Coordination Failures in Immigration Policy*

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Abstract

We propose a theoretical framework for analyzing the problems associated to unilateral immigration policy in receiving countries and for evaluating the grounds for reform of international institutions governing immigration. We build a model with multiple destination countries and show that immigration policy in one country is influenced by measures adopted abroad as migrants choose where to locate (in part) in response to differences in immigration policy. This interdependence gives rise to a leakage effect of immigration policy, an international externality well documented in the empirical literature. In this environment, immigration policy becomes strategic and unilateral behavior may lead to coordination failures, where receiving countries are stuck in welfare inferior equilibria. We then study the conditions under which a coordination failure is more likely to emerge and argue that multilateral institutions that help receiving countries make immigration policy commitments would address this inefficiency.

Keywords: Immigration policy, cross-border externalities, coordination failures, multilateral institutions.

JEL Classification: F02, F22, J61

1 Introduction

What type of multilateral institutions do countries need to govern international migrations? Several economists have recently raised this question (among others, Bhagwati, 2003, Hatton, 2007, and Hanson, 2009). In particular, Hatton (2007) examines whether the basic

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principles governing the World Trade Organization could improve international cooperation on migration between sending and receiving countries.

The present work aims at contributing to this debate but takes a somewhat different approach for two reasons. In our view, a prerequisite for a precise answer to the above question is the identification of the international externalities associated to unilateral policy-making in migration policy. In some sense, this is a key lesson that can be inferred from the past sixty years of the multilateral trading system. As Bagwell and Staiger (1999 and 2002) show, the GATT/WTO system has effectively improved international trade policy cooperation precisely because it provides a framework to neutralize a key cross-border spillover associated to unilateral policy-making in the trade domain, the terms-of-trade externality. Second, the scope of our analysis is different -and possibly more limited- compared to Hatton (2007). Rather than looking at the problems of international cooperation between host and sending economies, we focus on the interaction of immigration measures implemented by countries that are on the receiving end of immigration. Our goal is to clearly identify the externality associated to immigration policy in this set of countries and to investigate the welfare implications of this economic interdependence.[1]

A large body of empirical literature has recently studied the long-run determinants of immigration policy and found three key (and somehow interrelated) economic channels: distributional, political economy and international determinants.[2] Distributional factors include the effect of immigration on the labor market and on welfare systems (Borjas, 1994 and 2003, Boeri et al., 2002, Razin et al., 2002). In turn, distributional determinants are channelled into government policies through voting and/or lobbying activity by interest groups that stand to lose or gain from immigration (Goldin, 1993, Facchini et al., 2008). Finally, and crucially for the present work, immigration policy abroad is a determinant of immigration policy at home (Timmer and Williamson, 1998, Boeri and Bruecker, 2005, Hatton and Williamson, 2005). The positive correlation between domestic and foreign measures suggests that countries aim

[1] While we explicitly model the migration decision of foreign workers (as further discussed below, the migratory decisions are the key transmission mechanism of policy spillovers), the welfare effects of emigration on the *sending* region are not analyzed in this work.

[2] A series of empirical papers look at the determinants of attitudes towards immigration. A partial list includes Scheve and Slaugther (2001) and Mayda (2006). In particular, the work of Dustmann and Preston (2007) and O'Rourke and Sinnott (2006) suggests that *non-economic* forces, such as racism or xenophobia, may influence attitudes (and, hence, immigration policy) –even after other determinants have been controlled for. While our model does not account for such factors, non-economic forces could be included in the analysis (for instance, as a congestion cost of immigration) without altering the key results of the paper.

at anticipating an externality associated to the immigration policy of other destination countries.

As these international determinants are a key concern of this paper, we briefly review the available evidence. In their historical account of migratory flows and immigration policy in the New World in the late 19th and early 20th century, Timmer and Williamson (1998) argue that countries in the New World must have paid close attention to each others' policies as migrants were pulled from and pushed toward one country in response to less or more restrictive policies in others.[3] In particular, they find that "*Australia's openness decreased flows to Canada, Brazil's pro-immigrants subsidies reduced flows to Australia, and Argentina saw an increased share of the immigrant pie as the United States closed its doors*" (Timmer and Williamson, 1998, p. 756). A second study that documents the immigration policy spillover is Boeri and Bruecker (2005) who adopt a different methodology and look at a different immigration episode. In January 2004, the European Union enlarged to ten new member states from Eastern and Central Europe. Transitional arrangements allowed individual EU countries to temporarily breach the principle of free movement of people inside the Union and to impose restrictions on immigration from the new member states. Boeri and Bruecker (2005) find that these arrangements affected the geographical orientation of migrants from the new member states and resulted in substantial diversion of migration flows from countries closing their borders to countries with more open rules.

Contrasting with these developments in the empirical literature, there have been few attempts to integrate these factors into formal models of immigration policy formation. In particular, existing models such as Benhabib (1996), de Melo et al. (2001), Dolmas and Huffman (2004), Ortega (2005) and Facchini and Willman (2005) incorporate the first two factors, but are silent about international determinants. The main reason is that the existing theoretical literature is based on a benchmark model with two simplifying assumptions. Specifically, standard theory focuses on the effects of immigration on a single receiving economy and considers as exogenous the migratory decision of foreign workers (see Borjas, 1995).[4] These features, by construction, shut down any possible cross-border spillover created by im-

[3] See also Hatton and Williamson (2005).

[4] Few theoretical contributions have considered the interdependence between immigration policy in the host economy and immigration decisions (Bellettini and Berti Ceroni, 2007, Bianchi, 2007, and Giordani and Ruta, 2010).

migration policy. The present work contributes to filling this gap in the formal literature by providing a simple and tractable model of immigration policy interdependence.

In our model immigration policy and migration choices are endogenous. The set up considers two regions. The receiving region is formed of a set of countries with identical fundamentals (technology, factor endowments, preferences, welfare system). Each country is populated by capitalists and workers and produces a single final good using capital and labor (possibly including both native and foreign workers) that are complement in production. A social policy redistributes income from capitalists to native and immigrant workers. Finally, each destination country in the receiving region sets its immigration policy independently. The sending region is populated by a set of workers who can choose whether to migrate or not and -to a certain extent- in which country to move to. Migratory decisions depend on the economic incentives that foreign workers face (wages and welfare benefits), and on the policy regulating migratory flows enacted in the receiving country.

If the world had only a single receiving country, a host government could easily select the (politically) efficient level of immigration that trades off efficiency gains, labor market effects, social welfare costs and political concerns. Policy, however, is not chosen in a vacuum: immigration policy in one country alters the migratory choices of foreign workers and, hence, the flows of migrants into other destinations (the **immigration policy spillover**). Note that this externality is created by the international mobility of prospective migrants. When foreign workers choose, not only *whether* to migrate or not, but also *where* to migrate (i.e. the destination country), policy restrictions (liberalizations) in one country increase (decrease) migratory flows in other receiving economies, as a larger number of migrants will target the country with lower restrictions. In other words, the costs and benefits of immigration in any host economy are, in part, determined by the policy stance of other receiving countries. This international externality lowers the ability of national governments to optimally manage their immigration policy.

In this interdependent environment, coordination failures can materialize that lead to inefficient equilibria. The choice of immigration policy is strategic and defines a symmetric, simultaneous game among all destination countries from which multiple symmetric policy equilibria emerge that can be Pareto-ranked. The "cooperative solution", that is, the immigration policy associated with the optimal number of migrants for each country, is only one in the *continuum* of Nash equilibria of this policy game. Coordination failures in immigration policy may arise because, for each policy maker, expectations on the behavior of the governments of other destination economies are critical in the determination of the policy outcome of the receiving region. For instance, if any one government expects that others will strengthen immigration barriers, then it will find it convenient to restrict its policy stance to neutralize the negative externality of an excessive influx of migrants, thus triggering a series of restrictive measures. Too little immigration will result relative to the efficient level for the overall destination region. Similarly, beliefs of immigration liberalizations by other receiving economies will trigger a reduction in restrictions that will result in a Pareto-inferior equilibrium characterized by too much immigration.

Once we identify the problem that characterizes immigration policy in this framework, we discuss two further issues. First, we analyze the problem of equilibrium selection and show that coordination failures in immigration policy are not only possible, but they are also likely to emerge in presence of uncertainty on the policy strategy of other receiving governments. The game-theoretic literature has proposed alternative equilibrium refinements for coordination games admitting a multiplicity of equilibria. These refinements stress the fact that players may coordinate on a strategy which is less risky, even if Pareto-dominated.[5] In particular, we characterize the immigration policy equilibrium that is robust to strategic uncertainty (Andersson et al., 2010) and show that the Pareto-efficient equilibrium is not robust -i.e. that the unilateral policy outcome may well support inefficiently low or high immigration.

The second issue that we investigate is how an increase in the international mobility of migrants (for instance due to technological innovations, such as improvements in transportation and communication means) affects the "likelihood" of a coordination failure. We find that an increase in migrants' mobility does not change the efficient policy for the receiving region, but it expands the set of equilibria (a measure of the indeterminacy of equilibria) and alters the robust equilibrium, as it increases each policy maker's uncertainty about other governments' strategies. Intuitively, both findings can be rationalized as an increased international mobility of migrants magnifies the cross-border externality associated to immigration

[5] The classic work is Harsanyi and Selten (1988) on the risk-dominant equilibrium. Cooper et al. (1990 and 1992) and van Huyck et al. (1990) find that coordination failures are likely to arise in experimental settings. For a survey of the empirical literature see Cooper (1999), chapter 1.

policy. This suggests that the "globalization" may be amplifying the chances of coordination failures across destination countries, thus augmenting the need for policy coordination in the immigration domain.

While we leave a further discussion of the policy implications of our model to the conclusion, some preliminary considerations can be put forward. First, while both trade policy and immigration policy are characterized by a cross-border externality, the immigration policy game has radically different features. Trade policy interactions determine a (terms-of-trade driven) prisoner's dilemma situation, while interactions in the domain of immigration policy lead to a coordination problem where governments achieve efficient policies only if they make mutually consistent decisions. Second, while the trade policy game leads to too little trade, coordination failures in immigration policy may determine either too little or too much immigration from the perspective of the receiving world. Third, multilateral institutions should help countries escape inefficient equilibria. This theory suggests that immigration policy commitments (that can be credibly enforced) can provide a coordination device to receiving countries.

The paper is organized as follows. Section 2 presents the simple immigration policy model with two countries, a receiving and a sending country. This is a useful benchmark and allows for an easy comparison with other formal models of immigration policy. Section 3 introduces the multiple-country framework. In this setting, we formalize the immigration policy spillover, prove the existence of a multiplicity of Nash equilibria and carry out the comparative statics analysis. Section 4 studies the issue of equilibrium selection under strategic uncertainty. A concluding section discusses the implications of this model for the design of international institutions governing immigration.

2 A Standard Model of Immigration Policy

This section sets the stage by presenting a model of immigration policy with a sending country and a receiving country, and where the migratory choice of foreign workers and the policy set by the host government are endogenous. As we will see shortly, in this benchmark model immigration has the following effects on the receiving economy: it lowers its wage rate and raises its capital rent, and it exacerbates the burden of the social policy upon capitalists as they are assumed to redistribute part of their income to (native and foreign) workers. None of these features is however crucial for the results we obtain in Section 3.

Let us first characterize the receiving country's economy and its "optimal" number of immigrants. Later in this section we endogenize the migratory choice and introduce the immigration policy. The receiving country -or "home"- denoted by h, is populated by N_h ("native") workers, each of whom supplies one unit of labor inelastically, and by K_h capitalists, each of whom is endowed with one unit of capital. Population in the sending country is made up of workers who can potentially migrate to country h, and whose total number is $\tilde{F}$.

