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# Do Immigrants Make Us Safer? A Model on Crime, Immigration and the Labor Market

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# Do Immigrants Make Us Safer? A Model on Crime, Immigration and the Labor Market

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January 2011

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Does immigration cause crime? To answer this question, we build a two-country labor matching model in which, in equilibrium, the migration (in/out-)flows, the crime rates and the wages are determined by the interaction between crime, the labor market, and the decision to migrate. The main result of our model is that, in equilibrium, the relationship between immigration and crime depends on both crime profitability and the labor market conditions. When frictions in the labor market of the host country are sufficiently small, immigration causes a reduction in the domestic crime rate. A policy implication of our model is that migration flows from countries with strong rigidities to societies characterized by more elastic labor markets are mutually benefic in terms of reducing the corresponding crime rates.

**Keywords:** Crime Rate, Labor Market, Immigration.

**JEL classification**: J61, J64, K42.

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# 1 Introduction. Immigration and Crime: A Controversial Relationship

*'Do immigrants make us safer?'*[1] Among the "hot" issues faced by policymakers in industrialized countries, the relationship between immigration and crime is one of the most controversial. Natives in host countries generally perceive immigration as a source of criminality. By analyzing data from the National Identity Survey during the period 1995-2003, Bianchi et al. (2011) report that the majority of the population in OECD countries is worried that immigrants increase crime, with the proportion of respondents in line with this view ranging from a low of 40% in the United Kingdom to a high of 80% in Norway (see also Martinez and Lee, 2000; Bauer et al. 2001). Despite public opinion, the nature of the relationship between immigration and crime is still an open question for social scientists.

The recent empirical literature is not conclusive. While in some cases immigrants' inflows are found to be positively correlated with the domestic crime rate (Borjas et al, 2006; Alonso et al, 2008), several other studies report opposite conclusions (Bianchi et al, 2011; Sampson, 2008; Butcher and Piehl, 2007; Reid et al, 2005; Moehling and Piehl, 2007).

Figure 1 plots the 2005-2006 growth rate of the number of crimes per thousand of inhabitant[2] ($CPG2006$) and the net migration rate per thousand of inhabitants in 2005[3] ($NMR2005$) of 36 developed and transition economies.

[1] New York Times Magazine, December 3rd, 2006.

[2] Data from Eurostat (http://epp.eurostat.ec.europa.eu/).

[3] The annual net migration rate of a country is defined as the difference between the number of migrants entering and those leaving the country in a year per thousand midyear population. Data from the US census bureau (http://www.census.gov/).

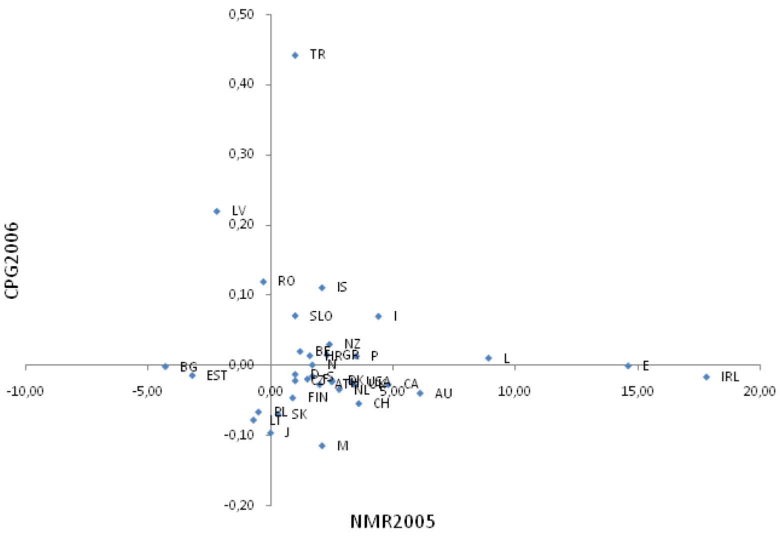


Figure 1. Immigration and Crime in 36 countries.

Focusing on the 29 economies with a positive net migration rate, in 18 countries[4] immigration is associated with a negative growth rate of crime per inhabitant, while in the other 11 countries the sign of the relationship is reversed[5].

Surprisingly, there are no theoretical contributions that offer convincing explanations for this puzzling evidence. Existing models either focus on the relationship between (un)employment and crime or analyze how natives' decision to migrate abroad depends on the economic conditions of the domestic labor market. In light of traditional theories of rational choice (Becker, 1968; Sah, 1991), agents decide to commit crime when the expected benefits from engaging in criminal activities overcome the associated expected costs. Similarly, agents migrate to foreign countries when the expected net benefits from moving abroad are higher than the expected earnings from remaining in the home country and participating in the domestic labor market. As far as we know, there are no theoretical contributions that build up a unified framework analyzing the simultaneous interplay between immigration, the (domestic and foreign) labor market and crime decisions. Introducing both migration and crime as available economic alternatives to detrimental labor conditions in the home country has two main advantages. First, it offers a richer and more realistic setting to account for migration flows. Indeed, in addition to better job opportunities, the decision of rational agents to move abroad can also be motivated

[4] Australia, Austria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Malta, the Netherlands, the Slovak Republic, Spain, Sweden, Switzerland, the United Kingdom, the United States.

[5] Belgium, Croatia, Greece, Iceland, Italy, Luxembourg, New Zealand, Norway, Portugal, Slovenia, Turkey.

by the profitability of crime in the host country. Second, in this general setting the relationship between immigration and crime ultimately depends on the structural characteristics of the labor market of the host country.

We present a two-country equilibrium model with search costs in which, in equilibrium, the migration (in/out)flows, the crime rates and the wages are simultaneously determined by the interaction between immigration, labor market and crime activities in both countries. In each country, the labor market is characterized by the presence of search costs for both workers and firms. As in the standard matching theory, these costs lead to frictional unemployment and a non (perfectly) competitive wage that is the result of a Nash bargaining process between firms and job-seekers. Criminal activities impose victimization costs on residents that are assumed to increase in the domestic crime rate. Agents are free to undertake criminal activities. This implies that the marginal agent will be indifferent between committing a crime and participating in the labor market if and only if the expected benefits of a job-seeker are equal to the earnings associated with criminal activities. We proceed by steps. First, we analyze the interaction between the labor market and crime decisions in the autarkic case. Then, we enrich the model by allowing the agents to migrate to the other country. In particular, rational agents will migrate if and only if the expected gains from moving abroad are higher than the expected benefits from remaining in the home country. In this general setting, we study how the relationship between immigration and crime depends on the characteristics of the domestic labor market.

Our main results can be summarized as follows. First, criminal activities are endemic to economic systems, meaning that there are no equilibria in which one country registers a null crime rate. Second, there exists a negative relationship between the domestic crime rate and the tightness of the national labor market such that a reduction in the domestic crime rate will lead to higher employment opportunities for residents. At the same time, by reducing the unemployment duration, an increase in the tightness of the domestic labor market implies a higher probability of finding a job. Third, within the host country, the relationship between immigration and crime depends on the flexibility of the domestic labor market. In particular, when frictions in the labor market of the host country are sufficiently small, immigration causes a reduction in the domestic crime rate. The intuition behind this result proceeds as follows. Consider a country that in equilibrium registers migration inflows. Ceteris paribus, by increasing the population size, immigration causes a reduction in the domestic crime rate of the host country. This effect modifies the equilibrium conditions of both the labor market and crime. In the former, given the reduction in the victimization costs, firms offer higher wages and create more vacancies while job-seekers demand lower wages. If the tightness of the labor market is sufficiently elastic with respect to the victimization cost, the Nash bargaining process leads to an equilibrium characterized by a higher number of vacancies per job-seeker. Thus, the expected benefits from participating in the labor market as job-seekers increase. Regarding crime, there is a reduction in the proportion of criminals and an increase in the expected benefits of crime. If the labor market over-reacts with respect to crime, then the economy reaches a new equilibrium in which immigration is associated with a lower domestic crime rate in the host country.

The rest of the paper is organized as follows. In the next section, we discuss the novelty of our contribution by relating it to the existing empirical and theoretical literature. In Section 3, we state the assumptions and solve the model in autarky, namely, assuming the existence of a single, closed economy. In Section 4, we extend our analysis to the two-country context, and we derive the conditions for open economy equilibria. At the end of the section, we also present results from panel data models that highlight how the relationship between crime and immigration is influenced by the elasticity of the labor market. In Section 5, we discuss some extensions of the original model by relaxing some assumptions. Finally, in Section 6, we conclude and discuss the policy implications of our findings.

## 2 Literature Review

The basic framework of our contribution is based on a model of search in the labor market. Seminal contributions to this approach go back to Diamond (1981, 1982a, b), Mortensen (1982a, b), and Pissarides (1984a, b).[6] In particular, we propose an equilibrium model in which the sign of the relationship between immigration and crime depends on the tightness of the domestic labor market, namely, on the probability of an immigrant to find a job in the host country.

Although not dealing with the relationship between immigration and crime, Ortega (2000) is probably the paper most related to ours. The author presents a two-country labor matching

[6] Excellent surveys of the literature until the 80s and the 90s are provided by Mortensen (1986) and Mortensen and Pissarides (1999), respectively.

model, with no crime, in which domestic firms offer job-vacancies to residents, taking into account the average search costs of population, while job-seekers look for a position either in their own country or, by bearing mobility costs, abroad. In each country, the equilibrium wage is the outcome of a Nash bargaining between firms and job-seekers based on a constant returns to scale matching function. Finally, countries can differ in their structural characteristics. Two main results are derived. First, the model generally admits multiple equilibria: a no-migration equilibrium, where job-seekers look for a position in their country exclusively; a full-migration equilibrium where all the natives in the country with worse structural conditions migrate and look for a job abroad; and an intermediate-migration equilibrium, where only a fraction of the natives in the country with worse structural conditions migrate. Second, the equilibria are Pareto-ranked along with the level of migration, such that the full-migration and the no-migration equilibria are the Pareto-superior and Pareto-inferior outcomes, respectively. Our model differs from Ortega's (2000) in several respects. First, while in his model countries differ from each other in the probability faced by workers of losing their job, we consider cross-country differences in the expected costs of being victims of crime. In particular, while in Ortega (2000) firms observe whether a worker is immigrant or native and pay different wages accordingly, we assume firms in one country are more vulnerable to crime (suffer larger victimization costs) than firms in the other country. Second, in our model, firms do not observe origins of job-seekers and pay the same wage to all workers. Third, unlike Ortega (2000), we study the interplay between immigration and crime.

Leaving aside agents' decision to migrate, Burdett at al. (2003) build up a search model in a closed economy to analyze the interaction between crime, inequality and unemployment. Each firm posts a (fixed) wage and hires all the job-seekers who are willing to work at that wage. Crime is introduced as an opportunity to steal resources from someone else. The probability of an agent engaging in criminal activities differs according to her labor status and depends on the wage opportunity she encounters. With a given probability, criminals are caught and sent to jail. Finally, everyone can also fall victim to crime, and the probability of victimization depends on the likelihood of an agent engaging in criminal activities. Given this setting, the authors show that introducing crime as an alternative opportunity implies both wage dispersion and multiplicity of equilibria in terms of the crime rate and the unemployment rate. In a subsequent paper (Burdett et al. 2004), the authors extend their framework to incorporate on-the-job search. Our setting differs from these contributions in several respects. First, in our model, wages are determined through a bargaining mechanism between firms and workers (Pissarides, 2000) such that, in equilibrium, the wages reflect bargaining power and costs borne by both parts. Second, Burdett et. al. (2003, 2004) introduce crime as an activity agents can commit at any time and state (employed or unemployed). Unlike those authors, we model crime as an occupational choice. An agent can be either employed, unemployed or criminal. Finally, differently from these papers, we deal with an open economy with migration across countries.

Engelhardt et al. (2008) build up a model that differs from that by Burdett at al. (2003) in the assumptions about the labor market. As in Pissarides (2000), the authors explicitly model a bilateral bargaining between workers and employers to determine the terms of the employment contract. Moreover, they endogenize the job-finding rate by assuming free entry for firms. Thus, in the Engelhardt et al. (2008) model, a worker's decision to commit a crime depends on both her bargaining strength and the chance of an unemployed worker finding a job. After having studied the conditions of the existence and uniqueness of an equilibrium, the authors show that agents' propensity towards crime is ranked according to their labor force status, with unemployed workers being the most likely to engage in criminal activities. Given this setting, they analyze the effects of labor and crime policies on the crime rate. In particular, while labor policies (such as unemployment insurance, small wage subsidies, hiring subsidies) reduce the crime rate to the cost of altering the labor market conditions, crime policies significantly affect the crime rate, implying only negligible effects on the labor market. Although based on the same wage determination process, our model extends the analysis to a more general open economy framework with migration (in/out-)flows. As a consequence, policy interventions that positively affect the elasticity of the tightness of the labor market with respect to the victimization cost turn out to be the most influential instrument for reducing the crime rate of host countries.

A final remarkable difference between our model and the existing literature mentioned above concerns the assumptions used to model crime. Indeed, while in other studies the structure of crime is exogenously imposed and both the subjective probability of committing a crime as well as the expected profits from criminal activities are fixed by assumption, in our contribution the expected profits from criminal activities may change with the population size in a non linear way. In his seminal work, Becker (1968) uses the elasticity of crime with respect to the expected punishment as a measure of the individual propensity to commit a crime. In our model, crime opportunities depend on the population size in two ways. First, when population increases there are more crime opportunities. Second, when population increases, social control may increase the costs of crime, implying a reduction of the number of criminals.

