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Refugee Migration: How Is It Affected by Benefits and Foreign Aid? A Theoretical Analysis and Numerical Simulations

Carolina Persson

ABSTRACT

Three features of the refugee crisis in Europe have been (1) the near absence of aid to the countries of origin; (2) the lack of policy coordination among EU member states and; (3) gradually more restrictive refugee policies. My model is designed to capture these features. It analyses explicitly migration decisions and the determination in destination countries of policy instruments that affect migration: benefit levels for migrants and aid to the region of origin. A plausible equilibrium in the model is one with generous benefits but zero aid. Cooperation between destination countries results in much more generous benefits and much higher migration than non-cooperation. Substantial aid to countries of origin is more likely under cooperation. Even a drastic deterioration in living conditions in the region of origin causes in the end only a limited increase in migration. The explanation is that destination countries choose to lower benefits radically in this situation.

To all those who have to leave their homes to become refugees in a foreign country

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1.   Introduction

Recently, the most pressing problem for the EU has been the refugee crisis. However, refugee immigration is not new. During the last twenty years more than six million people have applied for asylum in the EU. As can be seen in Figure 1, there has been a strongly increasing trend. In 2004-2008, the yearly average of asylum seekers was 230 000. In 2011, the number had increased to around 310 000 and in 2014 to around 625 000. The year 2015 saw a virtual explosion to more than 1 320 000. This was mainly due to dramatically increased migration from Syria, Afghanistan and Iraq because of the ongoing conflicts there.
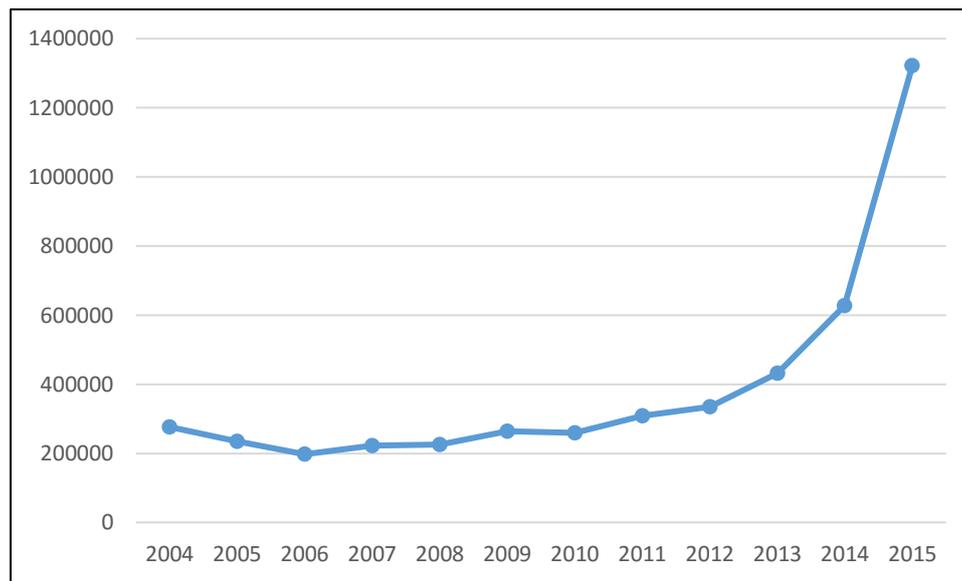
During the acute refugee crisis in 2015, some European countries, in particular Germany, Austria and Sweden, initially admitted large numbers of refugees, but after some time restrictions were imposed. For example, Austria introduced a daily ceiling on the number of refugee immigrants. Sweden tightened border controls, replaced permanent residence permits with temporary ones and made family reunion more difficult. Based on a German proposal, in April 2016 the EU entered an agreement with Turkey according to which boat refugees arriving in Greece from that country would be sent back.

A characteristic feature of the refugee crisis has been the difficulties of coordinating migration policies within the EU. Instead, member states have acted in an uncoordinated way, taking their own decisions without prior consultation with the other states.

Another typical feature of the crisis has been the (near) absence of measures from the EU states to help the countries of origin to deal with the situation domestically in a way that would reduce refugee flows. This could potentially include everything from foreign aid to direct military engagement. The military efforts in Afghanistan by EU states were small and have successively been wound down. Only marginal military interventions in the Syrian conflict have been made. Figure 2 shows that total official development assistance from the EU has remained more or less constant relative to GNI over the last decade. In 2011-2015, total cumulative aid from EU member states and institutions to refugees inside Syria and in neighbouring countries amounted to a mere €6.5 billion. In 2016 only an additional €3 billion were pledged.[1]

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[1] European Commission (2016). The amount of aid can be contrasted with EU28 GDP in 2015, which was €14 635 billion according to
http://ec.europa.eu/eurostat/tgm/download.do?tab=table&plugin=1&language=en&pcode=tec00001.

Figure 1 Asylum Seekers in the EU

Note: The data for 2004-2007 apply to the then 27 member states. The data for 2008-2015 also include Croatia which became a member of the EU in 2008.
Source: Eurostat (2016).

Figure 2 Total Official Development Assistance from EU28, Percent of GNI
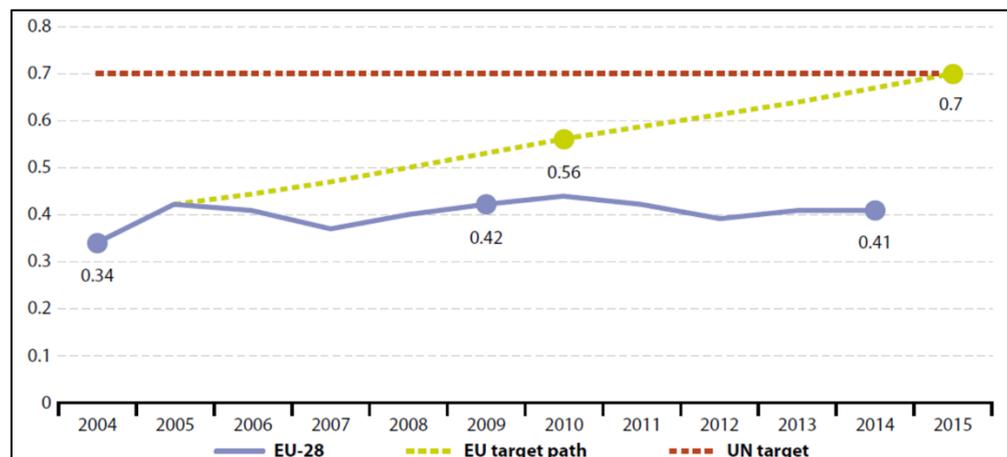
Source: Eurostat (2015).

My aim is threefold: (1) to study what difference to migration it makes whether or not destination countries coordinate their immigration policies; (2) to analyse how migration is affected by a drastic deterioration of living conditions in regions of origin once policy responses in destination countries are taken into account; and (3) to explain why destination countries may end up in a situation with only very small efforts to help the potential refugees in their home countries.

There exists theoretical research on the importance for refugee policies of cooperation versus non-cooperation among destination countries. However, this literature does not explicitly model the migration decisions on the supply side. It only models the demand side, i.e., destination countries are assumed to take direct decisions on the number of refugees admitted. This makes it impossible to analyse the policy instruments that destination countries can use to influence migration.

My study sets up a theoretical model which explicitly analyses the decisions made by refugees. A key question is how migration depends on the destination countries' policy instruments. I focus on two such instruments: benefits offered to migrants (as a proxy for the general conditions made available to them) and foreign aid (as a proxy for all kinds of efforts from the destination countries to alleviate the situation in the region of origin).[2] This allows an analysis of the determination of these policy instruments (which has not been done before) as well as of the determination of the amount of migration. The difference between cooperative and non-cooperative solutions is examined. It is also studied how the policy instruments and migration are affected by changes in the conditions in the countries of origin. Finally, the question under what conditions the model can replicate the real-world feature of very little (no) aid to the countries of origin is analysed.