The final good at home is produced competitively via a constant-return-to-scale technology in labor and capital:

$$Y_h = K_h^\alpha L_h^{1-\alpha}.$$

L_h is the sum of natives and immigrants working in country h, that is, $L_h = N_h + I_h$, where $I_h \leq \tilde{F}$ denotes the endogenous number of migrants. The final good is the numeraire in the receiving economy, and its price is normalized to one. As the product market is competitive, input factors are paid their marginal productivities:

$$w_h = (1-\alpha)\left(\frac{K_h}{L_h}\right)^\alpha \text{ and } r_h = \alpha\left(\frac{K_h}{L_h}\right)^{\alpha-1}.$$

Country h has a welfare system that, *de facto*, redistributes income from capitalists to workers. Specifically, the policy consists of a fixed lump-sum transfer γ_h to (native and foreign) workers which is financed through a proportional tax $\tau_h \in [0,1]$ on the capital rent. This simple formulation captures the idea that welfare spending in h depends on the number of migrants.[6] A balanced government budget implies

$$\tau_h r_h K_h = \gamma_h (N_h + I_h),$$

and hence the tax rate on capital income, as a function of the number of immigrants is

$$\tau_h(I_h) = \frac{\gamma_h (N_h + I_h)}{r_h(I_h) K_h}. \tag{1}$$

[6]The welfare system is assumed to be pre-existent to immigration. This is reasonable when the size of the migrant labor force is low relative to the size of the native population. When this is not the case, one can think that welfare and immigration policy are jointly determined (see for instance Casella, 2005 and Armenter and Ortega 2010).

We introduce a general representation of the Home government preferences over immigrants, which includes both the case where policy makers maximize the host economy's national welfare as well as the general possibility that governments are also motivated by the distributional effects of immigration among natives. We assume that agents use their (disposable) income to purchase the final good and have a linear utility function in consumption. Let us define the objective function of the government as a function of the number of immigrants as

$$W_h\left(I_h\right) \equiv b\left[r_h\left(I_h\right) \cdot K_h - \gamma_h\left(N_h + I_h\right)\right] + (1-b)\left[w_h\left(I_h\right) + \gamma_h\right] N_h, \tag{2}$$

where we used the above balanced budget condition (1) to substitute for τ_h and where $b \in [0,1]$ is the political bias (i.e. the weight on the utility of capitalists). This formulation includes as a special case *national* income maximization for $b = 1/2$.

The optimal number of migrants in country h, denoted by $\hat{I} \in \left[0, \tilde{F}\right]$, is the one which maximizes condition (2).[7] To make the problem meaningful for our purpose and realistic, we restrict attention to the cases in which $\hat{I} \in \left(0, \tilde{F}\right)$, that is, in which the maximum problem admits an interior solution.[8]

We now endogenize the migratory choice of foreign workers and show how the policy maker in h is able to "attract" the optimal number of migrants by using immigration policy. A foreign worker in the pool $\tilde{F}$, indexed by i, may decide to migrate to country h. Immigration is a non-reversible decision. Each migrant faces a psychological cost to leave her own country, θ_i, which is uniformly distributed in $[0, \bar{\theta}]$, where $\bar{\theta}$ is normalized to 1. The wage rate if she does not migrate is denoted by w^* and normalized to zero.[9] In addition, the government in h can set up an immigration policy which is parametrized by a cost borne by immigrants once in the new country, $\mu_h \in \mathbb{R}_+$. This parameter can be interpreted in several ways, from the cost of bureaucratic procedures that each immigrant faces in the host economy to laws that affect the life of immigrants in the host country, such as the number of years to obtain voting rights or citizenship. More broadly, we can consider $\gamma_h - \mu_h$ as the net policy incentive to

[7] In the rest of the paper we refer to $\hat{I}$ as the "optimal" number of migrants. Needless to say, this is the "politically-optimal" level of immigration, as it maximizes the government's objective function, and it corresponds to the "socially-optimal" number of migrants only in the special case in which $b = 1/2$.

[8] Appendix A discusses this maximum problem and its solution.

[9] These assumptions are only made for simplicity and are without loss of generality.

migrate to h.

A foreign worker i will migrate if and only if

$$w_h + \gamma_h - \mu_h - \theta_i \geq 0,$$

from which it is immediate to find the threshold value of the psychological cost (such that all those below that value are willing to migrate) as

$$\theta_h = w_h + \gamma_h - \mu_h.$$

As foreign workers are distributed uniformly in $[0, 1]$, the number of migrants will be $I_h = \theta_h \tilde{F}$, where θ_h is a function of policy both directly and via its effect on the equilibrium level of wage.

Given the optimal number of migrants in h as $\hat{I}$, the optimal policy, denoted by $\hat{\mu}$, will be defined as

$$\hat{\mu} = \hat{w} + \gamma_h - \hat{\theta} = (1-\alpha)\left(\frac{K_h}{N_h + \hat{I}}\right)^{\alpha} + \gamma_h - \frac{\hat{I}}{\tilde{F}}. \tag{3}$$

In other words, if the policy maker sets up $\mu_h = \hat{\mu}$, the number of migrants will be the one maximizing welfare, $I_h = \hat{I}$.

In alternative, country h's welfare can be expressed as a direct function of its immigration policy μ_h, by simply substituting for $I_h = \theta_h(\mu_h)\tilde{F}$ into (2). We restrict the attention to those economies for which the welfare function $W_h(\mu_h)$ is strictly concave: a graphical representation of this function is provided in Figure 1, while a rigorous analytical characterization is given in Appendix B, where we also define the "open door" policy (μ^{od}) and the "closed door" policy (μ^{cd}) as the policies which induce, respectively, *all* foreign workers and *no* foreign worker to emigrate to h.[10]

In this simple model we can equivalently adopt either of these formulations, as there is a univocal mapping between the number of migrants (I_h) and the immigration policy (μ_h) set up in the host country. In the multiple-country model of Section 3 instead, the flow of migrants actually entering a single host country will depend not only on its own immigration policy but also on the policies enacted in the rest of the receiving region. We will then define

[10] Appendix B also works out an explicit condition on parameters for the postulated strict concavity of the welfare function with respect to μ_h. This assumption is indeed more than is required to prove our main result in Proposition 1. It however simplifies the subsequent comparative statics analysis.

the payoff function of each host country as function of all policies set up in the whole region.

INSERT FIGURE 1 HERE

As we claimed above, none of the results of this paper relies on the special characteristics of the model developed in this section, such as the effects of immigration on the domestic labor market and on the welfare state. These effects are however quite standard and include distributional and political economy effects. A change in μ_h alters the equilibrium in the domestic labor market and the two key prices in the model economy, the wage rate and the rate of return on capital, as it alters foreign workers' incentives to migrate. In addition, changes in immigration policy affect the costs of the welfare system. For instance, a higher μ_h lowers labor supply, which depresses rents and increases the wage rate. On the other hand, a lower immigration reduces welfare spending and, hence, the tax rate on the returns from capital. Finally, as the government weighs differently the welfare of capitalists and native workers, political economy determinants (here captured by the parameter b) affect the openness of immigration policy in the host economy. For instance, a higher weight on native workers' welfare in the government objective function (i.e. lower b) implies a lower optimal number of foreign workers in the host country ($\hat{I}$) and, hence, a higher level of the optimal immigration restriction ($\hat{\mu}$).

3 A Multiple-Country Model of Immigration Policy

The standard model introduced in Section 2 captures the distributional and political economy determinants of immigration policy, but is silent about its international determinants. This section provides an extension of the model in which the host economy is formed of a set of independent countries, and foreign workers can choose whether and *where* to migrate. This simple extension is sufficient to determine the international externality characterizing immigration policy and, hence, the type of strategic problem associated to unilateral immigration policies in the receiving world.

More precisely, we assume that m destination countries exist, indexed by $h = 1, ..., m$, each of which is free to choose its own immigration policy independently. These countries have the same technology, endowments, preferences and welfare systems, as presented in the previous section for the model with only one receiving country. This symmetry assumption allows us to clearly isolate the effects of the immigration policy externality introduced in the next subsection.

3.1 The Immigration Policy Spillover

Migrants are internationally mobile, in the sense that in a world formed of several potential host economies they have some freedom in choosing their destination. Clearly, the international mobility of migrants is limited by a series of factors in addition to immigration restrictions in the receiving world, including primarily geographical distance, but possibly other factors such as technology (e.g. communication technologies) or cultural diversity (e.g. adaptability to different cultures).[11]

We capture the limited international mobility of migrants by assuming that foreign workers are of two kinds. A fraction ΨF, with $\Psi \in (0, 1)$, can decide freely which receiving country to move to in the set m ("free foreign workers"), where F is the total population in the sending region (representing the total number of potential migrants). The remaining fraction $(1-\Psi)F$ are instead constrained in their choice ("constrained foreign workers"). For simplicity, we further suppose that each receiving country can attract at most $(1 - \Psi)F/m$ constrained foreign workers; that is, potential migrants of "constrained type" are distributed uniformly across the receiving region. The parameter Ψ captures the international mobility of migrants. A higher value of Ψ, that is, an increase in the set of "free foreign workers", can be motivated by several factors that reduce the (non-policy) constraints to the migrants' mobility, such as an improvement in transportation or telecommunication technologies.

This extension does not affect the "demand" for migrants, as the government's objective function is still given by expression (2) and the optimal number of migrants for any country h is $\hat{I}$ (see Section 2). It instead affects the "supply" of migrants, that is, the migration choice of foreign workers and, as a result, the immigration policy set up by host countries. The migration choice of constrained foreign workers is identical to the one developed in the standard setting of Section 2. Consider the generic receiving country h. Each foreign worker

[11] See, among others, Belot and Hatton (2008) and Grogger and Hanson (2008).

i "constrained to country h" decides to move to h if and only if

$$w_h + \gamma_h - \mu_h - \theta_i \geq 0, \tag{4}$$

and thus the number of constrained migrants (as function of μ_h) will be $\theta_h(1-\Psi)F/m$, where $\theta_h = w_h + \gamma_h - \mu_h$, and where we used the fact that constrained foreign workers are uniformly distributed over the set of destination countries.

The number of free foreign workers *potentially* entering each country h is instead given by the whole pool of free foreign workers, ΨF. In addition to satisfying condition (4), these foreign workers will also compare the payoff obtained by migrating to country h to the one obtained by migrating to any other receiving country (denoted by $-h$). Free foreign workers will target country h if [12,13]

$$w_h - \mu_h > w_{-h} - \mu_{-h} \Longleftrightarrow \mu_h < \mu_{-h}, \tag{5}$$

that is, if country h sets up a softer immigration policy than any other country in the receiving region.

Therefore, policy differences in the destination world affect migration choices. Specifically, the number of free foreign workers actually migrating to h is 0 if $\mu_h > \mu_{-h}$ (*crowding out*), and $\theta_h \Psi F$ (where $\theta_h = w_h + \gamma_h - \mu_h$) if $\mu_h < \mu_{-h}$ (*crowding in*). Finally, if $\mu_h = \mu_{-h}$, free migrants are indifferent, and we assume that they distribute symmetrically across the receiving region, that is, $\theta_h \Psi F/m$ for any h.