# 3 Autarky: The One-Country Model

Country $A$ is a closed economy with population, $P_A$, that is made up of a continuum of agents and is fixed over time. Agents live forever and can be either employed ($L_A$), unemployed ($U_A$) or criminals ($N_A$). It follows that $P_A = L_A + U_A + N_A$.[7] At any instant of time, unemployed agents choose whether to participate in the labor market as job-seekers or commit crime.

## 3.1 The Labor Market

The labor market of country $A$ is characterized by the presence of search frictions. This means that, due to some source of imperfect information in the labor market, the matching process between vacancies and job-seekers is costly in terms of both time and economic resources. Given these costs, the interaction between firms and job-seekers generates an equilibrium level of frictional unemployment. In particular, suppose that the following expression describes the matching function in the labor market:

$$M_A = M(U_A, V_A), \quad \frac{\partial M_A}{\partial U_A}, \frac{\partial M_A}{\partial V_A} > 0, \tag{1}$$

where $V_A$ is the number of vacancies in country $A$. Following the standard literature, we assume that the matching function is homogenous of degree one. Therefore, we will have

$$m_A \equiv \frac{M_A}{V_A} = q(\phi_A), \tag{2}$$

where $\phi_A \equiv \frac{V_A}{U_A}$ measures the tightness of the labor market. Since $M_A \leq V_A$ and $M_A \leq U_A$, $q(\phi_A)$ represents the probability for a vacancy to be covered, and it is decreasing in $\phi_A$. Therefore, the corresponding instantaneous probability of covering a vacancy is $q(\phi_A)dt$. Assuming a

[7] Here, we do not explicitly model the incarceration flows. Nonetheless, $P_A$ can be considered as the fraction of total population that is not in a jail, assuming that at each instant the fraction of captured criminals and released prisoners is the same.

Poisson distribution, the average arrival time of a match for a vacancy is $\int_0^\infty e^{-q(\phi_A)dt}dt = \frac{1}{q(\phi_A)}$.

Similarly, the probability of finding a job is $\phi_A q(\phi_A)$, with an instantaneous probability of $\phi_A q(\phi_A)dt$. This means that the average time for a worker to find a job is $\frac{1}{\phi_A q(\phi_A)}$. As usual, the probability of finding a job is increasing in $\phi_A$. Therefore, by considering the constraint on the population size, $L_A = P_A - U_A - N_A$, we can write the level of frictional unemployment (the ratio between unemployed inhabitants and the size of the population) as a function of the equilibrium crime rate (the ratio between criminals and the size of the population):

$$u_A(n_A) = \frac{\delta_A(1-n_A)}{\delta_A + \phi_A q(\phi_A)}, \tag{3}$$

where $\delta_A > 0$ is the instantaneous probability of an employed worker losing her job and $n_A$ is the crime rate.[8]

Let us consider the problem faced by a generic value-maximizer firm in country $A$ when entering the search process. Let $J_{A,0}$ and $J_{A,1}$ be the value of an uncovered and covered vacancy in country $A$, respectively. The two no arbitrage conditions for hiring and losing a job-seeker faced by the firm are

$$\begin{cases} r_A J_{A,0} = q(\phi_A)(J_{A,1} - J_{A,0}) - \Omega_A(n_A) \\ r_A J_{A,1} = \Lambda_A - w_A - \delta_A(J_{A,1} - J_{A,0}) - k(n_A), \end{cases} \tag{4}$$

where $r_A$ is the interest rate, $\Lambda_A$ is the marginal productivity of labor assumed to be constant, $\delta_A(J_{A,1} - J_{A,0})$ is the turnover cost in terms of the firm's value, while $\Omega_A(n_A) = c_A + k(n_A)$ represents the total cost borne by firms at each moment. The total cost includes the cost of searching for a new employee in country $A$, $c_A > 0$, and the expected victimization cost of crime, $k(n_A)$. We assume that both firms and individuals bear the same victimization cost. In this way, we exclude the possibility that our results are driven by differences in victimization costs. Moreover, this implies that there are no differences in security across occupations, i.e. individuals cannot become criminals to obtain protection from crime. The function $k(n_A)$ can be written as $k(n_A) \equiv \varphi(n_A)\widetilde{K}_A$, where $\varphi(n_A)$ is the probability of being victim of a crime and $\widetilde{K}_A > 0$ is the corresponding victimization cost that is assumed to be constant.[9] We further

[8] Usually the crime rate is defined as the ratio of crimes in geographic area to the population size in that area. Since in our model criminals commit the same amount of crime, there is a one-to-one relationship between this definition and the ratio of criminals to the population size.

[9] In other words, we assume that any attempt of crime implies some victimization costs such as health

assume that $\varphi(n_A)$ is strictly increasing in the crime rate, $n_A$, and $\varphi(0) = 0$. Thus, when $n_A = 0$, our setting collapses into a traditional search model. Finally, to avoid trivial results, we assume $\Lambda_A > c_A$. More in general, the victimization cost can be written as $\frac{\Psi(N_A)}{P_A}\widetilde{K}_A$, where $\Psi(N_A)$ represents the total amount of victims and is assumed to be homogenous of degree one. This allows us to draw conclusions in terms of the crime rate and to relate our results to the existing stylized facts. Finally, notice that $\varphi(n_A)P_A$ and $k(n_A)P_A$ represent the total amount of victims and the total cost of crime to society, respectively.

Given the free entry condition in the market, $J_{A,0}$ must be null. Therefore, system (4) implies that the expected (total) cost of hiring an employee must be equal to the present value of firm's net income: $\frac{\Omega_A(n_A)}{q(\phi_A)} = \frac{\Lambda_A - w_A - k(n_A)}{r_A + \delta_A}$. From this equality, we obtain the (so-called) job-creation (JC) curve, that is, the relationship between the tightness of the labor market and the wages offered by the firms:

$$w_A^d = \Lambda_A - \frac{(r_A + \delta_A)\Omega_A(n_A)}{q(\phi_A)}. \tag{5}$$

Moving to the labor force, let $W_{0,A}$ and $W_{1,A}$ be the current values of being unemployed and employed in country $A$, respectively. Thus, similarly to system (4), we can write two no arbitrage conditions for unemployed inhabitants. In particular, the first imposes that the current value of being job-seeker is equal to the expected value of finding a job. Similarly, the second condition imposes that the current value of being employed is equal to the expected value of losing the job and moving back to the status of job-seeker:

$$\begin{cases} r_A W_{0,A} = \phi_A q(\phi_A)(W_{1,A} - W_{0,A}) - z_A - k(n_A) \\ r_A W_{1,A} = w_A - \delta_A(W_{1,A} - W_{0,A}) - k(n_A), \end{cases} \tag{6}$$

where $z_A$ is the search cost faced by an unemployed inhabitant and $\phi_A q(\phi_A)(W_{1,A} - W_{0,A})$ and $\delta_A(W_{1,A} - W_{0,A})$ are the expected gains of passing from unemployed to employed and from employed to unemployed in country $A$, respectively. For simplicity, we assume henceforth that $z_A = 0$.

Given the presence of search costs, the equilibrium expression of the wage in the labor market is the result of a negotiation process between firms and job-seekers. In particular, by

expenditures, damages to properties, transaction costs due to the justice system.

assuming a Nash bargaining process (NBP), we have that

$$w_A = \arg\max(W_{1,A} - W_{0,A})^{\gamma}(J_{A,1} - J_{A,0})^{1-\gamma}, \quad \gamma \in (0,1),$$

where $\gamma$ measures the relative bargaining power of workers. Therefore, the total surplus $H_A = J_{A,1} - J_{A,0} + W_{1,A} - W_{0,A}$ is allocated between job-seekers and firms as follows: $W_{1,A} - W_{0,A} = \gamma H_A$. By solving the maximization problem and considering systems (4) and (6) together with the fact that $J_{A,0} = 0$, we obtain the current value of being a job-seeker:

$$x_A(n_A) \equiv r_A W_{0,A} = \frac{\gamma}{1-\gamma}\Omega_A(n_A)\phi_A - k(n_A). \tag{7}$$

The value of being job-seekers is increasing in the tightness and the workers' bargaining power. From Equation (7) and the result of the maximization problem, we obtain the labor supply curve in terms of $\phi_A$:

$$w_A^s = \gamma\Lambda_A + \gamma\Omega(n_A)\phi_A - (1-\gamma)k(n_A). \tag{8}$$

By equalizing Equation (8) to (5), we obtain the expression of $\phi_A$ as a function of the other parameters of the model. Formally,

$$\gamma\Lambda_A + \gamma\Omega_A(n_A)\phi_A - (1-\gamma)k(n_A) = \Lambda_A - \frac{(r_A + \delta_A)\Omega_A(n_A)}{q(\phi_A)}. \tag{9}$$

Equation (9) implicitly defines $\phi_A(n_A)$ as a function of $n_A$.[10] Therefore, the corresponding wage is given by

$$w_A(n_A) = \gamma\Lambda_A + \gamma\Omega_A(n_A)\phi_A(n_A) - (1-\gamma)k(n_A). \tag{10}$$

Let $\eta_{\phi(n_A),k(n_A)} \equiv \frac{d\phi(n_A)}{dn_A}\frac{1}{\phi(n_A)}\Omega_A(n_A)$ represent the elasticity of the tightness of the labor market with respect to the victimization costs of crime. There is a direct linkage between $\eta_{\phi(n_A),k(n_A)}$ and the flexibility of the labor market. A decrease in the crime rate reduces the search costs of firms. The higher the reaction of the tightness of the labor market to the change in the search costs, the higher the capacity of the system to create vacant positions for job-seekers.

[10] In Appendix B, Lemma B1 shows that there is a negative relationship between $\phi_A(n_A)$ and $n_A$.

### 3.2 Crime decisions

By committing a crime, each criminal subtracts the same amount of resources from the society. The expected revenue of a criminal is expressed by the product of two terms: the number of victims per criminal and the number of crimes per victim. The former is defined as the ratio of the number of victims to the number of criminals $\left(\frac{\varphi(n_A)P_A}{N_A}\right)$. The latter is given by the ratio of the number of total crimes, $Q(P_A)$, to the number of victims, $\varphi(n_A)P_A$, $\left(\frac{Q(P_A)}{\varphi(n_A)P_A}\right)$. We assume $Q(P_A)$ to increase in the population size. Chamlin and Cochran (2004) show that the population size is by far the best predictor of crime counts. Moreover, authors argue that $Q(P_A)$ is a nonlinear function. On the one hand, the population size may affect the number of crime opportunities in terms of potential victims and economic resources. On the other hand, by making social control more accurate, the population size may imply an increase in the cost of committing a crime. Formally, the expected revenue of a criminal is $\frac{Q(P_A)}{N_A}K_A$, or $\frac{Q(P_A)}{n_A P_A}K_A$ where $Q' > 0$, $Q(0) = 0$. The expression $\frac{Q(P_A)}{N_A}$ is the amount of successful crimes committed by each criminal, while $K_A$ is the net reward of each crime (once the expected cost of being arrested has been taken into account) and is assumed to be constant.[11] We further assume that criminals incur in the same costs of committing crimes, which is fixed, $C = F_A$.

The expected crime profit net of the victimization costs is

$$\Pi(P_A, n_A) = \frac{Q(P_A)}{n_A P_A}K_A - F_A - k(n_A). \tag{11}$$

The marginal agent will be indifferent to commit crime or not when the expected profit from committing crime is equal to the expected revenue from participating in the labor market as a job-seeker: $\Pi(n_A, P_A) = x_A(n_A)$. Indeed, $x_A(n_A)$ and $\Pi(n_A, P_A)$ respectively represent the instantaneous value of being a job-seeker and the instantaneous profit from crime. When $\Pi(n_A, P_A) > x_A(n_A)$, by committing a crime, the rational agent increases the expected value of her earning flow. In this sense, crime is a (profitable) opportunity rather than a job status and, therefore, it does not enter system (6). By combining Equations (11) and (7), we obtain the following expression:

[11] The expected cost of being arrested can be considered a function of the amount of crimes committed by a criminal: $\frac{Q(P_A)}{N_A}Z_A$, where $Z_A$ is the (constant) expected cost for each crime.Therefore, in general, $K_A$ differs from the average victimization cost, $\widetilde{K}_A$.

$$\frac{Q(P_A)}{n_A P_A} K_A - F_A = \frac{\gamma}{1-\gamma} \Omega_A(n_A) \phi_A^*(n_A). \tag{12}$$

Given our theoretical framework, the next section provides an equilibrium analysis of the one-country model.

