ECONOMIC RESEARCH
FEDERAL RESERVE BANK OF ST. LOUIS

WORKING PAPER SERIES

Unauthorized Immigration and Fiscal Competition

Authors	Subhayu Bandyopadhyay, and Santiago Pinto
Working Paper Number	2014-030C
Revision Date	August 2016
Citable Link	https://doi.org/10.20955/wp.2014.030
Suggested Citation	Bandyopadhyay, S., Pinto, S., 2016; Unauthorized Immigration and Fiscal Competition, Federal Reserve Bank of St. Louis Working Paper 2014-030. URL https://doi.org/10.20955/wp.2014.030

Published In	European Economic Review
Publisher Link	https://doi.org/10.1016/j.euroecorev.2016.12.010

Federal Reserve Bank of St. Louis, Research Division, P.O. Box 442, St. Louis, MO 63166

The views expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Federal Reserve System, the Board of Governors, or the regional Federal Reserve Banks. Federal Reserve Bank of St. Louis Working Papers are preliminary materials circulated to stimulate discussion and critical comment.

Unauthorized Immigration and Fiscal Competition*

Subhayu Bandyopadhyay†
and
Santiago M. Pinto‡

August 2, 2016

Abstract

Reflecting upon recent enforcement policy activism of US states and countries within the EU towards unauthorized workers, we examine the overlap of centralized (federal) and decentralized (state or regional) enforcement of immigration policies in a spatial context. Among other results, we find that if interstate mobility is costless, internal enforcement is overprovided, and border enforcement and local goods are underprovided when regions take more responsibility in deciding policies. This leads to higher levels of unauthorized immigration under decentralization. Interregional migration costs moderate such over/underprovision. Moreover, income distributive motives in the host country may shape the design of immigration policies in specific ways. The basic model is extended in several ways. First, we study how the policies change when regions can exclude unauthorized immigrants from the consuming of regionally provided goods or services. Second, we assume that the potential number of unauthorized immigrants is endogenous. And finally, we examine the effect of considering an alternative spatial configuration that includes border and "interior" regions.

JEL Classification: F22, H73, J15, J61, J68
Keywords: Unauthorized immigration; Vertical and horizontal externalities; Border and internal enforcement; Publicly provided local goods

*The views expressed are those of the authors and do not necessarily represent official positions of the Federal Reserve Bank of St. Louis, the Federal Reserve Bank of Richmond, or of the Federal Reserve System. The authors gratefully acknowledge the Associate Editor and two anonymous referees for their helpful comments and suggestions.
†Federal Reserve Bank of St. Louis, and IZA, Bonn; Subhayu.Bandyopadhyay@stls.frb.org. Corresponding author.
‡Federal Reserve Bank of Richmond; Santiago.Pinto@rich.frb.org.

1 Introduction

Enforcement of immigration policies has traditionally been the exclusive responsibility of federal and central governments. However, a few states in the US (Arizona, Alabama, and South Carolina, among others), have recently promoted state level initiatives against the employment of unauthorized immigrants. The decentralized implementation of such policies brings an intra-national spatial dimension to the discussion of unauthorized immigration that has not been previously explored in the literature. Similar situations are observed elsewhere, for instance, in the European Union (EU). Because of a commitment to free mobility of labor in the EU, once an unauthorized immigrant enters the EU through a bordering nation, the immigrant can move between EU member nations with relative freedom from border detection.[1] The economic drivers of such mobility and their consequent international spillovers share many similarities with state to state migration of unauthorized immigrants in the US. Just like US federal policies interact with state level policies, the common EU immigration policies overlap with policies in the national domain of EU members.[2] Reflecting these realities, we develop a model that allows us to evaluate and understand, in a spatial framework, the extent to which a shift towards a more decentralized implementation of immigration enforcement affects the effectiveness of these policies. While empirical studies on this subject are rapidly emerging, the development of a concise theoretical framework of analysis that can complement the empirics has not kept pace. The current work should serve as one of the first attempts (to our knowledge) to address this gap.

Specifically, the paper considers the case in which workers can migrate between a source and a host country, where the latter consists of two regions that share their borders with the source country.[3] There are, however, legal restrictions to the movement of labor across countries. Workers in the source country face the following decisions: (i) Move to the host country as an undocumented worker or stay in the source country; and (ii) Stay and work in the region of entry or move elsewhere in the host country considering that moving entails a cost. The host country enforces immigration laws by devoting resources to apprehend unauthorized immigrants at the border (preventing them from entering the country), and/or by choosing different levels of internal enforcement to determine whether firms employ unauthorized immigrant workers.

[1]See Orrenius and Zavodny (2016) for a discussion of unauthorized immigration into the EU, its border and internal enforcement efforts, and a comparison with the US system. The discussion clearly points to many parallels between the US and the EU, and while our analysis is not limited only to these two contexts, we provide a useful benchmark for thinking of immigration policies for these entities.

[2]The EU has been developing common immigration rules for its member nations since 1999, although their effective implementation varies from nation to nation. However, distinct from the US case, individual EU nations retain authority on several aspects of immigration policy, particularly related to immigration from non-EU nations. For example, each EU country decides: (1) The total number of migrants that can be admitted to the country to look for work; (2) All final decisions on migrant applications; (3) Rules on long-term visas (stays for periods longer than three months); and, (4) Conditions to obtain residence and work permits when no EU–wide rules have been adopted (see `http://ec.europa.eu/immigration/who-does-what/more-information/explaining-the-rules-why-are-there-eu-rules-and-national-rules_en`).

[3]Throughout the paper we use the general term "region", but the analysis applies to alternative jurisdiction levels, including states and countries.

Internal and border enforcement may, in principle, differ across regions (i.e., enforcement levels can be regionally targeted). Residents in each region also have access to locally provided goods and services, such as schools and hospitals. Unauthorized immigration in our model affects residents in the host country in conflicting ways. First, it reduces the return to domestic factors of production that are substitutes to unauthorized immigration (wages), and increases the return to those factors that are complements (rents on fixed factors or profits). Overall, even though income is higher in the host country, unauthorized immigration generates a redistributive effect. Second, a higher number of unauthorized immigrants increases the cost of providing the regional goods and increases deportation costs, leading to a rise in taxes paid by domestic residents.

Within this analytical framework, the paper examines how the provision of enforcement (both border and internal), and the levels of the publicly provided regional goods vary under alternative institutional arrangements that grant the central and regional governments different degrees of responsibility in implementing the policies. While a centralized choice of policies would internalize the impact that unauthorized immigration has in all regions within the host country, decentralized decisions could potentially encourage regional governments to behave strategically, initiating a process generally referred to as fiscal competition. In this context, the paper evaluates how interregional migration costs and redistributive considerations in the host affect the policy outcomes.[4] A proper analysis of these issues within a well-developed public economics model would shed light on the implications of decentralizing enforcement activities.

The main findings of the study can be summarized as follows. In the basic model, as the provision of enforcement is more decentralized, enforcement levels will tend to depart from the centralized solution due to the effect of several opposing externalities. To the extent that targeted regional border enforcement reduces the overall pool of unauthorized immigrants, it would generate a positive externality on the other region. Higher levels of targeted regional internal enforcement, on the other hand, would generate a negative externality by diverting unauthorized immigrants from one region to the other. Additionally, the decentralized provision of the regional good would also contribute to attract or deter unauthorized immigrants affecting other regions accordingly. Unambiguous conclusions can be derived under certain assumptions. For instance, when moving across regions within the host country is costless for unauthorized immigrants, border enforcement and regional goods tend to be underprovided in the decentralized case, while internal enforcement tends to be overprovided. Indeed, optimal internal enforcement is zero under centralization, but in spite of this fact, the equilibrium level of unauthorized immigration is lower under centralization compared to the decentralized case. As inter-regional mobility costs rise, internal enforcement efforts tend to decline while border enforcement tends to increase in the decentralized cases. In the extreme case of complete immobility, internal enforcement becomes completely irrelevant in all cases, and the levels of both border enforcement and the regional good could even be higher when decisions are completely decentralized compared to the fully

[4]In the paper, central and regional governments refer interchangeably to federal and sub-national (state) governments, respectively, or to supra-national and national governments, respectively. We also consider mixed cases in which each level of government is responsible for implementing specific policies.

centralized outcome.

We also examine the implications of changing some of the model's underlying assumptions not only to check the robustness of our conclusions, but also to characterize the policy outcomes arising in alternate realistic settings. We modify the assumptions in three different ways.[5] First, we assume that governments can restrict the access of unauthorized immigrants to certain regional goods and services, such as access to schools or health services. In particular, we assume that internal enforcement allows governments to identify unauthorized immigrants, and restrict their access to the provision of the regional goods. The main difference with respect to the basic model is that now internal enforcement becomes relatively more effective in the decentralized case because regional governments may increase the provision of regional goods without attracting more unauthorized immigrants. Consequently, utility of local residents is increased. Second, we assume that the supply of unauthorized immigrants is endogenous. Specifically, wages in the source country adjust in response to the amount of workers leaving the country. In this case, policies that in the basic model only induce a regional relocation of unauthorized immigrants, now also affect the total pool of effective immigrants, producing an externality that generally operates in the opposite direction. Third, we consider a model with both border and "interior" (i.e., states or countries that only share borders with other states or countries within the US or EU, respectively). By changing the spatial configuration of regions in the host country, this model, by design, treats regions asymmetrically. Even though regions may differ in several different dimensions, this particular variation is particularly relevant because it resembles situations observed in the US as well as in the EU. Enforcement policies decided and implemented by bordering states or countries (i.e., states or countries of entry from outside the US or the EU) clearly affect interior states/countries. The main conclusions from the basic model generally survive these enrichments, while providing characterization for alternate realistic scenarios.

The paper is organized in the following way. Section 2 reviews some of the related theoretical and empirical literature. Section 3 introduces the model, while Section 4 characterizes the behavior of unauthorized immigrants conditional on the levels of enforcement and regional good. Section 5 studies the determination of the relevant policy variables under alternative institutional arrangements and Section 6 compares the results. In Section 7 we perform a welfare evaluation of the policies and study how decisions change when unauthorized immigration has redistributive effects on local residents. We evaluate the policy implications of extending the basic model in several different directions in sections 8 through 10. Section 11 concludes.

[5]We consider a fourth variation in Appendix D. In that version, we assume the responsibility of deporting unauthorized immigrants falls entirely on the central government. While this is generally the case in the US, the allocation of responsibilities is somewhat different in the EU. Current EU policy (known as the "Dublin Regulation") is driven by the "first country of entry" principle. This principle states that the country in which a person first arrived is responsible for dealing with them.

2 Related literature

The paper contributes to several strands of the literature. First and foremost, it extends the traditional models of unauthorized immigration. The seminal contribution by Ethier (1986) provides an equilibrium migration framework within a Harris–Todaro type framework, where the host nation controls unauthorized immigration using border and internal enforcement to achieve either maximum national income, or to restrict immigration to some socially desirable target level. Bond and Chen (1987) highlight the role of internal enforcement in raising national income through an exercise of monopsonistic power in the international labor market. Put simply, as higher internal enforcement reduces demand for unauthorized immigrants in the host's labor market, the illegal wage drops, conferring a terms-of-trade gain in the factor market for the host nation. Djajić (1987) considers the problem from the source country perspective, and examines the resource allocation effects of unauthorized immigration on the host nation. Bandyopadhyay and Bandyopadhyay (1998) consider the effects of trade liberalization in a source nation on unauthorized immigration outflows to a neighboring host nation. If liberalization of some import competing sectors releases unskilled labor that cannot be absorbed by expanding sectors in the source nation, then unauthorized immigration flows may rise along with international trade. Essentially, in their model, trade and unauthorized immigration flows can be complements. This literature continues to progress to address evolving policy issues. For instance, Gaytan-Fregoso and Lahiri (2000) consider how foreign aid from the host nation may impact the household migration decision in the source nation. Woodland and Yoshida (2006) highlight a potential migrant's risk preference in the immigration decision, and Djajić and Michael (2014), reflecting the realities of both the US and EU, present an analysis where a migrant may move through a transit nation to get from her/his source nation to a richer host nation.

Our paper incorporates some features of the literature on unauthorized immigration, such as its focus on border and internal enforcement policies. However, we depart in several significant and novel ways: we consider a more granular spatial structure, the immigrants' localization decisions are based on a random utility model (RUM), and regional policy variables are endogenously determined by the central and/or regional governments depending on the institutional arrangement prevailing in the host country. Such decentralization of policies may induce governments to behave strategically, leading to a wide range of outcomes not considered in the previous literature.

Second, the conceptual framework within which we model the interaction between states' policies and federal policies is similar to strands of the fiscal federalism and tax competition literature in public economics. From Wilson (1986) and Wildasin (1986), among others, we know that when capital is mobile between regions, tax rates on capital and provision of local public goods may be inefficiently low. Brueckner (2003), Wilson and Wildasin (2004), and Agrawal et al. (2015), discuss several important recent contributions in this area which build on the initial insights of the tax competition literature. The relation of our work to this literature is in the characterization of inefficiencies in enforcement given the different inter-state externalities. On the other hand, the horizontal interactions between states and vertical linkages resulting from the implementation of immigration policies by federal and state governments add a separate dimension to our analysis. This is more closely linked to the literature on decentralized income redistribution, such as Pauly (1973), Brown and Oates (1987), Brueckner (2000), and Pena (2014). These papers claim that decentralized redistributive polices (including welfare programs) would induce an inefficient relocation of lower income households across states. This process could lead to an underprovision of welfare benefits relative to the centralized solution. A similar result arises in our paper, explained by the fact that unauthorized immigrants are assumed to be attracted by higher levels of locally provided goods, but they do not pay for the cost of providing such goods. Besley and Coate (2003), Brueckner (2004), and Gordon and Cullen (2012) also examine the tradeoffs between centralization and decentralization, and describe conditions that determine which arrangement may dominate in specific circumstances.[6] Even though our focus is quite different, we also attempt to qualitatively examine the policies implemented under various institutional arrangements that grant state and federal governments different degrees of responsibilities.

Finally, there is a substantial empirical literature that focuses on various aspects of unauthorized immigration that are related to our work. For instance, Hanson and Spilimbergo (1999), and Orrenius and Zavodny (2005), among others, find that flows of unauthorized immigrants are quite sensitive to returns to migration.[7] Pena (2014), using data from the National Agricultural Workers Survey, finds no evidence that states' provision of more generous welfare benefits attracts greater unauthorized immigration. Bohn and Pugatch (2015) investigate the relationship between border enforcement and the location decisions of Mexican immigrants in the US.

The relatively recent state level policy activism regarding unauthorized immigration in the US has spurred several empirical studies addressing the effects of the state level policies on labor market outcomes. Most of these studies have looked at the effects of state level implementation of specific programs that would be categorized as "internal" enforcement policies. The E-verify program is an example.[8] Except for certain categories of employers like federal government contractors, participation in this program is voluntary, so states can decide whether they will implement this program. Amuedo-Dorantes and Bansak (2012) analyze the impact of state level use of E-verify mandates and find that such mandates may be especially costly to the extent that they induce a reallocation of unauthorized workers from industries that are affected most by these regulations to others which may enjoy some exclusions (such as agriculture and food services). Bohn et al. (2014) investigate the effects of Arizona's 2007 Legal Arizona Workers Act

[6]Besley and Coate (2003) develops a political economy model, based on a citizen-candidate model of political representation, to compare the relative performance of centralized and decentralized regimes. Heterogenous preferences for a locally provided good and a financing mechanism that shares the burden across residents from different regions generate a conflict of interests and drive their results.

[7]Hanson (2006) provides a thorough review of the earlier empirical literature on unauthorized immigration.

[8]The U.S. Citizenship and Immigration Services agency describes the program as: "... an Internet–based system that compares information from an employee's Form I–9, Employment Eligibility Verification, to U.S. Department of Homeland Security and Social Security Administration records to confirm employment eligibility. See `http://www.uscis.gov/e-verify/what-e-verify` for more details.

(LAWA) which mandates use of E-verify by all Arizona employers for all employees hired after January 1, 2008. A major finding is that they observe a significant reduction in the proportion of the Hispanic non-citizen population of Arizona, but do not find similar declines for Hispanic naturalized citizens. Amuedo-Dorantes et al. (2013) use survey data based on interviews of voluntary returnees or deportees to Mexico, and find that measures such as E-verify curb internal mobility of unauthorized immigrants and also curb deportees' intentions to return to the US. Orrenius and Zavodny (2015) investigate the effects of such implementation on the labor market outcomes of Mexican immigrants who are likely to be unauthorized. Among other findings, they observe that state use of E-verify reduces hourly earnings by about 8 percent for male Mexican immigrants who are likely to be unauthorized. Interestingly, these mandates do not seem to affect the labor market outcomes of non-Hispanic whites, although they improve the outcomes for male immigrants from Mexico who have become naturalized US citizens. Our analytical framework complements this literature by highlighting the role of both federal and state level enforcement policies as well as state level public good provision policies in affecting immigration flows. In addition, we provide a characterization of optimal determination of these policies keeping in mind their effects on economic efficiency at both state and national levels.