Immigration flows to country h are, therefore, a function of h's immigration policy as well as of the measures imposed in the rest of the destination countries. The *total* number of (constrained plus free) migrants to country h can then be described as $I_h = \theta_h F_h$, where $\theta_h = w_h + \gamma_h - \mu_h$ and

$$F_h = \begin{cases} F\left[(1-\Psi)/m + \Psi\right] \equiv \overline{F} & \text{if } \mu_h < \mu_{-h} \\ (1-\Psi)F/m \equiv \underline{F} & \text{if } \mu_h > \mu_{-h} \\ F/m \equiv \tilde{F} & \text{if } \mu_h = \mu_{-h}. \end{cases} \tag{6}$$

This effect of immigration policy abroad on the flow of migrants into the host economy

[12] The absence of asymmetric equilibria (which will be proven in Appendix D) allows us to simplify the notation: w_{-h} and μ_{-h} denote the (identical) wage and policy set in all $m-1$ countries other than h.

[13] It is easy to show that $dw_h/d\mu_h \in (0,1)$ and thus condition (5) holds true.

is the key cross-border externality in this model and the mechanism of economic interdependence that we highlight. Importantly, the theory closely captures the essential international policy spillover emphasized in the empirical literature discussed in the Introduction.

Two related considerations seem relevant. The first consideration is on the interpretation of parameter Ψ in the model. If Ψ is equal to zero (i.e. no international mobility of foreign workers), the model collapses to the standard setting, as $F_h = F/m = \tilde{F}$ independently of the policy abroad. As Ψ increases, differences in immigration policies among destination countries have a larger effect on the flow of migrants. In other words, Ψ can be interpreted as an elasticity -i.e. the responsiveness of migrants to policy differences. Factors such as improvements in transportation and communication technologies or proximity are likely to increase this elasticity and hence magnify the size of the immigration policy spillover.

The second consideration relates to the size of this international externality. In their study, Timmer and Williamson (1998) find that the effect of the immigration policy spillover is statistically significant but small, while Boeri and Bruecker (2005) show that policy differences increased by up to five times immigration to more open EU members compared to the counterfactual of free mobility in the EU. The two studies need not be in contradiction as they are consistent with different values of Ψ in the model. The international mobility of migrants from the Old to the New World in the 19th century was limited by distance and technological factors compared to modern immigration from Eastern to Western Europe. This is consistent with a higher value of Ψ in the latter immigration episode and, hence, with a stronger policy externality.

3.2 Multiple Policy Equilibria and Coordination Failures

Given the international externality created by the migratory behavior of foreign workers, we now characterize the equilibrium immigration policies by studying the strategic interaction among receiving countries. Formally, this interaction can be represented as a symmetric coordination game among the governments of the m destination countries, each deciding its own immigration policy in a non-cooperative fashion. As we will see, this game admits a *continuum* of symmetric, Pareto-rankable, Nash equilibria. In particular, we prove that there exists an interval of immigration policies $\left[\underline{\mu}, \overline{\mu}\right]$ such that, if all countries but h select any policy in that interval, country h will find it best to do the same. We also show that there exists a pay-off dominant equilibrium belonging to that interval, and that such equilibrium is associated with policy $\hat{\mu}$ (as given by (3)) which, if implemented by all host countries, is able to attract the optimal number of migrants $\hat{I}$ for all of them. All other equilibria around this optimal policy equilibrium are instead sub-optimal and represent a *coordination failure* among the receiving countries driven by the immigration policy spillover.

A coordination failure arises in this game because immigration policies across receiving countries are *strategic complements*. To give an intuition, start from the globally optimal policy equilibrium, $\hat{\mu}$. If all other countries but h restrict their policy above $\hat{\mu}$, country h finds it better to follow this restriction rather than suffer the "crowding in" of migrants that would result from sticking to $\hat{\mu}$. This incentive continues up to policy $\overline{\mu}$. Symmetrically, if all other countries but h loosen up their policy below $\hat{\mu}$, country h is better off by implementing this softer policy stance rather than suffering a "crowding out" of migrants. This incentive continues up to policy $\underline{\mu}$. A strategic complementarity across host countries is thus responsible for the positive co-movement of immigration policies documented in the data.

Let us now define the payoff function of the government of generic country h as a function of its immigration policy, μ_h, and of the policy strategy followed by all other receiving countries, μ_{-h}, $\Pi_h\left(\mu_h, \mu_{-h}\right)$. Intuitively, this payoff function now depends on whether μ_h is higher, lower or equal to μ_{-h}. If it is equal, then migrants distribute equally across the host region ($F_h = \tilde{F}$), and the welfare function is obtained by simply substituting for $I_h = \theta_h \tilde{F}$ into (2), exactly as in the standard model of Section 2 (expression B1 in Appendix B). If it is higher, country h will experience a crowding out ($F_h = \underline{F}$), and the welfare function is obtained from (2) by substituting for $I_h = \theta_h \underline{F}$. Finally, if it is lower, country h will instead experience a crowding in ($F_h = \overline{F}$), and the welfare function is still obtained from (2) but substituting for $I_h = \theta_h \overline{F}$. We can then write[14]

$$\Pi_h \left(\mu_h, \mu_{-h}\right) = \begin{cases} W_h \left(\mu_h, \underline{F}\right) & \text{if } \mu_h > \mu_{-h} \\ W_h \left(\mu_h, \tilde{F}\right) & \text{if } \mu_h = \mu_{-h} \\ W_h \left(\mu_h, \overline{F}\right) & \text{if } \mu_h < \mu_{-h}, \end{cases}$$

where the expressions of the government h's payoff under crowding out ($W_h \left(\mu_h, \underline{F}\right)$), crowding in ($W_h \left(\mu_h, \overline{F}\right)$) and equal distribution of migrants across the region ($W_h \left(\mu_h, \tilde{F}\right)$) are drawn in Figure 2 and formally defined in Appendix C.

INSERT FIGURE 2 HERE

The solid curve in Figure 2 represents the (politically weighted) welfare of country h when its immigration policy is equal to the one implemented in the rest of the receiving region. The dashed curve captures h's welfare when its policy stance is more restrictive than abroad, while the dotted curve represents the opposite case. Note that the optimal number of migrants for country h is unambiguously given by $\hat{I}$ and, hence, the three functions have the same maximum. However, the policy associated to this level of immigration depends on whether this policy is higher, lower or equal to the one implemented abroad. In Figure 2, we have called these policy values respectively $\underline{\underline{\hat{\mu}}}$,$\overline{\overline{\hat{\mu}}}$, $\hat{\mu}$ (formally defined in Appendix C).

Before proving the existence of the *continuum* of policy equilibria, we provide a simple intuition of this result. A combination of immigration policies $\boldsymbol{\mu}^* = (\mu_1^*, ..., \mu_m^*)$ is a Nash equilibrium if for any country h it is $\Pi_h (\mu_1^*, ..., \mu_h^*, ..., \mu_m^*) > \Pi_h (\mu_1^*, ..., \mu_h, ..., \mu_m^*)$ $\forall \mu_h \neq \mu_h^*$. In particular, in a *symmetric* Nash equilibrium it must also be that $\mu_h^* = \mu_{-h}^*$ $\forall h$ (at the end of Appendix D we prove that this game does not admit asymmetric equilibria). Hence, a policy $\mu_h = \mu^*$ $\forall h$ is a symmetric Nash equilibrium whenever $W_h \left(\mu^*, \tilde{F}\right) \geq W_h \left(\mu^*, \underline{F}\right), W_h \left(\mu^*, \overline{F}\right)$. As shown in Figure 3, there exists a *continuum* of immigration policies, given by the interval $\left[\underline{\mu}, \overline{\mu}\right]$, for which the solid curve ($W_h \left(\mu^*, \tilde{F}\right)$) is above the dashed and dotted functions

[14] The pay-off function is not continuously differentiable, which prevents us from using the standard tools of differential calculus to find the best-response functions and the Nash equilibria of the game. Note also that, albeit more complicated, this function resembles the pay-off function in the Bertrand competition game with homogeneous goods, in which each firm's profit depends on whether its price is higher, lower or equal to the one set up by its rivals (see for instance Tirole, 1988, pp. 209-211). In particular, the policy game described in this paper shares many features with price competition games where firms' costs are assumed to be convex (Dastidar, 1995, Weibull, 2006).

$\left(W_h\left(\mu^*,\underline{F}\right)$ and $W_h\left(\mu^*,\overline{F}\right)\right)$. In other words, whatever $\mu_{-h} \in \left[\underline{\mu},\overline{\mu}\right]$, country h's best response is $\mu_h = \mu_{-h}$.

Policy $\hat{\mu}$ belongs to that interval and is a Nash equilibrium. Indeed, it is the pay-off dominant Nash equilibrium in that, if all other countries set up $\hat{\mu}$, country h is able to attract the optimal number of migrants $\hat{I}$ by adopting the same policy, $\mu_h = \hat{\mu}$. Equilibria surrounding the globally optimal policy equilibrium are Pareto-inferior outcomes which result from a coordination failure driven by the international policy spillover associated with migrants' mobility across the receiving region.

INSERT FIGURE 3 HERE

The logic of the proof is simple and proceeds as follows. Exploiting some of the properties of the two welfare functions $W_h\left(\mu_h,\tilde{F}\right)$, $W_h\left(\mu_h,\underline{F}\right)$ (such as continuity and strict concavity), we prove (i) that there exists a unique value of immigration policy, call it $\underline{\mu} \in \left(\underline{\underline{\hat{\mu}}},\hat{\mu}\right)$, in which the two functions cross each other (and hence for which it is $W_h\left(\underline{\mu},\tilde{F}\right) = W_h\left(\underline{\mu},\underline{F}\right)$) and (ii) that $W_h\left(\mu_h,\tilde{F}\right)$ lies above $W_h\left(\mu_h,\underline{F}\right)$ for any $\mu_h \in \left[\underline{\mu},\hat{\mu}\right]$. Via an analogous reasoning regarding welfare functions $W_h\left(\mu_h,\tilde{F}\right)$, $W_h\left(\mu_h,\overline{F}\right)$, we prove (i) that there exists a unique value of $\overline{\mu} \in \left(\hat{\mu},\overline{\overline{\hat{\mu}}}\right)$, such that $W_h\left(\overline{\mu},\tilde{F}\right) = W_h\left(\overline{\mu},\overline{F}\right)$, and (ii) that $W_h\left(\mu_h,\tilde{F}\right) \geq W_h\left(\mu_h,\overline{F}\right)$ for any $\mu_h \in [\hat{\mu},\overline{\mu}]$. From these two facts we conclude that, for any $\mu_h \in \left[\underline{\mu},\overline{\mu}\right]$ and for any h, it is $W_h\left(\mu^*,\tilde{F}\right) \geq W_h\left(\mu^*,\underline{F}\right), W_h\left(\mu^*,\overline{F}\right)$, and thus any policy in that interval is a symmetric Nash equilibrium. We can now enunciate the following

Proposition 1 *There exist a lower and an upper threshold, $\underline{\mu}$ and $\overline{\mu}$, such that any symmetric configuration of immigration policies, $(\mu_1,...,\mu_m) = (\mu^*,...,\mu^*)$, for which $\mu^* \in \left[\underline{\mu},\overline{\mu}\right]$ is a Nash equilibrium of the game. The globally optimal policy equilibrium $\mu_h = \hat{\mu}$ $\forall h$ as defined in (3) belongs to the set of symmetric Nash equlibria. All other equilibria are sub-optimal and are Pareto-ranked by the distance from $\hat{\mu}$.*