I assume two countries of destination and one country of origin. The non-cooperative solution is analysed as a Nash equilibrium. The cooperative solution is analysed as the solution chosen by a social planner who maximises the joint utility of the two countries of destination.

Both corner solutions with no aid and interior solutions with positive aid are allowed for. This permits an explain of why a refugee crisis of the type that Europe has been exposed to may or may not trigger assistance to the countries concerned.

The analysis is both qualitative and quantitative. A theoretical part models both the decisions of the migrants and the decisions on policy parameters in the countries of destination. Another part contains numerical simulations to study the quantitative differences between cooperation and non-cooperation as well as the effects of deteriorating living conditions in the country of origin, for instance due to war.

The paper is structured as follows. Section 2 briefly reviews the earlier literature. Section 3 presents the model. Section 4 contains the theoretical analysis and Section 5 the numerical simulations. Section 6 concludes.

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[2] See, e.g., Malm (2016) for an example of a policy discussion where aid is seen as a way of limiting migration.

2. Related Literature

There exists a research literature on the effects of non-cooperation versus cooperation on refugee policies among destination countries. Examples are Facchini et al. (2006), Czaika (2009), Hatton (2011, 2015), and Fernández-Huertes Moraga and Rapoport (2014, 2015, 2016). In these models, refugees are admitted because of altruistic reasons (the humanitarian motive of protecting refugees from persecution) by governments acting in the interest of domestic voters. In, for example, Hatton (2011, 2015), residents of one country benefit from the knowledge that refugees find safety outside their countries of origin independently of whether this occurs domestically or in another destination country. Providing a safe haven to refugees can thus be thought of as a public good. Admitting refugees domestically therefore gives utility also to residents in other potential destination countries. This represents a positive externality. When each country takes decisions individually, there is underprovision of refugee admittance. The externality is internalised under cooperation among destination countries, which results in socially optimal volumes of migration.

The papers referred to above use similar utility functions for destination countries. In the case when there are two such countries, Czaika (2009) assumes the following utility function:

$$U_i = r_i + \beta_i r_j - c_i r_i^2, \qquad i,j = 1,2, i \neq j$$

where U_i is the utility of a representative voter in the destination country i, r_i is the migration to destination country i, r_j is the migration to the destination country j and β_i, c_i are positive preference parameters. The linear terms capture an altruistic motive associated with receiving refugees with different weights for admitting them to one's own country and to the other country. The quadratic term captures disutility from receiving refugees in the own country (xenophobic "dislike of seeing foreigners around"). Marginal disutility is increasing in the number of refugees.

Hatton (2015) uses a utility function similar to Czaika's, the only difference being that there is both a linear and a quadratic disutility term. Hatton's formulation is:

$$U_i = \alpha r_i + \lambda r_j - \beta r_i^2 - c r_i,$$

where $\alpha, \lambda, \beta, c$ are positive parameters.

Facchini et al. (2006) differ from the above papers by assuming heterogeneous, instead of representative, voters, so that decisions are taken by the median voter. The utility function of voter k in country i is:

$$U_{i,k} = [1 + \alpha_{i,k}][r_i + r_j] + ln[1 - \lambda r_i - (1 - \lambda)r_j],$$

where $\alpha_{i,k}, \lambda$ are positive preference parameters. $\alpha_{i,k}$, differs between voters inside each destination country. Receiving refugees to one's own country or to the other country has the same weight. The second term represents disutility from receiving refugees both to one's own country and to the other country. $(1 - \lambda)r_j$ represents a disutility "spillover" effect (because of free movement of refugees between the two countries or trade competition). Again, there is increasing disutility in the amount of migration.

The papers described analyse both cooperative equilibria (social planners' equilibria or Nash bargaining solutions) and non-cooperative ones (Nash equilibria). The cooperative equilibria involve more refugees than the non-cooperative ones due to the internalisation of altruism effects on the other country. A particular feature in Czaika (2009) is the analysis of heterogeneity between the two countries. A twist in Facchini et al. (2006) is the analysis of strategic delegation, i.e., that the median voter can elect a government (another voter) with different preferences in order to maximize utility. Such strategic delegation only occurs in the case of disutility spillovers ($\lambda < 1$).

Similar analyses have been performed by Fernández-Huertas Moraga and Rapoport (2014, 2015, 2016). In their models, the focus is on how refugees are allocated among destination countries. They stress another positive externality of admitting refugees than the papers referred to above: that this reduces migration from a common pool of migrants to other destination countries and thus their costs for receiving refugees. The result is once again underprovision of refugee admittance.

A common deficiency in the above models is that they all are of a reduced-form character where the country of destination takes a direct decision on the amount of migration. There is no modelling of how various policy instruments influence migration. Neither is there any modelling of the decisions of migrants themselves.

3. Model

The model features two countries of destination and one country of origin. The two destination countries are symmetric. Each destination country decides both a benefit level for migrants and how much aid to give to the country of origin. In the latter country, aid is distributed equally among the remaining population. The two policy variables of destination countries should be interpreted in a broad sense. The benefit level can be seen as a proxy for the expected utility a migrant receives in the destination country, thus reflecting not only benefit income but also factors

such as the probability of obtaining a permanent residence permit, the job-finding probability (which among other things depends on labour market policy) and access to housing, education, health care, etc. Foreign aid could be regarded as a proxy not only for monetary contributions but also for diplomatic and military efforts to improve the situation in the country of origin.

3.1 MIGRATION DECISION

When deciding whether or not to migrate from the country of origin, potential migrants take into account the benefit that will be received in the country of destination and compare it with the total income received in the country of origin plus the cost of migrating. The latter two variables should also be interpreted broadly. Income in the country of origin reflects both monetary income and the monetary equivalent of the psychological value attached to living there (which is affected by the extent of conflict/war, criminality, the lack of a well-functioning state, etc.). Income in the country of origin defined in this way is common to all individuals living there. The migration cost captures monetary and psychological costs (disutility of leaving the country of origin, risks of life associated with dangerous transportation provided by people smugglers, etc.) that are individual-specific.

I make the simplifying assumption that the population in the country of origin consists of two equally large groups: one group that only contemplates migrating to destination country 1 and one group that only contemplates migrating to destination country 2. A person will migrate to country i if there is a net income gain from that. This is the case if:

$$b_i > S + \frac{\sum A_k}{m_S - \sum r_k} + C, \qquad i, k = 1, 2$$

where b_i is the benefit received in country i, S is the *own* per-capita income (excluding aid from the destination countries) in the country of origin, $\sum A_k$ is the sum of aid from the two destination countries received by the country of origin, C is the migration cost, m_S is the total population in the country of origin and r_k is migration to country k. The total income of a person remaining in the country of origin is thus the person's own income S plus the total amount of aid divided by the remaining population, $\sum A_k/(m_S - \sum r_k)$.

The migration cost differs among individuals. The probability of a certain migration cost is given by a uniform probability density function with finite support $[0, \bar{C}]$. Hence the number of persons with migration cost

$$C < b_i - S - \frac{\sum A_k}{m_S - \sum r_k},$$

which equals migration to country i, r_i, is

$$r_i = \int_0^{b_i - S - \frac{\sum A_k}{m_S - \sum r_k}} \frac{m_S}{2\bar{C}} \, dC = \frac{m_S}{2\bar{C}} \, [C]_0^{b_i - S - \frac{\sum A_k}{m_S - \sum r_k}} = \left(b_i - S - \frac{\sum A_k}{m_S - \sum r_k} \right) \frac{m_S}{2\bar{C}}. \quad (1)$$