3 The model

Consider two countries: a source and a host (or destination) of unauthorized immigration. Both countries employ labor and an immobile region specific production factor to produce a homogeneous good. The host country consists of two regions (jurisdictions or states): A and B. The regions share their borders with the source country. Legal restrictions prevent a free movement of labor from the source to the host country. The host country controls unauthorized immigration using two policy instruments: (i) it can devote resources to prevent unauthorized immigrants from entering the country at the border (border enforcement); and/or (ii) it can allocate resources to enforce immigration laws internally (internal enforcement). The latter consists basically of inspecting domestic firms and determining whether they employ unauthorized workers. If firms are caught employing unauthorized immigrants, they are subject to penalties and workers are deported.[9]

Internal and external enforcement may differ across regions. The probability of detecting an unauthorized immigrant at the border is $q^i(c^i)$, where c^i is expenditure on enforcement at the border between region i of the host country and the source country. It is assumed that $q(0) = 0$, $q^{i\prime}(c^i) > 0, q^{i\prime\prime}(c^i) < 0$, and $0 \leq q^i(c^i) \leq 1$ for all $c^i \geq 0$. A firm operating in region i is detected hiring unauthorized workers with probability $p^i(e^i)$, where e^i denotes internal enforcement expenditures in region i. Additionally, $p^i(0) = 0$, $p^{i\prime}(e^i) > 0, p^{i\prime\prime}(e^i) < 0$, and $0 \leq p^i(e^i) \leq 1$ for all $e^i \geq 0$. If a firm is caught hiring unauthorized workers, it has to pay a penalty of z^i per unauthorized worker.[10]

[9] Appendix A, attached separately, includes a graphical representation of the model.

[10] For simplicity, the probabilities $q^i(\cdot)$ and $p^i(\cdot)$ only depend on border and internal law enforcement expenditures.

After observing the levels of border and internal enforcement, workers from the source country decide to enter the host as unauthorized immigrants through region A or region B, or stay in the source country. Once they enter the host, they choose where (in which region of the host) to reside and work. Unauthorized immigrants face, however, a cost of moving across regions in the host country. Firms operating in each region of the host decide, at the same time, the number of unauthorized workers to hire. The functions $f^i(n^i), i = A, B$, describe the production technology in the host country, where n^i the total number of workers, both authorized and unauthorized, in region i of the host country, with $f^{i\prime}(\cdot) > 0$, and $f^{i\prime\prime}(\cdot) \leq 0$.

Legal residents/workers. There are $\bar{n}^i$ immobile legal residents in region i, who also own the local fixed factor. Individuals derive utility from the consumption of private goods, and from a publicly provided regional good g^i. The consumption of private goods is equal to disposable income y^i_L. Legal residents in i are paid a wage as legal workers $w^i_L(n^i) = f^{i\prime}(n^i)$, receive rents from the ownership of the fixed factor, and pay taxes. Total rents, given by $\pi^i = f^i(n^i) - f^{i\prime}(n^i)n^i$, are equally divided among legal residents, so each legal resident receives $\pi^i/\bar{n}^i$. Legal residents pay lump-sum taxes to finance expenditures in law enforcement and the cost of providing the regional public goods. In the model, g^i is assumed to be a publicly provided private good, such as health services, or maybe education. We assume that the cost of providing the good rises with the number of users. Alternatively, we could have assumed that g^i is subject to congestion, so as the number of users increase, the quality and the utility derived from the consumption of this good declines. Specifically, the utility of a legal resident of region i is $u^i_L = y^i_L + \phi(g^i)$, with $\phi' > 0, \phi'' < 0$, and $\phi(0) = 0$.

Unauthorized residents/workers. M^i workers attempt to enter the host country unlawfully through region i. Each worker faces a cost from such action that depends positively on the number of unauthorized immigrants attempting to cross through border i. We denote this cost by $\mu^i(M^i)$, with $\mu^{i\prime}(M^i) > 0, \mu''^i(M^i) \geq 0$.[11] A proportion q^iM^i are caught at the border, which means that only $\hat{M}^i = (1 - q^i)M^i$ enter the host through region i. The total number of unauthorized workers in the host country is $\hat{M} = \hat{M}^A + \hat{M}^B = (1 - q^A)M^A + (1 - q^B)M^B$.

An unauthorized worker that succeeds in migrating into region i may stay in region i or move and work in region j. Moving to the other region entails an explicit moving cost represented by τ. The number of unauthorized workers in region i is $m^i = m^{ii} + m^{ji}$, where m^{ii} is the number of unauthorized workers that enter the country through region i and stay there, and m^{ji} the number of those that enter through region j and decide to move and work in region i.

The residential localization decision is formalized through a random utility model. Consider the decision of an unauthorized immigrant that enters the host through region i. If he stays

In a more general setting, $q^i(\cdot)$ may also depend on the number of unauthorized migrants crossing the border, and $p^i(\cdot)$ on the number of unauthorized workers employed by the firms. Additionally, we assume that $\lim_{e^i \to 0} p^{i\prime}(e^i) = P^i$ and $\lim_{c^i \to 0} q^{i\prime}(c^i) = Q^i$, where P^i and Q^i are large enough numbers, and $\lim_{e^i \to \infty} p^{i\prime}(e^i)$ and $\lim_{c^i \to \infty} q^{i\prime}(c^i)$ approach 0.

[11] This cost may be justified as follows. Imagine that unauthorized immigrants enter through a single entry point in region i. As more unauthorized immigrants attempt entry through i, the cost for an individual unauthorized immigrant would also increase.

in i, he obtains a utility $\tilde{u}^{ii} = u^i + \varepsilon^i$. The first term is a deterministic component described by $u^i = y^i + \phi(g^i)$. We assume unauthorized workers do not pay taxes and do not receive rents from the fixed factor, so disposable income is simply the wage received as an unauthorized worker, i.e., $y^i = w^i$. An unauthorized immigrant also receives utility from the regionally provided public good g^i, captured by $\phi(g^i)$. The term ε^i is a random component. Note that ε^i varies by individual, but we suppress the subscripts to simplify notation. This variable may also be thought to capture the unauthorized immigrant's perception about local attitudes towards immigration. Since moving to j is costly, the utility of that same unauthorized worker when he moves from i to j is $\tilde{u}^{ij} = u^j - \tau + \varepsilon^j$, where $u^j = y^j + \phi(g^j)$. We assume that $(\varepsilon^i, \varepsilon^j)$ are independent (across individuals and regions) Gumbel-distributed random variables.[12]

We consider two alternative scenarios concerning the number of potential unauthorized immigrants. In the first case, the pool of workers in the source country willing to migrate to the host country is assumed fixed in supply, i.e., $\bar{M} = M^A + M^B$. We assume that a worker that is caught at the border and sent back to the source country will earn an exogenously given wage w^*. In the second case, the pool of potential migrants is endogenously determined. We assume the total number of workers in the source country is $\bar{n}^*$. A worker that participates in the source country's labor market (either because the worker never attempted to migrate or because the worker was stopped at the border and sent back to the source country) is paid the wage at the source country $w^*(n^*) = f^{*\prime}(n^*)$. The wage depends on the number of effective workers in the source country $n^* = \bar{n}^* - \hat{M}$, with $w^{*\prime}(n^*) \leq 0$. In both cases, the level of the publicly provided good at the source country is fixed and normalized to 0, so the utility of a worker residing in the source country that decides not to move is simply $u^* = w^*$ in the first case, and $u^* = w^*(n^*)$, in the second case.

Firms. We assume that the firm operating in region i can distinguish between legal and unauthorized workers (complete discernment case).[13] A firm in region i is detected hiring unauthorized workers with probability $p^i(e^i)$. If the firm is caught, it pays a penalty of z^i per unauthorized worker.[14] In equilibrium, since legal and unauthorized residents are perfect substitutes in production and firms can discriminate between legal and unauthorized workers, $w^i_L = f^{i\prime}(\bar{n}^i + m^i)$, and $w^i = w^i_L - p^i(e^i)z^i$.

Governments. Legal residents pay lump-sum taxes to governments (central or regional governments, depending on the specific institutional arrangement). These taxes are used to finance three types of expenses: the cost of internal enforcement T^i_e, the cost of border enforcement T^i_c, and the cost of providing the publicly provided local good T^i_g. Specifically, $T^i_e = \sigma^i e^i + (v^i - z^i)p^i m^i$,

[12]For convenience, we assume the Gumbel distributions have identical location and scale parameters. In particular, the location parameter is equal to 0 and the scale parameter equal to 1. These assumptions do not affect our subsequent analysis in any substantial way.

[13]In the no discernment case, domestic firms cannot discriminate between legal and unauthorized workers. In this model, a domestic firm in region i hires an unauthorized immigrant with probability $m^i/(m^i + \bar{n}^i)$.

[14]The firm maximizes $\pi^i = f^i(\bar{n}^i + m^i) - w^i_L \bar{n}^i - w^i m^i - p^i z^i m^i$ with respect to $\{\bar{n}^i, m^i\}$. The FOCs are, respectively, $f^{i\prime}(\bar{n}^i + m^i) - w^i_L = 0$, and $f^{i\prime}(\bar{n}^i + m^i) - w^i - p^i z^i = 0$. This means that $w^i = w^i_L - p^i z^i = f^{i\prime}(\bar{n}^i + m^i) - p^i z^i$.

$T_c^i = \theta^i c^i$, $T_g^i = (\bar{n}^i + m^i)\delta^i g^i$, and $T^i = T_e^i + T_c^i + T_g^i$. The cost of internal enforcement T_e^i is the sum of direct enforcement costs, $\sigma^i e^i$, and a cost that depends on the number of immigrants found working without authorization in region i, $p^i m^i v^i$, net of the penalties paid by firms that hire unauthorized immigrants $p^i m^i z^i$. In general, we think of v^i as the cost of deporting an unauthorized immigrant, so $p^i m^i v^i$ represents total deportation costs.[15] The marginal costs σ^i and v^i, and the penalty per unauthorized worker z^i are assumed positive and constant throughout the analysis. The cost of border enforcement T_c^i is assumed to increase linearly with c^i, where $\theta^i > 0$ is the constant marginal cost. Finally, the marginal cost of g^i is given by $\delta^i > 0$. Note, additionally, that T_g^i increases with number of users of that good, which includes both local residents and unauthorized immigrants.

Governments are engaged in what is called a game of fiscal competition. In this type of games, policy choices in one region have implications in other regions. Moreover, when deciding their respective policies, governments take the policies chosen by other governments as given.

Timing of decisions. We solve the following sequential game by backward induction which ensures sub-game perfectness:

1. Government(s) in the host country decides (decide) the levels of border c^i, e^i, and g^i. When more than one government decide the policy variables, they do so simultaneously.

2. (i) Unauthorized immigrants decide to enter the county through region A or region B. An unauthorized immigrant entering the country through region i is stopped at the border and returned to the source country with probability q^i;

   (ii) Unauthorized immigrants that successfully entered through region i stay and work in i or move and work in region j, with $i \neq j = A, B$. A firm in region i is detected hiring unauthorized immigrants with probability p^i and pays a penalty z^i per unauthorized worker employed; and

   (iii) Regional labor markets clear.

4 Unauthorized workers: Entry and residential choice

In this section, we examine the choices made by prospective unauthorized workers: migrate to the host or stay in the source country; enter the host country through region A or B; and, finally, decide whether to stay in the region of entry or move to the other region.

[15] To simplify the comparison between the institutional arrangements considered later in the paper, we assume that in those cases in which regional governments choose border enforcement, they are also responsible for deporting unauthorized immigrants and collecting the fines on firms detected hiring unauthorized immigrants. In the US, the federal government is responsible for conducting the deporting process. We examine in Appendix D how the conclusions change if regional governments choose e^i, but the expenses associated with deportation are shared across the entire domestic population.

4.1 Residential choice

Consider the decision of an unauthorized immigrant that has already successfully entered the host country through region i. A proportion of the $\hat{M}^i = M^i(1-q^i)$ unauthorized immigrants stays in i, and the rest moves to j. The probability an unauthorized immigrant stays in i is $\lambda^{ii} = Pr(\tilde{u}^{ii} = \max\{\tilde{u}^{ii}, \tilde{u}^{ij}\})$, and the probability he moves to j is $\lambda^{ij} = Pr(\tilde{u}^{ij} = \max\{\tilde{u}^{ii}, \tilde{u}^{ij}\})$. Then, $m^{ii} = \lambda^{ii}\hat{M}^i$, and $m^{ij} = \lambda^{ij}\hat{M}^i$. As a result, the total number of unauthorized immigrants in each region becomes

$$m^A = m^{AA} + m^{BA} = \lambda^{AA}\hat{M}^A + \lambda^{BA}\hat{M}^B, \tag{1}$$

$$m^B = m^{BB} + m^{AB} = \lambda^{BB}\hat{M}^B + \lambda^{AB}\hat{M}^A. \tag{2}$$

Given that the ε's are identically and independently distributed and follow an extreme value distribution, then

$$\lambda^{AA} = \frac{\exp(u^A)}{\exp(u^A) + \exp(u^B - \tau)}, \quad \lambda^{BB} = \frac{\exp(u^B)}{\exp(u^A - \tau) + \exp(u^B)},$$

with $\lambda^{AB} = 1 - \lambda^{AA}$, and $\lambda^{BA} = 1 - \lambda^{BB}$.

4.2 Entry decision

Suppose initially the pool of unauthorized immigrants attempting to enter the host country is fixed and equal to $\bar{M}$, such that $\bar{M} = M^A + M^B$, where M^i is the number of unauthorized immigrants that attempt entry through region i. Prior to the residential choice, an unauthorized immigrant decides whether to enter the host country through region A or region B. This decision is made as before taking wages as given.[16] The expected utility of an unauthorized immigrant that already entered the host country through region i is denoted u_E^i and is defined as

$$u_E^A = \mathbb{E}\left[\max\{\tilde{u}^{AA}, \tilde{u}^{AB}\}\right] = \log\left[\exp(u^A) + \exp(u^B - \tau)\right] + \gamma, \tag{3}$$

$$u_E^B = \mathbb{E}\left[\max\{\tilde{u}^{BA}, \tilde{u}^{BB}\}\right] = \log\left[\exp(u^A - \tau) + \exp(u^B)\right] + \gamma, \tag{4}$$

where γ is the Euler-Mascheroni constant. Using this notation, we define the (expected) utility of an unauthorized immigrant deciding to enter through i as $U_E^i = q^i(w^* - k) + (1-q^i)u_E^i - \mu^i(M^i)$, where w^* is assumed constant. If $U_E^A = \max\{U_E^A, U_E^B, w^*\}$, unauthorized immigrants will enter through region A, and if $U_E^B = \max\{U_E^A, U_E^B, w^*\}$, they will all enter through B. Our focus is on equilibria in which unauthorized immigrants enter through both regions. In other words, in equilibrium we should observe $U_E^A = U_E^B \geq w^*$, or $q^A(w^* - k) + (1-q^A)u_E^A - \mu^A(M^A) = q^B(w^* - k) + (1-q^B)u_E^B - \mu^B(M^B) \geq w^*$.

[16] This choice could have also be formalized using a RUM. The conclusions from the analysis do not change, though.

4.3 Equilibrium

The entry and residential decisions are made individually by potential unauthorized immigrants from the source country assuming they do not have an effect on other potential unauthorized immigrants' choices and taking the outcome of the regional labor markets as given. At the end, labor markets should clear. The labor demand in region i, $\ell^i(w_L^i)$, is implicitly defined by $w_L^i = f^{i\prime}(\ell^i)$. Thus, in equilibrium, $\ell^i(w_L^i) = \bar{n}^i + m^i$. Unauthorized immigrants in region i are paid $w^i = w_L^i - p^i(e^i)z^i$. In sum, the equilibrium is defined as follows.

Definition: (Fixed supply of immigrants). When the number of migrants from the source country is fixed at $\bar{M}$, the equilibrium values $\{w^A, w^B, M^A, M^B\}$ are implicitly determined by:

$$w_L^i = f^{i\prime}(n^i + m^i), i = A, B, \quad U_E^A = U_E^B \geq w^*, \text{ and } \bar{M} = M^A + M^B,$$

where m^A and m^B are defined in (1) and (2), respectively. The equations determine $\{w^i, M^i\}$ for $i = A, B$, as a function of $\{c^A, c^B, e^A, e^B, g^A, g^B, \bar{M}, \tau\}$. By substituting the solutions $\{w^i, M^i\}$ into (1) and (2), we obtain m^i.