### 3.3 The Autarkic Equilibrium

An equilibrium in autarky is defined as follows,

**Definition 1.** *Given the size of the population, $P_A$, an autarkic equilibrium is a list $\{n_A^*, \phi(n_A^*), w(n_A^*), u_A(n_A^*)\}$ such that $\phi(n_A^*)$ satisfies Equation (9), $w(n_A^*)$ satisfies Equation (10), $u_A(n_A^*)$ satisfies Equation (3) and $n_A^*$ satisfies $\Pi(P_A, n_A^*) \geqslant x_A(n_A^*)$.*

In other words, the economy is in equilibrium when no agent has an incentive to move from the labor market to crime or vice versa. Notice that the case in which $\Pi(P_A, n_A^*) > x_A(n_A^*)$ defines a corner solution in autarky. In this case, it is always profitable for an agent to engage in criminal activities. Formally, $n_A^* = 1$, $\phi(n_A^*) = \phi(1)$, $w(n_A^*) = w(1)$, $u_A(n_A^*) = 0$.

The model can be solved recursively. Once the equilibrium crime rate, $n_A^*$, is determined, Equations (9), (10) and (3) are used to derive $\phi(n_A^*)$, $w_A(n_A^*)$ and $u_A(n_A^*)$, respectively. We obtain conditions for existence, uniqueness and stability. The existence result is presented in the following proposition,

**Proposition 1.** *An autarkic equilibrium always exists.*

Proofs are left to the appendix. Proposition 1 states that the one-country model always admits an autarkic equilibrium. When the proportion of criminals is small enough, criminal activities are more profitable than productive activities, and agents have an incentive to move from the labor market to crime activities. By Definition 1, this process may even drive the system to converge to an equilibrium associated with $n_A^* = 1$.

Interestingly, as stated by the following corollary, crime is endemic in the one-country model, and there is no equilibrium with a null crime rate.[12]

**Corollary 1.** *There is no autarkic equilibrium with $n_A^* = 0$.*

In the appendix, we derive sufficient and necessary conditions for uniqueness and stability. We show that an interior equilibrium is locally stable if a (sufficiently) small increase in $n_A^*$

[12] Indeed, *"all societies have crime and deviance - and - [...] crime may be a necessary price to pay for a certain social freedom"* (Macionis and Plummer, 2008, pp. 543).

makes unemployment more valuable than crime. If not, a higher crime rate will induce more agents to commit crime, making the economy diverge from the initial equilibrium. Moreover, the structure of the labor market plays a crucial role in determining the number of autarkic equilibria. Recall that $\eta_{\phi(n_A),k(n_A)}$ represents the elasticity of the tightness of the labor market with respect to the victimization costs of crime. A decrease in the crime rate reduces the search costs of firms. The higher the reaction of the tightness of the labor market to the change in the search costs, the higher the capacity of the system to create vacant positions for job-seekers. As we show in the appendix, if $\eta_{\phi(n_A),k(n_A)}$ is greater than a critical value, $\widetilde{\eta}_{\phi(n_A),k(n_A)}$, then the autarkic equilibrium is unique and stable.

## 4 Open Economy: The Two-Country Model

We now extend our analysis to an open economy. Suppose there are two countries, $A$ and $B$, with initial population sizes $P_A$ and $P_B$, respectively. We assume the world population, $P$, is fixed. Thus, the size of the population in country $B$ can be expressed as the difference between the world population and the size of population in country $A$, $P_B = P - P_A$. As before, populations in the two countries are composed of a continuum of agents. Unless explicitly mentioned, countries are identical in all other respects, and all the assumptions above hold in this context. The key difference with respect to the closed economy case is that in the open economy inhabitants of country $A$ can move to country $B$ and vice versa. Migration has two main implications. First, differently from the autarkic case, the size of the country population is not fixed: it increases if the country registers migration inflows and decreases when natives migrate abroad. Second, in an open economy, agents face a higher number of economic activities they can engage in. Indeed, in addition to participating in both the labor market and crime activities in their own country, agents can also decide to work or to commit a crime in the host country.

Assuming that agents do not bear any mobility cost from migration,[13] in an interior international equilibrium the following no arbitrage conditions must be satisfied:

$$\Pi(P_A, n_A) = x_A(n_A), \tag{13}$$

[13] In the extensions, we will discuss how introducing positive mobility costs affects the equilibrium analysis.

$$\Pi(P_B, n_B) = x_B(n_B), \tag{14}$$

$$x_A(n_A) = x_B(n_B). \tag{15}$$

The previous conditions imply the following no arbitrage condition:

$$\Pi(P_A, n_A) = \Pi(P_B, n_B). \tag{16}$$

Expressions (13) and (14) are no arbitrage conditions stating that, within each country, committing a crime must be as profitable as being job-seekers in the labor market. Expressions (15) and (16) describe no arbitrage conditions between countries and characterize the international equilibrium: when the value of being job-seekers and the profits from crime are the same in both countries, agents are indifferent between migrating and remaining in their own country. When these two conditions are satisfied, countries do not register any migration flow. In the following equilibrium analysis, we assume that conditions (13) and (14) always hold such that we restrict our attention to situations in which either Equation (16) or (15) are not satisfied and agents have an incentive to migrate. That is, if (say) $\Pi_A(P_A, n_A) > \Pi_B(P_B, n_B)$, we will observe agents moving from country $B$ to country $A$, because they will be attracted by both higher profits from crime and the higher value of being job-seekers (given that the first two no arbitrage conditions hold). As long as migration flows occur, the size of the population in the two countries as well as the corresponding domestic equilibria change.

We study an equilibrium in an open economy. In particular, the definition of autarkic equilibria can be generalized as follows:

**Definition 2.** *An equilibrium in an open economy is a list* $\{P_i^*, n_i^*, \phi(n_i^*), w(n_i^*), u_i(n_i^*)\}$, *with* $i = A, B$, *such that* $\phi(n_i^*)$ *satisfies Equation (9),* $w(n_i^*)$ *satisfies Equation (10),* $u_i(n_i^*)$ *satisfies Equation (3),* $\{P_i^*, n_i^*\}$ *represents a domestic equilibrium (as defined in Definition 1) and one of the following conditions holds: (i)* $\Pi(P_A^*, n_A^*) = \Pi(P_B^*, n_B^*)$*; (ii)* $\Pi(P_A^*, n_A^*) > \Pi(P_B^*, n_B^*)$ *and* $P_A^* = P$*; (iii)* $\Pi(P_A^*, n_A^*) < \Pi(P_B^*, n_B^*)$ *and* $P_B^* = P$.

As stated by the previous definition, an international equilibrium is a situation in which there is no incentive to migrate abroad and, within countries, no agents have an incentive to move from the labor market to the criminal activities or vice versa.

Notice that the cases in which $\Pi(P_A^*, n_A^*) \gtrless \Pi(P_B^*, n_B^*)$ define two (symmetric) corner solutions in the open economy. When $\Pi(P_A^*, n_A^*) > \Pi(P_B^*, n_B^*)$, $P_A^* = P$ and $P_B^* = 0$ where the pair $\{P, n_A^*\}$ satisfies Definition 1. Correspondingly, when $\Pi(P_A^*, n_A^*) < \Pi(P_B^*, n_B^*)$, then $P_B^* = P$, $P_A^* = 0$ and $\{P, n_B^*\}$ satisfies Definition 1.

To conduct our analysis, we introduce two fundamental relationships: the domestic locus and the international locus. The domestic locus of country $i$ describes the combinations $\{P_i, n_i^D\}$ corresponding to the domestic equilibrium of country $i$ (given by condition (13) for country $A$ or (14) for country $B$). The international locus is given by the combinations $\{P_i, n_i^I\}$, such that the no arbitrage condition (15) is satisfied. Hereafter, indices $D$ and $I$ denote the values assumed by the variables when they are on the domestic and international loci, respectively.

Since the world population is fixed, we can focus the analysis on the domestic and international loci of one the countries. With no loss of generality, we will refer to country $A$. An international equilibrium is described by a combination $\{P_A^*, n_A^*\}$ that simultaneously belongs to the domestic and international loci. By symmetry, we show that any equilibrium pair $\{P_A^*, n_A^*\}$ is associated with a unique combination $\{P_B^*, n_B^*\}$ in country $B$. Given these preliminary considerations, we analyze the existence and properties of an international equilibrium. We proceed in two steps. First, we derive the properties of the domestic and international loci of country $A$. Second, we study the characteristics of an international equilibrium given the behavior of the domestic and international locus.

## 4.1 The Domestic Locus

The domestic locus describes the relationship between the size of the population of a country and the corresponding equilibrium crime rate in autarky. To analyze this relationship, we totally differentiate Equation (13):

$$\frac{dn_A^D(P_A)}{dP_A} = \frac{\frac{\partial \Pi(P_A, n_A)}{\partial P_A}}{\frac{dx(n_A)}{dn_A} - \frac{\partial \Pi(P_A, n_A)}{\partial n_A}}. \tag{17}$$

The derivative in (17) is well-defined when $\frac{dx(n_A)}{dn_A} \neq \frac{\partial \Pi(P_A, n_A)}{\partial n_A}$, implying that the locus is continuous.[14] Notice that the effect of a variation of $n_A$ on $x_A(n_A)$ is ambiguous (see Equation (7). The reason is that a higher crime rate both reduces the tightness of the labor market (which decreases the value of being unemployed) and increases the total costs of firms (which increases the value of being unemployed). Using Equation (11), we obtain the following derivatives:

$$\begin{cases} \frac{\partial \Pi(P_A,n_A)}{\partial n_A} = -\frac{Q(P_A)}{P_A}K_A - \frac{dk(n_A)}{dn_A} < 0, \\ \frac{\partial \Pi(P_A,n_A)}{\partial P_A} = \frac{dQ(P_A)}{dP_A}\frac{1}{n_A P_A}K_A - \frac{Q(P_A)}{n_A P_A^2} \gtrless 0 \quad \Longleftrightarrow \eta_{Q(P_A),P_A} \gtrless \frac{1}{K_A}. \end{cases} \tag{18}$$

Where $\eta_{Q(P_A),P_A} \equiv \frac{dQ(P_A)}{dP_A}\frac{1}{Q(P_A)}P_A$ is the elasticity of $Q(.)$ with respect to the population size.

Let us focus our attention on stable equilibria (See Appendix B). In Proposition B3 we show that for stable domestic equilibria we have

$$\begin{cases} \frac{dn_A^D(P_A)}{dP_A} \geqslant 0 \iff \eta_{Q(P_A),P_A} \geqslant \frac{1}{K_A} \\ \frac{dn_A^D(P_A)}{dP_A} < 0 \iff \eta_{Q(P_A),P_A} < \frac{1}{K_A}. \end{cases} \tag{19}$$

Stable equilibria belong to the decreasing (increasing) part of the domestic locus when the elasticity $\eta_{Q(P_A),P_A}$ is lower (higher) than $\frac{1}{K_A}$.

## 4.2 The International Locus

The international locus is defined over the space of combinations $(P_A, n_A^I)$ that satisfy the no migration condition (15), with $P_A \in (0, P)$ and $n_A^I \in (0, 1]$. In other words, for any population level $P_A \in (0, P)$, this locus gives the value that the crime rate in $A$ should assume in order to guarantee the absence of migration flows from one country to the other, given the domestic equilibrium in country $B$. Rewriting (15) using (7) and (9), we obtain

$$\Lambda_A - \frac{(r_A + \delta_A)\Omega_A(k(n_A^I))}{(1-\gamma_A)q(\phi(k(n_A^I)))} = \Lambda_B - \frac{(r_B + \delta_B)\Omega_B(k(n_B^D))}{(1-\gamma_B)q(\phi(k(n_B^D)))}. \tag{20}$$

When countries are identical in all respects, the international locus of country $A$ corresponds to the domestic locus of country $B$ expressed in terms of combinations $(P_A, n_A^I)$. In this case, we will have $n_A = n_B$, and the crime rate in the two countries is determined by the domestic

[14] In case in which $\frac{dx(n_A)}{dn_A} > \frac{\partial \Pi(P_A,n_A)}{\partial n_A}$, $\forall n_A \in (0,1]$, Proposition B2 implies the existence of only one equilibrium level of $n_A$ for any given level of $P_A$ and consequently the domestic locus will be a function $n_A^D(P_A)$ defined in the space $(P_A, n_A)$.

loci at $P_A = P_B = \frac{P}{2}$.

Now, let us introduce a source of asymmetry between the two countries. For instance, following Harris and Todaro (1970), labor markets can exhibit a productivity (wage) gap such that, $\Lambda_A \neq \Lambda_B$. In section 5, we will show how this assumption changes the equilibrium analysis, the crime rates and the migration flows. For the purpose of tractability, suppose the two countries differ in the victimization costs. In particular, we assume that $k_A(n) < k_B(n)$, $\forall n \in (0, 1)$ and $k_A(0) = k_B(0)$ and $k_A(1) = k_B(1)$. These assumptions imply that, for a given value of the crime rate, the expected loss from crime is smaller in country $A$ than in country $B$. For instance, insurance services as well as health aids may be more effective in country $A$ than in country $B$. Nonetheless, when all agents are criminals, no insurance service or health institutions can exist, implying that the cost is the same in both countries.