The maximum number of individuals migrating to country i is half the population in the country of origin. Everyone in this half will migrate if

$$b_i - S - \frac{\sum A_k}{m_S - \sum r_k} \geq \bar{C}.$$

Figure 3 The shaded area is the fraction of half the population that chooses to migrate to destination country *i*
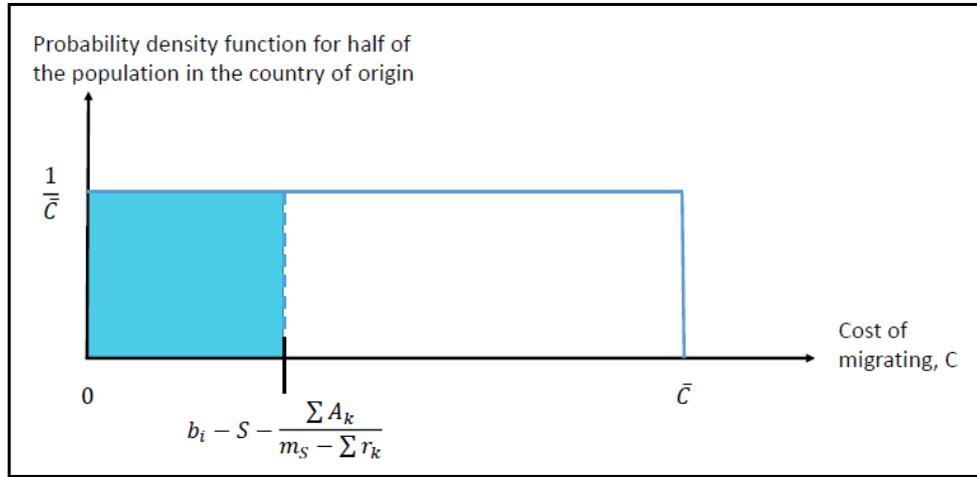
Equation (1) is a second-degree equation with two roots for r_i, but, as shown in Appendix A.1, only one root is in the definition set, $0 \leq r_i \leq m_s/2$.

3.2 UTILITY FUNCTION OF A REPRESENTATIVE VOTER IN THE DESTINATION COUNTRY

The population in the countries of destination consists of identical individuals. The utility function of a representative individual in destination country i is

$$U_i = L\left(\sum_{k=1}^{2} A_k \right) + V\left(\sum_{k=1}^{2} r_k \right) + Z(Y_i - T_i) - W(r_i), \quad i = 1,2 \quad (2)$$

where Y_i is the (exogenously given) pre-tax per-capita income of a citizen in country i and T_i is a per-capita tax. The first two terms on the RHS capture altruism, i.e., concern for the citizens of the country of origin. According to the first term, citizens in destination country i obtain utility when the country of origin receives aid. Aid from the two destination countries are regarded as perfect substitutes. According to the second term, citizens in country i also obtain utility when refugees are admitted in either of the destination countries. Refugee migration flows to either destination country are also perfect substitutes in the utility function. Both altruistic marginal utilities are positive but decreasing, i.e. $L', V' > 0$ and $L'', V'' < 0$. The third term captures "own" utility, which depends on own disposable income (private consumption).[3] Marginal utility of own disposable income is also positive and decreasing, i.e. $Z' > 0$ and $Z'' < 0$. The fourth term captures a xenophobic motive, i.e., disutility of seeing foreigners around in the own neighbourhood. The marginal *dis*utility is positive and increasing, i.e., $W' > 0$ and $W'' > 0$.[4] Like in the earlier literature, the utility function thus captures that each citizen has conflicting feelings with respect to migrants, both altruistic and xenophobic ones. To this I add concern about own consumption.

Only fully financed policies are considered. Taxes thus have to cover both benefit costs for migrants and foreign aid so that

$$T_i = \frac{r_i b_i}{m_i} + \frac{A_i}{m_i} \ , \qquad (3)$$

where m_i is the native population of destination country i. In the subsequent analysis it is assumed that the two destination countries are completely symmetric. This means that their populations and pre-tax per-capita incomes are the same, i.e., $m = m_1 = m_2$ and $Y = Y_1 = Y_2$.

4. Theoretical Analysis

Benefits for refugees and foreign aid are determined so as to maximise the utility of the representative citizen in a destination country, taking into account the migration and tax equations. It is assumed that there is always an interior solution for benefits, in which they are so high that there is migration. For aid, there can be either an interior solution with positive aid or a corner

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[3] To simplify public consumption is assumed to be zero.
[4] These assumptions receive support from Hatton (2016), who finds that attitudes to migration flows in the EU countries are more negative the larger the stock of migrants.

solution with no aid. I also distinguish between solutions where destination countries do not cooperate and where they do cooperate. This gives me the four cases shown in Table 1 to analyse:

Table 1 Cases to Analyse

• Interior solution for both policy variables • Non-cooperation between destination countries	• Interior solution for both policy variables • Cooperation between destination countries
• Corner solution for aid and interior solution for benefits • Non-cooperation between destination countries	• Corner solution for aid and interior solution for benefits • Cooperation between destination countries

4.1 INTERIOR SOLUTION FOR BOTH BENEFITS AND AID

This section analyses interior solutions for both benefits and aid. First the non-cooperative case is studied and then the cooperative case.

Non-cooperation

The utility function (2) is maximised w.r.t. b_i and A_i under the constraints given by the migration equation (1) and the tax equation (3). In the maximisation, b_j and A_j, with $j \neq i$, are taken as exogenous. The following FOCs are obtained:

$$\Phi = \frac{\partial U_i}{\partial b_i} = V'\left(\frac{dr_i}{db_i} + \frac{dr_j}{db_i}\right) - Z'\frac{r_i}{m} - Z'\frac{b_i}{m}\frac{dr_i}{db_i} - W'\frac{dr_i}{db_i} = 0 \quad i \neq j = 1,2 \tag{4}$$

$$\Gamma = \frac{\partial U_i}{\partial A_i} = L' + 2V'\frac{dr_i}{dA_i} - Z'\frac{b_i}{m}\frac{dr_i}{dA_i} - Z'\frac{1}{m} - W'\frac{dr_i}{dA_i} = 0, \tag{5}$$

where[5]

$$\frac{dr_i}{db_i} = \frac{M(1+MP)}{1+2MP} > 0 \tag{6}$$

$$\frac{dr_j}{db_i} = -\frac{M^2 P}{1+2MP} < 0 \tag{7}$$

$$\frac{dr_i}{db_i} + \frac{dr_j}{db_i} = \frac{M}{1+2MP} > 0 \tag{8}$$

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[5] See Appendix A.2 for the derivations of dr_i/db_i, dr_j/db_i and dr_i/dA_i.

$$M = \frac{m_S}{2\bar{C}}$$

$$P = \frac{\sum A_K}{(m_S - \sum r_K)^2}$$

$$\frac{dr_i}{dA_i} = \frac{-m_S(m_S - \sum r_k)}{2\bar{C}(m_S - \sum r_k)^2 + 2m_S \sum A_k} < 0. \qquad k = 1, 2 \qquad (9)$$

According to equation (6), a benefit increase in destination country i raises migration to it. This is because the utility of migrating there increases for citizens in the country of origin. Equation (7) shows that a benefit increase in country i reduces migration to country j. The explanation is that when the benefit increase in country i raises migration there, the population in the country of origin falls and hence aid per remaining person increases. This weakens the incentive to migrate to country j. The increase in migration to country i when b_i rises is always larger than the decrease in migration to country j. This is shown by equation (8).

Equation (4) is the marginal utility of benefits in country i, $\Phi = \partial U_i / \partial b_i$. The first term in the equation is positive. It measures the marginal utility associated with altruism of an increase in the sum of migration to the two destination countries due to a benefit rise in country i. The second term is negative and captures the marginal disutility of higher taxes associated with the direct cost of an increased benefit. The third term is also negative and is the marginal disutility from higher taxes when a benefit rise increases migration and thus total benefit costs. Finally, also the fourth term is negative. It measures the marginal disutility from xenophobia of having to put up with more foreigners when a benefit rise increases migration. In an interior optimum these marginal effects balance.