To derive further results, the rest of the analysis assumes that regions are completely identical. We will therefore focus on symmetric equilibria in which $e^i = e$, $c^i = c$, $g^i = g$, $i = A, B$.[17] Under these conditions, the symmetric equilibrium is given by $\{M^i, w^i, m^i\} = \{M, w, m\}$, where $M = \bar{M}/2$, $w = f'(\bar{n} + m)$, $\hat{M} = \bar{M}(1-q)$, and $m = [(1-q(c)]\bar{M}/2$. We characterize the previously defined equilibrium by performing a comparative static analysis with respect to $\{c^i, e^i, g^i, \tau\}$. The results, which are evaluated at a symmetric equilibrium, are summarized in the following proposition.[18]

Proposition 1. *The following comparative static results hold at a symmetric equilibrium for $\tau \in [0, \infty)$:*

(i) $\partial M^i/\partial e^i = -\partial M^j/\partial e^i \leq 0$ *(with equality when $\tau = 0$);* $\partial m^i/\partial e^i = -\partial m^j/\partial e^i < 0$; $\partial w^i/\partial e^i = -\partial w^j/\partial e^i > 0$; *and* $\partial \hat{M}/\partial e^i = 0$;

(ii) $\partial M^i/\partial g^i = -\partial M^j/\partial g^i \geq 0$ *(with equality when $\tau = 0$);* $\partial m^i/\partial g^i = -\partial m^j/\partial g^i > 0$, $\partial w^i/\partial g^i = -\partial w^j/\partial g^i < 0$; *and* $\partial \hat{M}/\partial g^i = 0$;

(iii) $\partial M^i/\partial c^i = -\partial M^j/\partial c^i \gtrless 0$ *(with $<$ when $\tau = 0$);* $\partial m^i/\partial c^i < 0$, $\partial m^j/\partial c^i \gtrless 0$; $\partial m^i/\partial c^i + \partial m^j/\partial c^i = -q'M$ *(with $\partial m^i/\partial c^i = \partial m^j/\partial c^i$ when $\tau = 0$);* $\partial w^i/\partial c^i > 0, \partial w^j/\partial c^i \gtrless 0$ *(with $\partial w^i/\partial c^i = \partial w^j/\partial c^i$ when $\tau = 0$); and* $\partial \hat{M}/\partial c^i < 0$;

(iv) $\partial w_L^i/\partial \tau = \partial m^i/\partial \tau = \partial M^i/\partial \tau = 0$. *If $\bar{M}$ is large enough, then* $\partial^2 m^i/\partial e^i \partial \tau \geq 0$ *(with equality at $\tau = 0$);* $\partial^2 m^i/\partial c^i \partial \tau < 0$; *and* $\partial^2 m^i/\partial g^i \partial \tau \leq 0$ *(with equality at $\tau = 0$);*[19]

(v) $\partial^2 m^i/\partial e^i \partial c^i > 0$; $\partial^2 m^i/\partial g^i \partial c^i < 0$; *and* $\partial^2 m^i/\partial e^i \partial g^i = 0$.

[17] To denote identical variables we suppress indexes identifying the regions.

[18] The derivations are shown in Appendix B.

[19] Appendix B shows that the results hold when $\mu'\bar{M}/2 > (1-q)$. In particular, the condition is satisfied when $\bar{M}$ is sufficiently large, or c sufficiently large. Throughout the analysis, we assume the previous condition is satisfied.

A few remarks are worth emphasizing from these results. First, (i) states that an increase in e^i has no effect on the number of unauthorized immigrants attempting entry through i, M^i, when $\tau = 0$, and simply diverts the entry of unauthorized immigrants from region i to region j when $\tau > 0$ (i.e., M^i decreases and M^j increases in exactly the same amount as e^i rises). At the same time, a higher level of e^i reduces the number of unauthorized immigrants working in i, m^i. Wages in each region adjust accordingly in response to m^i. Specifically, consider the effect of increasing e^i. Suppose, initially, that $\tau = 0$. Then, a higher level of e^i does not affect the entry decisions. However, since the firm discerns between legal and unauthorized residents, an increase in the (expected) cost of hiring an unauthorized immigrant translates into a lower wage for unauthorized immigrants. Thus, the immediate effect of a higher level of e^i is to reduce w^i. As unauthorized immigrants now find it less attractive to work in i and start moving to j, w_L^i will tend to rise. Now suppose that $\tau > 0$. In this case, it is less desirable to enter through i than through j because unauthorized immigrants anticipate they will later move to j, which is costly. Hence, M^i declines when e^i increases and $\tau > 0$. A smaller (relative) supply of unauthorized immigrants in i makes w_L^i higher. Note, however, that compared to the perfect mobility case, the changes in w_L^i and m^i are smaller because both less unauthorized immigrants enter through i and some of those that enter through i end up moving to the other region. The corresponding effects on region j are exactly the opposite. Concerning the effect of g^i on $\{w_L^i, M^i, m^i\}, i = A, B$, stated in (ii), note that lowering g^i has the same effect on these variables as increasing e^i, so a similar reasoning can be used in this case. In other words, the effects e^i and g^i are qualitatively similar. Given that we assume, for the moment, that the pool of potential migrants is fixed at $\bar{M}$, neither e^i nor g^i affect the total number of effective unauthorized immigrants $\hat{M}$ in the host.

Second, as stated in (iii), a change in c^i, in addition to diverting unauthorized immigrants from region i to j, also reduces the overall pool of (effective) unauthorized immigrants, $\hat{M}$. Only the latter effect is present at a symmetric equilibrium when $\tau = 0$, so wages in both regions unambiguously increase with higher levels of c^i. When $\tau > 0$, an increase in c^i reduces the overall number of (effective) unauthorized immigrants and the supply of unauthorized immigrants in region i, rising wages in the region. The impact on region j is, however, ambiguous. Even though the number of unauthorized immigrants is smaller, some of those previously entering through i would now enter through j, so the supply would tend to rise in j due to this effect. To the extent that the latter effect dominates the former, w^j could even end up declining as c^i rises.

Third, the first part (iv) states that at a symmetric equilibrium, the values of $\{w_L^i, M^i, m^i\}, i = A, B$, are independent of τ, but as explained in the previous two paragraphs, the effect of a change in $\{c^i, e^i, g^i\}$ on $\{w_L^i, M^i, m^i\}, i = A, B$, does not directly depend on τ. The second part of (iv) compares the effectiveness of the policies in reducing unauthorized immigration as mobility costs rise. In first place, note that $\partial m^i / \partial c^i$ becomes in absolute value larger, and $\partial m^i / \partial e^i$ becomes in absolute value smaller as τ increases. In other words, when mobility costs increase, border enforcement becomes more effective than internal enforcement at reducing m^i. In second place, (iv) states that the impact of g^i on m^i gets smaller as mobility costs get larger. This means that the same increase in the level of public goods in region i attracts less unauthorized immigrants to i when τ is large than when τ is small.

A similar result appears in the traditional tax competition literature. In these models, when mobility costs tend to infinity, regional governments can perfectly tailor the level of local goods to satisfy the preferences of immobile local residents, without attracting residents from other regions. In other words, under complete immobility, changing the level of local goods in one region does not affect other regions, so the centralized and decentralized solutions coincide. Mobility in our framework, however, involves not only moving across regions within the host nation, but also across international borders. As a result, unauthorized immigrants are able to respond to differential levels of g^i by entering the host country through different regions. Proposition 1 states that $\partial m^i/\partial g^i = -\partial m^j/\partial g^i > 0$ holds even when $\tau \to \infty$, while in the traditional tax competition model this derivative would be zero.

Fourth, from (iii) we know that $\partial m^j/\partial c^i = -\partial m^i/\partial c^i - q'M$, and from (iv) we know that $|\partial m^i/\partial c^i|$ gets larger as τ increases. Thus, combining (iii) and (iv), we may infer that $\partial m^j/\partial c^i$ could become positive for sufficiently large values of τ. Note that $\partial m^j/\partial c^i$ captures the magnitude of the external effect on region j generated by raising c^i. This conclusion is relevant because the sign of the external effect determines to a large extent whether there is under- or overprovision of c^i in the decentralized case compared to the centralized solution.[20]

Finally, (v) compares the effectiveness of each policy in terms of reducing unauthorized immigration when other policies change. For instance, a higher level of c^i (e^i) reduces the impact of e^i (c^i) on m^i. In other words, increasing one type of enforcement reduces the effectiveness of the other type of enforcement. Similarly, $\partial m^i/\partial g^i$ decreases as c^i increases. This means that higher levels of g^i will not attract that many unauthorized immigrants to region i when c^i gets larger. However, changes in e^i does not affect $\partial m^i/\partial g^i$.

5 Choosing internal and border enforcement

We now examine the problem faced by the host country governments, regional and federal, in choosing the level of border and internal enforcement levels under different institutional arrangements. Specifically, we consider four alternative scenarios and compare the outcomes reached in each case. In the first scenario, the central government chooses all policy variables: internal enforcement, border enforcement, and the levels of locally provided goods (fully centralized case). In the second scenario, the regional governments choose all the policy variables in a decentralized way (fully decentralized case). The last two scenarios consider mixed cases. In the first mixed case (mixed case X_1), the central government chooses the level of border enforcement and regional governments choose internal enforcement and the level of local goods. In the second mixed case (mixed case X_2), the central government chooses border and internal enforcement, and regional

[20] Appendix B illustrates with a numerical example how $\partial m^A/\partial c^A$ and $\partial m^B/\partial c^A$ change as τ increases. Specifically, it shows that when τ increases from zero to infinity, $\partial m^B/\partial c^A$ changes sign from negative to positive. All numerical examples shown in the paper are based on the specifications and parameter values described in Appendix H.

governments only choose the level of local goods.

In what follows, we assume that governments only care about the well-being of legal residents with the following caveat: while the regional governments are only concerned about the well-being of legal residents in their respective regions, the central government takes into account the well-being of all legal residents, regardless of where they reside.

5.1 Fully centralized solution (C)

In this case, the central government chooses the levels of $\{e^i, g^i, c^i : i = A, B\}$, that maximize the total utility of all domestic legal residents $U_L = U_L^A + U_L^B = \bar{n}^A u_L^A + \bar{n}^B u_L^B$, where $u_L^i = w_L^i + \pi^i/\bar{n}^i - (T^A + T^B)/(\bar{n}^A + \bar{n}^B) + \phi(g^i)$. As explained earlier, the income of a legal resident in region i is given by the legal wage w_L^i, and the share $1/\bar{n}^i$ of the returns to the fixed factor π^i. A legal resident pays (lump-sum) taxes only to the central government. Taxes cover total expenses in both regions. Substituting into the objective function, the central government's problem can be rewritten as

$$\begin{aligned}\max_{\{e^i,c^i,g^i\}_{i=A,B}} \quad U_L &= f^A(\bar{n}^A + m^A) - f'^A(\bar{n}^A + m^A)m^A + \bar{n}^A\phi(g^A) - T^A \\ &\quad + f^B(\bar{n}^B + m^B) - f'^B(\bar{n}^B + m^B)m^B + \bar{n}^B\phi(g^B) - T^B.\end{aligned} \tag{5}$$

The Kuhn-Tucker conditions for $i \neq j = 1, 2$, are characterized by

$$\frac{\partial U_L}{\partial e^i} = \frac{\partial U_L^i}{\partial e^i} + \frac{\partial U_L^j}{\partial e^i} = -\Delta^i \frac{\partial m^i}{\partial e^i} - \Delta^j \frac{\partial m^j}{\partial e^i} - \left[\sigma^i + (v^i - z^i)p'^i m^i\right] \leq 0, \tag{6}$$

$$\frac{\partial U_L}{\partial c^i} = \frac{\partial U_L^i}{\partial c^i} + \frac{\partial U_L^j}{\partial c^i} = -\Delta^i \frac{\partial m^i}{\partial c^i} - \Delta^j \frac{\partial m^j}{\partial c^i} - \theta^i \leq 0, \tag{7}$$

$$\frac{\partial U_L}{\partial g^i} = \frac{\partial U_L^i}{\partial e^i} + \frac{\partial U_L^j}{\partial e^i} = -\Delta^i \frac{\partial m^i}{\partial g^i} - \Delta^j \frac{\partial m^j}{\partial g^i} + \left[\bar{n}^i\phi' - (\bar{n}^i + m^i)\delta^i\right] \leq 0, \tag{8}$$

and the corresponding non-negativity constraints $e^i \geq 0, c^i \geq 0, g^i \geq 0$, where

$$\Delta^i = [f^{i\prime\prime}m^i + (v^i - z^i)p^i + \delta^i g^i], \quad \Delta^j = [f^{j\prime\prime}m^j + (v^j - z^j)p^j + \delta^j g^j]. \tag{9}$$

The terms Δ^i and Δ^j play a crucial role in the analysis. These expressions capture the effect on local residents of a change in the number of unauthorized immigrants in region i and j due to a change in the policy variable $\{e^i, c^i, g^i\}$. Consider a policy change in i that reduces the presence of unauthorized immigrants in region i. Local residents are affected in three ways. First, since m^i declines, deporting costs decrease, so legal residents pay lower taxes. The decline in costs, and consequently taxes, is equal to $(v^i - z^i)p(e^i) \geq 0$. Second, since a smaller number of unauthorized residents benefit from the locally provided good, the cost of financing its provision falls in $\delta^i g^i$. And third, total income received by local residents decline in the amount $(-f^{i\prime\prime}m^i)$. Similar effects take place in region j when changes in the policy variables e^i, c^i, and g^i affect m^j. The other terms in the FOCs capture the direct effects of the policy variables on legal residents in i. The system of equations (6) - (8) determine the centralized solution denoted by $\{e_C^i, c_C^i, g_C^i : i = A, B\}$.

5.2 Fully decentralized solution (D)

Suppose that $\{e^i, c^i, g^i\}$, $i = A, B$, are determined in a decentralized way. Each region maximizes the total utility of local legal residents $U_L^i = \bar{n}^i u_L^i$ and faces the cost of providing interior and border enforcement at its own border, and the cost of publicly providing the regional good. The problem for the regional government in i is

$$\max_{\{e^i, c^i, g^i\}} U_L^i \quad = \quad f^i(\bar{n}^i + m^i) - f^{i\prime}(\bar{n}^i + m^i)m^i + \bar{n}^i \phi(g^i) - T^i, \tag{10}$$

taking $\{e^j, g^j, c^j\}$ as given. The Kuhn-Tucker conditions are given by

$$\frac{\partial U_L^i}{\partial e^i} = -\Delta^i \frac{\partial m^i}{\partial e^i} - \left[\sigma^i + (v^i - z^i)p'^i m^i\right] \leq 0, \tag{11}$$

$$\frac{\partial U_L^i}{\partial c^i} = -\Delta^i \frac{\partial m^i}{\partial c^i} - \theta^i \leq 0, \tag{12}$$

$$\frac{\partial U_L^i}{\partial g^i} = -\Delta^i \frac{\partial m^i}{\partial g^i} - \left[(\bar{n}^i + m^i)\delta^i - \bar{n}^i \phi'\right] \leq 0, \tag{13}$$

in addition to the non-negativity constraints. The solution is denoted $\{e_D^i, c_D^i, g_D^i : i = A, B\}$.

5.3 Mixed case 1 (X_1): Decentralized provision of local goods and internal enforcement and centralized border enforcement

Consider a mixed case in which $\{c^i : i = A, B\}$ is determined by the central government authority, and $\{e^i, g^i : i = 1, 2\}$ by the respective regional governments in a decentralized way. We consider this case because the allocation of responsibilities across governments closely describes the current situation observed in the US. The policy variables are all chosen simultaneously. The utility of a legal resident of region i is

$$u_L^i = w_L^i + \pi^i/\bar{n}^i + \phi(g^i) - T_e^i/\bar{n}^i - T_c/(\bar{n}^A + \bar{n}^B) - T_g^i/\bar{n}^i.$$

In this case, the cost of internal enforcement in i, T_e^i, is borne by residents in i, while the total cost of border enforcement, $T_c = T_c^A + T_c^B$ is equally shared across the entire legal resident population $\bar{n}^A + \bar{n}^B$. As a result, each legal resident of the host country pays $T_c \ / \ (\bar{n}^A + \bar{n}^B)$ to the central government. The government in region i maximizes $U_L^i = \bar{n}^i u_L^i$ with respect to $\{e^i, g^i\}$, or

$$\max_{\{e^i, g^i\}} U_L^i = f^i(\bar{n}^i + m^i) - f^{i\prime}(\bar{n}^i + m^i)m^i + \bar{n}^i \phi(g^i) - \ T_e^i - [\bar{n}^i/(\bar{n}^A + \bar{n}^B)]T_c - T_g^i,$$

taking $\{e^j, g^j, c^A, c^B\}$ as given. In fact, the Kuhn-Tucker conditions from this problem are identical to (11) and (13).