Since $q(.)$ monotonically decreases in $\phi(.)$, it follows that there is a positive relationship between $n_i$ and $q(\phi(k_i(n_i)))$.[15] We also have that $\Omega(k_i(n_i))$ is monotonically increasing in $n_i$. Since $\frac{1}{q(\phi(k_i(n_i)))}$ is the average arrival time of a match for a firm, $\psi(k_i(n_i)) \equiv \frac{\Omega(k_i(n_i))}{q(\phi(k_i(n_i)))}$ represents the expected search cost for a firm, and it can be increasing or decreasing in $n_i$.[16] Assuming the same (constant) parameters and search technology for both countries, condition (20) can be written as $\psi(k_A(n_A)) = \psi(k_B(n_B))$. The assumption of homogeneous search technology implies that countries have the same functional form for the matching function, $q(\phi(k_i(n_i)))$, and the same search cost, $c_A = c_B$. Therefore, to have an international equilibrium, the victimization costs of the two countries must coincide: $k_A(n_A) = k_B(n_B)$. This equality leads to the expression of the international locus:

$$n_A^I(P_A) = k_A^{-1}(k_B(n_B^D(P_B))). \tag{21}$$

$n_A^I(P_A)$ indicates the value of $n_A$ that satisfies the no migration condition expressed by Equation (15) while $n_B^D(P_B)$ is the equilibrium crime rate of country $B$ satisfying Equation (14), with $P_B = P - P_A$. Since in both countries the victimization costs increase in the crime rate, we have that $\frac{dn_A^I(P_A)}{dn_B^D(P_B)} > 0$.

Notice that the domestic locus of country $B$ takes values $n_B \in (0, 1]$, for $P_B \in (0, P]$. Given the assumptions on $k_i(n)$ and the continuity of $k_A^{-1}(k_B(n_B^D(P - P_A)))$, then the international

[15] In the appendix, we show that there is always a negative relationship between $n$ and $\phi(.)$.

[16] Indeed, when $n$ increases the victimization cost increases, but, due to a reduction in the tightness of the labor market, the arrival time of a match for a vacancy decreases.

locus always exists for $(P_A, n_A) \in [0, P) \times (0, 1]$.

Taking into account the population constraint, the slope of the international locus is

$$\frac{dn_A^I(P_A)}{dP_A} = -\frac{dn_A^I(P_A)}{dn_B^D(P_B)}\frac{dn_B^D(P_B)}{dP_B}. \tag{22}$$

Therefore, the international locus presents a positive (negative) slope when the slope of the domestic locus of country $B$ is negative (positive). Notice that the continuity of the domestic locus of country $B$ in the interval $P_A \in [0, P)$ implies continuity of the international locus of country $A$ in the same interval. Moreover, by the assumption on the victimization costs in the two countries, for any $P_A \in (0, P)$, we have that $n_A^I(P_A) > n_B^D(P_B)$, with $P_B = P - P_A$.

### 4.3 International Equilibrium

By definition, an international equilibrium is a combination $\{P_A^*, n_A^*\}$ that simultaneously belongs to the domestic and international loci. Therefore, given our loci, we turn our attention to the equilibrium analysis. As in the one-country model, the results on the (non-)uniqueness and stability of equilibria are left to Appendix B.

**Proposition 2.** *An international equilibrium exists.*

The model might exhibit multiple equilibria. In this respect, several results concerning the multiplicity of equilibria stated above can be extended to the open economy model. For instance, in any interior equilibrium, $P_A^* > 0$, $P_B^* = P - P_A^* > 0$, and $n_A^* > 0$ implies $n_B^* = k_B^{-1}(k_A(n_A^*)) > 0$. In the trivial case of an equilibrium characterized by full migration from country $B$ to country $A$, $P_A^* = P$ and $n_A^* > 0$ while $P_B^* = 0$. Similarly, when profits from crime are (always) higher than the value of being job-seeker in both countries, an equilibrium with full crime emerges such that $n_A^* = n_B^* = 1$ while Equations (11) and (16) imply that $P_A^*$ and $P_B^*$ are determined according to the following condition:

$$\frac{P_A^*}{P - P_A^*} = \frac{Q(P_A^*)}{Q(P - P_A^*)}. \tag{23}$$

According to our results (included in the appendix), if the two countries present persistent and similar characteristics of crime and the labor market, then there exists a unique international equilibrium. Moreover, when the international equilibrium is unique, the domestic crime rates in both countries are unequivocally determined.

As in the one-country model, uniqueness of the international equilibrium implies its stability. Looking at Equations (21) and (22) we can see that the victimization cost plays a crucial role in determining the stability of an international equilibrium. Indeed, by affecting the magnitude of $\frac{dn_A^I(P_A)}{dn_B^D(P_B)}$, the victimization cost defines the reaction of $n_A^I(P_A^*)$ to migration for any given slope of the domestic locus of country $B$. Figure 2 offers a graphic intuition of these results.

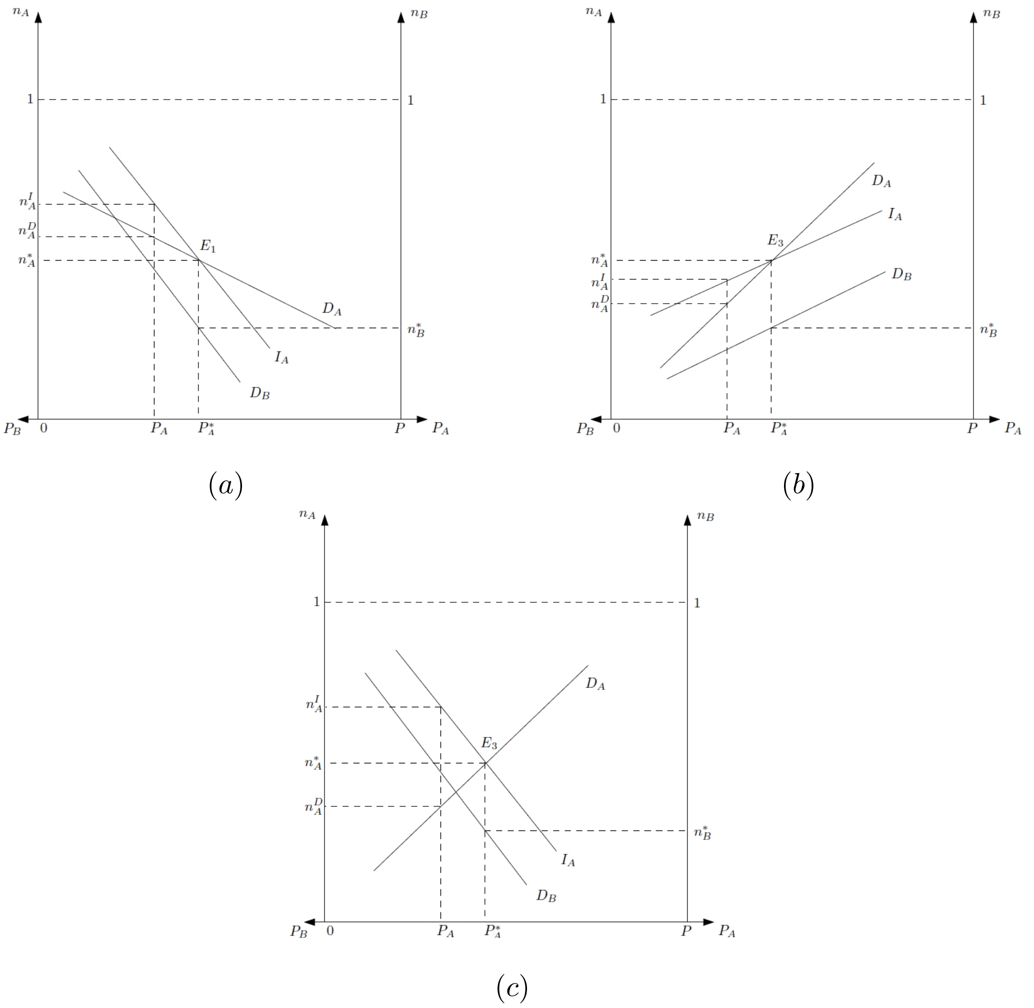


Figure 2. International equilibria and slopes of the (domestic and international) loci.

Let $D_i$ and $I_i$ represent the domestic and international loci of country $i = A, B$. Given the constraint on the population, the intersection of these two curves represents the international equilibrium in the space $(P_i, n_i)$. As shown in the Appendix, the stability of this equilibrium depends on the slopes of the domestic and international loci.

Figure 2.a shows the case in which $A$ presents a negative relationship between immigration

and crime and $B$ presents a positive relationship between immigration and crime. Let us focus on the stability of the international equilibrium $E_1$. Starting from $E_1$, suppose the population of country $A$ decreases below the equilibrium level. By assumption, the domestic markets adjust instantaneously. Thus, the crime rate in country $A$ jumps to the level implied by the domestic locus, $n_A^D(P_A)$, which is lower than that associated with the international locus, $n_A^I(P_A)$. In this situation, profits from crime in country $A$ are higher than those in country $B$, which in turn implies that the expected benefit from participating in the labor market as a job-seeker is higher in country $A$ than in country $B$. Thus, inhabitants of country $B$ will find it convenient to migrate to country $A$. The economy moves along the domestic locus until it moves back to the international equilibrium, $E_1$. During this adjustment process, as shown in Proposition B3, the crime rate of country $A$ decreases. The intuition behind this result can be explained as follows. Migration flows from country $B$ to country $A$ have two effects. First, as $P_A$ increases, the demand of crime increases. Second, given the initial number of criminals, the increase in $P_A$ reduces the crime rate in country $A$. If the labor market is flexible enough, the increase in the value of being a job-seeker will overcome the variation in the profits from crime, causing a reduction in the number of criminals and a consequent further reduction in the crime rate, $n_A$.

Figure 2.b shows the opposite case of Figure 2.a. That is, this represents the situation in which $B$ is characterized by a negative relationship between immigration and crime, whereas $A$ is characterized by a positive relationship between immigration and crime. Finally, Figure 2.c describes the case in which both countries have a positive relationship between immigration and crime. There, migration causes an increase in the crime rate of the host country and a decrease in the crime rate of the other.[17]

By taking advantage of Figure 2, the next proposition states the conditions such that migration flows are beneficial for both countries.

**Proposition 3.** *With no loss of generality, suppose that in a neighborhood of a stable international equilibrium, country $A$ is characterized by a negative relationship between $P_A$ and $n_A$ while the opposite holds for country $B$. Then, migration flows from country $B$ to country $A$ reduce the crime rates of both countries. Vice versa, migration flows from country $A$ to country $B$ increase the crime rates of both countries.*

When $A$ exhibits a negative relationship between the size of the population and the domestic

[17] The equilibrium in which both countries are characterized by a negative relationship between immigration and crime is unstable. For this reason we have omitted the graphical representation.

crime rate, migration inflows imply a reduction of the crime rate due to a reduction in the profits from crime. Therefore, for the stability of the international equilibrium, the level of the crime rate compatible with the international equilibrium must decrease. This will guarantee the convergence between $n_A^D(P_A)$ and $n_A^I(P_A)$. However, in order to have a lower value of $n_A^I(P_A)$, $n_B^D(P_A)$ must decrease. At the end of the process, the crime rates of both countries will be lower.

The last result concerns the role of the characteristics of the domestic labor market on the relationship between immigration and crime. Countries characterized by sufficiently elastic labor markets exhibit a negative relationship between migration inflows and the domestic crime rate. Suppose country $A$ registers migration inflows. Immigration implies an increase in the size of the population, $P_A$, and, given the initial number of criminals, a reduction in the crime rate, $n_A$. Depending on the elasticity $\eta_{Q(P_A),P_A}$, the former effect makes crime more profitable. Similarly, depending on the elasticity of the tightness of the labor market with respect to the victimization cost, $\eta_{\phi(n_A),k(n_A)}$, the latter effect increases the value of participating in the labor market as job-seekers. Since agents' economic decisions are based on the no arbitrage condition between committing a crime and looking for a (legal) job, the net effect of immigration on the domestic crime rate is likely to depend on the characteristics of both the crime and labor market of country $A$. This is formally stated in the next proposition.

**Proposition 4.** *If the absolute value of $\eta_{\phi(n_A),k(n_A)}$ is sufficiently high, then there is a negative relationship between $n_A$ and $P_A$.*

The threshold value of $\eta_{\phi(n_A),k(n_A)}$ such that $n_A$ can be negatively or positively related to $P_A$ depending on the variation of $Q(P_A)$ with respect to the population level. Thus, we might expect such a value to depend on country-specific institutional characteristics. For countries in which $Q(P)$ is concave in $P$, the threshold value of $\eta_{\phi(n_A),k(n_A)}$ necessary to observe a negative relationship between immigration and crime decreases with migration flows. At the same time, for countries in which $Q(P)$ is convex in $P$, the threshold value of $\eta_{\phi(n_A),k(n_A)}$ necessary to observe a negative relationship between immigration and crime increases with migration flows.

### 4.4 Reinterpreting the Stylized Facts

Given our theoretical findings, we present results from fixed effects panel models to assess how the relationship between migration and crime is influenced by the elasticity of the labor market. The Sargan-Hansen statistic supports the decision to use a fixed effects model intead of a random effects model ($\chi^2 = 7.646$, $p - value = 0.0219$). We consider data from 36 countries in the period 2005-2008. The main variables used in our econometric analysis include the number of crimes per thousand of inhabitant, $CP$, the net migration rate per thousand of inhabitants, $NMR$, and the Index of Freedom in the Labor Market[18], $IFLM$. In particular, $IFLM$ represents a proxy of the elasticity of the tightness with respect to the victimization cost, such that the higher the value of $IFLM$, the more flexible the labor market and the more volatile the unemployment duration of the corresponding country are.

