))]y_a\right\}$$

Notice that this expression is increasing in χ: as the inequality in consumption tomorrow goes down, the planner borrows less which is equivalent to decreasing consumption - or lowering the transfer- for agents getting endowment a at $t = 1$. This is just a consequence of the fact that future total endowment decreases as χ raises. After some simple manipulation,

[1]

$$\max_B \log\left(y_a - \frac{B}{1+r}\right) - e(\chi) + \beta p(e)\log(c_{b2}(\chi, B)) + \beta[1 - p(e)]\log(\chi c_{b2}(\chi, B)) \propto$$
$$\max_B \log\left(y_a - \frac{B}{1+r}\right) + \beta\log(c_{b2}(\chi, B)) + g(\chi)$$

I can express all the policy functions for consumption as a function of χ alone:

$$c_{a1}(\chi) = \frac{1}{1+\beta}\left\{y_a(1-\beta r) + p(e(\chi))y_b + [1-p(e(\chi)]y_a\right\}$$

$$c_{a2}(\chi) = \frac{1}{1+\beta}\left\{y_a\beta(1+r) + p(e(\chi))y_b + [1-p(e(\chi)]y_a\right\}\frac{1}{\frac{p(e(\chi))}{\chi} + [1-p(e(\chi))]}$$

$$c_{b2}(\chi) = \frac{1}{1+\beta}\left\{y_a\beta(1+r) + p(e(\chi))y_b + [1-p(e(\chi)]y_a\right\}\frac{1}{p(e(\chi)) + [1-p(e(\chi))]\chi}$$

Consider the simple case in which $r = 0$ and $\beta = 1$. Notice that with the current assumptions $\theta(\chi)$ simplifies to $\frac{1}{\frac{p(e(\chi))}{\chi}+[1-p(e(\chi))]}$. Consequently

$$\frac{\partial}{\partial\chi}\theta(\chi) = -\frac{p'(e(\chi))e'(\chi)\left(\frac{1}{\chi}-1\right) - \frac{p(e(\chi))}{\chi^2}}{\left\{\frac{p(e(\chi))}{\chi} + [1-p(e(\chi))]\right\}^2}$$

Notice that $p'(e(\chi)) > 0$, $e'(\chi) < 0$ and $\left(\frac{1}{\chi}-1\right) > 0$, which leads to $p'(e(\chi))e'(\chi)\left(\frac{1}{\chi}-1\right) < 0$. Since $-\frac{p(e(\chi))}{\chi^2} < 0$ as well, and the denominator is positive, $\frac{\partial}{\partial\chi}\theta(\chi) > 0$ □

Proof of **Proposition 1.3.4**

The results is derived using the first order condition for c_t^a and the envelope conditions $\frac{\partial V}{\partial \Delta_t}$, $\frac{\partial V}{\partial B_t}$.

Let

- λ_t be the multiplier on the resource constraint
- γ_t be the multiplier on the incentive constraint
- θ_t be the multiplier on the promise keeping constraint

Notice first that in optimality, the following holds

$$u'(c_t^a) = \lambda_t \frac{\mu_t}{\mu_t - \theta_t}$$

$$u'(c^a_{t+1}) = \lambda_{t+1} \frac{\mu_{t+1}}{\mu_{t+1} - \theta_{t+1}} = \lambda_{t+1} \frac{\mu_t[1 - p(e_t)]}{\mu_t[1 - p(e_t)] - \theta_{t+1}}$$

The envelope condition fot Δ_t gives

$$\frac{\partial V}{\partial \Delta_t} = -\theta_t$$

The first order condition for Δ_{t+1} yields the following:

$$\frac{\partial V}{\partial \Delta_{t+1}} = -\theta_t[1 - p(e_t)] - \gamma_t p'(e_t)$$