Now, consider the central government's problem. As before, the central government's objective function is $U = U_L^A + U_L^B$. When choosing $\{c^A, c^B\}$, the central government takes $\{e^A, e^B, g^A, g^B\}$ as given. The expressions resulting in this case are exactly the same as those described by (7). The Nash Equilibrium, denoted $\{e_{X_1}^i, c_{X_1}^i, g_{X_1}^i : i = A, B\}$, is the solution of the system of equations (7), (11), and (13).

5.4 Mixed case 2 (X_2): Decentralized provision of local goods and centralized internal and border enforcement

Finally, consider a different mixed case in which $\{e^i, c^i : i = A, B\}$ are determined by the central government authority, and $\{g^i : i = 1, 2\}$ by the regional governments. The utility of a legal resident of region i is the same as before except for the financing of the government expenditures. Specifically,

$$u_L^i = w_L^i + \pi^i/\bar{n}^i + \phi(g^i) - (T_e + T_c)/(\bar{n}^A + \bar{n}^B) - T_g^i/\bar{n}^i.$$

In this case, total enforcement $T_e + T_c = (T_e^A + T_e^B) + (T_c^A + T_c^B)$ is equally shared among the entire legal resident population. The government in region i simply maximizes $U_L^i = \bar{n}^i u_L^i$ with respect to g^i, or

$$\max_{\{g^i\}} U_L^i = f^i(\bar{n}^i + m^i) - f^{i\prime}(\bar{n}^i + m^i)m^i + \bar{n}^i\phi(g^i) - [\bar{n}^i/(\bar{n}^A + \bar{n}^B)](T_e + T_c) - T_g^i, \tag{14}$$

taking $\{g^j, e^A, e^B, c^A, c^B\}$ as given. The Kuhn-Tucker conditions are

$$\frac{\partial U_L^i}{\partial g^i} \quad = \quad -\Delta^i \frac{\partial m^i}{\partial g^i} + \left[\bar{n}^i\phi' - (\bar{n}^i + m^i)\delta^i\right] + \Gamma_g^i \leq 0, \tag{15}$$

where

$$\Gamma_g^i \quad = \quad \frac{\bar{n}^j}{\bar{n}^A + \bar{n}^B}(v^i - z^i)p^i\frac{\partial m^i}{\partial g^i} - \frac{\bar{n}^i}{\bar{n}^A + \bar{n}^B}(v^j - z^j)p^j\frac{\partial m^j}{\partial g^i}. \tag{16}$$

The central government's problem consists of maximizing $U = U_L^A + U_L^B$, by choosing $\{e^A, e^B, c^A, c^B\}$, taking $\{g^A, g^B\}$ as given. The expressions resulting from the central government's first-order conditions are exactly the same as those described by (6) and (7). The Nash Equilibrium in this case, denoted $\{e_{X_2}^i, c_{X_2}^i, g_{X_2}^i : i = A, B\}$, is the solution of the system of equations (6), (7), and (15).

6 Comparing the solutions

We now compare the policies chosen in the four scenarios presented earlier, and examine how the solutions change for different levels of interregional mobility cost, τ. In this section, we focus on the case in which the supply of migrants from the source country is fixed at $\bar{M}$. Consider, in first place, the fully centralized and decentralized solutions. In general, evaluating the centralized FOCs at the decentralized solution gives

$$\left.\frac{\partial U_L}{\partial x^i}\right|_C = \frac{\partial U_L^j}{\partial x^i} = -\Delta^j \frac{\partial m^j}{\partial x^i}, \tag{17}$$

where $x^i = \{e^i, c^i, g^i\}$, since $\partial U_L^i/\partial x^i = 0$. Expression (17) reveals that the centralized and decentralized solutions do not necessarily coincide. Specifically, these expressions describe the external effects imposed by region i on region j, not internalized by the authorities in i when they decide the policy variables in a decentralized way.

As mentioned earlier, our analysis focuses on symmetric equilibria at which $e^i = e$, $c^i = c$, $g^i = g$, $i = A, B$. The equilibrium in the second stage is, consequently, given by $\{M^i, w^i, m^i\} = \{M, w, m\}$, where $M = \bar{M}/2$, $w = f'(\bar{n} + m)$, $\hat{M} = \bar{M}(1-q)$, and $m^i = m = [(1-q(c)]\bar{M}/2$.

Consider the fully centralized case. At a symmetric solution, $\partial m^i/\partial e^i = -\partial m^j/\partial e^i$. As a result, $\partial U_L/\partial e^i = -[\sigma + (v-z)p'(e)m] < 0$, which means that $e_C = 0$. Additionally, by substituting $\partial m^i/\partial c^i + \partial m^j/\partial c^i = -q'(c)M$ into (7) and using $\partial m^i/\partial g^i = -\partial m^j/\partial g^i$ in (8), we obtain that c_C and g_C are jointly determined by

$$[f''m + \delta g]q'(c)M - \theta = 0, \tag{18}$$

$$\phi'(g) - \frac{(\bar{n}+m)}{\bar{n}}\delta = 0. \tag{19}$$

A similar reasoning can be applied to conclude that in mixed case X_2, the levels of internal enforcement chosen by the central government are zero as well, i.e. $e_C = e_{X_2} = 0$. The reasoning is straightforward. A central authority responsible for choosing e^i internalizes the impact of e^i on region j. Given that a higher e^i does not have a real impact on the number of effective unauthorized immigrants in the country and purely displaces unauthorized immigrants from i to j, and, moreover, given that it is costly to raise e^i, then the central authority chooses $e^i = 0$. In other words, internal enforcement is completely wasteful in cases C and X_2.

However, the latter does not necessarily hold in the completely decentralized case nor in mixed case X_1. Consider the expression $\partial U_L^i/\partial e^i$ in these two cases:

$$\frac{\partial U_L^i}{\partial e^i} = -\Delta\frac{\partial m^i}{\partial e^i} - \left[\sigma + (v-z)p'(e)m\right], \quad e > 0, \tag{20}$$

with $\Delta = [f''m + (v-z)p(e) + \delta g]$. An interior solution for internal enforcement may be observed in cases D and X_1 whenever $\partial U_L^i/\partial e^i = 0$ at $e > 0$. The levels of internal enforcement in cases D and X_1 do not generally coincide, though. Note that the first term in (20) captures the effect of a change in the number of unauthorized immigrants on the utility of local residents due to an increase in e. Since $(\partial m^i/\partial e^i) < 0$, the first term would be positive if the expression between squared brackets is positive. The latter holds when as a result of a smaller presence of unauthorized immigrants in the region, deporting costs and the cost of providing the local good decrease more than the decline in total regional income. The second expression in brackets represents the increase in the direct costs of a raising e and is positive. This expression consists of two parts. The first term is the cost of providing an additional unit of e, denoted with σ. The second term is the increase in deporting costs. A higher level of e increases the probability of detecting an unauthorized immigrant by $p'(e)$, so $p'(e)m$ additional unauthorized immigrants would be deported. Since the net cost of sending an unauthorized immigrant back to the source country is $(v-z) \geq 0$, a higher e would increase costs in $(v-z)p'(e)m$. Under certain parameter conditions, there exists a value of $e > 0$ at which the two expressions are equal, so that $\partial U_L^i/\partial e^i = 0$.[21] For the purpose of our analysis, we assume that the condition $\Delta > 0$ is satisfied. Similarly, from (12) and given that $\partial m^i/\partial c^i < 0$, it is clear that for c to be strictly positive, this same condition should hold in

[21] Appendix C discusses necessary conditions for an interior solution of e in the decentralized case.

equilibrium. The following proposition summarizes the previous results.

Proposition 2. *At a symmetric equilibrium, the solutions in the centralized and mixed X_2 cases entail no interior enforcement of immigration policies, i.e., $e_C = e_{X_2} = 0$. In the decentralized and mixed X_1 cases internal enforcement may be zero or positive, i.e, $e_D \geq 0$, $e_{X_1} \geq 0$.*

The proposition states that when internal enforcement is decided in a decentralized way (cases D and X_1), internal enforcement is never lower than the level chosen when e is centrally chosen (cases C or X_2). In fact, when condition (20) is met, e will be overprovided.

This result departs from some of the conclusions found in previous literature. For instance, in a model in which the host country consists of one single region, Ethier (1986) concludes that to lower the cost of the immigration policy, both border and internal enforcement should be used. The main reason that explains the difference in the results is that unauthorized immigrants in our model are also mobile within the host country, so they can partially "escape" the effect of local internal enforcement by moving across regions. As a result, internal enforcement becomes relatively less effective.[22]

When comparing the solutions among the four institutional arrangements considered here for different mobility costs τ, it should be emphasized that the values of c and g in the centralized case (given by (18) and (19)) do not depend on τ. However, the latter does not hold when at least one of the policies is decided in a decentralized way.

6.1 Perfect mobility across regions: $\tau = 0$

Suppose, initially, that once unauthorized immigrants successfully enter the host country, they can freely move across regions, or $\tau = 0$. Evaluating the FOCs of the centralized case for c^i and g^i at the symmetric decentralized solution $\{e_D, c_D, g_D\}$ (shown in expression (17)), and since from proposition 1, $\partial m^j/\partial x^i = \partial m^j/\partial x^i < 0$, $x^i = g^i, c^i$, when $\tau = 0$, then $\partial U_L/\partial c^i > 0$ and $\partial U_L/\partial g^i > 0$. This means that starting at this point, the central authority should increase both c^i and g^i. Since in the symmetric case $\partial^2 U_L/\partial c^i \partial g^i > 0$, then the curves $\partial U_L/\partial c^i$ and $\partial U_L/\partial g^i$ shift to the right as g^i and c^i increase.[23] As a result, both c^i and g^i end up being unambiguously higher in the centralized case.[24] Moreover, as mentioned earlier, internal enforcement in the decentralized case will never be underprovided: it will be either overprovided or provided at the same level as in the centralized case. Hence, we conclude that $e_D \geq e_C$, $c_C > c_D$, and $g_C > g_D$. Using a similar reasoning, we can compare the solutions of the centralized and mixed X_2 cases and conclude that $e_C = e_{X_2}$, $c_C > c_{X_2}$, and $g_C > g_{X_2}$.[25]

[22]Our model presents other differences with the model in Ethier (1986). For instance, our model relies on lump-sum taxes to finance the policies, while Ethier (1986) uses income taxes.

[23]This result is shown in Appendix C.

[24]In addition to $(\partial^2 U_L/\partial c^i \partial c^i) < 0$ and $(\partial^2 U_L/\partial g^i \partial g^i) < 0$, the SOCs require that the direct effects are stronger than the indirect effects, i.e., $(\partial^2 U_L/\partial c^i \partial c^i)(\partial^2 U_L/\partial g^i \partial g^i) - (\partial^2 U_L/\partial c^i \partial g^i)^2 > 0$. Alternatively, consider expressions (18) and (19) that determine c and g in the centralized case. A higher level of c implies a lower $m = (\bar{M}/2)[1 - q(c)]$. A lower m, in turn, decreases the marginal cost of g (from (19)), resulting in a higher level of g.

[25]Appendix C shows the details of the reasoning behind this result.

It is straightforward to compare the solutions of cases X_1 and X_2 when $v = z$. Substituting the solutions $\{e_{X_1}, c_{X_1}, g_{X_1}\}$ into the FOCs of case X_2 gives

$$\left.\frac{\partial U_L}{\partial c^i}\right|_{X_2} = -(v-z)p\,q'M, \quad \left.\frac{\partial U_L^i}{\partial g^i}\right|_{X_2} = (v-z)p\frac{\partial m^i}{\partial g^i}. \tag{21}$$

Hence, if $v = z$, the solutions in both cases are exactly the same, i.e., $c_{X_1} = c_{X_2}$ and $g_{X_2} = g_{X_2}$. The only difference between the two cases is that while internal enforcement could be positive in case X_1, it is always zero in case X_2, i.e., $e_{X_1} \geq e_{X_2} = 0$.

Next, we compare the solutions of the centralized and X_1 cases. Substituting $\{e_{X_1}, c_{X_1}, g_{X_1}\}$ into the FOCs of the centralized case gives

$$\left.\frac{\partial U_L}{\partial c^i}\right|_{C} = -(v-z)p\,q'M, \quad \left.\frac{\partial U_L}{\partial g^i}\right|_{C} = \frac{[f''m + (v-z)p + \delta g](1-q)M\phi}{2[1-(1-q)Mf'']} > 0, \tag{22}$$

where $m = (1-q)(\bar{M}/2)$ and $M = \bar{M}/2$. To derive unambiguous results, assume as before that $v = z$. In this case, starting from the mixed X_1 case solution, the central authority should initially increase g^i and keep c^i unchanged. However, as g^i changes, curve (18) shifts. Specifically, since $\partial^2 U_L/\partial c^i \partial g^i > 0$, as g^i increases, the curve $\partial U_L/\partial c^i$ shifts to the right. The latter eventually shifts the curve that determines g^i to the right as well (given by (19)), and so on. The SOC guarantees that this process stops at values of c^i and g^i that are higher in the centralized case relative to the mixed case.

Combining these results and given that at a symmetric equilibrium with free mobility across regions $\partial \hat{M}/\partial e^i = 0, \partial \hat{M}/\partial c^i < 0, \partial \hat{M}/\partial g^i = 0$, it follows that the total number of unauthorized immigrants successfully entering the host country $\hat{M}$, and, consequently, the number of immigrants working in each region m, are unambiguously lower when c^i and g^i are chosen by the central government.

Proposition 3. *Consider a symmetric equilibrium with perfect mobility, i.e., $\tau = 0$. Then, the following results hold:*

(i) Both c and g are underprovided in the completely decentralized case relative to the completely centralized case, i.e., $c_C > c_D, g_C > g_D$.

(ii) Suppose $v = z$. Then, the levels of c and g in cases X_1 and X_2 are identical, i.e., $c_{X_1} = c_{X_2}$ and $g_{X_1} = g_{X_2}$.

(iii) Both c and g in mixed case X_2 are underprovided relative to the completely centralized case, i.e., $c_C > c_{X_2}$ and $g_C > g_{X_2}$. Moreover, if $v = z$, then the latter also holds for mixed case X_1, in which case $c_C > c_{X_2} = c_{X_1}$ and $g_C > g_{X_2} = g_{X_1}$.

(iv) The decentralized level of internal enforcement is greater than or equal to the corresponding centralized level, i.e., $e_D \geq e_C = 0$. The level of internal enforcement in case X_1 is never underprovided relative to the case X_2 and the completely centralized case. In other words, $e_{X_1} \geq e_{X_2} = e_C = 0$.

(v) The effective number of unauthorized immigrants in the host, and, consequently, the total number of unauthorized immigrants in each region, are lower in the completely centralized case relative

to the completely decentralized case, i.e., $\hat{M}_C < \hat{M}_D$ *and* $m_C < m_D$*. Similarly,* $\hat{M}_C < \hat{M}_{X_2}$ *and* $m_C < m_{X_2}$*. Moreover, if* $v = z$*,* $\hat{M}_C < \hat{M}_{X_2} = \hat{M}_{X_1}$ *and* $m_C < m_{X_2} = m_{X_1}$*.*

In brief, the proposition states that under perfect mobility, the decentralization of policy decisions, which include the enforcement of immigration laws and the provision of local goods, would lead to outcomes characterized by the presence of more unauthorized immigrants than in the centralized case. The central government limits unauthorized immigration by relying exclusively on border enforcement. Internal enforcement, in the model, is wasteful since it only displaces unauthorized immigrants from one region to the other. At the same time, since the central government is more successful at limiting the entry of unauthorized immigrants, it is also capable of providing higher levels of local goods to legal residents.

Our conclusions depart from those found in the traditional fiscal competition literature in an important way. In the fiscal competition, mobile factors of production are generally fixed in supply, and regional policies simply attract or displace factors from one region to the other. In our model, while internal enforcement and the provision of local goods simply encourage unauthorized immigrants to relocate, border enforcement can actually affect the total supply of unauthorized immigrants. Moreover, even though both internal and border enforcement are both ex-ante available as policy tools, the central government only selects the latter.