According to equation (9), an increase in aid from country i reduces migration to it. This is because the aid increase raises total income in the country of origin. In equation (5) for the marginal utility of aid, $\Gamma = \partial U_i / \partial A_i$, the first term captures that giving aid per se has a positive marginal utility due to altruism. The second term is negative. It measures the utility decrease associated with the altruistic motive of receiving migrants that occurs when more aid reduces migration. The third term is positive and captures the utility gain due to reduced taxes when more aid reduces migration. The fourth term is negative and represents the utility loss due to the tax increase associated with the direct cost of increased aid. The fifth term is also positive. It measures the utility gain associated with xenophobia of seeing fewer foreigners around because increased aid reduces migration. In an interior optimum these marginal effects balance.

Equations (4) and (5) can be rewritten:

$$\Phi = \frac{\partial U_i}{\partial b_i} = \frac{dr_i}{db_i}\left[V' - Z'\frac{b_i}{m} - W'\right] + V'\frac{dr_j}{db_i} - Z'\frac{r_i}{m} = 0 \qquad (4a)$$

$$\Gamma = \frac{\partial U_i}{\partial A_i} = L' + \frac{dr_i}{dA_i}\left[2V' - Z'\frac{b_i}{m} - W'\right] - Z'\frac{1}{m} = 0. \qquad (5a)$$

As $V'(dr_j/db_i) < 0$, $-Z'\,r_i/m < 0$ and $dr_i/db_i > 0$, it follows that

$$\left[V' - Z'\frac{b_i}{m_i} - W'\right] > 0 \qquad (10)$$

is a necessary condition for an interior solution with such a high b_i that $r_i > 0$.[6] The interpretation is that, if the benefits level is held constant, the marginal altruistic utility of receiving more migrants outweighs the marginal disutility of higher taxes and the xenophobic marginal disutility of seeing more migrants around. As $V' > 0$, inequality (10) implies that also $2V' - Z'\,b_i/m_i - W' > 0$. Thus, since $dr_i/dA_i < 0$, it follows that:

$$\frac{dr_i}{dA_i}\left[2V' - Z'\frac{b_i}{m_i} - W'\right] < 0. \qquad (11)$$

Consequently, the sum of the two last terms in equation (5) is negative. An interior solution with positive aid can thus only exist if the direct altruistic marginal utility of giving foreign aid, L', is sufficiently large. If this is not the case, the negative effects of more aid will outweigh the positive effects.

Cooperation

One way of finding the cooperative solution is to add up the utility functions for the two destination countries and then maximize the new utility function w.r.t. the two benefit levels, b_i and b_j, and the two aid levels, A_i and A_j. An alternative, which in the case of symmetry produces the same result, is to maximise the utility function of only one of the countries taking into account that the two benefit levels and the two aid levels have to be equal, i.e. $b = b_i = b_j$ and $A = A_i = A_j$. This also means that migration is the same to both destination countries, i.e., $r = r_1 = r_2$. In this social planner's solution, it thus always holds that a change in one country's benefit and aid levels implies equal changes in the other country's benefit and aid levels. Hence, if the

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[6] Since $r_1 = r_2 = 0$ in equation (1) gives $b_i = S + \sum A_k/m_S$, it follows that $b_i > S + \sum A_k/m_S$ for $r_i > 0$.

maximisation is done for country i, the following two FOCs are obtained in the case of interior solutions for both benefits and aid:

$$\theta = \frac{\partial U_i}{\partial b} = \frac{\partial U_i}{\partial b_i} + \frac{\partial U_i}{\partial b_j} = V'\left(\frac{dr_i}{db} + \frac{dr_j}{db}\right) - Z'\frac{r_i}{m_i} - Z'\frac{b_i}{m_i}\frac{dr_i}{db} - W'\frac{dr_i}{db} = 0 \quad i \neq j = 1,2 \quad (12)$$

$$\psi = \frac{\partial U_i}{\partial A} = \frac{\partial U_i}{\partial A_i} + \frac{\partial U_i}{\partial A_j} = 2L' + 2V'\frac{dr_i}{dA} - Z'\frac{b_i}{m_i}\frac{dr_i}{dA} - Z'\frac{1}{m_i} - W'\frac{dr_i}{dA} = 0, \quad (13)$$

where[7]

$$\frac{dr}{db} = \frac{dr_i}{db} = \frac{dr_j}{db} = \frac{M}{1 + 2MP} > 0 \quad (14)$$

$$\frac{dr}{dA} = \frac{dr_i}{dA} = \frac{dr_j}{dA} = \frac{-m_S(m_s - 2r)}{\bar{C}(m_S - 2r)^2 + 2m_S A} < 0. \quad (15)$$

Equations (12) and (13) can be rewritten:

$$\theta = \frac{\partial U_i}{\partial b} = \frac{\partial U_i}{\partial b_i} + \frac{\partial U_i}{\partial b_j} = \frac{dr}{db}\left[2V' - Z'\frac{b}{m_i} - W'\right] - Z'\frac{r}{m_i} = 0 \quad (12a)$$

$$\psi = \frac{\partial U_i}{\partial A} = \frac{\partial U_i}{\partial A_i} + \frac{\partial U_i}{\partial A_j} = 2L' + \frac{dr}{dA}\left[2V' - Z'\frac{b}{m_i} - W'\right] - Z'\frac{1}{m_i} = 0. \quad (13a)$$

The FOCs under cooperation differ from those under non-cooperation because the externalities arising from spillover effects on the other destination country are internalised. According to equation (12a), the decision maker under cooperation takes into account that a benefit change occurs simultaneously in both destination countries. The result is that the marginal utility of benefits (at given aid levels) is larger under cooperation than under non-cooperation.[8]

According to equation (13a), the decision maker under cooperation takes into account that a change in the aid level occurs simultaneously in both destination countries. I cannot tell whether

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[7] See Appendix A.3 for the derivations of dr_i/db, dr_j/db and dr_i/dA.

[8] Equations $(4a)$ and (12a) can be written:

$$\Phi = \frac{M}{1 + 2MP}V' - \frac{M(1 + MP)}{1 + 2MP}\left[Z'\frac{b_i}{m_i} + W'\right] - Z'\frac{r_i}{m_i} = 0$$

$$\theta = \frac{2M}{1 + 2MP}V' - \frac{M}{1 + 2MP}\left[Z'\frac{b}{m_i} + W'\right] - Z'\frac{r}{m_i} = 0.$$

For given benefit and aid levels $\theta > \Phi$ as $2M/(1 + 2MP) > M/(1 + 2MP)$ and $M/(1 + 2MP) < M(1 + MP)/(1 + 2MP)$.

or not the marginal utility of aid (at given benefit levels) is larger under cooperation than under non-cooperation.

With interior solutions for both benefits and aid it cannot be derived whether benefit and aid levels are higher or lower under cooperation than under non-cooperation. To sort this out, I have to rely on the numerical simulations in Section 5.

4.2 CORNER SOLUTION FOR AID AND INTERIOR SOLUTION FOR BENEFITS

This section analyses cases with corner solutions for aid and interior solutions for benefits. Like in the previous section, first non-cooperative and then cooperative outcomes are considered.