Combining the envelope condition at $t + 1$ and the latter first order condition, I get

$$-\theta_{t+1} = -\theta_t[1 - p(e_t)] - \gamma_t p'(e_t) \quad \text{(A.1)}$$

The envelope condition for B_t and the first order condition for B_{t+1} give respectively

$$\frac{\partial V}{\partial B_t} = \lambda_t$$

$$\beta \frac{\partial V}{\partial B_{t+1}} = \lambda_t \frac{1}{1 + r}$$

$$\downarrow$$

$$\beta(1 + r) = 1$$

$$\downarrow$$

$$\frac{\partial V}{\partial B_t} = \frac{\partial V}{\partial B_{t+1}}$$

$$\downarrow$$

$$\lambda_t = \lambda_{t+1}$$

I can finally divide the first order optimality condition for c_t^a by the condition for c_{t+1}^a and obtain

$$\frac{u'(c_t^a)}{u'(c_{t+1}^a)} = \frac{\lambda_t}{\lambda_{t+1}} \frac{\mu_t}{\mu_t - \theta_t} \frac{\mu_t[1 - p(e_t)] - \theta_{t+1}}{\mu_t[1 - p(e_t)]}$$

$$\downarrow$$

$$\frac{u'(c_t^a)}{u'(c_{t+1}^a)} = \frac{\mu_t}{\mu_t - \theta_t} \frac{\mu_t[1 - p(e_t)] - \theta_t[1 - p(e_t)] - \gamma_t p'(e_t)}{\mu_t[1 - p(e_t)]}$$

Notice that if $\gamma_t = 0$, so in absence of incentive problems, the condition implies perfect consumption smoothing:

$$\frac{u'(c_t^a)}{u'(c_{t+1}^a)} = 1$$

However, if $\gamma_t > 0$, then notice that

$$\frac{\mu_t[1 - p(e_t)] - \theta_t[1 - p(e_t)] - \gamma_t p'(e_t)}{\mu_t[1 - p(e_t)]} = \frac{\mu_t - \theta_t - \gamma_t \frac{p'(e_t)}{[1-p(e_t)]}}{\mu_t} < \frac{\mu_t - \theta_t}{\mu_t}$$

$$\downarrow$$

$$\frac{\mu_t - \theta_t - \gamma_t \frac{p'(e_t)}{[1-p(e_t)]}}{\mu_t} \frac{\mu_t}{\mu_t - \theta_t} < 1$$

$$\downarrow$$

$$\frac{u'(c_t^a)}{u'(c_{t+1}^a)} < 1$$

$$\downarrow$$

$$y^a + T_{t+1}^a = c_{t+1}^a < c_t^a = y^a + T_t^a \quad \square$$

Appendix B

Quantitative Exercise

Individual Countries Calibration Tables

Table B.1: Australia

Parameter	Value (Comm)	Value (Best Sust)
y^a	46256	46256
y^b	61521	61521
μ_0	0.056	0.056
Δ_0	1.33	1.33
β	.9	.9

Table B.2: Canada

Parameter	Value (Comm)	Value (Best Sust)
y^a	48769	48769
y^b	61936	61936
μ_0	0.047	0.047
Δ_0	0	0
β	.9	.9

Table B.3: EU

Parameter	Value (Comm)	Value (Best Sust)
y^a	17399	17399
y^b	40539	40539
μ_0	0.11	0.11
Δ_0	3.96	3.96
β	.9	.9

Table B.4: Japan

Parameter	Value (Comm)	Value (Best Sust)
y^a	25400	25400
y^b	90169	90169
μ_0	0.047	0.047
Δ_0	5.37	5.207
β	.9	.9

Table B.5: Korea

Parameter	Value (Comm)	Value (Best Sust)
y^a	10649	10649
y^b	32053	32053
μ_0	0.26	0.26
Δ_0	4.05	4.05
β	.9	.9

Table B.6: Norway

Parameter	Value (Comm)	Value (Best Sust)
y^a	47740	47740
y^b	112500	112500
μ_0	0.07	0.07
Δ_0	1.68	1.68
β	.9	.9

Table B.7: New Zealand

Parameter	Value (Comm)	Value (Best Sust)
y^a	28390	28390
y^b	37474	37474
μ_0	0.10	0.10
Δ_0	0.29	0.29
β	.9	.9

Table B.8: Switzerland

Parameter	Value (Comm)	Value (Best Sust)
y^a	22438	22438
y^b	92671	92671
μ_0	0.057	0.057
Δ_0	2.39	2.39
β	.9	.9

Table B.9: USA

Parameter	Value (Comm)	Value (Best Sust)
y^a	39892	39892
y^b	54651	54651
μ_0	0.03	0.03
Δ_0	0.137	0.137
β	.9	.9