By constructing a numerical example, we can rank the solutions of all the policy variables under the alternative regimes considered above. Figures (1a), (1b), and (1c) show the solution values of e, g, and c in each case for different values of τ. We focus in this section on the solutions at $\tau = 0$. The exercise reveals the following ordering: $e_D > e_{X_2} > e_{X_1} = e_C = 0$, $g_C > g_{X_1} = g_{X_2} > g_D$, and $c_C > c_{X_1} = c_{X_2} > c_D$. In brief, the analysis shows that when unauthorized immigrants are perfectly mobile, those institutional arrangements that involve some kind of decentralized decision tend to underprovide border enforcement and the provision of local goods relative to the centralized case. It is also true that these kind of arrangements tend to rely too much on internal enforcement. Figures (1d) and (1e) show the impact of these policies on the level of unauthorized immigration and local wages. Notice that the largest amount of unauthorized immigration is observed in the decentralized case and the smallest in the centralized case. As a consequence, local wages end up being substantially lower in the decentralized case relative to the other solutions.

6.2 Imperfect mobility across regions: $\tau > 0$

The conclusions may change when unauthorized immigrants are imperfectly mobile once they successfully enter the host nation. We examine, in this section, the case with $\tau > 0$. We mentioned earlier that the centralized solutions are independent of τ. However, since the partial derivatives $\partial m^i / \partial e^i$, $\partial m^i / \partial c^i$, and $\partial m^i / \partial g^i$ depend on τ, the decentralized solutions will change as τ changes.

Consider the completely decentralized case. Proposition 1 states that $|\partial^2 m^i / \partial e^i|$ and $\partial m^i / \partial g^i$ decline when τ gets larger. These expressions state that as mobility costs rise the policy variables e^i and g^i become less effective at inducing unauthorized immigrants to relocate because unauthorized immigrants will tend to move less once they enter the host country. For e^i, the latter effect combined with the fact that it is costly for the regions to enforce internal measures to detect unauthorized immigrants result in equilibrium levels of e^i that tend to decline as τ rises. Eventually, e^i may even become zero for a sufficiently large value of τ. The opposite effect would be observed for g^i. With perfect mobility, the decentralized equilibrium is characterized by relatively low levels of g^i, mostly because regional governments do not want to attract unauthorized immigrants into their regions (recall that unauthorized immigrants consume the regionally provided good but they do not pay for it). When mobility costs rise, regions would be able to choose higher levels of g^i given that such decisions would not attract as many unauthorized immigrants into the respective regions (compared to the perfect mobility case).

Proposition 1 also states that $|\partial m^i/\partial c^i| > 0$ when τ increases, meaning that c^i in fact becomes more effective in controlling unauthorized immigration when mobility costs rise. Taking this effect into account, it is likely to expect higher levels of c^i as τ increases. In fact, considering that the centralized solutions do not depend on τ, border enforcement in the decentralized case could even be larger than the value of c^i centrally decided for high enough levels of τ. This would happen for values of τ at which the impact of c^i on the total pool of effective unauthorized immigrants more than compensates the diversionary effect that c^i has on m^j, so that $\partial m^j/\partial c^i \leq 0$. In other words, when the mobility costs are high enough, decentralized border enforcement may end up being higher or overprovided relative to the centralized border enforcement.

The solutions arising in each of the institutional arrangements discussed previously cannot be easily compared when $\tau > 0$, at least analytically. We can gain further insights by referring to the numerical example introduced earlier. Specifically, figures (1c), (1a), and (1b) compare the solutions $\{c^i, e^i, g^i\}$ as a function of τ for: (i) the completely centralized case, C; (ii) the completely decentralized case, D; (iii) mixed case X_1; and (iv) mixed case X_2. In all cases, it is assumed that $v = z$. The conclusions from this exercise can be summarized as follows. First, $c_{X_1} = c_{X_2}$ and $g_{X_1} = g_{X_2}$ hold for $\tau > 0$, and not only for $\tau = 0$.

Second, the ordering $c_D < c_{X_1} < c_C$ and $g_D < g_{X_1} < g_C$ observed under perfect mobility is not necessarily preserved for values of $\tau > 0$. In particular, figures (1c) and (1b) show that border enforcement and the level of the regionally provided good increase in the decentralized case as τ increases, and when τ becomes sufficiently high, they even become larger than the corresponding levels of c and g in the centralized and mixed cases. More precisely, it can be shown that when τ tends to infinity, the values of c and g are in each case are given by $\{c_D, g_D\}_{\tau\to\infty} = \{1.50, 4.10\}$, $\{c_{X_1}, g_{X_1}\}_{\tau\to\infty} = \{c_{X_2}, g_{X_2}\}_{\tau\to\infty} = \{1.25, 3.93\}$. The centralized solution, however, does not depend on τ, so that $\{c_C, g_C\} = \{1.27, 4.05\}$ for all $\tau \geq 0$. Comparing the results, it can be concluded that when it is prohibitively costly to move across regions (so immigrants must remain in the region of entry), c and g end up being overprovided in the decentralized case relative to the other cases. Note that even in the extreme case of no internal mobility of unauthorized immigrants, the completely centralized and decentralized solutions do not coincide. Since unauthorized immigrants can still decide to enter through A or B, the policies in region i, mostly c^i and g^i, will affect region j.

Third, when τ gets sufficiently large, specifically, for values of $\tau \geq \tau_D^*$ and $\tau \geq \tau_{X_1}^*$, internal enforcement in cases D and X_1 become zero.[26] In other words, as τ increases, e_D declines and $e_D = 0$, for $\tau \geq \tau_D^* = 1.84$. Similarly, e_{X_1} becomes zero for values of $\tau \geq \tau_{X_1}^* = 2.50$. Recall that e_C and e_{X_2} are always zero. So in line with the explanation provided earlier for proposition 1(iv), the graph shows that as τ gets larger, internal enforcement becomes more and more ineffective, and eventually $e_D = e_{X_1} = 0$.

Finally, figures (1d) and (1e) describe the effect of the policies on the level of unauthorized immigration and wages in the host country for different values of τ. First, note that in the mixed cases X_1 and X_2 the equilibrium values of m^i and w^i are identical. Second, under perfect mobility ($\tau = 0$), the lowest level of unauthorized immigration is achieved when the policies are centrally decided, and the highest level of m^i in the completely decentralized case. Specifically, $m_C < m_{X_1} = m_{X_2} < m_D$. As a result $w_C > w_{X_1} = w_{X_2} > w_D$. Third, as τ rises, unauthorized immigration falls in the decentralized and mixed cases and it is constant in the centralized case. For high enough values of τ, however, unauthorized immigration becomes lowest in the decentralized cases. The latter also implies that wages will be highest in the decentralized case when mobility costs are large enough.

7 Welfare effects of unauthorized immigration

So how is the welfare of local residents affected by the policies, and, in particular, how do the levels of welfare compare across the different scenarios? In the model, unauthorized immigration affects the welfare of local residents in several ways. First, a higher number of unauthorized immigrants depresses local wages. Second, more unauthorized immigrants increase the returns of the fixed factors or profits of local firms. Third, the presence of unauthorized immigrants affects the provision of regional public goods, and, consequently, the utility of local residents. Finally, the policies are financed through taxes on local residents, imposing an additional cost on them.

Policies implemented under different institutional arrangements produce different outcomes, and entail different welfare levels for local residents. Figure 1(h) shows total utility of local residents U_L, which account for the factors mentioned above, in cases C, D, X_1, and X_2, for different levels of τ. Total utility is highest in the centralized case C. However, the ranking of utilities in the other three cases varies as τ changes. In the first place, $U_L(X_1)$ is never higher than $U_L(X_2)$. In fact, for values of $\tau < \tau_{X_1}^*$, $U_L(X_2) > U_L(X_1)$. The intuition is straightforward. When $\tau < \tau_{X_1}^*$, the level of internal enforcement in case X_1 is positive. Recall that $e_{X_2} = 0$ for all values of τ. From the previous section, we know that $c_{X_1} = c_{X_2}$ and $g_{X_1} = g_{X_2}$ when $v = z$. Moreover, from proposition 1(i), internal enforcement is purely wasteful in the sense that it does not affect total immigration of unauthorized immigrants ($\partial \hat{M} / \partial e^i = 0$), and simply affects the regional allocation of immigrants ($\partial m^i / \partial e^i = -\partial m^j \partial e^i$). As a result, when $\tau < \tau_{X_1}^*$, the total utility

[26] The value of τ_D^* is obtained by solving (11), (12), and (13) for $\{c^i, g^i, \tau\}$ when the system of equations is evaluated at $e^i = 0$ and the equations hold with equality. Similarly, $\tau_{X_1}^*$ is obtained by using equations (7), (11), and (13).

of local residents is lower in case X_1 relative to X_2 because they pay taxes to finance a policy (internal enforcement) that only generates external effects across regions and has no real impact on the number of immigrants entering the country. In the second place, $U_L(D)$ is lower than all the other utilities for small values of τ, it increases with τ, and eventually becomes higher than $U_L(X_1)$. However when τ is sufficiently large, $U_L(D)$ starts to decline and becomes, once more, lower than $U_L(X_1)$.[27]

The welfare comparisons reveal, among other things, that an institutional arrangement that assigns regional governments the responsibility of choosing both internal enforcement and the level of their regional public goods, as in case X_1, is weakly dominated by the institutional arrangement defined by case X_2, in which regional governments only choose the levels of the local good. In fact, when the cost for unauthorized immigrants of moving across regions in the destination country is sufficiently low, X_2 dominates even the completely decentralized case D. The result is relevant in light of some recent efforts by a number of state governments in the US. to devote resources to enforce illegal immigration laws. According to the predictions of our model, this shift in the allocation of responsibilities may reduce the welfare of domestic residents.

The four scenarios are associated with different levels of unauthorized immigration, which ultimately have an impact on local firms, workers, and, in general, residents in conflicting ways. We can qualitatively examine these effects by decomposing the impact of m^i on each one of the factors affecting U_L (mainly w^i, π^i, g^i and T^i) for each case C, D, X_1, and X_2.[28] The graphs in figure 1 indicate that mobility costs play a key role when comparing the outcomes across institutional arrangements. First, when τ is low, case D is characterized by high levels of unauthorized immigration (figure 1(d)), low domestic wages (figure 1(e)), and high profit levels (figure 1(f)) relative to the other three cases. When τ is large, the opposite outcomes are observed. Utility is positively affected by the provision of the regional good (figure 1(b)), and negatively affected by total taxes (figure 1(g)). Both are generally highest in case C.[29]

In sum, the four institutional arrangements not only offer different aggregate welfare levels, but they also entail different redistributive effects between owners of the fixed factor and labor. Depending on the value of τ, a specific arrangement would be preferred by one group over the others. For instance, when τ is low, owners of the fixed factor are better-off in case D, while labor receives relatively higher wages in case C. The opposite happens when τ is high enough.

In order to understand the implications of adopting a specific institutional arrangement and examine the differential impact on local residents, we consider a (domestic) welfare function that

[27] $U_L(D)$ increases until τ reaches τ_D^*, and decreases thereafter. Also, $U_L(D)$ could be higher than $U_L(X_2)$ under alternative parameter values, but, as mentioned earlier, $U_L(D)$ will never be higher than $U_L(C)$.

[28] The notion of centralization used by Besley and Coate (2003) is not the same as ours. They assume that the policy outcome in the centralized case are determined through a voting system that aggregates regions' preferences in a specific way. In this framework, an additional effect comes into play: districts may strategically select citizens with high demand for local goods to represent them in the legislature ("strategic delegation"), leading to overprovision of the good in the "centralized" case.

[29] Note that $T^i(X_1) > T^i(X_2)$ for $\tau < \tau^*_{X_1} = 2.50$, and $T^i(X_1) = T^i(X_2)$ for $\tau \geq \tau^*_{X_1} = 2.50$. Moreover, $T(X_1)$ and $T(X_2)$ are always lower than $T^i(C)$, but $T^i(D)$ could be higher $T^i(C)$ for large enough values of τ, mostly due to the higher cost of providing larger levels of g^i_D.

distinguishes individuals by their sources of income. So far, we have assumed that local residents in region i are workers and also own the local fixed factor. We established earlier that under these conditions the net effect of unauthorized immigration on total income received by legal residents is positive: one additional unit of m^i increases income in region i in $(-f^{i\prime\prime}m^i)$. However, as stated earlier, unauthorized immigration affects wages and rents of the fixed factor in opposite directions. In this section, we analyze what happens when the ownership of factors of production is not distributed uniformly across legal residents. Specifically, ownership is divided among groups that are affected differently by the inflow of unauthorized immigrants.

Consider a case in which the good in region i is produced using two factors of production, n^i and k^i. Moreover, there are two types of legal residents: a group of $\bar{n}^i$ workers, each owning one unit of labor; and a group of $\bar{k}^i$ "capitalists", each owning one unit of factor k^i. The technology is represented by a constant returns to scale production function $f^i(n^i, k^i)$, where $n^i = \bar{n}^i + m^i$, $f^i_n > 0$, $f^i_k > 0$, $f^i_{nn} < 0$, $f^i_{kk} < 0$, and $f^i_{kn} > 0$. Legal residents receive the returns from owning the respective factor of production. As before, individuals derive utility from a locally provided good and pay taxes. Suppose the utility of workers and capitalists are valued ψ^i_n and ψ^i_k, respectively, in region i, with $\psi^i_k = 1 - \psi^i_n$. Then, total weighted utility in i is defined as[30]

$$U^i_L = \psi^i_n \bar{n}^i f^i_n + \psi^i_k \bar{k}^i f^i_k + (\psi^i_n \bar{n}^i + \psi^i_k \bar{k}^i)\left[\phi(g^i) - \frac{T^i}{\bar{n}^i + \bar{k}^i}\right]. \tag{23}$$

The FOCs in each of the cases examined earlier are similar, with the exception that expression Δ^i now changes to

$$\Delta^i = \left[\frac{-(\bar{n}^i + \bar{k}^i)}{(\psi^i_n \bar{n}^i + \psi^i_k \bar{k}^i)}(\psi^i_n \bar{n}^i f^i_{nn} + \psi^i_k \bar{k}^i f^i_{kn}) + (v^i - z^i)p^i + \delta^i g^i\right]. \tag{24}$$

Since the production exhibits CRS, it follows that $-f^i_{nn}m^i = \bar{n}^i f^i_{nn} + \bar{k}^i f^i_{kn}$. Hence if $\psi^i_n = \psi^i_k = 1/2$, then the conclusions from the previous sections are unchanged. However, as the weight attached to labor increases, i.e., as ψ^i_n rises and ψ^i_k falls, expression $(\psi^i_n \bar{n}^i f^i_{nn} + \psi^i_k \bar{k}^i f^i_{kn})$ tends to increase, meaning that the costs for region i of one additional unit of m^i gets larger. Note that the cost is highest when $\psi^i_n = 1$, $\psi^i_k = 0$, and it is lowest, and, in fact, negative, when $\psi^i_n = 0$, $\psi^i_k = 1$. So how does this redistributive consideration affect the equilibrium policy choices? We construct a numerical example to address this issue. The numerical example evaluates how the equilibrium levels of $\{e^i, c^i, g^i\}$ change with ψ^i_n in the completely centralized and decentralized cases, assuming $\tau = 0$. We still consider a symmetric equilibrium, which assumes, among other things, $\psi^A_n = \psi^B_n$, and the weights are the same for both the regional and national levels. Similar conclusions hold for mixed X_1 and X_2 cases.

Figure 2 presents the results of the exercise. The following conclusions are obtained. First, figure 2(a) shows that e_C is always zero (from proposition 2), and e_D increases as the weight attached to labor, ψ^i_n, gets higher. This happens because when ψ^i_n is large, the "social cost" of one

[30]This utility specification would arise, for instance, in a context where individuals belong to different interest groups and policies are determined by the outcome of a probabilistic voting model.

additional immigrant is higher. Decentralized governments are induced to be more aggressive to prevent unauthorized immigrants from locating in their respective regions. These efforts are, however, wasteful in the sense that the regions could have attained the same level of m^i by coordinating on lower levels of e^i. Second, figures 2(b) and 2(c) show that the level of the regional good and border enforcement increase in both the completely centralized and decentralized cases as ψ_n rises.[31] The intuition works as follows. For a pro-labor government the presence of a higher number of unauthorized immigrants is relatively more costly, so they will choose a higher level of border enforcement. A higher level of c, in turn, reduces the effective number of unauthorized immigrants in i, which also decreases the marginal cost of g. It results from equation (19) that g ends up being higher.[32] And, third, figures 2(d) and 2(e) show how the implementation of these policies end up affecting the number of unauthorized immigrants and wages in i. Specifically, as ψ_n^i rises, m^i declines and w^i rises, as expected.

8 Restricting the access to regional goods

We now examine the implications of changing some of the model's underlying assumptions.[33] In this section, we consider the possibility that by devoting efforts to internal enforcement, governments may not only detect firms that are hiring unauthorized immigrants, but they can also prevent those unauthorized immigrants from having access to certain regional goods and services, such as health and education services.