We estimate the following econometric specification:

$$CP_{i,t} = \alpha_0 + \alpha_1 NMR_{i,t-1} + \alpha_2 \cdot IFLM_{i,t-1} \cdot NMR_{i,t-1} + \varepsilon_{i,t}, \tag{24}$$

with $i = 1, 2, ..., 36$ and $t = 2006, 2007, 2008$. Two aspects of the previous specification are worth of notice. First, in line with our theoretical model, $IFLM$ is not a direct explanatory variable of the per capita crime rate, but it affects the relationship between immigration and per capita crime. In particular, the $IFLM$ interacts with the migration flow changing the nature of this relationship after a certain threshold level. Second, we consider the lagged values of $NMR$ and $IFLM$ to be consistent with the causality relation highlighted in our model as well as to reduce endogeneity issue.

Columns 1 and 2 of Table 1 present our estimates with and without controlling for a direct

[18]The IFLM is built by the Heritage Foundation. It is built upon six quantitative factors of the labor market that are equally weighted: (a) Ratio of minimum wage to the average value added per worker; (b) Hindrance to hiring additional workers; (c) Rigidity of hours; (d) Difficulty of firing redundant employees; (e) Legally mandated notice period; (f) Mandatory severance pay. For further references on methodological issues, http://www.heritage.org/index/

effect of $IFLM_{t-1}$ on $CP_t$, respectively.

Table 1. Fixed Effects Panel Models

| *CP(t)* | (1) | (2) |
|---|---|---|
| *IFLM(t-1)* | $-0.265$ | |
| | (0.230) | |
| *NMR(t-1)* | 1.934 | 2.793* |
| | (1.217) | (1.208) |
| *IFLM(t-1)*NM(t-1)* | $-0.039$* | $-0.051$** |
| | (0.017) | (0.017) |
| *Constant* | 68.446*** | 52.214*** |
| | (14.974) | (0.707) |
| *F* | 381.98 | 34.58 |
| *Prob>F* | 0.000 | 0.000 |
| *N. Obs.* | 102 | 102 |
| *N. Countries* | 36 | 36 |
| *N. Clusters* | 8 | 8 |

Coefficient estimates (robust standard errors in parentheses corrected for clustering; clusters: 1=AT, BE, DK, FIN, F, D, GR, IRL, I, L, NL, P, E, S, UK; 2=BG, CZ, EST, H, LV, LT, M, PL, RO, SK, SLO; 3=HR, IS, N, CH; 4=USA, CA; 5=TR; 6=RUS; 7=AUS, NZ; 8=J) from fixed (at country and time level) panel models using data from 36 country in 2005, 2006, 2007, 2009. Determinants of the crime rate per thousand population, $CP(t)$: $IFLM(t-1)$ is the lagged value of the Index of Freedom in the Labor Market; $NM(t-1)$ is the lagged value of the net migration rate per thousand population; $IFLM(t-1) * NM(t-1)$ is the interaction between $IFLM(t-1)$ and $NM(t-1)$. *,**, and *** denote significance at a level of 0.1, 0.05 and 0.01 respectively.

Empirical results confirm our theoretical results. First, the $IFLM$ does not seem to play any direct, significant role on the per capita crime level of the next period. Second, the coefficient on the net migration rate is positive and slightly significant when we do not control for the direct effect of $IFLM$. Finally, the interaction term between $NMR_{t-1}$ and $IFLM_{t-1}$ shows that labor market flexibility significantly reduces the impact of net migration on per capita crimes. The coefficient of the interaction term is negative and statistically significant. This coefficient is particularly strong ($-0.051$) and significant when we estimate the proper specification of our theoretical model. Therefore, we can compute the threshold value of $IFLM_{t-1}$ above which the relationship between $NMR_{t-1}$ and $CP_t$ becomes negative. Formally, this threshold is given by $\overline{IFLM} = -\frac{\alpha_1}{\alpha_2} = 54.76$. The F-test supports the validity of our regressions, but country-specific effects remain relevant to explain the per capita crime rate. To conclude, together with the usual determinants of crime, future empirical studies on the relationship between immigration and crime must consider the interaction between immigration and labor market flexibility.

# 5 Extensions

In this section, we discuss some extensions of our theoretical framework. In particular, by starting from a stable international equilibrium, we show the effects on the equilibrium crime rates and the migration flows of relaxing specific assumptions of the model. We study the effects of the following variations in country $A$: (i) a change in the (relative) bargaining power of job-seekers and firms; (ii) a negative shock on the profitability of crime due to a decrease in the number of successful crimes or a an increase in the fixed costs of committing criminal activities; (iii) an increase in the labor productivity; and (iv) a change in the structure of mobility costs.

## 5.1 The Role of $\gamma_A$

In this section, we analyze the effects of a (marginal) increase in the bargaining power of workers in country $A$, $\gamma_A$, on the initial international equilibrium. In general, an increase in $\gamma_A$ may lead to a decrease or an increase in the value of being job-seekers according to the characteristics of the labor market. In Appendix B, Lemma B2 proves that, under the usual assumptions on the matching function, if the tightness of the labor market is small enough, for a wide range of $\gamma_A \in [0, 1]$, we have that $\frac{dx_A(n_A)}{d\gamma_A} < 0$. In this case, when $\gamma_A$ increases, for any level of $n_A$, we will observe a reduction in $x_A(n_A)$. For the domestic market, this implies the following inequality $x_A(n_A) < \Pi(P_A, n_A)$ and, by the assumption that the domestic markets adjust instantaneously, $n_A$ increases and $\Pi(P_A, n_A)$ decreases. In terms of no migration conditions, the previous considerations imply that $x_A(n_A) = \Pi(P_A, n_A) < \Pi(P_B, n_B) = x_B(n_B)$.

Thus, inhabitants in country $A$ have an incentive to migrate to country $B$. In terms of Figure 2, the $D_A$ curve shifts up. At the end of the process, we can have higher or lower values of the crime rate $n_A^*$. For instance, in the case of Figure 2.b, an upward shift in curve $D_A$ will cause a decrease in $n_A^*$, while in the other two cases we will observe a higher level of the equilibrium crime rate $n_A^*$. Vice versa, for countries in which $\frac{dx_A(n_A)}{d\gamma_A} > 0$, an increase in the bargaining power of workers, through a downward shift in curve $D_A$, will cause the opposite effects on the equilibrium crime rate $n_A^*$.

## 5.2 Labor Productivity and Skilled Immigrants

Now, we consider the effects of an increase in the labor productivity of country $A$. In Appendix B, we show that the higher the productivity of country $A$, the higher the tightness of the domestic labor market. Ceteris paribus, this implies an increase in the value of being job-seekers such that $x_A(n_A) > \Pi(P_{A,} n_A)$. As a consequence, $n_A$ decreases. The reduction in the crime rate in country $A$ increases both $x_A(n_A)$ and $\Pi(P_{A,} n_A)$. By the no migration conditions, agents in country $B$ move to country $A$. If country $A$ is characterized by high values of $\phi(n_A)$ and $\eta_{\phi(n_A)k(n_A)}$ (i.e., high rates of job creation), migration inflows imply a further decrease of $n_A$. Moreover, by Equation (22) and Proposition B6, the previous considerations also imply a reduction in the crime rate in country $B$. Again, as in the other extensions, an increase in the labor productivity of country $A$ implies a downward shift in the domestic locus of country $A$. In other words, public policies as well as technological innovations that increase labor productivity reduce crime.

If we assume a certain degree of substitutability between skilled and unskilled workers, when immigrants are relatively skilled workers, we may expect the average productivity to increase and then a decrease in the crime rate. Similarly, in a search model with two different types of work, educated immigrants enter the skilled labor market in which typically workers earn higher wages and face a lower unemployment duration. That is, even in this case we expect a reduction in the crime rate. Obviously, in real economies these two effects coexist and some educated immigrants enter the unskilled labor market, increasing the average productivity and reducing crime.

### 5.3 Profitability of Crime

We now turn to the profitability of crime, and we consider two variations. First, we analyze the effects of a decrease in the number of successful crimes, $Q(P_A)$. For instance, assume that police services in country $A$ become more efficient. Therefore, according to our setting, the probability to be caught increases for any level of $n_A$, and $Q(P_A)$ decreases. Recalling Equation (11),

$$\Pi(P_{A,}n_A) = \frac{Q(P_A)}{n_A P_A} K_A - F_A - k(n_A), \tag{25}$$

we can say that, when $Q(P_A)$ decreases, ceteris paribus, the profits from criminal activities decrease. For a given crime rate, this makes $x_A(n_A) > \Pi(P_{A,}n_A)$. Given the assumption of instantaneous adjustment of the domestic markets, both the number of criminals and the crime rate decrease. As a consequence, if $\frac{dx_A(n_A)}{dn_A} < 0$, then the previous considerations imply an increase in both $x_A(n_A)$ and $\Pi(P_{A,}n_A)$. Thus, $x_A(n_A) = \Pi(P_{A,}n_A) > \Pi(P_{B,}n_B) = x_B(n_B)$, and, by the no migration conditions, inhabitants of country $B$ have an incentive to migrate to country $A$. If country $A$ is characterized by high job creation rates (i.e., high values of $\phi(n_A)$ and $\eta_{\phi(n_A)k(n_A)}$), migration inflows will lead to a further decrease in the crime rate in country $A$. Similarly, country $B$ registers migration outflows and, by (22) and Proposition B6, a reduction in the crime rate. The opposite is true when country $A$ is characterized by low job creation rates (i.e., low values of $\phi(n_A)$ and $\eta_{\phi(n_A)k(n_A)}$). By the same reasoning, we obtain opposite results when $\frac{dx_A(n_A)}{dn_A} > 0$. In terms of Figure 2, the $D_A$ curve shifts down. At the end of the process, we can have higher or lower values for the crime rate $n_A^*$. For instance, in the case of Figure 2.b, a downward shift in $D_A$ will cause an increase in $n_A^*$, while in the other two cases we will observe a lower level of the equilibrium crime rate $n_A^*$.

Second, we show how results change when the fixed costs of committing crimes in country $A$ increase. For any pair $(P_A, n_A)$, higher fixed costs of crime imply a lower value of $\Pi(P_A, n_A)$ and then a lower crime rate in country $A$ due to an increase in the number of job-seekers. Given $P_A$, in the new domestic equilibrium, country $A$ registers higher (lower) values of $x_A(n_A)$ and $\Pi(P_{A,}n_A)$ when $\frac{dx_A(n_A)}{dn_A} < 0$ ($\frac{dx_A(n_A)}{dn_A} > 0$). The conclusions (as well as the graphic representation) coincide with those associated with a decrease in $Q(P_A)$.

### 5.4 The Role of Mobility Costs

Suppose that migration is associated with some mobility costs ($m_i$) such that agents living in country $B$ who move to country $A$ bear costs $m_B$ while agents migrating from country $A$ to country $B$ incur costs $m_A$. Let us assume that $m_B > m_A$. Then $m_B - m_A \equiv \Delta m > 0$. The no mobility conditions (16) and (15) become:

$$x(n_A) = x(n_B) + \Delta m, \tag{26}$$

$$\Pi(P_A, n_A) = \Pi(P_B, n_B) + \Delta m. \tag{27}$$

Let $(\widehat{P}_A, \widehat{n}_A, \widehat{P}_B, \widehat{n}_B)$ be the population sizes and the crime rates of the two countries in the international equilibrium when $\Delta m > 0$. It follows that $\Pi(\widehat{P}_A, \widehat{n}_A) = x(\widehat{n}_A) > x(\widehat{n}_B) = \Pi(\widehat{P}_B, \widehat{n}_B)$, implying $\widehat{P}_A < P_A^*$, where $P_A^*$ still indicates the equilibrium size of the population when there are no mobility costs. Now, since $\widehat{P}_A < P_A^*$, when the relationship between $P_A$ and $n_A$ is negative (see Figure 2.a), we will have $\widehat{n}_A > n_A^*$; moreover, Proposition 3 implies that $\widehat{n}_B > n_B^*$. That is, when the domestic locus of one country presents a negative slope, then the mobility costs increase the equilibrium crime rates of both countries. Similarly, when the relationship between $P_A$ and $n_A$ is positive (Figures 2.b and 2.c.) we will have $\widehat{n}_A < n_A^*$. That is, when the mobility costs to migrate from $B$ to $A$ are relatively higher than the mobility costs to migrate from $A$ to $B$, then country $A$ will experience a lower crime rate. Concerning country $B$, $\widehat{n}_B < n_B^*$ when $\frac{dn_B^D(P_B)}{dP_B} < 0$ (Figure 2.b) and $\widehat{n}_B > n_B^*$ when $\frac{dn_B^D(P_B)}{dP_B} > 0$ (Figure 2.c).