Proof. In Appendix D ■

Another way to look at this set of Nash equilibria is by drawing the reaction curves of the host countries in the immigration policy game. The reaction function of generic country

h is drawn as the black line in space μ_{-h}, μ_h in Figure 4. For any $\mu_{-h} \in \left[\underline{\mu}, \overline{\mu}\right]$ country h's best response is $\mu_h = \mu_{-h}$. Hence, along that interval, the reaction curve is a 45 degree line (as in Bryant's (1983) game). For any $\mu_{-h} < \underline{\underline{\hat{\mu}}}$ ($\mu_{-h} > \overline{\overline{\hat{\mu}}}$), country h's best response is to set up $\underline{\underline{\hat{\mu}}}$ ($\overline{\overline{\hat{\mu}}}$) -as that policy allows country h to attract the optimal number of migrants, $\hat{I}$. Hence, the reaction curve is a horizontal line along that policy value. When μ_{-h} is any value inside the interval $[\underline{\underline{\hat{\mu}}}, \underline{\mu})$, country h's best response is to set up a slightly (by a however small ε) tougher immigration policy, and the best response is drawn as the solid black line slightly above the 45 degree line. Finally, when $\mu_{-h} \in [\overline{\mu}, \overline{\overline{\hat{\mu}}})$, country h's best response is to set up a slightly (by a however small ε) softer immigration policy, and the best response is drawn as the solid black line slightly below the 45 degree line.[15] The best-response function of country h can then be written as

$$br_h\left(\mu_{-h}\right) = \begin{cases} \underline{\underline{\hat{\mu}}} \text{ if } \mu_{-h} < \underline{\underline{\hat{\mu}}} \\ \mu_{-h} + \varepsilon \text{ if } \mu_{-h} \in [\underline{\underline{\hat{\mu}}}, \underline{\mu}) \\ \mu_{-h} \text{ if } \mu_{-h} \in \left[\underline{\mu}, \overline{\mu}\right] \\ \mu_{-h} - \varepsilon \text{ if } \mu_{-h} \in (\overline{\mu}, \overline{\overline{\hat{\mu}}}] \\ \overline{\overline{\hat{\mu}}} \text{ if } \mu_{-h} > \overline{\overline{\hat{\mu}}} \end{cases} \tag{7}$$

The reaction curve of country $-h$ is the mirror image of the one of country h and is depicted as the light grey line in Figure 4. They overlap along the interval $\left[\underline{\mu}, \overline{\mu}\right]$, which then constitutes the measure of equilibria, while no intersection occurs when μ_h is lower than $\underline{\mu}$ or higher than $\overline{\mu}$.

INSERT FIGURE 4 HERE

The above discussion illustrates the key problem associated to immigration policy when the receiving economy is formed by multiple countries: coordination failures can arise in this environment. The economy can be stuck in an inferior Nash equilibrium where restrictions to immigration are either inefficiently high ($\mu_h \in (\hat{\mu}, \overline{\mu}]\ \forall h$) or inefficiently low ($\mu_h \in [\underline{\mu}, \hat{\mu})$

[15] In rigourous mathematical terms the best response function is not defined when μ_{-h} belongs to $[\underline{\underline{\hat{\mu}}}, \underline{\mu})$ or to $[\overline{\mu}, \overline{\overline{\hat{\mu}}})$, the reason being that we have defined the policy variable μ as a continuous variable. With an abuse of notation we write $\mu_{-h} \pm \varepsilon$ instead of $\varnothing$ in the expression for the best-response function (7), as if variable μ were defined as a discrete variable which could only take multiple values of an indivisible ε. This is because we here privilege intution to rigour. Of course, nothing substantial changes.

$\forall h$), and hence destination countries fail to attract the "right" number of foreign workers. The reason for this inefficiency is the international spillover created by immigration policy, which in turn results from the international mobility of migrants (i.e. their ability to choose their destination in addition to whether they want to migrate or not).

Starting at an inefficient equilibrium, no country can improve its welfare with unilateral immigration policy initiatives, but all receiving economies could be made better off under an agreement that called for mutual policy adjustments. In this respect, immigration policy has much to learn from trade policy, even if the structure of the immigration and the trade policy game is quite different. In particular, most authors consider current immigration policy in advanced economies as too restrictive.[16] As this model shows, even after controlling for other determinants of immigration policy (namely, distributional and political economy effects), excessive restrictions can be the result of a coordination failure among receiving countries. No country would unilaterally choose to loosen up its policy stance as this would result in an influx of migrants beyond its efficient point. While each government, acting independently, is powerless to coordinate the policy choices of the others, an international agreement could provide governments with an avenue to commit to a reduction of immigration restrictions and escape from a coordination failure.

However, the model also makes quite clear the differences in the economic problem facing trade and immigration policy makers. Differently from the trade context, in the immigration policy game among receiving countries the key element is confidence rather than conflict. As it is well known from the trade literature (Bagwell and Staiger, 1999 and 2002), excessive trade restrictions can be the result of a terms-of-trade driven prisoner's dilemma situation. In contrast, the analysis of this section shows that receiving countries face a coordination problem which leads to multiple equilibria. While in both situations governments can be stuck at an inefficient equilibrium, a key issue of the immigration policy game is equilibrium selection (an issue that does not emerge in a prisoner's dilemma situation, where there is only one equilibrium). Governments may coordinate on the inefficient equilibrium as this is the one that is associated to policy choices that are less "risky", an issue that will be addressed in Section 4.

[16] In particular, several authors find that there would be *global* gains from lowering immigration restrictions that limit the movement of workers from low-income to high-income countries. See Clemens, Montenegro and Pritchett (2008), Hanson (2008) and Rosenzweig (2007).

3.3 Migrants' International Mobility and Coordination Failures

An important question is how the set of equilibria is affected by the underlying parameters of the model. In particular, in this subsection we study the effect on the receiving countries of a change in the international mobility of foreign workers (Ψ). As discussed above, this parameter captures the responsiveness of migrants to differences in the policy stance and is determined by factors, such as technology, that are likely to change over time.

We begin by stating the following

Proposition 2 *An increase in international mobility of foreign workers (Ψ) expands the set of symmetric Nash equilibria, while it does not affect the Pareto dominant equilibrium. That is,*

$$\frac{d\underline{\mu}}{d\Psi} < 0,\ \frac{d\overline{\mu}}{d\Psi} > 0 \ \textit{and} \ \frac{d\hat{\mu}}{d\Psi} = 0 \ .$$

Proof. In Appendix F. ■

To grasp the intuition, recall that function $W_h\left(\mu_h, \tilde{F}\right)$ is not affected by changes in Ψ as the adoption of the same policy across the receiving region neutralizes the spillover effect. Therefore, the solid curve in Figure 2 does not move as Ψ varies. On the other hand, following an increase in Ψ, function $W_h\left(\mu_h, \underline{F}\right)$ shifts leftward and function $W_h\left(\mu_h, \overline{F}\right)$ shifts rightward. Intuitively, workers' international mobility is responsible for the cross-border externality, which is the source of the equilibrium multiplicity. An increase in international mobility implies a more powerful externality and an ever expanding measure of policy equilibria.

Taken together, Propositions 1 and 2 have two implications. First, higher realizations of parameter Ψ, by expanding the set of equilibria, worsen the problem of coordination failure and indeterminacy. Second, as the "new" equilibria are more distant from the globally optimal policy, they are associated to lower welfare for the receiving region. To put it differently, this result suggests that the new wave of globalization, driven by a fall in transportation and communication costs, may be exacerbating coordination failures and increasing the gains from immigration policy coordination for all receiving countries.

4 Selection of Equilibria under Strategic Uncertainty

The previous section illustrates the possibility of coordination failures in immigration policy due to the presence of multiple Nash equilibria in the immigration policy game. Whether coordination failures actually occur depends on which equilibrium policy makers coordinate. As shown above, the "payoff-dominant" equilibrium, the one associated with policy $\mu_h = \hat{\mu}$ $\forall h$, is in the set of equilibria. This, however, is not necessarily the equilibrium that players select.

Experimental evidence on coordination games quite convincingly rejects the view that coordination problems will not occur in simple strategic interactions (Cooper et al., 1992, Van Huyck et al., 1990). One possible rationalization of this evidence is that payoff-dominance is not the only basis for coordination, and that players may converge towards other equilibria which present alternative salient features. An alternative proposed in this literature is that players coordinate towards the "risk-dominant" equilibrium (Harsanyi and Selten, 1988), the key insight being that a strategy may be preferred over the other if it is less risky in the face of strategic uncertainty.[17]

An evolution of this equilibrium selection criterion, which applies to games characterized by a continuous space of strategies (as the immigration policy game introduced in Section 3), is the *robustness to strategic uncertainty (* Andersson et al., 2010). Whenever a game admits a continuum of equilibria, even the slightest uncertainty about the opponents' strategies might lead each player to deviate from any given policy equilibrium. It is then "arguably reasonable to require equilibria to be robust to small amounts of uncertainty about other players' strategies" (Andersson et al., 2010, p.2).[18]

In this subsection we prove that there is a unique equilibrium which is robust to strategic uncertainty and show that the *robust equilibrium* is different from the payoff-dominant equilibrium. This result reveals that coordination failures in immigration policy are not only possible but also likely to emerge.

[17] Whether players are more likely to coordinate towards payoff-dominant or risk-dominant equilibria is the focus of empirical literature (for a survey see Cooper, 1999). The experimental evidence in Cooper et al. (1992) shows that risk-dominance can provide a better guide to equilibrium selection than payoff-dominance.

[18] Specifically, Andersson et al. (2010) show that there is only one equilibrium surviving the robustness test in a price competition game with a continuous strategy space and admitting a continuum of equilibria (Dastidar, 1995). Abbink and Brandts (2008) and Argenton and Muller (2009) provide experimental evidence in favor of this "robust equilibrium".

We first formally characterize strategic uncertainty in the immigration policy game. Following Andersson et al. (2010), we model strategic uncertainty by assuming that the probabilistic belief of policy maker h about the action of any other government j in the receiving economy is given by:

$$\tilde{\mu}_{hj} = \mu_j + t\varepsilon_{hj},$$

where $t \in R_+$ and $\varepsilon_{hj} \sim \Phi_{hj}$ are statistically independent noise terms. The distribution Φ_{hj} belongs to an arbitrary family of probability distributions with non decreasing hazard rate function.

The introduction of this "noise" defines a new, "perturbed", game. Intuitively, the robust equilibrium is an equilibrium of this perturbed game when the noise tends to zero. More formally, if an equilibrium strategy profile $(\mu^r, ..., \mu^r)$ is the unique limit to any sequence of equilibria indexed by t as $t \to 0$, that strategy profile is *robust to strategic uncertainty.* In the next proposition we prove that such limit exists and is unique.

Proposition 3 *There exists a unique equilibrium which is robust to strategic uncertainty. This equilibrium,* $(\mu^r, ..., \mu^r)$*, is defined by* $W_h(\mu^r, \underline{F}) = W_h(\mu^r, \overline{F})$ $\forall h$ *and is Pareto-inferior to the payoff dominant equilibrium* $(\hat{\mu}, ..., \hat{\mu})$*.*

Proof. In Appendix E. ■

Policy μ^r is the one for which the incentives to restrict or loosen the immigration policy stance for each strategically uncertain government in the receiving region exactly offset each other. As shown in Figure 5, the robust equilibrium of the immigration policy game corresponds to the point where the functions $W_h(\mu_h, \underline{F})$ (the dashed curve) and $W_h(\mu_h, \overline{F})$ (the dotted curve) intersect. In this point, denoted by A, the expected welfare loss associated to a policy higher or lower than the rest of the host region tends to zero.