Non-cooperation

A corner solution with zero aid and an interior solution with so high benefits that there is positive migration obtains if in this situation:[9]

$$\Phi = \frac{\partial U_i}{\partial b_i} = \frac{dr_i}{db_i}\left[V' - Z'\frac{b_i}{m_i} - W'\right] + V'\frac{dr_j}{db_i} - Z'\frac{r_i}{m_i} =$$

$$= \frac{dr_i}{db_i}\left[V' - Z'\frac{b_i}{m_i} - W'\right] - Z'\frac{r_i}{m_i} = 0 \qquad (4b)$$

$$\Gamma = \frac{\partial U_i}{\partial A_i} = L' + \frac{dr_i}{dA_i}\left[2V' - Z'\frac{b_i}{m_i} - W'\right] - Z'\frac{1}{m_i} < 0, \qquad (5b)$$

where[10]

$$\frac{dr_i}{db_i} = \frac{m_s}{2\bar{C}} \qquad (6a)$$

$$\frac{dr_j}{db_i} = 0 \qquad (7a)$$

$$\frac{dr_i}{dA_i} = \frac{-m_S(m_S - \sum r_k)}{2\bar{C}(m_S - \sum r_k)^2} < 0. \quad k = 1, 2 \qquad (9a)$$

As above, an interior solution with so high benefits that there is positive migration according to equation $(4b)$ requires that $V' - Z'\, b_i/m_i - W' > 0$, i.e., that the marginal utility of migration at a constant benefit level is positive. It then follows that $(dr_i/dA_i)[2V' - Z'\, b_i/m_i - W'] < 0$

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[9] In this case the economy finds itself in a Nash equilibrium. Appendix A.4 shows that the equilibrium is dynamically stable.
[10] When $A_i = A_j = 0$, the migration equation (1) simplifies to $r_i = (m_s/2\bar{C})(b_i - S)$, which gives the expressions $(6a)$ and $(7a)$.

in equation $(5b)$. This means that an increase in aid has a negative utility effect for the destination country because it reduces migration there. The last term, Z'/m_i, in equation $(5b)$ which reflects the utility loss from the higher taxes needed to finance aid, is also negative. Unless the direct altruistic marginal utility from giving aid, L', is sufficiently large, the negative effects dominate and the marginal utility of aid is negative in a situation with no aid. Then, there is a corner solution where no aid is given. Such an outcome thus obtains when L' is small relative to V', i.e., the altruistic marginal utility of giving aid to the country of origin is small compared to the altruistic marginal utility of receiving migrants in the country of destination. A possible psychological motivation for this possibility is that receiving and helping migrants at home is more tangible than helping them abroad.

If a representative citizen in the destination countries does not obtain any direct altruistic utility from aid at all, i.e., if $L' = 0$, a corner solution with zero aid is always obtained. This is seen from equation $(5b)$, as it then contains only two negative terms. An increase in aid above zero then has only negative effects: it has a direct tax cost at the same time as it reduces migration in a situation when it has positive marginal utility.

The possibility of an equilibrium with positive benefits and migration, but no aid, is important. It can serve as an explanation of the situation that we have recently experienced in Europe with migration flows at the same time as no or very little aid has been given to countries of origin (such as Syria).

Cooperation

Using the same methodology as under cooperation in Section 4.1, the following FOCs are obtained in the case of a corner solution for aid (zero aid) and an interior solution for benefits (giving positive migration):

$$\theta = \frac{\partial U_i}{\partial b} = \frac{\partial U_i}{\partial b_i} + \frac{\partial U_i}{\partial b_j} = \frac{dr}{db}\left[2V' - Z'\frac{b}{m_i} - W'\right] - Z'\frac{r}{m_i} = 0 \qquad (12b)$$

$$\psi = \frac{\partial U_i}{\partial A} = \frac{\partial U_i}{\partial A_i} + \frac{\partial U_i}{\partial A_j} = 2L' + \frac{dr}{dA}\left[2V' - Z'\frac{b}{m_i} - W'\right] - Z'\frac{1}{m_i} < 0, \qquad (13b)$$

where

$$\frac{dr_i}{db_i} = \frac{dr}{db} = \frac{m_s}{2\overline{C}} \qquad (14a)$$

$$\frac{dr}{dA} = \frac{dr_i}{dA} = \frac{-m_S(m_s - 2r)}{\bar{C}(m_S - 2r)^2} < 0. \tag{14b}$$

Comparing the FOCs for benefits under non-cooperation and cooperation, i.e., equations (4b) and (12b), it is seen that

$$\frac{\partial U_i}{\partial b} = \theta = \Phi + V'\frac{dr_i}{db} = \frac{\partial U_i}{\partial b_i} + V'\frac{dr_i}{db}.$$

Thus, since $V' dr_1/db > 0$ it holds that $\theta > \Phi$. It follows that the benefit level $b_1 = b_2 = b$ giving $\Phi = 0$ (the equilibrium under non-cooperation) implies $\theta > 0$. Because $\theta_b = \partial\theta/\partial b < 0$ is the SOC for a maximum, it follows that a higher benefit is chosen under cooperation than under non-cooperation. Therefore, migration is also higher under cooperation. This is the same result as in Facchini et al. (2006), Czaika (2009) and Hatton (2011, 2015). The explanation is that under cooperation the positive altruism externality on the other country of more migrants in the own country is internalised.

4.3 THE EFFECTS OF INCOME CHANGES IN THE COUNTRY OF ORIGIN WITH CORNER SOLUTIONS FOR AID

This section analyses the effects of a change in income in the country of origin, S. As stated in Section 1, income should be given a broad interpretation as the monetary equivalent of the utility of living in the country of origin. With interior solutions for both benefits and aid, it is not possible to derive analytically how a change in S affects aid, benefits and migration. This case will instead be studied in the numerical simulations in Section 5.2. Analytical results can, however, be obtained when there are corner solutions for aid. Here I focus on this case.

Non-cooperation

I differentiate the Φ-function in (4.b) w.r.t. b_i, b_j and S:

$$\Phi_1 db_i + \Phi_2 db_j + \Phi_s dS = 0,$$

where $\Phi_1 = \partial\Phi/\partial b_i$, $\Phi_2 = \partial\Phi/\partial b_j$ and $\Phi_s = \partial\Phi/\partial S$.

Since the equilibrium is symmetric, $db_i = db_j = db$. Solving for db/dS, gives (see Appendix A.5):

$$0 < \frac{db}{dS} = -\frac{\Phi_S}{\Phi_1 + \Phi_2} < 1. \tag{16}$$

An increase in income in the country of origin thus causes an increase in the benefits in the destination countries. Conversely, a decrease in income in the country of origin causes a decrease in the benefit in the destination countries. The intuition is that an income decrease in the country of origin increases migration. This decreases the altruistic marginal utility of receiving refugees, V'. The increase in migration also raises the xenophobic marginal disutility of seeing foreigners around, W'. In addition, the increase in migration raises the benefit costs for migration and thus taxes. This lowers the disposable income and hence increases the marginal utility of disposable income, Z'. Together these effects reduce the marginal utility of benefits in equation (4b) and therefore provide an incentive to decrease the benefit level.

Inequality (16) also shows that the change in the benefit level in the destination countries is always smaller than the change in income in the country of origin. This can be understood in the following way. If the benefit level, b, is reduced by as much as the income in the country of origin, S, migration, r, would according to equation (1) be unchanged. This means that both the altruistic marginal utility of migration, V', and the xenophobic marginal disutility, W', in equation ($4b$) for the marginal utility of benefits are unchanged. But the marginal disutility of taxes to pay for benefits falls when benefits, and thus taxes, are reduced.[11] It follows that a reduction in b of the same magnitude as the fall in S must result in a positive marginal utility of benefits. Hence, the benefit level must fall by less than the income in the country of origin.

It is straightforward to show how migration, $r = r_i = r_j$, changes as income in the country of origin, S, changes. The effect is composed of a direct effect (the change in r at a constant benefit level) and an indirect effect (the change in r due to the induced change in the benefit level). These effects work in opposite directions. It can be computed from the migration equation (1) that:

$$\frac{dr}{dS} = \frac{\partial r}{\partial S} + \frac{\partial r}{\partial b}\frac{db}{dS} = \frac{m_S}{2\bar{C}}\left(\frac{db}{dS} - 1\right).$$

It has already been shown that $0 < db/dS < 1$. It follows that $dr/dS < 0$ so that an increase in income in the country of origin reduces migration. Conversely, a decrease in income in the country of origin raises migration. It is thus ensured that the direct effect on migration of a change

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[11] The marginal disutility of taxes to pay for benefits in equation ($4b$) is $(dr_i/db_i)Z' b_i/m_i + Z' r_i/m_i = (m_s/2\bar{C})Z' b_i/m_i + Z' r_i/m_i$. When benefits, and thus taxes, are reduced, disposable income increases and hence the marginal utility of disposable income, Z', falls. Thus, the marginal disutility of taxes to pay for benefits also falls.

in income in the country of origin dominates the indirect effect following from the induced change in the benefit level.