## 6 Conclusion

Does immigration cause crime? The empirical evidence is puzzling. We highlight the role of the structure of labor market and crime activities in defining the nature of this relationship. To analyze the interplay between immigration, unemployment and crime, we have developed a two-country model in which agents can choose between looking for legal jobs and committing crime either in their country or abroad. Our main result draws attention to the role of the elasticity of the tightness of the domestic labor market with respect to the victimization cost on defining how immigration and crime relate. If this elasticity is sufficiently high relative to the variation of total amount of crime with respect to immigration, an increase in the population size due to migration inflows is associated with a decrease in the crime rate of the host country. The opposite holds when the elasticity of the tightness is too small. As far as we know, this is the first contribution to underline the interplay between the elasticity of the labor market of the host country and the sign of the relationship between immigration and crime.[19]

Our model offers several additional insights to better understand the relationship between immigration and crime. First, crime is endemic to any economic system such that there are no equilibria in which the crime rate of a country is null. Second, migration flows from countries with strong work rigidities to societies characterized by more elastic labor markets are mutually benefic in terms of reducing the corresponding crime rates. Finally, although highly stylized, our results contribute to the debate on the effects of restrictive immigration policies. The controversial Bossi-Fini law[20] aimed at reforming the Italian immigration system is a valid example of such institutional interventions. According to the law, only those immigrants who prove they have a regular and permanent job in Italy are entitled to apply for a visa. Our model questions the efficacy of this legislative intervention by sharing the idea that *'to crack down on crime, closing the nation's doors is not the answer.'*[21] Indeed, in the most optimistic scenario, the inflows of *regular* foreign workers induced by the law would exert pressure on both the labor market and the criminal activity of the host country. In the former, the lower number of available positions would reduce the expected profits of native job-seekers. In the latter, the increase in the size of the population would stimulate the criminal activity through the expected profits of crime. For the marginal native agent, committing a crime would become more profitable than looking for a job. As a result, rather than producing significant effects on the size of the crime rate, the law would only modify the composition of the criminal population, with an increase in the share of natives compared to foreigners. On the contrary, policies aimed at improving the flexibility of the labor market and/or the productivity of workers are more effective in terms of crime dissuasion.

Several aspects of our model are worthy of further research. For instance, it might be interesting to study the effects of heterogeneous unemployment duration between foreigners and

[19]Engelhardt (2010) studies the effects of rigidities of the labor market on the incarceration rate. He finds that unemployed are incarcerated two times faster than low wage workers and four times faster than high wage workers.

[20]July 30th, 2002, n. 189.

[21]R. Sampson, New York Times, March 11th, 2006.

natives on migration flows and crime rates. Second, one might study how different immigration policies affect the probability of natives and immigrants to engage in criminal activities. Last (but not least), our model could be extended to the case of organized crime in order to study how immigration policies affect the profits of criminal organizations.

## References

Alonso, C, N. Garupa, M. Perera and P. Vazquez (2008). Immigration and Crime in Spain, 1999–2006. Fundación de Estudios de Economía Aplicada, Documento de Trabajo 2008-43.

Bauer, T. K, M. Lofstrom, and K. F. Zimmermann (2000). Immigration Policy, Assimilation of Immigrants and Natives' Sentiments Towards Immigrants: Evidence from 12 OECD Countries. IZA Discussion Paper No. 187.

Becker, G. S. (1968). Crime and Punishment: An Economic Approach. Journal of Political Economy, 76(2), 169-217.

Bianchi, M, P. Buonanno and P. Pinotti (2011). Do Immigrants Cause Crime? Journal of the European Economic Association, forthcoming.

Borjas, G, J. Grogger and G. Hanson (2006). Immigration and African-American Employment Opportunities: The Response of Wages, Employment, and Incarceration to Labor Supply Shocks. NBER Working Paper No. 12518.

Burdett, K, R. Lagos and R. Wright (2003). Crime, Inequality and Unemployment. American Economic Review, 93(5), 1764-1777.

Burdett, K, R. Lagos and R. Wright (2004). An On-The-Job Search Model Of Crime, Inequality, And Unemployment. International Economic Review, 45(3), 681-706.

Butcher, K. F., A. M. Piehl (2007). Why are Immigrants' Incarceration Rates so Low? Evidence on Selective Immigration, Deterrence, and Deportation. NBER Working Papers 13229.

Chamlin, M. B., J. K. Cochran (2004). An Excursus on the Population Size-Crime Relationship. Western Criminology Review, 5(2), 119-130.

Diamond, P. A. (1981). Mobility Costs, Frictional Unemployment and Efficiency. Journal of Political Economy, 89, 798-812.

Diamond, P. A. (1982a). Aggregate Demand Management in Search Equilibrium. Journal of Political Economy, 90, 881-894.

Diamond, P. A. (1982b). Wage Determination and Efficiency in Search Equilibrium. Review of Economic Studies, 49, 217-227.

Engelhardt, B. (2010). The Effect of Employment Frictions on Crime. Journal of Labor Economics, 28(3), 677-718.

Engelhardt, B, G. Rocheteau and P. Rupert (2008). Crime and the Labor Market: A Search

Model with Optimal Contracts. Journal of Public Economics, 92, 1876-1891.

Harris, J. R. and M. P. Todaro (1970). Migration, Unemployment and Development: A Two-Sector Analysis. American Economic Review, 60 (1), 126–142.

Martinez, R, and M. Lee (2000). On Immigration and Crime. In Gary LaFree (ed.) Criminal Justice: The Changing Nature of Crime, 1, 485–524. Washington, DC: National Institute of Justice.

Macionis, J. J. and K. Plummer (2008). Sociology: A Global Introduction. Pearson Education Limited, 4th ed., Harlow, Essex.

Moehling, C, A. M. Piehl (2007). Immigration and Crime in Early 20th Century America. NBER Working Papers 13576.

Mortensen, D. T. (1982a) The Matching Process as a Noncooperative/Bargaining Game, in J. J. McCall, ed. The Economics of Information and Uncertainty (University of chicago Press, Chicago, IL), 233-254.

Mortensen, D. T. (1982b). Property Rights and Efficiency in Mating, Racing and Related Games. American Economic Review, 72, 968-979.

Mortensen, D. T. (1986) Job Search and Labor Market Analysis, in O. Ashenfelter and R. Layard, eds., Handbook in Labor Economics (North, Holland, Amsterdam), 849-919.

Mortensen, D. T. and C. A. Pissarides (1999) New Developments in Models of Search in the Labor MArket, in O. Ashenfelter and D. Card, eds., Handbook in Labor Economics (North, Holland, Amsterdam), 2567-2627.

Ortega, J. (2000). Pareto-Improving Immigration in an Economy with Equilibrium Unemployment. Economic Journal, 110, 92-112.

Pissarides, C. A. (1984a). Short-run Equilibrium Dynamics of Unemployment, Vacancies and Real Wages. American Economic Review, 75, 676-690.

Pissarides, C. A. (1984b). Efficient Job Rejection. Economic Journal Conference Papers, 94, 97-108.

Pissarides, C. A. (2000). Equilibrium Unemployment Theory. MIT, Cambridge.

Reid, L. W, H. E. Weiss, R. M. Adelmana, C. Jareta (2005). The Immigration–Crime Relationship: Evidence Across US Metropolitan Areas. Social Science Research, 34(4), 757-780.

Sah, R. K. (1991). Social Osmosis and Patterns of Crime. Journal of Political Economy, 99(6), 1272-95.

Sampson, R. (2008). Rethinking Crime and Immigration. Contexts, 7, 28-33.

Stevens, M. (2007). New Microfoundations for the Aggregate Matching Function. International Economic Review, 48(3), 847-868.

# Appendix

## A Proofs of the Main Results

**Proposition 1.** *An autarkic equilibrium always exists.*

**Proof of Proposition 1.** The equilibrium crime rate, $n_A^*$, is determined by functions $\Pi(P_A, n_A)$ and $x(n_A)$. As $n_A$ goes to zero, $\lim_{n_A \to 0^+} \Pi(P_A, n_A) = \infty$ and $\lim_{n_A \to 0} x_A(n_A) = \frac{\gamma}{1-\gamma} c_A \phi_0 < \infty$, where $\phi_0 < \infty$ denotes the value of the market tightness when $n_A = 0$. From Equation (11), $\Pi(P_A, n_A)$ is decreasing in $n_A$, with $\Pi(P_A, 1) = \frac{Q(P_A)}{P_A} K_A - F_A - k(1)$; moreover, both functions $\Pi(P_A, n_A)$ and $x_A(n_A)$ are continuous on the interval $n_A \in (0, 1]$. Therefore, since $\Pi(P_A, 0) > \frac{\gamma}{1-\gamma} c_A \phi_0, \forall P_A \in (0, P]$, two cases are possible:

a) $\exists\ n_A^* \in (0, 1]$ such that $\Pi(P_A, n_A^*) = x(n_A^*)$

b) $\Pi(P_A, n_A) > x(n_A)$, $\forall n_A \in (0, 1]$

In the first case, an interior equilibrium, $n_A^*$, exists. The second case implies the existence of a corner solution in which the expected profit from crime is higher than the value of being job-seekers for any admissible and strictly positive crime rate. Thus, it is profitable for all agents to engage in criminal activities implying $n_A^* = 1$.■

**Corollary 1.** *There is no autarkic equilibrium with* $n_A^* = 0$.

**Proof of Corollary 1.** By contradiction, suppose that there exists an equilibrium in which $n_A^* = 0$. By Equation (11), $\lim_{n_A \to 0^+} \Pi(P_A, n_A) = \infty$. Moreover, by Equation (9), $\lim_{n_A \to 0} x_A(n_A) = \frac{\gamma}{1-\gamma} c_A \phi_0$. This implies that, as $n_A$ goes to zero, $\Pi_A(P_A, n_A) > x_A(n_A)$, $\forall P_A$. Therefore, for some agents it is profitable to commit a crime.■

**Proposition 2.** *An international equilibrium exists.*

**Proof of Proposition 2.** By Definition 2, an equilibrium is associated to both a population size, $P_A^*$, and a crime rate, $n_A^*$. Since the domestic locus of country $A$ is continuous on $(0, P] \times (0, 1]$ and the international locus is defined on $[0, P) \times (0, 1]$, three cases are possible:

1) $\exists P_A^* \in (0, P) : n_A^* = n_A^I(P_A^*) = n_A^D(P_A^*)$, thus $(P_A^*, n_A^*)$ will be an interior international equilibrium.

2) $n_A^I(P_A) < n_A^D(P_A)$, $\forall P_A \in (0, P)$. Since $n_A^I(P_A)$ represents the crime rate of country $A$ that satisfies the no migration condition (15) for given population $P_B = P - P_A$ and crime rate $n_B^D(P - P_A)$ in country $B$, then it follows that $\Pi(P_A, n_A^D(P_A)) < \Pi(P_A, n_A^I(P_A)) =$

$\Pi(P_A, n_B^D(P - P_A))$, $\forall P_A \in (0, P)$. Therefore, through the migration flows from country $A$ to country $B$, the international equilibrium collapses into a situation in which the crime rate of country $B$ is determined by the domestic locus of country $B$ at $P_B = P$.

3) $n_A^I(P_A) > n_A^D(P_A)$, $\forall P_A \in (0, P)$. Since $n_A^I(P_A)$ represents the crime rate of country $A$ that satisfies the no migration condition (15) for given population $P_B = P - P_A$ and crime rate $n_B^D(P - P_A)$ in country $B$, then it follows that $\Pi(P_A, n_A^D(P_A)) > \Pi(P_A, n_A^I(P_A)) = \Pi(P_A, n_B^D(P - P_A))$, $\forall P_A \in (0, P)$. Therefore, through the migration flows from country $B$ to country $A$, the international equilibrium collapses into a situation in which the crime rate of country $A$ is determined by the domestic locus of country $A$ at $P_A = P$.■

**Proposition 3.** *With no loss of generality, suppose that in a neighborhood of a stable international equilibrium, country $A$ is characterized by a negative relationship between $P_A$ and $n_A$ while the opposite holds for country $B$. Then, migration flows from country $B$ to country $A$ reduce the crime rates of both countries. Vice versa, migration flows from country $A$ to country $B$ increase the crime rates of both countries.*

**Proof of Proposition 3.** We must prove that, given the stability condition, when $\frac{dn_A^D(P_A^*)}{dP_A} < 0$, we also have $\frac{dn_B^D(P_B^*)}{dP_B} > 0$. Stability of the international equilibrium requires $\frac{dn_A^D(P_A^*)}{dP_A} > \frac{dn_A^I(P_A^*)}{dP_A}$, that is $\frac{dn_A^I(P_A^*)}{dP_A} < 0$. Thus, given condition (22), we can conclude that $\frac{dn_B^D(P_B^*)}{dP_B} > 0$.■

**Proposition 4.** *If the absolute value of $\eta_{\phi(n_A),k(n_A)}$ is sufficiently high, then there is a negative relationship between $n_A$ and $P_A$.*

**Proof of Proposition 4.** By Equation (11), we have that

$$\frac{\partial \Pi(P_A, n_A)}{\partial P_A} = \frac{dQ(P_A)}{dP_A} \frac{1}{n_A P_A} K_A - \frac{Q(P_A)}{n_A P_A^2} K_A, \tag{A5}$$

and

$$\frac{\partial \Pi(P_A, n_A)}{\partial n_A} = -\frac{Q(P_A)}{n_A^2 P_A} K_A - \frac{dk(n_A)}{dn_A} \tag{A6}$$

Thus,

$$\frac{\partial \Pi(P_A, n_A)}{\partial P_A} = \frac{dQ(P_A)}{dP_A} \frac{1}{n_A P_A} K_A + \left[ \frac{\partial \Pi(P_A, n_A)}{\partial n_A} + \frac{dk(n_A)}{dn_A} \right] \frac{n_A}{P_A} \tag{A7}$$