INSERT FIGURE 5 HERE

As there is a continuous strategy space, for any policy μ_h, government h's subjective probability that any other government will choose exactly the same policy is zero. Hence, with probability one, policy μ_h will either be the lowest or not. In the first case, country h will experience a crowding in, in the second it will experience a crowding out. In Figure 5, for any policy $\mu_h \in (\mu^r, \overline{\mu}]$, function $W_h\left(\mu_h, \overline{F}\right)$ lies above function $W_h\left(\mu_h, \underline{F}\right)$ and viceversa for any policy $\mu_h \in \left[\underline{\mu}, \mu^r\right)$. For strict Nash equilibrium policies, a government facing uncertainty on the strategies of other receiving governments has an incentive to lower immigration restrictions. The reason being that the welfare if other countries' policies are less stringent (i.e. under crowding out of migrants) is lower than the welfare if other receiving countries' immigration policies are more restrictive than the one set up in h (i.e. under crowding in of migrants). Conversely, for low Nash equilibrium immigration policies, every government has an incentive to raise restrictions as the expected welfare under a crowding in is lower than under a crowding out of migrants.

A comparison of the robust and Pareto-dominant equilibria sheds light on two issues. First, under strategic uncertainty, the immigration policy equilibrium is distinct from the one that maximizes welfare for the entire host region. The policy strategy robust to strategic uncertainty can be more or less stringent than the globally optimal policy depending on the fundamentals of the economy (which determine the shapes of the two curves in Figure 5). In this model, where immigration has both benefits and costs for the host economy, the presence of an immigration policy spillover may, therefore, induce countries to select an excessively restrictive or loose policy. In other words, this model suggests that coordination failures driven by the immigration policy spillover can give rise to both a "race to the top" and a "race to the bottom" in immigration restrictions in receiving countries (see, for instance, Boeri and Bruecker, 2005).

Second, an increase in the international mobility of migrants (Ψ) does not affect the globally optimal immigration policy (Proposition 2) but alters the robust equilibrium. Intuitively, the expected welfare loss associated to both a crowding in and a crowding out increases with the size of the immigration policy spillover (the dotted and the dashed curves in Figure 5 move further apart, while the position of the solid curve is not affected by changes in Ψ, see Proposition 2). Therefore, globalization, in the sense of an increase in the international mobility of migrants, exacerbates the strategic uncertainty by increasing the set of Nash equilibria, and has an ambiguous effect on the robust equilibrium on which governments coordinate.

5 Conclusions and Policy Implications

This paper has examined receiving countries' motives in setting immigration policy and how the institutional framework, particularly the absence of effective coordination mechanisms, translates these motives into policy outcomes. The analysis shows that, in addition to the traditional determinants of immigration policy, such as redistributive and political economy motives, policy at home is influenced by measures adopted abroad. The reason is that migrants choose where to locate, in part in response to immigration policies in host economies. In the model, the international mobility of migrants gives rise to a policy spillover effect which rationalizes the evidence in recent empirical studies on immigration. In this interdependent environment, immigration policy becomes strategic and unilateral behavior may well lead to coordination failures, where receiving countries are stuck in a welfare inferior equilibrium. The theory also shows that inefficient policy equilibria are more likely to emerge when governments are uncertain about the immigration policy of other receiving countries and when the international mobility of migrants is stronger.

In the rest of this section, we discuss some implications of this model and how (and to what extent) institutions dealing with immigration can address coordination failures. A first implication of the model is that the type of coordination problem facing immigration policy makers is different from the one facing trade policy makers. While both unilateral trade and immigration policies may lead to an inefficient equilibrium, the nature of this equilibrium in the two cases is not the same. In the trade policy game, the first-best policy outcome (i.e. trade openness) is not an equilibrium of the game as each government has an incentive to impose restrictions when the others choose free trade. Instead, the key element of coordination failures in the immigration policy game is the lack of confidence in the policy choice of other governments, not an inherent policy conflict as in trade policy. In other words, it is the inability of policy makers to commit to the efficient immigration policy vis-à-vis other countries that constrains efficient outcomes in this domain. Proper institutional arrangements should take into account this feature of the immigration policy game.

Several international agreements and organizations aim at coordinating immigration policy. For instance, the stated objective of the International Organization for Migration is "to promote international cooperation on migration issues". Moreover, a forum for dialogue on migration and immigration policy is also provided by other international institutions, such as the OECD. While these arrangements help coordination through dialogue and the dissemination of information among receiving countries, they do generally not envisage an effective enforcement mechanism. This implies that the uncertainty on other governments' strategies still characterizes policy makers' decisions, which can lead to coordination failures. An exception is Mode 4 of the General Agreement on Trade in Services (GATS), which provides an opportunity to WTO Members to take on commitments regarding the temporary presence of "natural persons" from a different Member who supply a service.[19] While GATS Mode 4 has a limited scope, the binding nature of commitments within the WTO, backed up by the enforcement mechanism provided by its dispute settlement system, is an appealing feature of this system.[20] In this sense, expanding the scope of Mode 4 may be in the interest of receiving countries.

Another implication of this analysis is that the extent of the coordination problem depends on the magnitude of the policy spillover effect. In the model this is captured by the size of the parameter Ψ -i.e. the international mobility of migrants. While in the paper we emphasized technology as a determinant of this parameter, other factors can influence the responsiveness of foreign workers to immigration policy differences. In particular, receiving countries that are more strongly interconnected, because of geographic proximity, common cultural background, or because they have formed an economic union, will experience stronger immigration policy spillovers and are, therefore, more likely victims of coordination failures. Institutions that allow for effective coordination (or, the creation of a single immigration policy) are more valuable in these circumstances. This provides formal support to the frequent calls in the policy debate for a single immigration policy in an integrated area such as the European Union (Boeri and Bruecker, 2005). Similarly, a greater involvement of the States of the US

[19] Natural persons falling within the scope of Mode 4 include independent contractual service suppliers and natural persons employed by service suppliers (WTO, 2004). Specifically, Mode 4 concerns a narrow (and not clearly defined) subset of temporary migration, as it excludes coverage of access to labour market, citizenship and employment on a permanent basis (see WTO Annex on Movement of Natural Persons).

[20] The size and scope of Mode 4 movements are an issue of current debate and negotiation. While a number of WTO Members have undertaken Mode 4 commitments that cover short-term employees (the US binding of 65.000 H-1B visas is a noteworthy example), the overall degree of Mode 4 commitments are low. WTO Members have generally granted access to selected categories of highly skilled persons linked to a commercial presence, such as managers, executives and specialists. The Hong Kong Ministerial declaration in December 2005 called for a new impetus on Mode 4 commitments (e.g. an extension of the categories of natural persons included in the commitments and of the permitted duration of stay), but improvements in the ongoing Doha negotiations have been so far slow to materialize (see Carzaniga, 2009).

(and, hence, a more limited role of the federal government) in immigration policy -implicit in the law passed in the State of Arizona in 2010- may lead to welfare reducing coordination failures within the US, as the choice of one State will inevitably affect others through location decisions of foreign workers within the US and trigger a series of policy responses in other States.

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A The Optimal Number of Migrants

Consider the following maximization problem for the policy maker in the receiving economy:

$$\max_{I_h}\left\{b\left[\alpha\left(\frac{K_h}{N_h+I_h}\right)^{\alpha-1}\cdot K_h-\gamma_h\left(N_h+I_h\right)\right]+(1-b)\left[(1-\alpha)\left(\frac{K_h}{N_h+I_h}\right)^{\alpha}+\gamma_h\right]N_h\right\}.$$

where $I_h\in\left[0,\tilde{F}\right]$. The FOC of this problem is

$$\frac{\partial W_h}{\partial I_h}=(1-\alpha)\,\alpha\left(\frac{K_h}{N_h+I_h}\right)^{\alpha}\left[b-(1-b)\,\frac{N_h}{N_h+I_h}\right]-b\gamma_h=0.$$

A number $\hat{I}$ solving the FOC above is a maximum if the second derivative, evaluated in $\hat{I}$, is strictly negative, that is, if

$$\frac{\partial^2 W_h}{\partial I_h^2}\left(\hat{I}\right)=(1-\alpha)\,\alpha\left(\frac{K_h}{N_h+\hat{I}}\right)^{\alpha}\frac{1}{N_h+\hat{I}}\left[(1-b)\,\frac{N_h}{N_h+\hat{I}}-\alpha\left(b-(1-b)\,\frac{N_h}{N_h+\hat{I}}\right)\right]<0.$$

In Appendix B we provide a sufficient condition for $\hat{I}$ to be the *global* maximum, that is, the only politically optimal number of migrants for the host country.

B The Optimal Immigration Policy

There exist an upper and a lower bound beyond which a change in μ_h has no effect on the number of migrants. For instance, if μ_h is such that all foreign workers $\tilde{F}$ are already willing to enter, a further decrease has no effect on immigration. Symmetrically, if μ_h is such that no foreign worker is willing to enter, a further increase has no effect on immigration either. We define "open door" policy (μ^{od}) and "closed door" policy (μ^{cd}) as the policies which induce, respectively, *all* foreign workers and *no* foreign worker to emigrate to h. Formally,

$$\mu_h^{od}=w_h+\gamma_h-\theta_h=(1-\alpha)\left(\frac{K_h}{N_h+\tilde{F}}\right)^{\alpha}+\gamma_h-1 \text{ and}$$

$$\mu_h^{cd}=w_h+\gamma_h-\theta_h=(1-\alpha)\left(\frac{K_h}{N_h}\right)^{\alpha}+\gamma_h.$$

Welfare as a function of immigration policy μ_h is defined as

$$\begin{aligned} W_h\left(\mu_h\right) &= b\left[K_h\alpha\left(\frac{K_h}{N_h+\theta_h\tilde{F}}\right)^{\alpha-1}-\gamma_h\left(N_h+\theta_h\tilde{F}\right)\right]+ \\ & \quad (1-b)\left[(1-\alpha)\left(\frac{K_h}{N_h+\theta_h\tilde{F}}\right)^{\alpha}+\gamma_h\right]N_h. \end{aligned} \tag{B1}$$

where θ_h is a function of μ_h. The problem for the host country is the one of maximizing the above function with respect to $\mu_h \in \left[\mu^{od}, \mu^{cd}\right]$. The FOC can be expressed as

$$\frac{\partial W_h}{\partial \mu_h} = -\left\{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\left[b-(1-b)\,\frac{N_h}{L_h}\right]-b\gamma_h\right\}\cdot\frac{\tilde{F}}{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{\tilde{F}}{L_h}+1}=0.$$

Denote as $\hat{\mu}$ a solution to the FOC. A *sufficient* condition for $\hat{\mu}$ to be the global maximum is that the welfare function is everywhere strictly concave in μ_h. The second derivative of the welfare function writes as

$$\begin{aligned} \frac{\partial^2 W_h}{\partial \mu_h^2} &= \left\{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{1}{L_h}\left[(1-b)\,\frac{N_h}{L_h}-\alpha\left(b-(1-b)\,\frac{N_h}{L_h}\right)\right]\right\}\times \\ & \quad \left(\frac{\tilde{F}}{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{\tilde{F}}{L_h}+1}\right)^2+ \\ & \quad \left\{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\left[b-(1-b)\,\frac{N_h}{L_h}\right]-b\gamma_h\right\}\times \\ & \quad \left(\frac{\tilde{F}}{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{\tilde{F}}{L_h}+1}\right)^2\times\frac{\left(1-\alpha^2\right)\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{\tilde{F}}{L_h^2}}{(1-\alpha)\,\alpha\left(\frac{K_h}{L_h}\right)^{\alpha}\frac{\tilde{F}}{L_h}+1}. \end{aligned}$$

Simple algebra shows that the following condition on the parameters of the model ensures that $\partial^2 W_h/\partial\mu_h^2$ is strictly lower than zero for any value of μ_h:

$$b > \frac{1+\alpha}{1+2\alpha+(1+\alpha)\,\gamma_h\frac{\tilde{F}}{N_h+\tilde{F}}-\alpha\left(1-\alpha\frac{K_h^{\alpha}\tilde{F}}{N_h^{\alpha+1}}\right)}.$$

In the remainder of the paper we assume that this condition is satisfied, so that $\hat{\mu}$ is the politically optimal immigration policy for the host country, that is, the policy which is able to attract the optimal number of immigrants, $\hat{I}$.