Cooperation

It is straightforward to show that the cooperative solution also implies that $0 < db/dS < 1$ and $dr/dS < 0$. The analysis is analogous to the one under non-cooperation and is therefore not reported.

5. Numerical Simulations

So far the analysis has been purely qualitative. With interior solutions for both benefits and aid, it was not possible to provide analytical solutions for the impact of a change in income in the country of origin on these variables. Nor could it be deduced whether or not benefit and aid levels are higher under cooperation than under non-cooperation in this case. With a corner solution for aid and an interior solution for benefits, analytical solutions were found, but they only gave limited information on the magnitude of various effects. For these reasons, the theoretical analysis is complemented by numerical simulations with the help of MATLAB.

For the simulations, a specific utility function for a representative citizen in the destination countries has to be chosen instead of the general one in equation (2). I stipulate the following function with the same qualitative features as that equation:

$$U_i = \delta ln\left(\left[\sum_{k=1}^{2} A_k\right] + R\right) + \alpha ln\left(\sum_{k=1}^{2} r_k\right) + \beta ln(Y - T_i) - \gamma r_i^2, \qquad i = 1,2 \qquad (2a)$$

where δ, R, α, β and γ are positive constants. The formulation in $(2a)$ implies that:

$$L' = \delta/\left(\left[\sum A_k\right] + R\right) > 0,$$

$$\lim_{A_k \to 0} L' = \delta/R,$$

$$L'' = -\delta/\left(\left[\sum A_k\right] + R\right)^2 < 0,$$

$$V' = \alpha/\sum r_k > 0,$$

$$\lim_{r_k \to 0} V' \to \infty,$$

$$V'' = -\alpha / \left(\sum r_k\right)^2 < 0,$$

$$Z' = \beta/(Y - T_i) > 0,$$

$$Z'' = -\beta/(Y - T_i)^2 < 0,$$

$$W' = 2\gamma r_i > 0,$$

$$\lim_{r_i \to 0} W' = 0,$$

$$W'' = 2\gamma > 0.$$

Two sets of simulations are made:

1. Simulations with a corner solution for aid (i.e., no aid) and an interior solution for benefits.
2. Simulations with interior solutions for both aid and benefits.

The two sets of simulations can be motivated by two different interpretations of refugee migration to Europe. The first interpretation starts out from the fact that most of the recent migration has come from a limited number of countries in West Asia and Africa that have received very little aid from EU countries. This motivates the approximation of zero aid in this case. The second interpretation is instead that the potential region of origin for refugees to Europe is much larger and encompasses countries, especially in Africa, to which EU states give more aid. If so, it makes sense to calibrate the model so that aid is given, which implies an interior solution also for aid.

Throughout, the pre-tax income for citizens in destination countries is normalised to unity, i.e., $Y = 1$. This implies that both income in the country of origin, S, and the benefit to migrants, b, are measured as ratios to pre-tax incomes in destination countries. I also normalise the population in each destination country to unity, i.e., $m = 1$. Then r is the ratio of migration to the native population in each destination country. Together the normalisations of Y and m mean that the total cost for benefits, rb, and foreign aid, A, in each destination country should be interpreted as shares of total income. Somewhat arbitrarily, I set $R = 1$.

The numerical simulations should not be taken as attempts literally to explain the migration to Europe that has actually occurred. For that purpose, they are far too stylised. This concerns, for example, the assumption that there are only two destination countries that may choose not to cooperate or to cooperate. The simulations should be seen only as attempts to illustrate important mechanisms under conditions that bear some resemblance to real-world conditions.

5.1 CORNER SOLUTIONS FOR AID AND INTERIOR SOLUTIONS FOR BENEFITS

UNDER NON-COOPERATION

Recent refugee migration to the EU has been concentrated from a small set of countries. In 2015, almost 3/4 of asylum seekers came from Syria, Afghanistan, Iraq, Pakistan and Eritrea. Over the two years 2014-2015, when refugee migration peaked, these five countries accounted for nearly 2/3 of all asylum seekers to the EU.[12] In 2010, before the large migration flows started, aid to these countries from EU28 only amounted to 0.02% of its GNI. If one also includes aid to neighbouring countries that have received large refugee migration from the top five countries of origin, then the number increased only to 0.05% of EU GNI.[13] Changes in aid between 2010 and 2015, when migration culminated, have been marginal. In 2011-2015, cumulative aid from EU28 to Syria totalled no more than €6.5 billion and in 2016 the sum pledged is around €3 billion.[14] In view of these numbers it is reasonable to approximate aid from EU28 to the main countries of origin for refugees to Europe to zero both before the start of the large refugee flows and during the refugee crisis. This motivates the model assumption of initially zero aid from destination countries under non-cooperation, i.e., of corner solutions for aid.

When calibrating the model, I use data from 2010 which I regard as the last pre-refugee crisis year. The total population of EU28 in that year was 501 million. The stock of immigrants born in a non-EU state was 31 million.[15] Hence, the population born inside the EU28 was 501-31= 470 million. This gives a ratio between immigrants and natives of $31/470 = 0.066 \approx 0.07$, which is the value for r that is used in the calibration. Since there are two destination countries in the model, each of them is assumed to have half the population (excluding immigrants) of the EU, i.e., $470/2 = 235$ million, which I normalise to unity, so that $m = 1$. The combined population of the five top countries in terms of recent refugee migration to the EU (excluding Eritrea for which no data are available) was 250 million.[16] Therefore, the approximation is made that $m_s = 1$.[17]

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[12] Data on refugee migration have been obtained from
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=migr_asyappctza&lang=en

[13] These countries are Egypt, Ethiopia, Kenya, Jordan, Lebanon and Turkey. Data on foreign aid (Official Development Assistance, ODA) have been taken from http://stats.oecd.org/Index.aspx?datasetcode=TABLE2A#

[14] http://europa.eu/rapid/press-release_IP-16-2262_en.htm

[15] Source: Eurostat (Migration and Migrant Population in EU).

[16] The data are from http://data.worldbank.org/indicator/SP.POP.TOTL

[17] The magnitude of m_s relative to m does not matter here as it will only affect the size of $\bar{C}$ in the calibration above designed to get a reasonable value for r under non-cooperation. This is because the m_s and the $\bar{C}$ variables only enter in the form $m_s/2\bar{C}$.

In the calibrations I also need to specify the per-capita income in the country of origin, S, before the start of the refugee crisis. As income in the country of origin in the model is given a broad interpretation (it reflects both monetary income and the psychological value attached to living there), it is not obvious which initial value to choose. A starting point can be GDP per capita in the top countries in terms of recent refugee migration. In 2010, average GDP per capita in those countries was 15% of the EU28 value.[18] To this I add a component reflecting the psychological value of living in the country of origin. As the magnitude of this component is hard to judge, the simulations are performed with two initial values for S: 0.5 and 0.2.

The calibrations are done as follows. I take the values of Y, m_s, m and S given above. I also assign values for the parameters in the utility function: α, β, γ and δ. The model is then calibrated by computing the maximum migration cost, $\bar{C}$, that gives a benefit level resulting in a stock of migrants $r_i = 0.07$ under non-cooperation according to the first-order condition $(4a)$, the migration equation (1) and the tax equation (3).

Simulations with Initial S = 0.5

Columns 5 and 6 in Table 2 show the calibrated values for the maximum migration cost, $\bar{C}$, and the benefit level, b, under the assumptions that there is non-cooperation and that $S = 0.5$. The benefit levels lie in the range of 0.69-0.86. The tax burden in the destination countries for the costs of benefits to migrants is quite small under non-cooperation: according to column 9, the disposable income of domestic citizens, $Y - T$, is 0.94-0.95.