Then, the domestic locus has a negative slope if and only if

$$\frac{dQ(P_A)}{dP_A}\frac{1}{n_A P_A}K_A + \left[\frac{\partial\Pi(P_A, n_A)}{\partial n_A} + \frac{dk(n_A)}{dn_A}\right]\frac{n_A}{P_A} < 0 \tag{A8}$$

that is,

$$\frac{\partial\Pi(P_A, n_A)}{\partial n_A} < -\frac{dQ(P_A)}{dP_A}\frac{1}{n_A^2}K_A - \frac{dk(n_A)}{dn_A} \tag{A9}$$

Since the stability condition requires $\frac{dx(n_A)}{dn_A} > \frac{\partial\Pi(P_A,n_A)}{\partial n_A}$, a sufficient condition for the previous inequality to hold is

$$\frac{dx(n_A)}{dn_A} < -\frac{dQ(P_A)}{dP_A}\frac{1}{n_A^2}K_A - \frac{dk(n_A)}{dn_A} \tag{A10}$$

From the derivative of (7) w.r.t. $n_A$, given the values of $\gamma_A$ and $\phi(n_A)$, the last inequality implies that the absolute value of $\eta_{\phi(n_A),k(n_A)}$ must be large enough. In this case, along the domestic locus, immigration reduces the crime rate. Moreover, the threshold value of both $\frac{dx(n_A)}{dn_A}$ and $\eta_{\phi(n_A),k(n_A)}$ depends on the variation of $Q(P_A)$ with respect to $P_A$. ■

# B Additional Results

## B.1 Autarky: the One-Country Model

**Lemma B1.** *There exists a strictly negative relationship between $\phi_A(n_A)$ and $n_A$, $\frac{d\phi_A(n_A)}{dn_A} < 0$.*

**Proof of Lemma B1.** By Equation (9), let $G(\phi_A(n_A), n_A)$ be given by

$$\begin{gathered} G(\phi_A(n_A), n_A) = (1-\gamma)\Lambda_A q(\phi_A(n_A)) - (r_A + \delta_A)\Omega_A(n_A) + \\ + q(\phi_A(n_A))(1-\gamma)k(n_A) - q(\phi_A(n_A))\gamma\Omega_A(n_A)\phi_A(n_A). \end{gathered} \tag{A1}$$

By the implicit function theorem, $\frac{d\phi_A(n_A)}{dn_A} = -\frac{\partial G(\phi_A(n_A),n_A)/\partial n_A}{\partial G(\phi_A(n_A),n_A)/\partial\phi_A(n_A)}$, with $\frac{\partial G(\phi_A(n_A),n_A)}{\partial\phi_A(n_A)} \neq 0$. It follows,

$$\frac{d\phi_A(n_A)}{dn_A} = \frac{[\gamma\phi_A(n_A)q(\phi_A(n_A)) + (r_A+\delta_A) - (1-\gamma)q(\phi_A(n_A))]\frac{dk(n_A)}{dn_A}}{[(1-\gamma)(\Lambda_A + k(n_A)) - \gamma\Omega_A(n_A)\phi_A(n_A)]\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} - \gamma\Omega_A(n_A)q(\phi_A(n_A))}. \tag{A2}$$

Since a sensible wage bargaining requires $W_{1,A} > W_{0,A}$, then $\Lambda_A - w_A > 0$. By Equation

(10), the term in squared brackets at the denominator of Equation (A2) is positive. Since $\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} < 0$, the denominator is negative. The sign of the numerator of (A2) is positive when

$$\gamma\phi_A(n_A)q(\phi_A(n_A))\frac{dk(n_A)}{dn_A} + (r_A+\delta_A)\frac{dk(n_A)}{dn_A} > (1-\gamma)q(\phi_A(n_A))\frac{dk(n_A)}{dn_A}.$$

The previous inequality can be rewritten as

$$\gamma\phi_A(n_A)q(\phi_A(n_A)) + (r_A+\delta_A) > (1-\gamma)q(\phi_A(n_A)). \tag{A3}$$

By Equation (9), we have

$$\gamma\phi_A(n_A)q(\phi_A(n_A)) = \frac{(1-\gamma)q(\phi_A(n_A))}{\Omega_A(n_A)}(\Lambda_A + k(n_A)) - (r_A+\delta_A). \tag{A4}$$

By replacing Equation (A4) in (A3), it follows that inequality in (A3) holds when $\Lambda_A > c_A$. Therefore $\frac{d\phi(n_A)}{dn_A} < 0$.■

**Proposition B1.** *The corner solution, $n_A^* = 1$, is the unique autarkic equilibrium if and only if* $\Pi(P_A, n_A) > x(n_A)$, $\forall n_A \in (0, 1]$.

**Proof of Proposition B1.** The proof of the necessary condition proceeds by contradiction. Suppose the corner solution is the unique autarkic equilibrium but $\exists\, \overline{n}_A \in (0, 1]$ such that $\Pi(\overline{n}_A, P_A) \leq x(\overline{n}_A)$. If $\Pi(\overline{n}_A, P_A) = x(\overline{n}_A)$, $\overline{n}_A$ is an equilibrium, contradicting the initial assumption. If $\Pi(\overline{n}_A, P_A) < x(\overline{n}_A)$, since both functions are continuous and $\Pi(n_A, P_A)$ monotonically decreases in $n_A$, $\Pi(0, P_A) > \frac{\gamma}{1-\gamma}c_A\phi_0, \forall P_A \in (0, P]$ implies that there exists another equilibrium $n_A^* \in (0, \overline{n}_A)$ such that $\Pi(P_A, n_A^*) = x(n_A^*)$. The proof of the sufficient condition is trivial. If $\Pi(P_A, n_A) > x(n_A)$, $\forall n_A \in (0, 1]$, then $\nexists\, n_A^* \in (0, 1]$ such that $\Pi(P_A, n_A^*) = x(n_A^*)$.■

**Proposition B2.** *If $\eta_{\phi(n_A),k(n_A)}$ is always larger than a certain critical value $\widetilde{\eta}_{\phi(n_A),k(n_A)}$, then $\frac{dx_A(n_A)}{dn_A} > \frac{\partial\Pi(P_A,n_A)}{\partial n_A}, \forall n_A \in (0, 1]$, and the autarkic equilibrium is unique.*

**Proof of Proposition B2.** First, we prove that if $\frac{dx_A(n_A)}{dn_A} > \frac{\partial\Pi(P_A,n_A)}{\partial n_A}, \forall n_A \in (0, 1]$, the autarkic equilibrium is unique. Let $n_A^*$ be the equilibrium crime rate in country $A$ when population is $P_A$ such that $x(n_A^*) = \Pi(P_A, n_A^*)$. Since $\Pi(0, P_A) > \frac{\gamma}{1-\gamma}c_A\phi_0, \forall P_A \in (0, P]$, if $\frac{dx_A(n_A)}{dn_A} > \frac{\partial\Pi(P_A,n_A)}{\partial n_A}$, we have $x(n_A) > \Pi(P_A, n_A)$ $\forall n_A \in (n_A^*, 1]$ and $x(n_A) < \Pi(P_A, n_A)$ $\forall n_A \in (0, n_A^*)$. Then, by continuity of $x(n_A)$ and $\Pi(P_A, n_A)$ in $n_A \in (0, 1]$, it follows that the equilibrium is unique.

Now, we prove that $\frac{dx_A(n_A)}{dn_A} > \frac{\partial \Pi(P_A,n_A)}{\partial n_A}$, $\forall n_A \in (0,1]$, implies the existence of a threshold value $\widetilde{\eta}_{\phi(n_A),k(n_A)}$ such that for $\eta_{\phi(n_A),k(n_A)} > \widetilde{\eta}_{\phi(n_A),k(n_A)}$, $\forall n_A \in (0,1]$, the autarkic equilibrium is unique. By differentiating (7) with respect to $n_A$ and imposing $\frac{dx_A(n_A)}{dn_A} > \frac{\partial \Pi(P_A,n_A)}{\partial n_A}$, $\forall n_A \in (0,1]$, it follows that

$$\frac{dk(n_A)}{dn_A}\left\{\frac{\gamma}{1-\gamma}\left[\phi(n_A)+\Omega_A(n_A)\frac{d\phi(k(n_A))}{dk(n_A)}\right]-1\right\} > -\frac{Q(P_A)}{n_A^2 P_A}K_A - \frac{dk(n_A)}{dn_A}. \tag{B1}$$

That is,

$$\eta_{\phi(n_A),k(n_A)} > \widetilde{\eta}_{\phi(n_A),k(n_A)} \tag{B2}$$

where $\widetilde{\eta}_{\phi(n_A),k(n_A)} \equiv \frac{1-\gamma}{\gamma}\frac{1}{\phi(n_A)}\left(-\frac{Q(P_A)}{n_A^2 P_A}K_A\frac{1}{\frac{dk(n_A)}{dn_A}}-1\right)-1$. Therefore, if $\eta_{\phi(n_A),k(n_A)} > \widetilde{\eta}_{\phi(n_A),k(n_A)}$, $\forall n_A \in (0,1]$, the following inequality holds: $\frac{dx_A(n_A)}{dn_A} > \frac{\partial \Pi(P_A,n_A)}{\partial n_A}$, $\forall n_A \in (0,1]$.■

**Proposition B3.** *An interior equilibrium is stable if and only if* $\frac{dx_A(n_A^*)}{dn_A} > \frac{\partial \Pi(P_A,n_A^*)}{\partial n_A}$.

**Proof of Proposition B3.** First, we focus on the sufficient condition. Let $n_A^* \in (0,1)$ be the equilibrium crime rate. Consider an increase from $n_A^*$ to $n_A^*+\varepsilon$, with $\varepsilon > 0$ small enough. If $x_A(n_A^*+\varepsilon) > \Pi(n_A^*+\varepsilon, P_A)$, at $n_A^*+\varepsilon$, unemployment is more profitable than crime. Thus, both the number and the proportion of criminals decrease and the economy moves back to the initial equilibrium. Now, consider a reduction of the crime rate from $n_A^*$ to $n_A^*-\varepsilon$. It is easy to check that $n_A^*$ is stable if $x_A(n_A^*-\varepsilon) < \Pi(n_A^*-\varepsilon, P_A)$. Since functions $x_A(n_A^*)$ and $\Pi(P_A, n_A^*)$ are differentiable, we can consider the limit as $\varepsilon$ goes to zero. The two conditions collapse into the following expression:

$$\frac{dx_A(n_A^*)}{dn_A} > \frac{\partial \Pi(P_A,n_A^*)}{\partial n_A} \tag{B3}$$

Moving to the necessary condition, by contradiction, suppose that the domestic equilibrium is stable and that $\frac{dx_A(n_A^*)}{dn_A} < \frac{\partial \Pi(P_A,n_A^*)}{\partial n_A}$. Since the equilibrium is (locally) stable, after any small perturbation, the economy must go back to the initial equilibrium. Consider a negative perturbation that makes the economy to pass from $n_A^*$ to $n_A^*-\varepsilon$. Since the equilibrium is stable the proportion of criminals must increase from $n_A^*-\varepsilon$ to $n_A^*$. But since we have assumed that $\frac{dx_A(n_A^*)}{dn_A} < \frac{\partial \Pi(P_A,n_A^*)}{\partial n_A}$, the reduction in the value of unemployment, $x_A(n_A^*)$, is smaller than the reduction in the value of crime, $\Pi(P_A, n_A^*)$, i.e. $x_A(n_A^*-\varepsilon) > \Pi(n_A^*-\varepsilon, P_A)$. This contradicts the hypothesis of stability.■

**Corollary B1.** *If the autarkic equilibrium is unique, then the equilibrium is stable.*

**Proof of Corollary B1.** Recall that $\lim_{n_A \to 0^+} \Pi(P_A, n_A) = \infty$ and $\lim_{n_A \to 0} x_A(n_A) = \frac{\gamma}{1-\gamma} c_A \phi_0$ (see Equations (11) and (9), respectively). This implies that, as $n_A$ goes to zero, $\Pi_A(P_A, n_A) > x_A(n_A)$, $\forall P_A$. When an interior equilibrium is unique, $\exists n_A^* \in (0,1) : \Pi(P_A, n_A^*) = x(n_A^*)$ and, by continuity of $\Pi(P_A, n_A)$ and $x_A(n_A)$, $\forall \varepsilon \in (0, n_A^*)$, $\Pi(n_A^* - \varepsilon, P_A) > x(n_A^* - \varepsilon)$.

That is,

$$\frac{x(n_A^*) - x(n_A^* - \varepsilon)}{\varepsilon} > \frac{\Pi(P_A, n_A^*) - \Pi(n_A^* - \varepsilon, P_A)}{\varepsilon} \tag{B4}$$

as $\varepsilon$ goes to zero, the previous expression collapses into

$$\frac{dx_A(n_A^*)}{dn_A} > \frac{\partial \Pi(P_A, n_A^*)}{\partial n_A} \tag{B5}$$

which is the condition to have stability of an interior equilibrium.