C Characterization of the Pay-Off Function

The payoff function can be written as

$$\Pi_h \equiv b\left[K_h\alpha\left(\frac{K_h}{N_h+\theta_h F_h}\right)^{\alpha-1} - \gamma_h\left[N_h+\theta_h F_h\right]\right] + \\ (1-b)\left[(1-\alpha)\left(\frac{K_h}{N_h+\theta_h F_h}\right)^{\alpha} + \gamma_h\right]N_h, \tag{C1}$$

where F_h is a function of both μ_h and μ_{-h} and is defined in (6). Thus, we can draw three distinct welfare functions depending on whether μ_h is higher, lower or equal to μ_{-h}. If $\mu_h = \mu_{-h}$, the welfare function, $W_h\left(\mu_h, \tilde{F}\right)$, is given by (C1) but where $F_h = \tilde{F}$. If $\mu_h > \mu_{-h}$ (crowding out), the welfare function $W_h\left(\mu_h, \underline{F}\right)$ is given by (C1) but where $F_h = \underline{F}$. Finally, if $\mu_h < \mu_{-h}$ (crowding in), then the welfare function, $W_h\left(\mu_h, \overline{F}\right)$, is still given by (C1) but where $F_h = \overline{F}$. The three functions are strictly concave in μ_h (see Appendix B), and have the same numerical value for maximum welfare, which is reached when $I_h = \hat{I}$. The maximum point, that is, the value of immigration policy associated with the highest government welfare, is however different as the policy restriction that supports the efficient number of migrants depends on the policy stance abroad. In particular, we have

$$\underline{\underline{\hat{\mu}}} \equiv (1-\alpha)\left(\frac{K_h}{N_h+\hat{I}}\right)^{\alpha} + \gamma_h - \frac{\hat{I}}{\underline{F}}$$

$$\hat{\mu} \equiv (1-\alpha)\left(\frac{K_h}{N_h+\hat{I}}\right)^{\alpha} + \gamma_h - \frac{\hat{I}}{\tilde{F}}$$

$$\overline{\overline{\hat{\mu}}} \equiv (1-\alpha)\left(\frac{K_h}{N_h+\hat{I}}\right)^{\alpha} + \gamma_h - \frac{\hat{I}}{\overline{\overline{F}}}.$$

Simple inspection of the above condition shows that $\underline{\underline{\hat{\mu}}} < \hat{\mu} < \overline{\overline{\hat{\mu}}}$.

Finally, we characterize the extremes of the three welfare functions. The *closed-door* policy (that is, the policy such that immigration is zero) is the same in the three cases and is defined by

$$\mu^{cd}\left(\underline{F}\right) = \mu^{cd}\left(\overline{F}\right) = \mu^{cd}\left(\tilde{F}\right) = w_h + \gamma_h - \theta_h = (1-\alpha)\left(\frac{K_h}{N_h}\right)^{\alpha}.$$

The *open-door* policy (that is, the policy such that the number of immigrants is at its maximum) is instead different in the three cases as the number of potential entrants is different. Specifically

$$\mu^{od}\left(\underline{F}\right) = w_h + \gamma_h - \theta_h = (1-\alpha)\left(\frac{K_h}{N_h + \underline{F}}\right)^{\alpha} + \gamma_h - 1,$$

$$\mu^{od}\left(\tilde{F}\right) = w_h + \gamma_h - \theta_h = (1-\alpha)\left(\frac{K_h}{N_h + \tilde{F}}\right)^{\alpha} + \gamma_h - 1,$$

$$\mu^{od}\left(\overline{F}\right) = w_h + \gamma_h - \theta_h = (1-\alpha)\left(\frac{K_h}{N_h + \overline{F}}\right)^{\alpha} + \gamma_h - 1.$$

It is easy to show that $\mu^{od}\left(\overline{F}\right) < \mu^{od}\left(\tilde{F}\right) < \mu^{od}\left(\underline{F}\right)$ and $W\left(\mu^{od}\left(\overline{F}\right)\right) < W\left(\mu^{od}\left(\tilde{F}\right)\right) < W\left(\mu^{od}\left(\underline{F}\right)\right)$. We can then draw the payoff function as in Figure 2.

D Proof of Proposition 1

A policy $\mu_h = \mu^* \ \forall h$ is a symmetric Nash equilibrium whenever $W_h\left(\mu^*, \tilde{F}\right) \geq W_h\left(\mu^*, \underline{F}\right)$, $W_h\left(\mu^*, \overline{F}\right) \ \forall h$, that is, whenever enacting the same policy as the rest of the region is better than enacting any other policy above or below that policy. We now show that any policy $\mu_h \in \left[\underline{\mu}, \overline{\mu}\right] \ \forall h$ is a symmetric Nash equilibrium of the game.

The welfare function $W_h\left(\mu_h, \underline{F}\right)$ admits a global maximum in $\underline{\underline{\hat{\mu}}}$, and it is continuous, strictly decreasing and strictly concave in the interval $\left(\underline{\underline{\hat{\mu}}}, \hat{\mu}\right)$. The welfare function $W_h\left(\mu_h, \tilde{F}\right)$ admits a global maximum in $\hat{\mu}$, and it is continuous, strictly increasing and strictly concave in the same interval $\left(\underline{\underline{\hat{\mu}}}, \hat{\mu}\right)$. Since $W_h\left(\underline{\underline{\hat{\mu}}}, \underline{F}\right) = W_h\left(\hat{\mu}, \tilde{F}\right)$, and since $\underline{\underline{\hat{\mu}}} < \hat{\mu}$, then the two curves must cross once and only once in the interval $\left(\underline{\underline{\hat{\mu}}}, \hat{\mu}\right)$. Denote this intersection point by $\underline{\mu}$. Moreover, for exactly the same reasons, it must be that $W_h\left(\mu_h, \tilde{F}\right) \geq W_h\left(\mu_h, \underline{F}\right)$ for any $\mu_h \in \left[\underline{\mu}, \hat{\mu}\right]$. An entirely analogous reasoning holds for the other interval, $\left(\hat{\mu}, \overline{\overline{\hat{\mu}}}\right)$: there exists a unique value $\overline{\mu} \in \left(\hat{\mu}, \overline{\overline{\hat{\mu}}}\right)$, such that $W_h\left(\overline{\mu}, \tilde{F}\right) = W_h\left(\overline{\mu}, \overline{F}\right)$, and it must be that $W_h\left(\mu_h, \tilde{F}\right) \geq W_h\left(\mu_h, \overline{F}\right)$ for any $\mu_h \in \left[\hat{\mu}, \overline{\overline{\hat{\mu}}}\right]$.

Since $\underline{\mu} < \hat{\mu} < \overline{\mu}$, policy $\hat{\mu}$ is a Nash equilibrium of the game. Moreover, it is immediate to show that it is the globally optimal policy equilibrium: when all other countries $-h$ set up $\hat{\mu}$, then $\mu_h = \hat{\mu}$ is the policy which maximizes welfare function $W_h\left(\mu_h, \tilde{F}\right)$, as it allows country h to attract the optimal number of migrants $\hat{I}$. Moreover, since $W_h\left(\mu_h, \tilde{F}\right)$ is strictly increasing in μ_h in the interval $\left[\underline{\mu}, \hat{\mu}\right]$ and strictly decreasing in the interval $\left[\hat{\mu}, \overline{\mu}\right]$, it is also immediate to verify that the efficiency loss is greater, the higher the distance from the globally optimal policy. This proves that the equilibria are Pareto-ordered by the distance of μ^* from $\hat{\mu}$.

Notice that any $\mu_h < \underline{\mu}$ as well as any $\mu_h > \overline{\mu}$ $\forall h$ are not Nash equilibria. If all other countries set up policy μ_{-h} in the interval $\left(\underline{\underline{\hat{\mu}}}, \underline{\mu}\right)$, then $W_h\left(\mu_h, \underline{F}\right) \geq W_h\left(\mu_h, \tilde{F}\right)$, that is, country h's best response is to set up a slightly tighter policy, and so there are no equilibria below $\underline{\mu}$. If instead $\mu_{-h} < \underline{\underline{\hat{\mu}}}$, country h's best response is simply $\mu_{-h} = \underline{\underline{\hat{\mu}}}$. The same reasoning applies for $\mu_h > \overline{\mu}$.

Finally, a simple contradiction argument (drawn from Amir et al., 1996) proves that asymmetric equilibria do not exist in this policy game. Let $(\mu_1, \mu_2, \mu_3..., \mu_h, ..., \mu_m)$ be an asymmetric equilibrium (thus with at least two μ's being distinct). Assume then, w.l.o.g., that $\mu_1 = \max_h \{\mu_h\}$ and $\mu_2 = \min_h \{\mu_h\}$ so that $\mu_1 > \mu_2$. Since the game is symmetric, every permutation of $(\mu_1, \mu_2, \mu_3..., \mu_h, ..., \mu_m)$ is also an equilibrium. Consider for instance $(\mu_1, \mu_2, \mu_3..., \mu_h, ..., \mu_m)$ and $(\mu_2, \mu_1, \mu_3..., \mu_h, ..., \mu_m)$. The fact that both of them are equilibria implies that country 1 strictly weakens its immigration policy from μ_1 to μ_2 as the other countries restrict theirs from $(\mu_2, \mu_3..., \mu_h, ..., \mu_m)$ to $(\mu_1, \mu_3..., \mu_h, ..., \mu_m)$, which contradicts the fact that country 1's best-response is nondecreasing (see expression (7)).

E Proof of Proposition 2

The lower threshold $\underline{\mu}$ is by definition the immigration policy such that $W_h\left(\underline{\mu}, \tilde{F}\right) = W_h\left(\underline{\mu}, \underline{F}\right)$ $\forall h$, where, remind, $\tilde{F} \equiv F/m$ and $\underline{F} \equiv (1-\Psi)F/m$. Let us define

$$G\left(\underline{\mu}, \Psi\right) \equiv W_h\left(\underline{\mu}, \underline{F}\right) - W_h\left(\underline{\mu}, \tilde{F}\right) = 0$$

as the implicit function of $\underline{\mu}$ with respect to Ψ. It holds that

$$\frac{d\underline{\mu}}{d\Psi} = -\frac{\frac{dG}{d\Psi}}{\frac{dG}{d\underline{\mu}}}.$$

We show that $d\underline{\mu}/d\Psi < 0$.