Specifically, suppose that the access to regional goods is restricted to individuals that legally reside in the region. Domestic governments rely on internal enforcement to detect unauthorized immigrants and prevent them from consuming the regionally provided good. Specifically, a larger value of $p^i(e^i)$ now also entails a smaller number of unauthorized immigrants having access to g^i. This assumption introduces two changes to the previous model. In the first place, since an unauthorized immigrant enjoys g^i only with probability $[1 - p^i(e^i)]$, the utility obtained in region i becomes $u^i = w^i - p^i(e^i)z^i + [1 - p^i(e^i)]\phi^i(g^i)$. The latter implies that now the effectiveness of e^i and g^i, as measured by their impact on m^i, depends on each other. While in the previous model $\partial^2 m^i/\partial g^i \partial c^i = 0$, in the new setup $\partial^2 m^i/\partial g^i c^i < 0$.[34] This means that when e^i is higher, the effect of g^i on m^i is smaller, so larger values of g^i do not attract as many unauthorized immigrants to i as before. Alternatively, when g^i is higher, $\partial m^i/\partial e^i$ becomes, in absolute value, higher as well, which means that e^i is now more effective at deterring unauthorized immigrants from residing and working in region i. In this sense, e^i and g^i now complement each other.

In the second place, the total cost of providing g^i is $T_g^i = \{\bar{n}^i + [1 - p^i(e^i)]m^i\}\delta^i g^i$. For given

[31] Since $\tau = 0$, then it follows from proposition 3 that $c_C(\psi_n^i) > c_D(\psi_n^i)$ and $g_C(\psi_n^i) > g_D(\psi_n^i)$ for all ψ_n^i. Similar conclusions hold for values of $\tau > 0$, with the caveat that for large enough values of τ, $e_D(\psi_n^i) = 0$ for all $0 \leq \psi_n^i \leq 1$, and the curves $c_D(\psi_n^i)$ and $g_D(\psi_n^i)$ are above the curves $c_C(\psi_n^i)$ and $g_C(\psi_n^i)$, respectively.

[32] We also showed earlier that $\partial^2 U_L/\partial c^i \partial g^i > 0$, so that a higher level of c would result in a higher level of g as well.

[33] Appendix D analyzes an alternative variation of the model in which deportation costs are equally shared by all residents in the country or in the economic union, even in the completely decentralized case.

[34] The result is shown in Appendix E.

values of g^i and m^i, T_g^i decreases with higher levels of e^i and $p^i(e^i)$, since a smaller number of individuals consume the regional good.

So how do these changes affect the policies chosen in each of the scenarios considered earlier? In general, internal enforcement in the present framework becomes a much more effective policy. In those cases in which e^i is decided in a decentralized way, the equilibrium values of e^i will tend to be higher. As a result, and given the complementarity between e^i and g^i explained earlier, g^i will tend to increase as well. Regional governments may now raise g^i, increase the utility of local residents, and attract only a small number of unauthorized immigrants, since a higher e^i reduces the expected utility of consuming g^i, making region i less attractive for them. As in the previous setup, the effectiveness of e^i still declines with τ, but the critical values at which internal enforcement becomes zero (τ_D^* and $\tau_{X_1}^*$) are now higher.

The assumption introduced in this section has some important implications on the policies chosen in case C, though. Specifically, e^i is not necessarily zero in a symmetric equilibrium in the centralized case when e^i also restricts the access to the consumption of the regional good. The reason is that even though the central authority internalizes the effect internal enforcement has on both regions (so that $\partial m^i/\partial e^i$ and $\partial m^j/\partial e^i$ cancel each other out), e^i also affects the budget constraint through its impact on T_g^i, as explained before. Hence, when deciding the level of internal enforcement, the central authority assesses the higher direct costs of increasing e^i and the lower costs of providing g^i. Specifically, the FOC for e^i (previously expression (6)) is now

$$\frac{\partial U_L}{\partial e^i} = -\tilde{\Delta}^i \frac{\partial m^i}{\partial e^i} - \tilde{\Delta}^j \frac{\partial m^j}{\partial e^i} - \left\{ \sigma^i + [(v^i - z^i) - \delta^i g^i] p^{i\prime} m^i \right\} \leq 0, \tag{25}$$

where $\tilde{\Delta}^i \equiv f^{i\prime\prime} m^i + p^i(v^i - z^i) + \delta^i g^i (1 - p^i)$. The first two terms cancel each other out, so only the expression between curly brackets remains. The latter is not necessarily positive, however, as before. Assuming $v^i = z^i$, it may be possible for this expression to hold as an equality at an interior solution for e^i, i.e., $\sigma^i = \delta^i g^i p^{i\prime} m^i$ at $e^i > 0$. Note additionally, that an interior solution for e^i will more likely be observed when the marginal cost of providing g^i (δ^i) is larger, or when the marginal cost of providing e^i (σ^i) is smaller.

9 Endogenous number of unauthorized immigrants

We now assume that the number of potential unauthorized immigrants is endogenous. In this way, the decision process for unauthorized migrants does not only involve deciding the region of entry and the final destination, but it also determines the total number of unauthorized immigrants entering the host country. Specifically, we allow for the wage in the source country to adjust depending on the number of workers in the source country.[35]

[35]The number of workers in the source country includes workers that attempted to migrate but were caught at the border. It does not include, however, workers that are caught as a result of internal enforcement. In our framework, workers that are deported as a result of internal enforcement are first compensated for their work in the host. In other words, they are deported after contributing to the production process in region i of the host.

9.1 Equilibrium

When M^A and M^B are endogenous, in equilibrium $U_E^i = q^i[w^*(\bar{n}^* - \hat{M}) - k] + (1-q^i)u_E^i - \mu^i(M^i)$ $= w^*(\bar{n}^* - \hat{M})$, for $i = A, B$, where $\hat{M} = (1-q^A)M^A + (1-q^B)M^B$. As in the previous analysis, we consider a situation in which unauthorized immigrants enter through both regions. If, for instance, $U_E^i > w^*$, workers from the source country will only enter the host through i. A solution with workers entering through both i and j necessarily entails $U_E^A = U_E^B = w^*$. Thus, the equilibrium when the pool of migrants is endogenously determined is defined as follows.

Definition: (Endogenous supply of immigrants). The equilibrium values $\{w^A, w^B, M^A, M^B, \hat{M}\}$ are implicitly determined by

$$f^{i\prime}(\bar{n}^i + m^i) = w^i,\ U_E^i = w^*(\bar{n}^* - \hat{M}),\ \hat{M} = (1-q^A)M^A + (1-q^B)M^B, \tag{26}$$

for $i = A, B$, where m^A and m^B are defined in (1) and (2), respectively. The equilibrium determines $\{w^i(x), M^i(x), \hat{M}(x)\}_{i=A,B}$, where $x = (c^A, c^B, e^A, e^B, g^A, g^B, \tau)$. By substituting the equilibrium values into (1) and (2), we obtain $m^i(x)$.

As before, we focus on a symmetric equilibrium of the form $M^i = M, m^i = m, w^i = w$, where $m = \hat{M}/2 = [1 - q(c)]M$. In the previous case, with a fixed supply of unauthorized immigrants, the (symmetric) equilibrium only depended on c. When the supply is endogenous, the entire policy set $\{e, g, c\}$ ultimately affects the equilibrium values. We characterize the equilibrium by performing a comparative static analysis.[36] A few conclusions are worth noting. First, when the supply of unauthorized immigrants is endogenous, changes in the policies implemented by region i affect $\hat{M}$ in the following way:

$$\frac{\partial \hat{M}}{\partial e^i} < 0, \quad \frac{\partial \hat{M}}{\partial g^i} > 0, \quad \frac{\partial \hat{M}}{\partial c^i} < 0. \tag{27}$$

Thus, the total supply of unauthorized immigrants declines when internal or border enforcement increase, and the total supply increases when the provision of the local good rises.

Second, in general, the effect of the policy variables $s^i = \{e^i, g^i, c^i\}$ on $\{w^A, M^A, m^A, w^B, M^B, m^B\}$ can be decomposed in two terms. The first term is the direct effect of the policy on the equilibrium variable taking the supply of unauthorized immigrants as given. This term is fully described by the comparative static results studied in Section 4.3. The second term includes expressions (27) and captures the indirect impact of the policy on the equilibrium variable through its effect on the supply of unauthorized immigrants. Consider, specifically, the effect of policy s^i on m^i. Denote $\partial m^i/\partial s^i|_{\text{fixed } \hat{M}}$ the effect of the policy keeping the supply of unauthorized immigrants constant, and dm^i/ds^i the total effect, which includes the effect taking place through $\hat{M}$. Then, it follows that

$$\frac{dm^i}{ds^i} = \left.\frac{\partial m^i}{\partial s^i}\right|_{\text{fixed } \hat{M}} + \left.\frac{\partial m^i}{\partial \hat{M}}\right|_{\text{fixed } \hat{M}} \frac{\partial \hat{M}}{\partial s^i}.$$

[36] The results are presented in Appendix F.

From this last expression, we conclude that $|dm^i/de^i| > |\partial m^i/\partial e^i|$, $dm^i/dg^i > \partial m^i/\partial g^i$, and $|dm^i/dc^i| > |\partial m^i/\partial c^i|$. In other words, m^i becomes more responsive to the policies implemented in region i when the supply of unauthorized immigrants is endogenous. The latter holds simply because changing the policies also affects $\hat{M}$. For instance, consider an increase in e^i. The immediate effect is to reduce m^i (and increase m^j in the same proportion). However, a higher e^i would also tend to reduce the supply of unauthorized immigrants in the host (from (27)), reducing the presence of unauthorized immigrants in both regions i and j. Similar intuition holds for the policies g^i and c^i.

Third, the impact of a change in policy s^i on the variables in region j is smaller when the supply is endogenous. Consider, for example, the effect of changing e^i on m^j:

$$\frac{dm^j}{de^i} = \frac{\partial m^j}{\partial e^i} + \frac{\partial m^j}{\partial \hat{M}} \frac{\partial \hat{M}}{\partial e^i}. \tag{28}$$

The first term is positive and captures the pure displacement effect. In fact, $\partial m^i/\partial e^i = -\partial m^j/\partial e^i$. The second term, however, is negative, and partially offsets the displacement effect, making the final impact of e^i on m^j smaller.

Finally, from the comparative static results, it follows that $d(m^i + m^j)/ds^i = \partial \hat{M}/\partial s^i$ does not depend on τ when $s^i = \{e^i, g^i\}$, but it depends on τ when $s^i = c^i$. This result is relevant because in the centralized case, the determination of the equilibrium policy variables depends on $\partial \hat{M}/\partial s^i$, which implies, as we will see later, that the centralized solution ultimately depends on τ when the supply of unauthorized immigrants is endogenous.

9.2 Determination of policy variables

The main implication of the previous analysis is that when the supply of unauthorized immigrants is endogenous, the policy variables do not only affect the relative attractiveness of a region (and, consequently, the localization of unauthorized immigrants across regions), but also affect the total pool of potential unauthorized immigrants. This last effect generates an additional externality, which typically operates in the opposite direction as the one examined earlier, when $\bar{M} = M^A + M^B$ is fixed.

Taking this effect into account affects the policy choices. The main difference with respect to the analysis performed in Section 6 concerns the determination of internal enforcement when this policy is decided by the central authority (cases C and X_2). Previously, we showed that if $\bar{M}$ is fixed, then $e_C = e_{X_2} = 0$ for all τ. When the number of unauthorized immigrants is endogenous, however, raising e^i displaces unauthorized immigrants to region j, but the rise in m^j is smaller because e^i also reduces the overall amount of unauthorized immigrants in the host country $\hat{M}$. Consider, for instance, the FOC with respect to e^i in the centralized case (previously expression

(6)), evaluated at a symmetric equilibrium:

$$\begin{aligned}\frac{\partial U_L}{\partial e^i} &= -\Delta\left(\frac{dm^i}{de^i}+\frac{dm^j}{de^i}\right)-\left[\sigma+(v-z)p'm\right]\le 0, \quad e^i\ge 0,\\ &= -\Delta\frac{\partial \hat{M}}{\partial e^i}-\left[\sigma+(v-z)p'm\right]\le 0, \quad e^i\ge 0. \end{aligned} \tag{29}$$

Since the first term $-\Delta(\partial\hat{M}/\partial e^i)$ is positive, (29) may now hold with equality at $e^i > 0$. This would occur, among other reasons, when the direct marginal cost of internal enforcement, σ, is relatively small. In other words, when M^i is endogenous, the central authority may rely on internal enforcement, in addition to border enforcement, to effectively restrain the number of unauthorized immigrants. A similar explanation holds for case X_2.

We examine this issue further using a few numerical examples. Figure 3(a) shows e^i_C as a function of τ, for different values of σ: low ($\sigma_0 = 0.02$), intermediate ($\sigma_1 = 0.026$), and high ($\sigma_2 = 0.05$). When σ is high, internal enforcement is always zero as before. However, e^i_C becomes positive for lower values of σ. For instance, when σ is sufficiently low, such as σ_0, internal enforcement is positive for all levels of τ in the centralized case; and when $\sigma = \sigma_1$, e^i_C is zero for low levels of τ and positive for high levels of τ. Also, note that when e^i_C is positive, e^i_C rises as τ increases. This behavior of e^i is partly driven, as shown in Appendix F, by the fact that internal enforcement becomes more "effective" at controlling the number of unauthorized immigrants $\hat{M}$ when mobility costs increase. In other words, the impact that e^i has on $\hat{M}$ (measured by $|\partial\hat{M}/\partial e^i|$) gets larger as τ rises.

We numerically calculate a critical value σ^*, such that for any $\sigma \ge \sigma^*$, $e_C = e_{X_2} = 0$ for all τ. As described earlier, when e_C and e_{X_2} are positive in equilibrium, $-\Delta(\partial\hat{M}/\partial e^i)$ monotonically increases with τ, reaching its highest level at $\tau \to \infty$. As a result, σ^* is defined as the the value of σ at which $e_C = e_{X_2} = 0$ and $\tau \to \infty$. We show in Appendix F that, for the parameter values of the numerical example, $e_C = e_{X_2} = 0$ when $\sigma \ge \sigma^* = 0.0295$.

In the other graphs shown in figure 3, we examine the policy outcomes observed when $\sigma = 0.02 < \sigma^*$ for different values of τ.[37] The numerical examples reveal the following. First, relative to case C, the completely decentralized case is characterized, for every level of τ, by a higher level of internal enforcement, a lower level of regional goods, and a lower level of border enforcement. These policy outcomes lead, as in the case with a fixed supply of total unauthorized immigrants, to a higher level of effective unauthorized immigrants m^i, and consequently, lower wages and higher profits in the destination country in case D.

Second, the solutions for cases X_1 and X_2 generally fall between cases C and D. The outcomes in case X_2 are generally closer to those observed in the centralized solutions. The only difference concerns the ranking of the equilibrium number of immigrants entering the country, given by $M^i_{X_1} < M^i_C < M^i_{X_2} < M^i_D$ for all τ. This result is driven by the fact that internal enforcement in case X_1 is higher than in case C. The other two policies, g and c, cannot explain this outcome because

[37]In Appendix F, we describe and characterize the solutions obtained when $\sigma = 0.05 > \sigma^*$, in which case $e_C = e_{X_2} = 0$ for all τ. The examination of this numerical example shows some differences with respect to the case of fixed $\bar{M}$.

these policies, if anything, would affect M^i in the opposite direction. For instance, $c_C > c_{X_1}$ and $g_C > g_{X_1}$, but still $M^i_C > M^i_{X_1}$. Hence, the impact of a higher level of internal enforcement in case X_1 more than compensates for the effect of the other two policies on M^i relative to the other institutional arrangements.

Third, relative to the centralized case, the utilities of local residents are systematically lower in the other three institutional arrangements, being lowest in the completely decentralized case. Specifically, the ranking of utilities is given by $U^i_L(C) > U^i_L(X_2) > U^i_L(X_1) > U^i_L(D)$ for all τ.

Finally, policy outcomes and variables in all institutional arrangements, including utilities, tend to converge, respectively, to common values as $\tau \to \infty$. However, for the reasons pointed out earlier, internal enforcement does not converge to zero when σ is low. This result contrasts with the behavior of utilities when $\bar{M}$ is fixed. Specifically, in the latter case, while $U^i_L(C)$, $U^i_L(X_1)$, and $U^i_L(X_2)$ converge to a common value, $U^i_L(X_1)$ tends to a different one as $\tau \to \infty$. This lack of convergence is partly explained by the fact that governments still have incentives to behave strategically when τ is infinitely large. Immigrants have the option of deciding the region of entry. They, of course, anticipate they will have to remain in that region after entry. But their decisions still depend on the policies chosen by the regional governments, and, as a result, policy choices in one region affect the other region. When the supply of unauthorized immigrants M^i adjusts depending on the relative wages and economic conditions across countries, the effects of fiscal competition tend to weaken and eventually vanish. A similar conclusion is generally found in the tax competition literature when comparing the results arising in the cases of fixed and variable supply of capital.