Assume $\Pi(P_A, n_A) > x(n_A)$, $\forall n_A \in (0,1]$, then the unique equilibrium is the corner solution, $n_A^* = 1$ (see Proposition 1). Thus, $\forall \varepsilon \in (0, n_A^*)$, $\Pi(n_A^* - \varepsilon, P_A) > x(n_A^* - \varepsilon)$ and some agents find profitable to commit a crime implying that the corner solution is stable.■

**Corollary B2.** *Let the equilibria of the model be ordered according to the corresponding crime rates in* $[\underline{n_A^*}, \overline{n_A^*}]$, *with* $\underline{n_A^*} > 0$ *and* $1 \geq \overline{n_A^*} > \underline{n_A^*}$, *representing the highest and the lowest equilibrium crime rates, respectively. The equilibrium associated with* $\underline{n_A^*}$ *is stable.*

**Proof of Corollary B2.** For a given size of the population of country $A$, $P_A$, we have multiple equilibria if and only if there are at least two crime rates, $\underline{n_A^*}$ , $\overline{n_A^*} \in (0,1]$ that satisfy Equation (12). Without loss of generality, suppose $\underline{n_A^*}$ is the lowest equilibrium level of the crime rate: $\underline{n_A^*} < \overline{n_A^*}$. As $n_A$ goes to zero, $\Pi_A(P_A, n_A) > x_A(n_A)$. Thus, by the continuity of $\Pi(P_A, n_A)$ and $x_A(n_A)$ and the fact that $x(\underline{n_A^*}) = \Pi(P_A, \underline{n_A^*})$, it follows that $\exists \varepsilon > 0 :$ $\Pi(\underline{n_A^*} - \varepsilon, P_A) > x(\underline{n_A^*} - \varepsilon)$. That is,

$$x(\underline{n_A^*}) - x(\underline{n_A^*} - \varepsilon) > \Pi(P_A, \underline{n_A^*}) - \Pi(\underline{n_A^*} - \varepsilon, P_A). \tag{B6}$$

By taking the limit of this inequality as $\varepsilon$ goes to zero,

$$\frac{dx_A(\underline{n_A^*})}{dn_A} > \frac{\partial \Pi(P_A, \underline{n_A^*})}{\partial n_A}, \tag{B7}$$

which is the condition to have stability of an interior equilibrium.■

## B.2 Open Economy: the Two-Country Model

**Proposition B4.** *If $\eta_{Q(P_A),P_A}, \eta_{Q(P_B),P_B} > \frac{1}{K}$ or $\eta_{Q(P_A),P_A}, \eta_{Q(P_B),P_B} < \frac{1}{K}$, $\forall P_A, P_B \in [0, P]$ with $P_B = P - P_A$ and $\frac{dx_A(n_A)}{dn_A} > \frac{\partial \Pi(P_A, n_A)}{\partial n_A}, \forall n_A \in (0,1]$, $\frac{dx_B(n_B)}{dn_B} > \frac{\partial \Pi(P_B, n_B)}{\partial n_B}, \forall n_B \in (0,1]$, there is a unique international equilibrium.*

**Proof of Proposition B4.** When $\frac{dx_A(n_A)}{dn_A} > \frac{\partial \Pi(P_A,n_A)}{\partial n_A}, \forall n_A \in (0,1]$, by Proposition B2, the equilibrium crime rate is unique for any size of the population. At the same time, if $\eta_{Q(P_A),P_A} > \frac{1}{K_A}$ (or $< \frac{1}{K_A}$) $\forall P_A \in (0, P]$, the profit function is always increasing (or decreasing) in $P_A$ implying the monotonicity of the domestic locus for country $A$. If $\eta_{Q(P_B),P_B} > \frac{1}{K_A}$ (or $< \frac{1}{K_A}$) $\forall P_A \in (0, P]$ also the domestic locus of $B$ is monotonically increasing (or decreasing) in $P_B$, thus from Equation (22) we can conclude that the international locus is always decreasing (or increasing) in $P_A$. Thus, the international equilibrium is also unique.■

**Proposition B5.** *If the international equilibrium is unique, then it is associated with a unique pair $(n_A^*, n_B^*)$.*

**Proof of Proposition B5.** Let $(P_A^*, n_A^*)$ be the size of the population and the crime rate of country $A$ associated with the unique international equilibrium. In country $B$ there is a unique equilibrium population size, $P_B^* = P - P_A^*$, and a unique equilibrium crime rate, $n_B^* = k_B^{-1}(k_A(n_A^*)$. By contradiction, suppose there is another equilibrium crime rate $n_B^{**}$ that is compatible with $P_B^*$ :

$$x(n_A^*) = x(n_B^*) = \Pi(P_B^*, n_B^*) = x(n_B^{**}) = \Pi(P_B^*, n_B^{**}) \tag{B8}$$

This equality violates the monotonicity of $\Pi(P_B^*, n_B)$ with respect to $n_B$.■

**Proposition B6.** *Let $(P_A^*, n_A^*)$ be an interior international equilibrium. This equilibrium is locally stable if and only if $\frac{dn_A^D(P_A^*)}{dP_A} > \frac{dn_A^I(P_A^*)}{dP_A}$.*

**Proof of Proposition B6.** Suppose $\frac{dn_A^D(P_A^*)}{dP_A} > 0$ and $\frac{dn_A^D(P_A^*)}{dP_A} > \frac{dn_A^I(P_A^*)}{dP_A}$. For $\varepsilon > 0$ small enough, it follows that $n_A^D(P_A^* + \varepsilon) > n_A^I(P_A^* + \varepsilon)$. Since the profits from crime monotonically decrease in the crime rate, it follows that $\Pi(P_A^* + \varepsilon, n_A^D(P_A^* + \varepsilon)) < \Pi(P_A^* + \varepsilon, n_A^I(P_A^* + \varepsilon)) = \Pi(P - P_A^* - \varepsilon, n_B^D(P - P_A^* - \varepsilon))$, with $n_A^I(P_A^* + \varepsilon) = k_A^{-1}(k_B(n_B^D(P - P_A^* - \varepsilon)))$. Therefore, migrations from country $A$ to country $B$ occur until $P_A = P_A^*$ and $n_A^* = n_A^D(P_A^*) = n_A^I(P_A^*)$.

The proof of the proposition when $\frac{dn_A^D(P_A^*)}{dP_A} < 0$ proceeds in an analogous way. We prove the necessary condition by contradiction. Suppose that the domestic equilibrium is stable and $\frac{dn_A^D(P_A^*)}{dP_A} < \frac{dn_A^I(P_A^*)}{dP_A}$. Consider a negative perturbation of $P_A^*$ to $P_A^* - \varepsilon$. Since the equilibrium is stable, the size of the population must converge back to $P_A^*$. However, since $\frac{dn_A^D(P_A^*)}{dP_A} < \frac{dn_A^I(P_A^*)}{dP_A}$, then $n_A^D(P_A^* - \varepsilon) > n_A^I(P_A^* - \varepsilon)$. Given that profits from crime are monotonically decreasing in the crime rate, inhabitants in country $A$ have an incentive to migrate to country $B$, contradicting the hypothesis of stability.■

**Corollary B3.** *If the international equilibrium is unique, then it is stable.*

**Proof of Corollary B3.** By contradiction, suppose that the unique international equilibrium is unstable. If this equilibrium is an interior solution, we have

$$\frac{dn_A^D(P_A^*)}{dP_A} < \frac{dn_A^I(P_A^*)}{dP_A} \tag{B9}$$

Then, $\forall \varepsilon \in (0, P - P_A^*)$, we get $n_A^D(P_A^* + \varepsilon) < n_A^I(P_A^* + \varepsilon)$. This implies $\Pi(P_A^* + \varepsilon, n_A^D(P_A^* + \varepsilon)) > \Pi(P_A^* + \varepsilon, n_A^I(P_A^* + \varepsilon)) = \Pi(P - P_A^* - \varepsilon, n_B^D(P - P_A^* - \varepsilon))$ such that full migration from country $B$ to country $A$ occurs. Thus, the model admits another equilibrium in which $P_A^* = P$ and $n_A^* = n_A^D(P)$. If the unique equilibrium is characterized by full migration, say $P_A^* = P$ and $n_A^* = n_A^D(P)$, and this equilibrium is unstable, it follows that $\Pi(P - \varepsilon, n_A^D(P - \varepsilon)) < \Pi(\varepsilon, n_B^D(\varepsilon))$, $\forall \varepsilon \in (0, P)$. Therefore, another full migration equilibrium in which $P_A^* = 0$ exists, contradicting uniqueness. The proof concerning the case in which the unique unstable equilibrium is $P_B^* = P$ and $n_B^* = n_B^D(P)$ proceeds in an analogous way.■

**Lemma B2.** *If* $\gamma_A \in (\underline{s}(n_A), \overline{s}(n_A))$, with $\underline{s}(n_A) = \frac{\Lambda_A + k_A(n_A)}{\Lambda_A + k_A(n_A) + \Omega_A(n_A)\phi_A(n_A) - \frac{\Omega_A(n_A)(r_A + \delta_A)}{\phi_A(n_A)\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)}}}$ and $\overline{s}(n_A) = \frac{\Lambda_A + k_A(n_A)}{\Lambda_A + k_A(n_A) + \Omega_A(n_A)\phi_A(n_A)}$, then $x_A(n_A)$ *strictly decreases in* $\gamma_A$.

**Proof of Lemma B2.** From Equation (9) we can write

$$q(\phi_A(n_A)) = \frac{\Omega_A(n_A)(r_A + \delta_A)}{(\Lambda_A + k_A(n_A))(1 - \gamma_A) + \gamma_A \Omega_A(n_A)\phi_A(n_A)}, \tag{A11}$$

that is,

$$q(\phi_A(n_A)) = \Psi(\phi_A(n_A), \gamma_A). \tag{A12}$$

By the implicit function theorem,

$$\frac{d\phi_A(n_A)}{d\gamma_A} = \frac{\frac{d\Psi(\phi_A(n_A),\gamma_A)}{d\gamma_A}}{\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} - \frac{d\Psi(\phi_A(n_A),\gamma_A)}{d\phi_A(n_A)}}. \tag{A13}$$

Since $\frac{d\Psi(\phi_A(n_A),\gamma_A)}{d\gamma_A} \geq 0$, $\frac{d\Psi(\phi_A(n_A),\gamma_A)}{d\phi_A(n_A)} \geq 0$ and $\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} < 0$, we conclude that $\frac{d\phi_A(n_A)}{d\gamma_A} \leq 0$. From (7), it follows that

$$\frac{dx_A(n_A)}{d\gamma_A} = \frac{1}{(1-\gamma_A)}\Omega_A(n_A)\phi_A(n_A)\left[\frac{1}{(1-\gamma_A)} + \frac{\gamma_A}{\phi_A((n_A))}\frac{d\phi_A(n_A)}{d\gamma_A}\right]. \tag{A14}$$

From the last two equations, we have that $\frac{dx_A(n_A)}{d\gamma_A} = 0$ when $\gamma_A = \underline{s}(n_A)$ or $\gamma_A = \overline{s}(n_A)$, with $\underline{s}(n_A) \equiv \frac{\Lambda_A + k_A(n_A)}{\Lambda_A + k_A(n_A) + \Omega_A(n_A)\phi_A(n_A) - \frac{\Omega_A(n_A)(r_A+\delta_A)}{\phi_A(n_A)\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)}}}$ and $\overline{s}(n_A) \equiv \frac{\Lambda_A + k_A(n_A)}{\Lambda_A + k_A(n_A) + \Omega_A(n_A)\phi_A(n_A)}$. Since $\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} < 0$, we have that $0 < \underline{s}(n_A) < \overline{s}(n_A) < 1$. Moreover we know that $\lim\limits_{\gamma_A \to 0} \frac{dx_A(n_A)}{d\gamma_A} > 0$ and $\lim\limits_{\gamma_A \to 1^-} \frac{dx_A(n_A)}{d\gamma_A} > 0$. Thus, when $\underline{s}(n_A) < \gamma_A < \overline{s}(n_A)$, then $\frac{dx_A(n_A)}{d\gamma_A} < 0$.■

Notice that when $\phi_A(n_A)$ goes to zero, $\overline{s}(n_A)$ goes to one, while the limit of $\underline{s}(n_A)$ depends on the term $\phi_A(n_A)\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)}$. If this term is increasing in $\phi_A(n_A)$ (as in the case of a Cobb-Douglas function with decreasing returns to scale, the specification most frequently used for $q(\phi_A(n_A))$; see Stevens (2007) for a detailed discussion on matching functions), the term converges to 0.

**Lemma B3.** *$\phi_A(n_A)$ is an increasing function of $\Lambda_A$.*

**Proof of Lemma B3.** As in Lemma B1, we have that $\frac{d\phi_A(n_A)}{d\Lambda_A} = -\frac{\partial G(\phi_A(n_A),n_A)/\partial\Lambda_A}{\partial G(\phi_A(n_A),n_A)/\partial\phi_A(n_A)}$. Thus,

$$\frac{d\phi_A(n_A)}{d\Lambda_A} = -\frac{(1-\gamma)q(\phi_A(n_A))}{(1-\gamma)\Lambda_A\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)} - \gamma(\Lambda_A + k(n_A))(q(\phi_A(n_A)) + \phi_A(n_A)\frac{dq(\phi_A(n_A))}{d\phi_A(n_A)})}. \tag{A15}$$

From Lemma B1 we know that the denominator is negative, so it is easy to check that for a non trivial economy the expression is strictly positive.■