The numerator writes as

$$\frac{dG}{d\Psi} = \frac{dG}{dI}\frac{dI}{d\Psi} = \frac{dW_h\left(\underline{\mu}, \underline{F}\right)}{dI}\frac{dI}{d\Psi} - \frac{dW_h\left(\underline{\mu}, \tilde{F}\right)}{d\Psi}.$$

The second term is null as $W_h\left(\underline{\mu}, \tilde{F}\right)$ does not depend on Ψ. The first term can be shown to be negative. First note that $dW_h\left(\underline{\mu}, \underline{F}\right)/dI > 0$ since in point $\underline{\mu}$ welfare increases when I increases (that is, when μ_h decreases). Second, it holds that

$$\frac{dI_h}{d\Psi} = -\frac{\frac{dg}{d\Psi}}{\frac{dg}{dI_h}},$$

where

$$g\left(I_h, \Psi\right) \equiv \left[(1-\alpha)\left(\frac{K_h}{N_h + I_h}\right)^{\alpha} + \gamma_h - \mu_h\right](1-\Psi)F/m - I_h = 0$$

is the implicit function for the number of migrants, I_h. Since it is

$$\frac{dg}{d\Psi} = -\left[(1-\alpha)\left(\frac{K_h}{N_h + I_h}\right)^{\alpha} + \gamma_h - \mu_h\right]F/m$$

and

$$\frac{dg}{dI_h} = -(1-\alpha)\,\alpha\left(\frac{K_h}{N_h + I_h}\right)^{\alpha}\frac{(1-\Psi)F/m}{L_h} - 1$$

then we obtain

$$\frac{dI_h}{d\Psi} = -\frac{F/m\left[(1-\alpha)\left(\frac{K_h}{N_h+I_h}\right)^{\alpha} + \gamma_h - \mu_h\right]}{(1-\alpha)\,\alpha\left(\frac{K_h}{N_h+I_h}\right)^{\alpha}\frac{(1-\Psi)F/m}{L_h} + 1} < 0$$

Then $dG/d\Psi < 0$.

As for the denominator, it is

$$\frac{dG}{d\mu_h}\left(\underline{\mu}\right) = \frac{dW_h\left(\underline{\mu}, \underline{F}\right)}{d\mu_h} - \frac{dW_h\left(\underline{\mu}, \tilde{F}\right)}{d\mu_h} < 0$$

as in point $\underline{\mu}$ it is $dW_h\left(\underline{\mu}, \underline{F}\right)/d\mu_h < 0$ and $dW_h\left(\underline{\mu}, \tilde{F}\right)/d\mu_h > 0$. This proves that

$$\frac{d\underline{\mu}}{d\Psi} = -\frac{\frac{dG}{d\Psi}}{\frac{dG}{d\mu_h}} < 0.$$

The proof that $d\overline{\mu}/d\Psi > 0$ is entirely analogous and is then omitted.

Finally, it is trivial to show that the globally optimal policy is not affected by an increase in international mobility. Notice that function $W_h\left(\mu_h, \tilde{F}\right)$ does not depend on Ψ, and thus $\hat{\mu}$, as a solution to equation $dW_h\left(\mu_h, \tilde{F}\right)/d\mu_h = 0$, will not depend on Ψ either.

F Proof of Proposition 3

The proof will follow closely the argument developed in Andersson et al. (2010) for the price competition game. Let $t \in R_+$ and suppose that the government of each country h holds a probabilistic belief about any other government j's policy of the following form:

$$\tilde{\mu}_{hj} = \mu_j + t\varepsilon_{hj}, \tag{F1}$$

for some statistically independent noise terms $\varepsilon_{hj} \sim \Phi_{hj}$. Distribution Φ_{hj} belongs to an arbitrary family Δ of cumulative distribution functions, $D : R \to [0,1]$, characterized by non-decreasing hazard rate function.[21]

Given that the support of random variable $\tilde{\mu}_{hj}$ is $\left[\mu^{od}, \mu^{cd}\right]$, this variable distributes according to the following cumulative distribution function (c.d.f.):

$$D^t_{hj}(x) = \frac{\Phi_{hj}\left(\frac{x-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}$$

The introduction of uncertainty defines a new, "perturbed", game. For any $t \in R_+$, a strategy profile $(\mu_1, \mu_2, \mu_3 ..., \mu_h, ..., \mu_m)$ is a *t-equilibrium* if, for each player h, the strategy μ_h maximizes h's expected payoff under the probabilistic belief of the form given in (F1). Notice that a $t-$ equilibrium is simply a Nash equilibrium of this perturbed game.

A strategy profile $\boldsymbol{\mu}^r$ is (strictly) *robust to strategic uncertainty* if, for any collection of c.d.f's $\Phi_{hj} \in \Delta$, there exists a sequence of $t-$ equilibria, $\langle \boldsymbol{\mu}^{t_k} \rangle_{k=1}^{\infty}$ with $t_k \to 0$, such that $\boldsymbol{\mu}^{t_k} \to \boldsymbol{\mu}^r$ as $k \to \infty$. We now apply these definitions to our policy game.

For any policy μ_h that the policy maker of country h decides to implement, her subjective probability that any other policy maker will choose exactly the same policy is zero. Hence, with probability one, her policy will either be the lowest or not. In the first case, country h will experience a "crowding in", in the second it will experience a "crowding out". Under strategic uncertainty, country h will then select that policy which maximizes the following

[21] Many common distributions, such as the normal or the exponential distribution, present this feature. This is the only assumption we impose on this arbitrary family of distribution functions, and it is useful to provide easily a sufficient condition for the uniqueness of the robust equilibrium.

expected payoff function:

$$\Pi_h^t(\boldsymbol{\mu}) = \prod_{j\neq h}\left[1-\frac{\Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}\right]\cdot W_h\left(\mu_h,\overline{F}\right)+ \left\{1-\prod_{j\neq h}\left[1-\frac{\Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu^{od}-\mu_j}{t}\right)}\right]\right\}\cdot W_h\left(\mu_h,\underline{F}\right). \tag{F2}$$

The expression above represents the expected payoff of country h when setting up policy μ_h. In particular, the first term is equal to the probability that μ_h is lower than any other policy μ_j $\forall j$ times the payoff associated to the resulting "crowding in". The second term is instead given by the probability that μ_h is higher than at least one μ_j times the payoff associated to the resulting "crowding out". The FOC for the maximization problem writes as

$$\frac{\partial\Pi_h^t(\boldsymbol{\mu})}{\partial\mu_h} = \prod_{j\neq h}\left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j}{t}\right)}\right]\times$$
$$\left[\left(\frac{\partial W_h\left(\mu_h,\overline{F}\right)}{\partial\mu_h}-\frac{\partial W_h\left(\mu_h,\underline{F}\right)}{\partial\mu_h}\right)-\frac{W_h\left(\mu_h,\overline{F}\right)-W_h\left(\mu_h,\underline{F}\right)}{t}\sum_{j\neq i}\frac{\phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right)-\Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}\right]+$$
$$\frac{\partial W_h\left(\mu_h,\underline{F}\right)}{\partial\mu_h}=0,$$

where $\phi_{hj}(\cdot)=\Phi'_{hj}(\cdot)$. It can be proven that the objective function (F2) is strictly concave along the interval $\left(\underline{\underline{\hat{\mu}}},\overline{\overline{\hat{\mu}}}\right)$ (to make the argument developed here less burdensome, this proof is provided separately in Subsection F1). Hence, every solution to the FOC above in that interval is a t-equilibrium.

Consider any sequence $\langle t_k\rangle_{k=1}^{\infty}\to 0$ and define $\lim_{k\to\infty}\mu_h^k\equiv\mu_h^*$ (for the Bolzano-Weierstrass theorem this limit exists and belongs to the interval $\left[\mu^{od},\mu^{cd}\right]$). We now investigate what happens to the solution to the FOC when t tends to zero. In particular, we prove that $\langle t_k\rangle_{k=1}^{\infty}\to 0$ implies $W_h\left(\mu_h^*,\overline{F}\right)=W_h\left(\mu_h^*,\underline{F}\right)$, whose solution is $\mu_h^*=\mu^r$ $\forall h$.

The FOC can be rearranged as follows:

$$t_k \left\{ \frac{\partial W_h\left(\mu_h^k, \underline{F}\right)}{\partial \mu_h^k} \prod_{j \neq h} \left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j^k}{t_k}\right) - \Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j^k}{t_k}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j^k}{t_k}\right) - \Phi_{hj}\left(\frac{\mu_h^k-\mu_j^k}{t_k}\right)} \right] + \left(\frac{\partial W_h\left(\mu_h^k, \overline{F}\right)}{\partial \mu_h^k} - \frac{\partial W_h\left(\mu_h^k, \underline{F}\right)}{\partial \mu_h^k} \right) \right\}$$

$$= \left[W_h\left(\mu_h^k, \overline{F}\right) - W_h\left(\mu_h^k, \underline{F}\right) \right] \sum_{j \neq i} \frac{\phi_{hj}\left(\frac{\mu_h^k-\mu_j^k}{t_k}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j^k}{t_k}\right) - \Phi_{hj}\left(\frac{\mu_h^k-\mu_j^k}{t_k}\right)}$$

Suppose by contradiction that, when t tends to zero, it is $W_h\left(\mu_h^*, \overline{F}\right) \neq W_h\left(\mu_h^*, \underline{F}\right)$. Then, in order for the FOC to be satisfied when $\langle t_k \rangle_{k=1}^{\infty} \to 0$, it must necessarily be that

$$\sum_{j \neq i} \phi_{hj}\left(\frac{\mu_h^k - \mu_j^k}{t_k}\right) \longrightarrow 0.$$

The expression above says that, in the limit, the sum of the instantaneous probabilities that any μ_j is equal to μ_h must tend to zero. This is true if $\mu_j^* \neq \mu_h^*$ $\forall j$. We now show that this is impossible.

The fact that $W_h\left(\mu_h^*, \overline{F}\right) \neq W_h\left(\mu_h^*, \underline{F}\right)$ implies that, for the generic government h, $W_h\left(\mu_h^*, \overline{F}\right)$ is either higher or lower than $W_h\left(\mu_h^*, \underline{F}\right)$. Suppose for instance it is higher (the reasoning under the opposite case in which $W_h\left(\mu_h^*, \overline{F}\right) < W_h\left(\mu_h^*, \underline{F}\right)$ is entirely analogous and is omitted). If that is the case then, in order for μ_h^* to be a best response, it must necessarily be that $\mu^r < \mu_h^* \leqslant \mu_j^*$ for any j. But since $\mu_j^* > \mu^r$, then also for country j it must be that $W_j\left(\mu_j^*, \overline{F}\right) > W_j\left(\mu_j^*, \underline{F}\right)$, and thus $\mu_j^* \leqslant \mu_h^*$ for any h. The two implications are true only when $\mu_h^* = \mu_j^*$, which contradicts the above statement. As a result, in order for the FOC to be true, it must necessarily be that $W_h\left(\mu_h^*, \overline{F}\right) = W_h\left(\mu_h^*, \underline{F}\right)$ whose solution is $\mu_h^* = \mu^r$ for any h. This completes the proof.