10 Implications of asymmetry

Up to this point, we have followed most of the literature on fiscal competition and focused on symmetric equilibria. More realistically, however, regions are heterogeneous, and this heterogeneity naturally leads to asymmetric outcomes. This section examines one possible source of heterogeneity that may significantly affect policies: differences in the cost of crossing the border through region i, represented in the model by the function $\mu^i(M^i)$. Specifically, we consider the simplest case in which the cost of entering the destination country through region B is infinitely high, but the cost of entering through A is still $\mu^A(M^A)$. The costs are, as before, exogenously given, and they do not depend on the policies chosen by domestic governments. The cost heterogeneity may arise, for instance, as a result of different physical constraints imposed by geography. This representation of the model actually describes a spatial configuration in which region A is a border region and region B an "interior" region (i.e., region B shares its border with A, but not with the source country). The present framework is particularly relevant to study and understand the outcomes observed in the EU and US, where the policies chosen by "border" regions or countries end up having an impact on "interior" regions or countries.

By design, this setup is asymmetric: while region A may choose the policy variables $\{e^A, c^A, g^A\}$, region B can only choose $\{e^B, g^B\}$. An unauthorized immigrant can only enter the country through region A. Once in the host country, she decides to stay in A or move to B. Hence, $m^A = m^{AA}$ and $m^B = m^{BA}$. The total number of effective immigrants in the host is $\hat{M} = (1 - q^A)M^A$. As before, unauthorized immigrants face the cost τ when moving from the region of entry to the interior region. In principle, if regions are completely identical in terms of technology and the costs of providing the policies, the equilibrium will not be necessarily symmetric given the structure of the model, unless $\tau = 0$.

10.1 Equilibrium

We focus here exclusively on the case in which M^A is endogenous.[38] In an equilibrium in which $M^A > 0$, $U_E^A = q^A[w^*(\bar{n}^* - \hat{M}) - k] + (1 - q^A)u_E^A - \mu^i(M^A) = w^*(\bar{n}^* - \hat{M}^A)$, where $\hat{M} = (1 - q^A)M^A$.

Definition: (Asymmetric case with endogenous supply of immigrants). The equilibrium values $\{w^A,\ w^B,\ M^A\ \}$ are implicitly determined by $f^{i\prime}(\bar{n}^i + m^i) = w^i$, $i = A, B$, $U_E^A = w^*(\bar{n}^* - \hat{M})$, where $\hat{M} = (1 - q^A)M^A$, $m^A = m^{AA}$, and $m^B = m^{AB}$ are defined in (1) and (2), respectively. The equilibrium determines $\{\ w^A(x), w^B(x), M^i(x)\ \}$, where $x = (c^A, e^A, e^B, g^A, g^B, \tau)$. By substituting the equilibrium values into (1) and (2), we obtain $m^i(x)$.

As in the case of endogenous M^i examined in Section 9, the main implication of the present analysis is that higher levels of internal enforcement and higher levels of the regional good in region i have ambiguous effects on the number of unauthorized immigrants in region j. The reason is that while a higher e^i (g^i) induces immigrants to relocate to j (i), it also it reduces (increases) M^A, and, consequently, m^A and m^B. Border enforcement, in this case c^A, unambiguously reduces M^A: c^A produces a positive externality on the interior region B.

10.2 Determination of policy variables

As in Section 5, policies are chosen to maximize the utility of local residents. We focus here on the decisions made in the completely centralized (C) and completely decentralized (D) cases. We assume that while in the completely centralized case the cost of border enforcement are equally shared among all legal residents in the host country, only residents of region A bear the burden of financing border enforcement in the completely decentralized case. The graphs in figure 4 summarize and help illustrate the main differences between the outcomes observed in each case. First, the graphs assume that regions are identical, except for the fact that A is a border region and B an interior region. The outcomes for each of the policies $\{e^i, g^i\}$ and each of the variables $\{m^i, w^i\}$ are identical for the two regions when $\tau = 0$, but they tend to depart from each other

[38]The case where M^A is fixed is very simple since the decision to move into the country is irrelevant (i.e., the condition $U_E^A = w^*$ no longer holds). Unauthorized immigrants simply decide whether to stay in A or move to B. To save space, we do not include here the analysis of the fixed M^A case. The comparative static analysis for the case considered in this section is included in Appendix G.

as τ increases. Note, additionally, that as τ tends to infinity, the outcomes observed in region for cases C and D tend to converge to each other. This happens because, at the limit, region B is not affected by unauthorized immigration at all, and regions choose their policies independently. Region A is the only region subject to unauthorized immigration, and when it chooses c^A and g^A, it does not affect the utility of residents in B. Similarly, region B chooses the (undistorted) level of g^B without having an impact on region A. This was not the case in the model analyzed in Section 5 mostly because, in that situation, regions still behave strategically when τ tends to infinity: even though unauthorized immigrants cannot move internally once they are in the host country, they still have the option to enter the host through either region A or B.

Second, given the parameter values chosen for this numerical example (particularly, a relatively high value of σ), interior enforcement is zero in case C, but e^A_D and e^B_D are positive for low values of τ.[39] The main difference with respect to the previous analysis is that e^B_D becomes zero at a lower level of τ than e^A_D. Specifically, in figure 4(a), $e^B_D = 0$ for $\tau \geq 0.34$, and $e^A_D = 0$ for $\tau \geq 0.70$. For the same reasons as those established in proposition 1, when τ gets larger, internal enforcement becomes less effective: a lower number of unauthorized immigrants are already moving into region B because it becomes more costly for them. The government in B, as a result, does not need to rely that much on e^B to reduce m^B. This policy is, on the other hand, still effective for region A as long as $\tau < 0.70$. Eventually, e^A will be zero as well when τ becomes sufficiently large.

Third, border enforcement c^A is underprovided in case D relative to case C. Border protection generates a positive external effect on the interior region B, which is not fully internalized by region A when choosing c^A in the decentralized case. As τ gets larger, the positive externality generated by border enforcement tends to vanish, so c^A_C declines, and c^A_D rises. Ultimately, c^A_C and c^A_D converge to the same value.

Fourth, both g^A and g^B are underprovided in case D relative to case C. In order to attract less unauthorized immigrants to their respective regions, governments end up choosing relatively low levels of g^i in the decentralized case. Note that $g^B(C) > g^A(C)$ and $g^B(D) > g^A(D)$: a higher level of the regional good can be provided in region B because less immigrants ultimately move into that region. It is also interesting to observe that $g^A(C)$ actually declines as τ increases. As the cost of moving to B gets higher, more unauthorized immigrants will stay in A instead of relocating to B, so this effect is compensated by offering a lower level of g^A.

Finally, the centralized and decentralized solutions are associated with different levels of unauthorized immigration, and, consequently, domestic welfare. Both the total number of unauthorized immigrants attempting entry to the host country M^A and the effective number of unauthorized immigrants $\hat{M}$, given by $m^A + m^B$ (which may be inferred from figure 4(e)) are lower in case C, leading to higher total wages and lower total profits. However, the distributional effects differ by region in each case when $\tau > 0$. For instance, in case D, even though immigration falls in both regions, the decline in m^B is substantially higher in region B, so wages increase more in that region. In the centralized case, m^B rises and m^A falls as τ gets larger, so wages tend to increase in

[39] As noted in Section 9, if σ is low enough, e^i_C may be positive.

B and fall in A. The opposite behavior would be observed on profits (the graphs are not shown). So how does all this affect welfare? Figure 4(h) shows that total utility $U_L(C)$ is always higher than $U_L(D)$, and $U_L(D)$ converges to $U_L(C)$ when $\tau \to \infty$ for similar reasons as those described in Section 9. However, figure 4(g) indicates that the policies have a differential welfare effect across regions: (i) the utility in the interior region B is higher, for all τ, than the utility in the border region A in both cases C and D; (ii) as τ rises, utility declines in region A and it increases in region B in cases C and D; and (iii) the utility in B is higher in case C, and the utility in A is higher in case D. The numerical example does not only show that unauthorized immigration has conflicting effects on domestic factors of production for different institutional arrangements, but it also reveals some of the tensions that arise across regions. For example, while, on aggregate and for every τ, the border region A would favor a decentralized arrangement, domestic workers in that region would always prefer a centralized regime.

11 Conclusions

Many states in the US have recently passed laws granting state governments the authority to enforce immigration policies. This paper investigates the economic impact of such initiatives using a model of border and internal enforcement of unauthorized immigration within a spatial framework. Specifically, it examines the determinants of internal and border enforcement policies and the levels of regionally provided goods under four institutional arrangements: (i) completely centralized case; (ii) completely decentralized case; (iii) regional governments choose internal enforcement and the level of regional goods and the federal government chooses the level of border enforcement; and (iv) regional governments decide the level of the regional goods and the federal government chooses both border and internal enforcement.

The analysis shows that the outcome of implementing immigration policies varies significantly depending on which level of government is involved in the decision process. The most salient conclusions can be summarized as follows. First, the level of internal enforcement (in a symmetric equilibrium) is always zero in the completely centralized case. In other words, a central government would only rely on border enforcement to control unauthorized immigration. Second, in the decentralized cases the solutions depend on the cost for unauthorized immigrants of moving across regions once they have successfully entered the host country. If unauthorized immigrants are perfectly mobile across regions , then internal enforcement tends to be overprovided and border enforcement and the regional good underprovided in the decentralized cases. As a result, the level of unauthorized immigration is higher and domestic wages end up being lower in these cases. Third, as mobility costs rise, internal enforcement efforts tend to decline while border enforcement tends to increase in the decentralized cases. Under complete immobility, internal enforcement becomes completely irrelevant in all cases. Moreover, the levels of both border enforcement and the regional good could even be higher when decisions are completely decentralized compared to the fully centralized outcome. Fourth, when the number of (potential) unauthorized immigrants is endogenous, then all policy variables affect the supply of effective unauthorized immigrants in the host nation, generating an additional external effect. This externality generally works in a countervailing direction of the diversionary effect that characterizes the exogenous case. And fifth, redistributive considerations in the host affect the outcomes. In particular, if domestic labor and unauthorized immigrants are substitutes in production, a higher weight on the welfare of domestic labor tends to increase border and domestic enforcement, and, simultaneously, the provision of the regional good.

We extend the basic setup in several ways. First, we allow governments to restrict the access of unauthorized immigration to the provision of regional goods. Second, we assume that the pool of unauthorized immigrants is endogenous. And third, we consider a richer spatial configuration that includes both bordering and non-bordering (interior) regions or states. Even though the main conclusions of the basic model survive all these enrichments, each extension offers some new and relevant insights.

Future research may consider other possible extensions. For instance, it might be relevant to examine what happens when firms do not know for sure if they are hiring an unauthorized immigrant (non-discernment case). This setup might be suitable, for instance, to describe the emergence of information sharing arrangements between regional and federal governments, such as E-verify. The consideration of workers with different skill levels, facing different mobility costs is another avenue for further research. Finally, international mobility of complementary factors like capital will add another relevant dimension to this research agenda.

References

Agrawal, David R, William F Fox, and Joel Slemrod (2015). "Competition and subnational governments: Tax competition, competition in urban areas, and education competition". *National Tax Journal*, 68(3), pp. 701–735.

Amuedo-Dorantes, Catalina and Cynthia Bansak (2012). "The labor market impact of mandated employment verification systems". *American Economic Review*, 102(3), pp. 543–548.

Amuedo-Dorantes, Catalina, Thitima Puttitanun, and Ana P. Martinez-Donate (2013). "How Do Tougher Immigration Measures Affect Unauthorized Immigrants?" *Demography*, 50(3), pp. 1067–1091.

Bandyopadhyay, Subhayu and Sudeshna C. Bandyopadhyay (1998). "Illegal immigration: A supply side analysis". *Journal of Development Economics*, 57(2), pp. 343–360.

Besley, Timothy and Stephen Coate (2003). "Centralized versus decentralized provision of local public goods: a political economy approach". *Journal of public economics*, 87(12), pp. 2611–2637.

Bohn, Sarah and Todd Pugatch (2015). "US border enforcement and Mexican immigrant location choice". *Demography*, 52(5), pp. 1543–1570.

Bohn, Sarah, Magnus Lofstrom, and Steven Raphael (2014). "Did the 2007 Legal Arizona Workers Act reduce the state's unauthorized immigrant population?" *Review of Economics and Statistics*, 96(2), pp. 258–269.

Bond, Eric W. and Tain-Jy Chen (1987). "The welfare effects of illegal immigration". *Journal of International Economics*, 23(3), pp. 315–328.

Brown, Charles C and Wallace E Oates (1987). "Assistance to the Poor in a Federal System". *Journal of Public Economics*, 32(3), pp. 307–330.

Brueckner, Jan K. (2000). "Welfare reform and the race to the bottom: Theory and evidence". *Southern Economic Journal*, pp. 505–525.

Brueckner, Jan K (2003). "Strategic interaction among governments: An overview of empirical studies". *International Regional Science Review*, 26(2), pp. 175–188.

Brueckner, Jan K (2004). "Fiscal decentralization with distortionary taxation: Tiebout vs. tax competition". *International Tax and Public Finance*, 11(2), pp. 133–153.

Djajić, Slobodan (1987). "Illegal aliens, unemployment and immigration policy". *Journal of Development Economics*, 25(1), pp. 235–249.

Djajić, Slobodan and Michael S. Michael (2014). "Controlling Illegal Immigration: On the Scope for Cooperation with a Transit Country". *Review of International Economics*, 22(4), pp. 808–824.

Ethier, Wilfred J. (1986). "Illegal immigration: The host-country problem". *American Economic Review*, 76(1), pp. 56–71.

Gaytan-Fregoso, Helena and Sajal Lahiri (2000). "Foreign aid and illegal immigration". *Journal of Development Economics*, 63(2), pp. 515–527.

Gordon, Roger H. and Julie B. Cullen (2012). "Income redistribution in a federal system of governments". *Journal of Public Economics*, 96(11), pp. 1100–1109.

Hanson, Gordon H. (2006). "Illegal Migration from Mexico to the United States". *Journal of Economic Literature*, 44(4), pp. 869–924.

Hanson, Gordon H. and Antonio Spilimbergo (1999). "Illegal immigration, Border Enforcement, and Relative Wages: Evidence from Apprehensions at the US–Mexico Border". *American Economic Review*, 89(5), pp. 1337–1357.

Orrenius, Pia M. and Madeline Zavodny (2005). "Self-selection among undocumented immigrants from Mexico". *Journal of Development Economics*, 78(1), pp. 215–240.

— (2015). "The Impact of E-Verify Mandates on Labor Market Outcomes". *Southern Economic Journal*, 81(4), pp. 947–959.

— (2016). "Irregular immigration in the European Union". (1603).

Pauly, Mark V. (1973). "Income redistribution as a local public good". *Journal of Public Economics*, 2(1), pp. 35–58.