Columns 10-13 show the outcomes for benefits, migration, aid and disposable income if there is instead cooperation between the two destination countries. In only four of the 13 cases, the cooperative outcome for aid is a corner solution (no aid) like under non-cooperation. In the situation with corner solutions under both non-cooperation and cooperation, benefits are higher under cooperation than under non-cooperation. This is in conformity with the theoretical analysis in Section 4.2. The differences are of the order of magnitude 0.10-0.24. Migration in the four cases with corner solutions for aid under cooperation are around 0.10-0.11, whereas it was 0.07 under non-cooperation. Cooperation thus implies 40-60% higher migration than non-cooperation. The tax burden for destination countries is now substantially higher than under non-cooperation:

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[18] According to World DataBank, World Development Indicators, (PPP-adjusted GDP per capita in EU28 was $33 250. The corresponding numbers were $6 374 for Syria, $1 630 for Afghanistan, $12 418 for Iraq and $4 210 for Pakistan (no data were available for Eritrea). The population-weighted average for the four countries was $5 052. Hence the ratio between per-capita incomes in the top countries in terms of refugee migration and the EU28 is 5 052/33 250 ≈ 0.15.

hence the disposable income of domestic citizens is only 0.90-0.91, i.e., around 4 percentage points lower.

Table 2 Calibration and Outcomes when $S = 0.5$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y-T$	b	r	A	$Y-T$
0,20	1	1	0,80	2,5407	0,8557	0,0700	0	0,9401	1,1034	0,0953	0,0482	0,8466
0,20	1	1	0,75	2,5407	0,8557	0,0700	0	0,9401	1,0631	0,0993	0,0235	0,8709
0,20	1	1	0,71	2,5407	0,8557	0,0700	0	0,9401	1,0292	0,1027	0,0029	0,8914
0,20	1	1	0,70	2,5407	0,8557	0,0700	0	0,9401	1,0244	0,1032	0	0,8943
0,20	1	2	0,75	2,0887	0,7924	0,0700	0	0,9445	0,9813	0,0995	0,0263	0,8761
0,20	1	2	0,70	2,0887	0,7924	0,0700	0	0,9445	0,9348	0,1036	0,0008	0,9024
0,20	1	2	0,60	2,0887	0,7924	0,0700	0	0,9445	0,9333	0,1037	0	0,9032
0,15	1	1	0,75	1,3794	0,6931	0,0700	0	0,9515	0,8522	0,1001	0,0304	0,8843
0,15	1	1	0,70	1,3794	0,6931	0,0700	0	0,9515	0,8003	0,1062	0,0029	0,9121
0,15	1	1	0,60	1,3794	0,6931	0,0700	0	0,9515	0,7947	0,1068	0	0,9151
0,20	1	3	0,75	1,6326	0,7286	0,0700	0	0,9490	0,8984	0,0996	0,0292	0,8813
0,20	1	3	0,70	1,6326	0,7286	0,0700	0	0,9490	0,8483	0,1036	0,0040	0,9081
0,20	1	3	0,60	1,6326	0,7286	0,0700	0	0,9490	0,8403	0,1042	0	0,9124

In nine of the 13 cases in Table 2, the solution for aid under cooperation is an interior one with positive aid. So, it is quite possible that going from non-cooperation to cooperation could mean moving from a situation with no aid to a situation with aid. This happens when the parameter δ, i.e., the weight for foreign aid in the utility function ($2a$), is sufficiently large. Then, the positive externality of giving more aid (because aid from both countries directly enters the utility function) outweighs the negative externality that arises due to the associated reduction of migration to the other country (which according to my assumptions has positive marginal utility in the optimum).[19] How much aid is given with interior solutions under cooperation is very sensitive to the value of δ. A value of 0.8-0.75 results in so much aid as 0.02-0.04, a value of 0.7 gives aid in the range of 0.008-0.004. Lower values for δ give corner solutions with zero aid also under cooperation.

The interior solutions for aid under cooperation always imply higher benefit levels than in the corner solutions under non-cooperation. The differences are in the range of 0.12-0.24. In some cases, benefit levels even exceed unity, i.e., the pre-tax income in the destination countries. Benefits are somewhat higher under cooperation when there are interior solutions for aid than when there are corner solutions. Also with interior solutions for aid under cooperation, migration is always larger than under non-cooperation. The difference to non-cooperation is, however, slightly smaller when there are interior solutions for aid than when there are corner solutions

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[19] See Section 4.1 for an analysis of these externalities.

under cooperation (because aid tends to reduce migration). With positive aid, the tax burden becomes higher: this results in disposable incomes in the destination countries of the order of magnitude of 0.85-0.92. As a result, benefit levels for migrants even become higher than disposable incomes of domestic citizens in about half the cases.

Table 3 shows the effects of a drastically lower income in the country of origin: $S = 0.1$. The idea is to capture the monetary equivalent of a dramatic deterioration in living conditions arising, for example, from civil war, as in Syria. Columns 6-9 give the outcomes under non-cooperation. These columns should be compared with the corresponding ones in Table 2. In all cases, there are still corner solutions with zero aid, so deteriorating conditions in the country of origin does not trigger aid as long as there is non-cooperation between destination countries. In most cases, migration increases by approximately 0.015-0.022 as compared to the non-cooperative outcomes with $S = 0.5$. This is a rise by no more than around 20-30% despite the fall in S being as large as 80%. The reason for the relatively small increase in migration is that destination countries lower benefits very substantially. The benefit levels now lie in the range 0.35-0.53, i.e., there is a reduction of approximately 0.35. Disposable incomes in the destination countries amount to 0.95-0.97, i.e., they are higher than with $S = 0.5$. The fall in income in the country of origin thus triggers such a large reduction in benefits that the overall tax cost for migration falls. This is an unexpected result. If one makes a broad interpretation of benefits as a proxy for the general conditions for migrants (see Section 1), the outcomes in the model can be seen as a way of capturing what actually happened when EU countries toughened their rules on refugee migration as a response to the large inflows in 2015.

The comparison between non-cooperative and cooperative solutions in Table 3 yields similar results as the corresponding comparison in Table 2. A difference, however, is that there are more corner solutions with zero aid under cooperation in Table 2. This is consistent with the result that with interior solutions for aid under cooperation less aid is chosen when $S = 0.1$ than when $S = 0.5$.

Table 3 Outcomes when $S = 0.1$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y - T$	b	r	A	$Y - T$
0,20	1	1	0,80	2,5407	0,5314	0,0849	0	0,9549	0,7741	0,1114	0,0420	0,8717
0,20	1	1	0,75	2,5407	0,5314	0,0849	0	0,9549	0,7342	0,1161	0,0170	0,8978
0,20	1	1	0,71	2,5407	0,5314	0,0849	0	0,9549	0,7070	0,1195	0	0,9155
0,20	1	1	0,70	2,5407	0,5314	0,0849	0	0,9549	0,7070	0,1195	0	0,9155
0,20	1	2	0,75	2,0887	0,4541	0,0848	0	0,9615	0,6395	0,1160	0,0211	0,9047
0,20	1	2	0,70	2,0887	0,4541	0,0848	0	0,9615	0,6010	0,1199	0,0000	0,9279
0,20	1	2	0,60	2,0887	0,4541	0,0848	0	0,9615	0,6010	0,1199	0	0,9279
0,15	1	1	0,75	1,3794	0,3543	0,0922	0	0,9673	0,4925	0,1268	0,0160	0,9216
0,15	1	1	0,70	1,3794	0,3543	0,0922	0	0,9673	0,4626	0,1314	0	0,9392
0,15	1	1	0,60	1,3794	0,3543	0,0922	0	0,9673	0,4626	0,1314	0	0,9392
0,20	1	3	0,75	1,6326	0,3763	0,0846	0	0,9682	0,5441	0,1158	0,0254	0,9116
0,20	1	3	0,70	1,6326	0,3763	0,0846	0	0,9682	0,4929	0,1203	0,0001	0,9406
0,20	1	3	0,60	1,6326	0,3763	0,0846	0	0,9682	0,4927	0,1203	0	0,9407

Simulations with Initial S = 0.2

As a robustness check, the calibrations above were repeated but now assuming instead that $S = 0.2$ initially. These calibrations are reported in columns 5-8 in Table 4. The outcomes for benefits, migration, aid and disposable income under non-cooperation in columns 6-9 can be compared with the corresponding outcomes under cooperation in columns 10-13. The pattern is similar to the one in Table 2. Out of eleven cases there are four corner solutions with zero aid and seven interior solutions with positive aid under cooperation. Benefits are always higher and migration larger under cooperation than under non-cooperation, although the differences are slightly smaller than in Table 2.