F.1 Concavity of the Objective Function

We here prove that a sufficient condition for function (F2) to be strictly concave along the interval $\left(\underline{\underline{\hat{\mu}}}, \overline{\overline{\hat{\mu}}}\right)$ is that distribution Φ_{hj} has non-decreasing hazard rate. The FOC can equivalently be written as

$$\frac{\partial \Pi_h^t(\boldsymbol{\mu})}{\partial \mu_h} = \frac{\partial W_h(\mu_h,\underline{F})}{\partial \mu_h} \cdot \left(1 - \prod_{j \neq h} \left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j}{t}\right)} \right]\right) +$$

$$\prod_{j \neq h} \left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j}{t}\right)} \right] \times$$

$$\left[\frac{\partial W_h\left(\mu_h,\overline{F}\right)}{\partial \mu_h} - \frac{W_h\left(\mu_h,\overline{F}\right) - W_h(\mu_h,\underline{F})}{t} \sum_{j \neq i} \frac{\phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)} \right] = 0.$$

It is now easy to show that function $\partial \Pi_h^t(\boldsymbol{\mu}) / \partial \mu_h$ is strictly decreasing in μ_h. Starting from the first addend, its derivative has the following expression and is negative:

$$\underset{-}{-\frac{\partial W_h(\mu_h,\underline{F})}{\partial \mu_h}} \cdot \underset{-}{D\left(\prod_{j \neq h} \left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j}{t}\right)} \right] \right)} +$$

$$\underset{+}{\left(1 - \prod_{j \neq h} \left[\frac{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{\Phi_{hj}\left(\frac{\mu^{cd}-\mu_j}{t}\right) - \Phi_{hj}\left(\frac{\mu_h^{od}-\mu_j}{t}\right)} \right] \right)} \cdot \underset{-}{\frac{\partial^2 W_h(\mu_h,\underline{F})}{\partial \mu_h^2}} < 0$$

where $D(\cdot)$ stands for "derivative with respect to μ_h". For practical reasons, the signs of the four terms are denoted under each of them. In particular, while the signs of the last three terms are self-apparent, the first term is negative whenever $\mu_h > \underline{\underline{\hat{\mu}}}$.

Turning to the second addend, the expression under the product operator is decreasing (as the cumulative distribution $\Phi_{hj}(\cdot)$ is an increasing function of μ_h). The derivative of $\partial W_h\left(\mu_h, \overline{F}\right) / \partial \mu_h$ with respect to μ_h is also strictly decreasing by assumption. The difference $W_h\left(\mu_h, \overline{F}\right) - W_h(\mu_h, \underline{F})$ is instead increasing in μ_h, at least for any $\mu_h < \overline{\overline{\hat{\mu}}}$. Finally, notice that the function under the sum operator is non-decreasing to the extent that the hazard rate, defined as

$$h\left(\frac{\mu_h - \mu_j}{t}\right) = \frac{\phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}{1 - \Phi_{hj}\left(\frac{\mu_h-\mu_j}{t}\right)}.$$

is assumed to be non-decreasing. Given that

$$\Phi_{hj}\left(\frac{\mu_h - \mu_j}{t}\right) \leq \Phi_{hj}\left(\frac{\mu^{cd} - \mu_j}{t}\right) \leq 1 \ \forall \mu_h$$

a decreasing hazard rate implies that the function under the sum operator is decreasing as well.

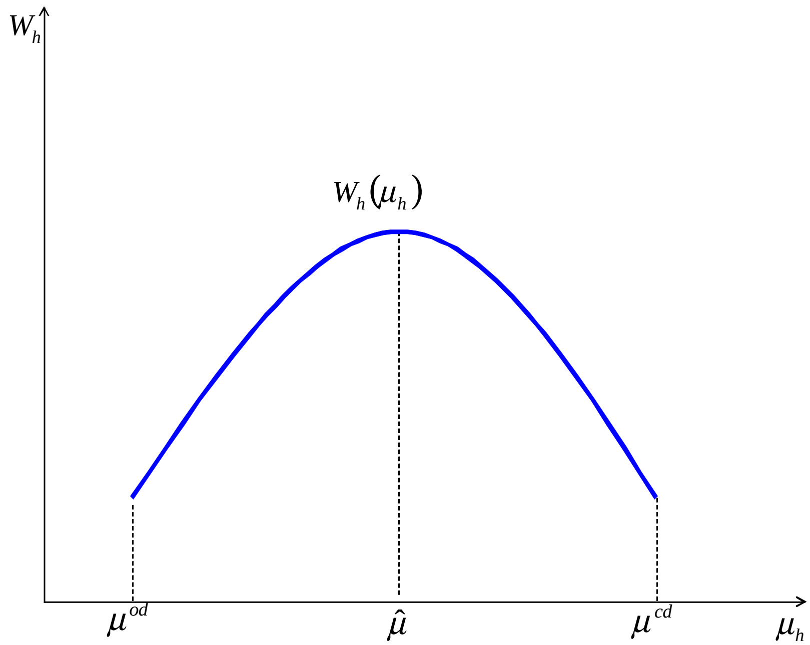

Figure 1: The welfare function of receiving country h in the benchmark two-country model.

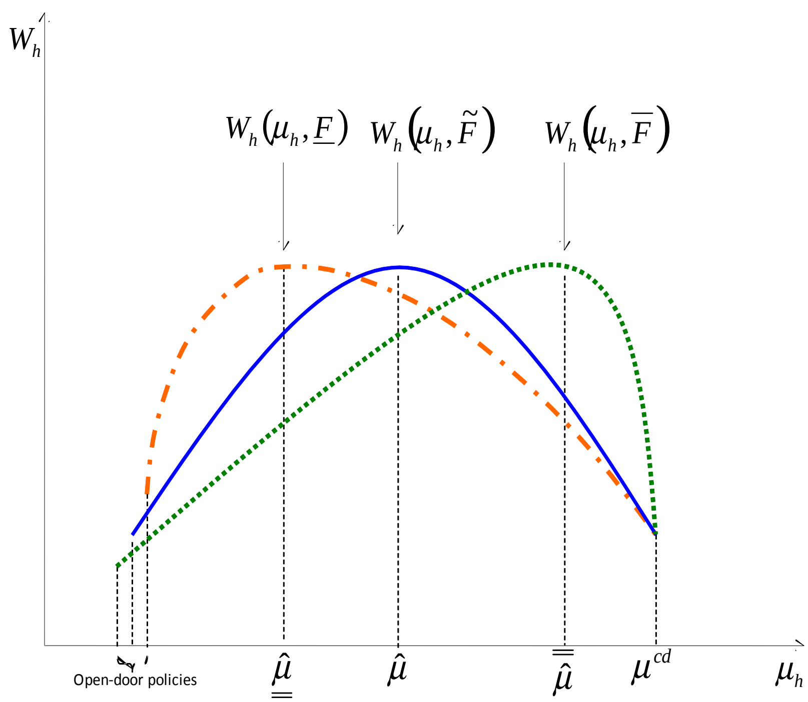

Figure 2: The payoff function of receiving country h depending on whether μ_h is higher, lower or equal to μ_{-h}.

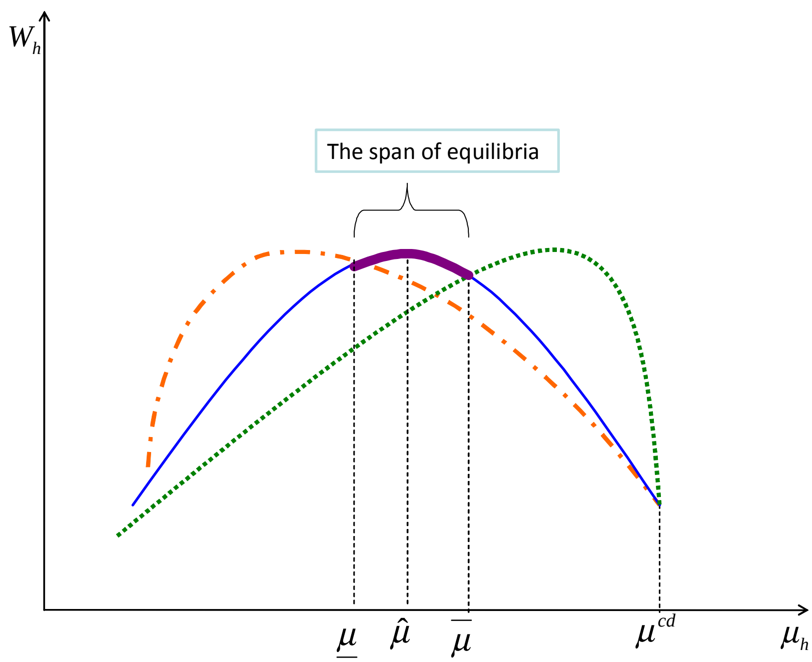

Figure 3: The policy equilibria of the game.

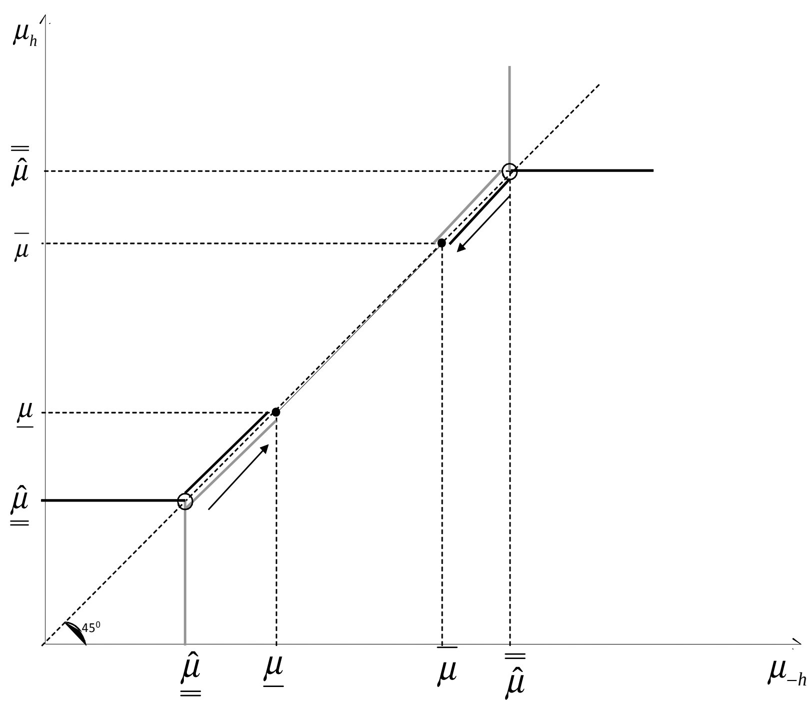

Figure 4: The best-response functions of country h (in black) and of country $-h$ (in grey).

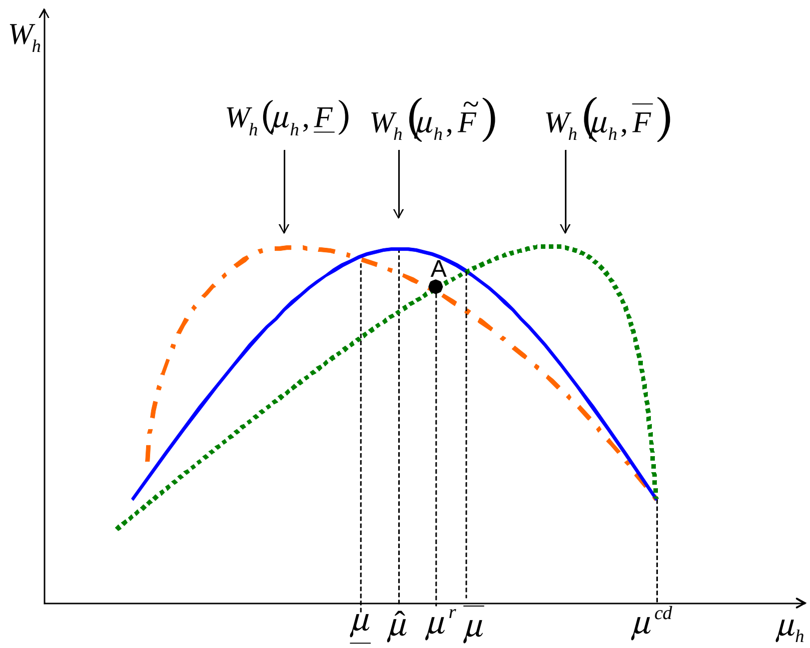

Figure 5: The equilibrium robust to strategic uncertainty in point A.