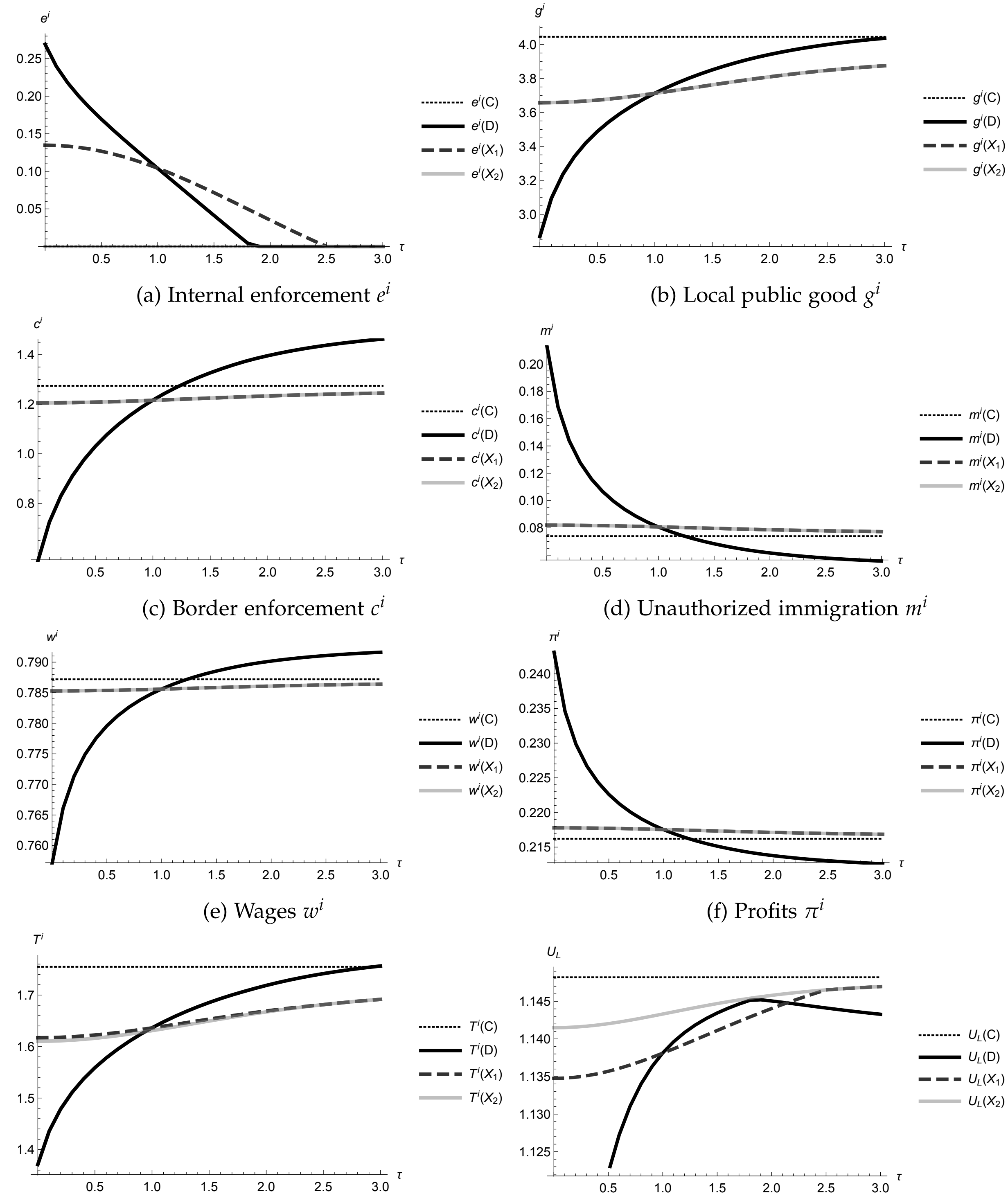
Pena, Anita Alves (2014). "Undocumented Immigrants and the Welfare State: The Case of Regional Migration and US Agricultural Labor". *Journal of Regional Science*, 54(1), pp. 96–113.

Wildasin, David E. (1986). *Urban public finance*. Harwood Academic Publishers.

Wilson, John D. (1986). “A theory of interregional tax competition”. *Journal of Urban Economics*, 19(3), pp. 296–315.

Wilson, John Douglas and David E Wildasin (2004). “Capital tax competition: bane or boon”. *Journal of Public Economics*, 88(6). {OTPR}, pp. 1065 –1091.

Woodland, Alan D. and Chisato Yoshida (2006). “Risk preference, immigration policy and illegal immigration”. *Journal of Development Economics*, 81(2), pp. 500–513.



(a) Internal enforcement e^i

(b) Local public good g^i

(c) Border enforcement c^i

(d) Unauthorized immigration m^i

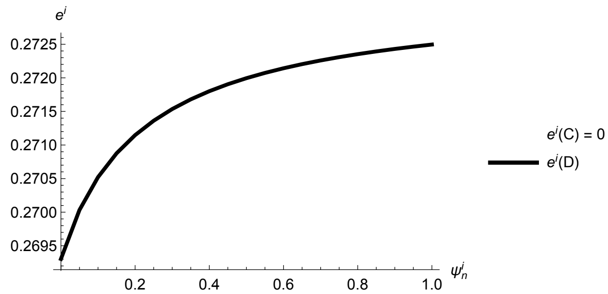
(e) Wages w^i

(f) Profits π^i

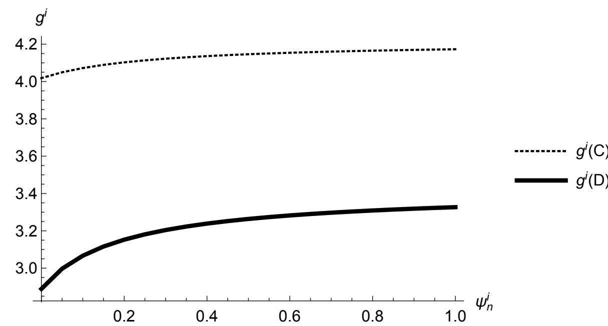
(g) Taxes T^i

(h) Total utility U_L

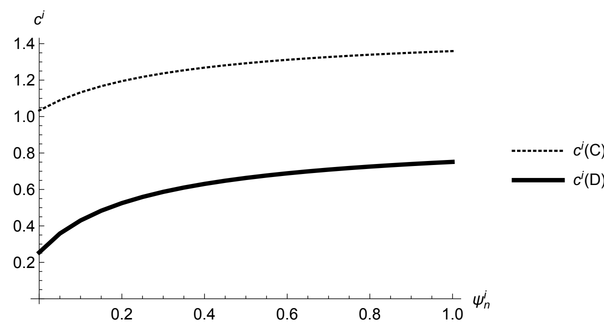
Figure 1: Fixed supply of unauthorized immigrants



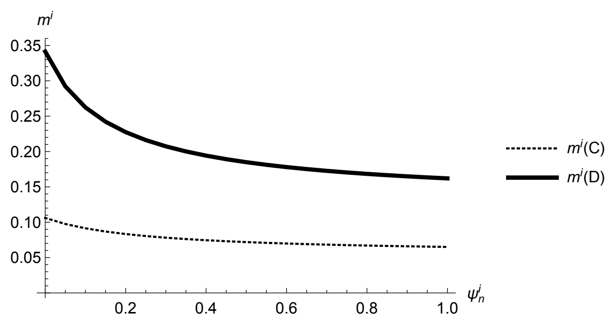
(a) e^i



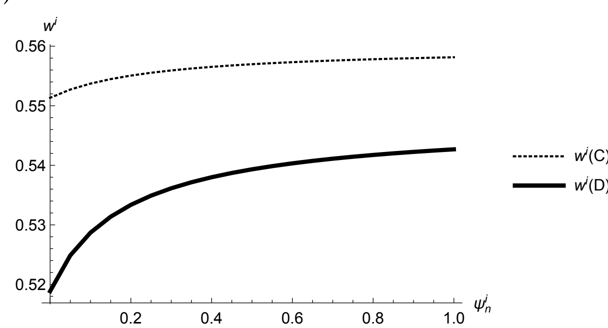
(b) g^i



(c) c^i

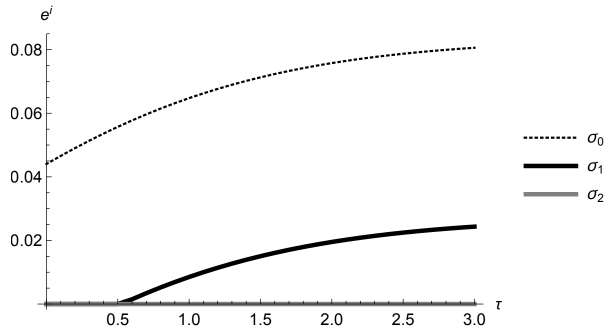


(d) m^i

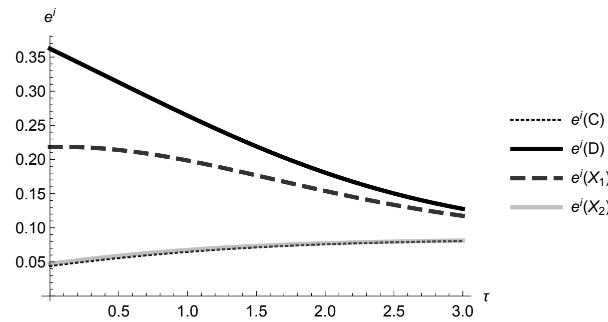


(e) w^i

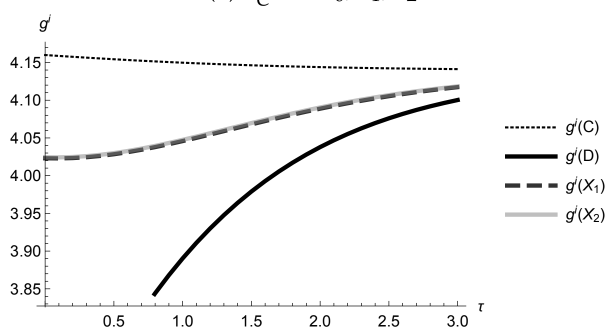
Figure 2: Unauthorized immigration and income redistribution: $\{e^i, g^i, c^i, m^i, w^i\}$ as a function of ψ_L ($\tau = 0$)



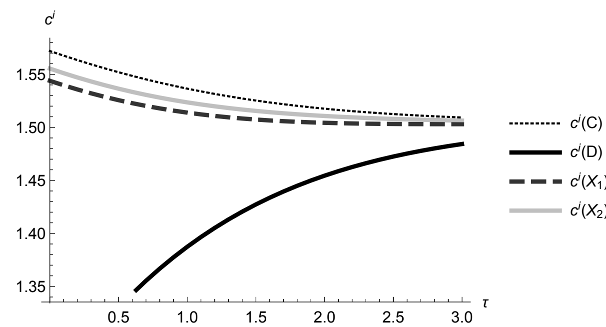
(a) e_C^i for $\sigma_0, \sigma_1, \sigma_2$



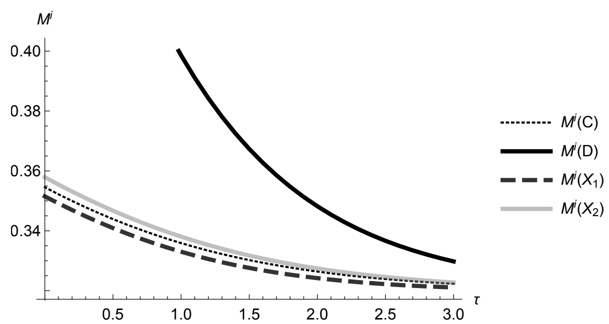
(b) e^i



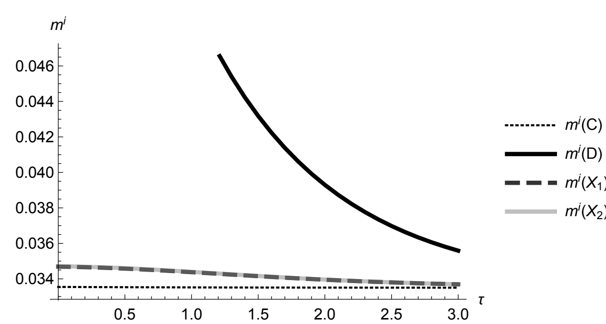
(c) g^i



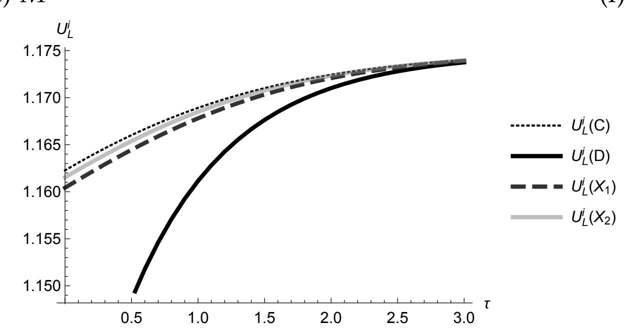
(d) c^i



(e) M^i

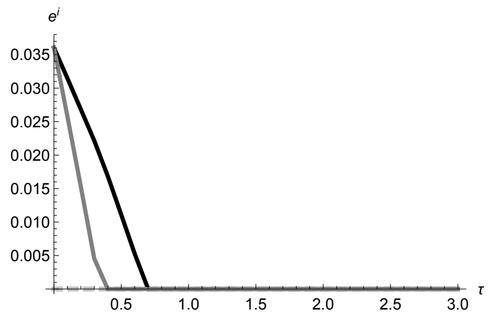


(f) m^i

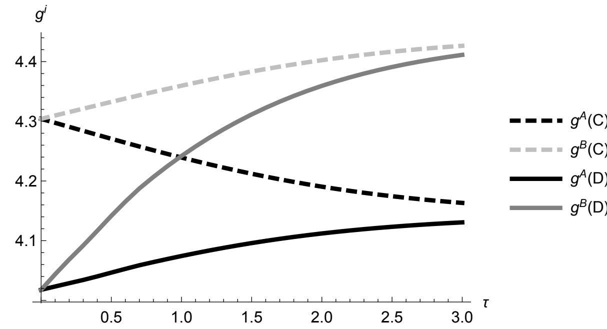


(g) U_L^i

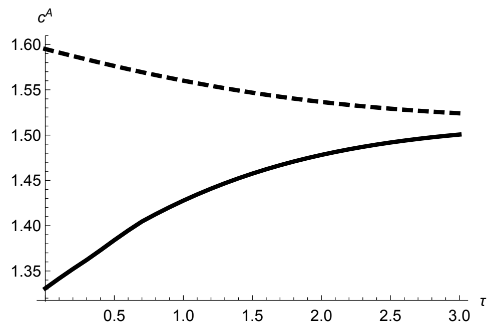
Figure 3: Endogenous supply of unauthorized immigrants



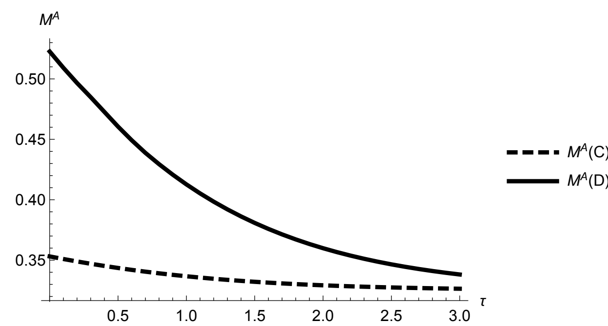
(a) e^i



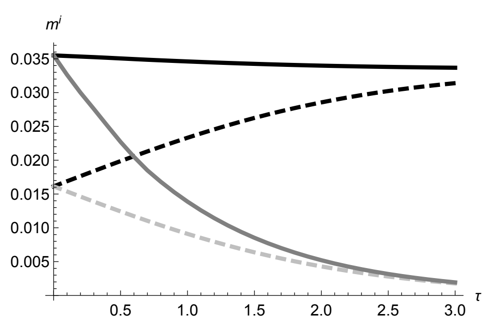
(b) g^i



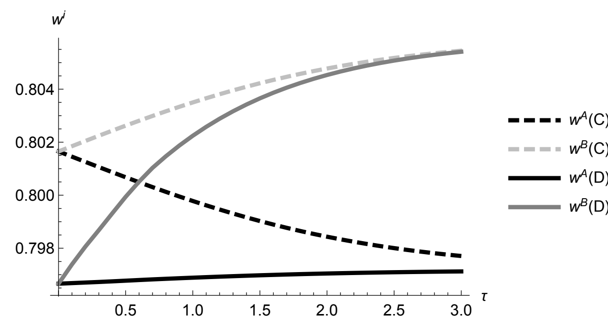
(c) c^A



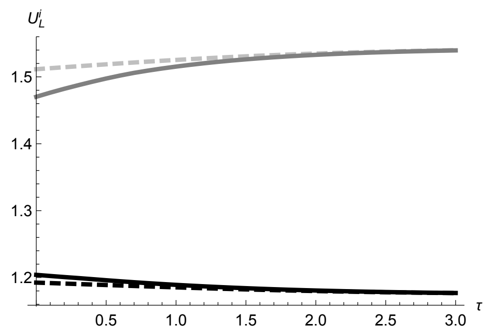
(d) M^A



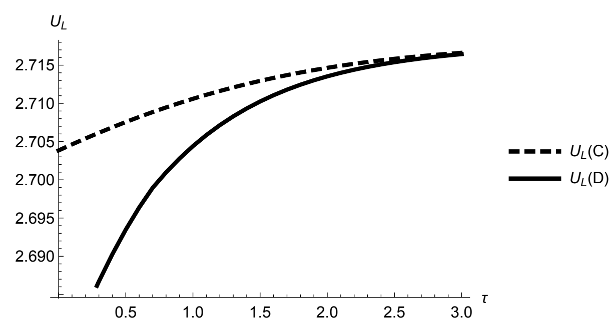
(e) m^i



(f) w^i



(g) U_L^i



(h) U_L

Figure 4: Asymmetric case: Endogenous supply of unauthorized immigrants