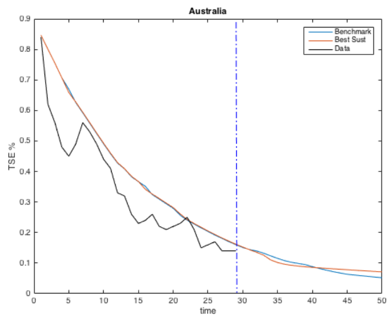

Figure B.1: Australia

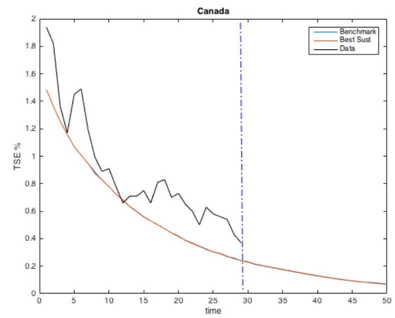

Figure B.2: Canada

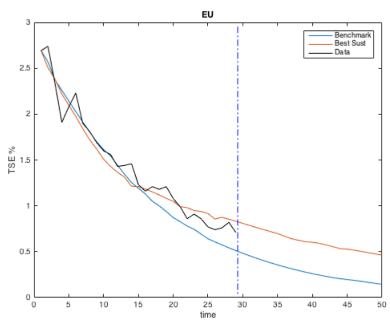

Figure B.3: European Union

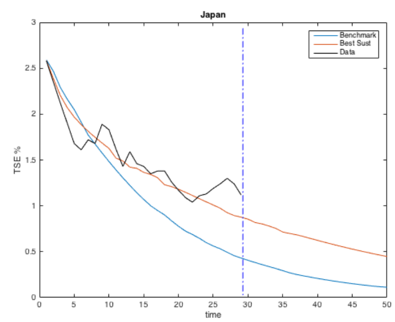

Figure B.4: Japan

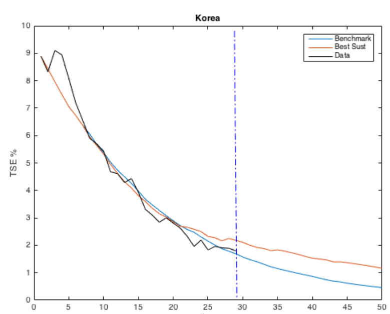

Figure B.5: Korea

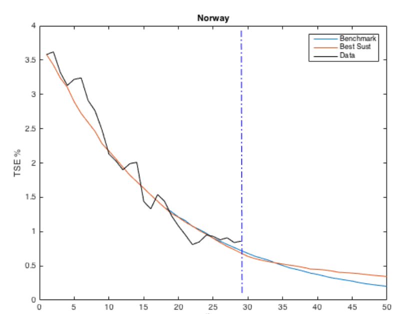

Figure B.6: Norway

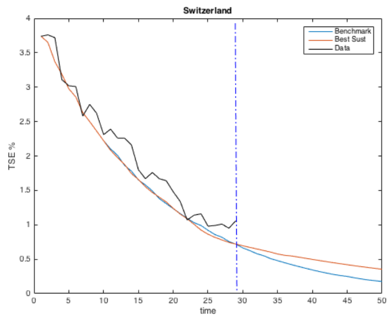

Figure B.7: Switzerland

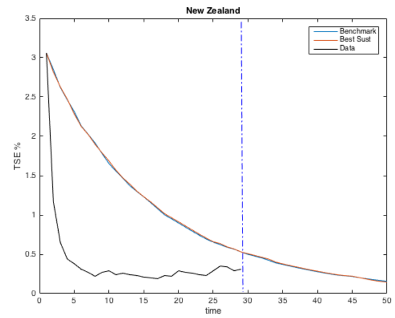

Figure B.8: New Zealand

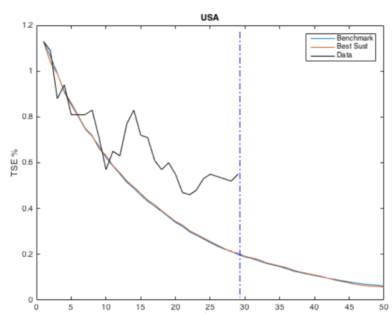

Figure B.9: USA