Table 4 Calibration and Outcomes when $S = 0.2$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y - T$	b	r	A	$Y - T$
0,20	1	1	0,75	3,6582	0,7122	0,0700	0	0,9501	0,9725	0,0947	0,0323	0,8756
0,20	1	1	0,70	3,6582	0,7122	0,0700	0	0,9501	0,9357	0,0982	0,0069	0,9012
0,20	1	1	0,60	3,6582	0,7122	0,0700	0	0,9501	0,9256	0,0992	0	0,9082
0,20	1	2	0,75	3,2016	0,6482	0,0700	0	0,9546	0,8937	0,0949	0,0349	0,8803
0,20	1	2	0,70	3,2016	0,6482	0,0700	0	0,9546	0,8535	0,0983	0,0098	0,9064
0,20	1	2	0,60	3,2016	0,6482	0,0700	0	0,9546	0,8377	0,0996	0	0,9166
0,15	1	1	0,70	2,4847	0,5479	0,0700	0	0,9617	0,7236	0,0980	0,0146	0,9145
0,15	1	1	0,60	2,4847	0,5479	0,0700	0	0,9617	0,6998	0,1006	0	0,9296
0,20	1	3	0,75	2,7406	0,5837	0,0700	0	0,9591	0,8139	0,0951	0,0376	0,8851
0,20	1	3	0,70	2,7406	0,5837	0,0700	0	0,9591	0,7704	0,0983	0,0127	0,9116
0,20	1	3	0,60	2,7406	0,5837	0,0700	0	0,9591	0,7480	0,1000	0	0,9252

I assume a smaller fall in S between Tables 4 and 5 than between Tables 2 and 3. I set $S = 0.1$ in Table 5. Comparing the outcomes under non-cooperation with $S = 0.1$ (columns 6-9 in Table 5) and $S = 0.2$ (columns 6-9 in Table 4) reveals the same pattern as when comparing the corresponding outcomes with $S = 0.1$ and $S = 0.5$ (columns 6-9 in Tables 3 and 2), although the differences now are smaller: for benefits the differences are around 0.1 and for migration 0.003-0.004.

Table 5 Outcomes when $S = 0.1$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y-T$	b	r	A	$Y-T$
0,20	1	1	0,75	3,6582	0,6339	0,0730	0	0,9537	0,8941	0,0978	0,0315	0,8810
0,20	1	1	0,70	3,6582	0,6339	0,0730	0	0,9537	0,8575	0,1015	0,0060	0,9070
0,20	1	1	0,60	3,6582	0,6339	0,0730	0	0,9537	0,8488	0,1023	0	0,9131
0,20	1	2	0,75	3,2016	0,5671	0,0730	0	0,9586	0,8128	0,0980	0,0343	0,8861
0,20	1	2	0,70	3,2016	0,5671	0,0730	0	0,9586	0,7726	0,1015	0,0091	0,9125
0,20	1	2	0,60	3,2016	0,5671	0,0730	0	0,9586	0,7579	0,1028	0	0,9221
0,15	1	1	0,70	2,4847	0,4677	0,0740	0	0,9654	0,6416	0,1025	0,0128	0,9215
0,15	1	1	0,60	2,4847	0,4677	0,0740	0	0,9654	0,6209	0,1048	0	0,9349
0,20	1	3	0,75	2,7406	0,4998	0,0729	0	0,9636	0,7305	0,0982	0,0372	0,8911
0,20	1	3	0,70	2,7406	0,4998	0,0729	0	0,9636	0,6868	0,1015	0,0122	0,9181
0,20	1	3	0,60	2,7406	0,4998	0,0729	0	0,9636	0,6652	0,1031	0	0,9314

5.2 INTERIOR SOLUTIONS FOR BOTH BENEFITS AND AID UNDER NON-COOPERATION

Another way of looking at refugee migration to Europe is to regard a much wider area as a potential region of origin. One could, for example, view Africa, the Middle East, South plus Central Asia less India as the region of origin. Official development assistance to this area made up 0.23% of EU28 GNI in 2010.[20] In this section, the model is calibrated using this number for aid. The population in this larger region amounted to 1 832 million inhabitants in 2010. The population born inside the EU28 was 470 million. This gives a ratio between the populations in the region of origin and the EU28 of $1832/470 = 3.9$. In the calibration I continue to set $m = 1$ (the population of one of the two destination countries) but now choose $m_s = 7$, which is slightly lower than the ratio between the populations in the larger region discussed above and in

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[20] See http://stats.oecd.org/Index.aspx?datasetcode=TABLE2A#

half the EU28.[21] It is now assumed that the initial per-capita income, S, in the country of origin is 0.2.[22]

Columns 5-9 in Table 6 show similar calibrations as in the previous Tables 2 and 4. The difference is that the model is now calibrated to get interior solutions with both migration and aid. Benefit levels under non-cooperation now are in the range 0.31-0.93. Disposable incomes for citizens in destination countries are of the order of magnitude of 0.93-0.98. Columns 10-13 show the outcomes under cooperation. Only interior solution for aid are obtained in this case. Migration is always higher under cooperation than under non-cooperation: 0.08-0.09 versus 0.07. This reflects higher benefit levels. At the same time, there is a huge increase in aid when going from non-cooperation to cooperation, which is also reflected in much higher taxes and thus much lower disposable incomes in the destination countries. The reason why migration still is higher under cooperation than under non-cooperation is that aid has only a limited effect on total incomes in the country of origin because the population is much larger there than in the destination countries. The increase in aid under cooperation may look very unrealistic: it is hard to imagine that destination countries would allocate a quarter of their GDP to foreign aid. But one should remember that I have made a broad interpretation of aid, potentially including also military interventions in the wars in the regions. So, one could possibly regard the large foreign aid under cooperation as including such military efforts that might have very large human and psychological costs (measured by their monetary equivalents) for the destination countries.

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[21] The downward adjustment is motivated by the fact that rich oil-producing countries should perhaps not be regarded as part of the region of origin for refugees.

[22] In 2010, per-capita income in North-Africa and the Middle East excluding high-income countries was 12.3%, in Sub-Saharan Africa 4.7%, and in South Asia 3.9% of that in EU28 (source: World DataBank): http://databank.worldbank.org/data/reports.aspx?Code=NY.GDP.PCAP.CD&id=af3ce82b&report_name=Popular indicators&populartype=series&ispopular=y). As in Table 4, I set S somewhat higher than per-capita incomes to capture the monetary equivalent of a common psychological value attached to living in the country of origin.

Table 6 Calibration and Outcomes when $S = 0.2$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y-T$	b	r	A	$Y-T$
0,10	1	2	1,11	5,5765	0,3122	0,07	0,0023	0,9758	0,4156	0,0876	0,2592	0,7043
0,10	0.5	1	0,55	22,3294	0,6473	0,07	0,0023	0,9524	0,8185	0,0860	0,2395	0,6902
0,10	1	1	1,09	8,9251	0,3792	0,07	0,0023	0,9712	0,4906	0,0852	0,2502	0,7080
0,20	1	1	1,10	25,5190	0,7111	0,07	0,0023	0,9479	0,8872	0,0847	0,2374	0,6874
0,20	2	1	2,16	10,5874	0,4124	0,07	0,0023	0,9688	0,5268	0,0841	0,2477	0,7080
5	20	1	22,3	36,4538	0,9297	0,07	0,0023	0,9326	1,1378	0,0835	0,2317	0,6733
5	50	1	54,0	12,1754	0,4442	0,07	0,0023	0,9666	0,5605	0,0829	0,2460	0,7075
10	50	1	55,1	28,6159	0,7730	0,07	0,0023	0,9436	0,9520	0,0835	0,2358	0,6846
0,20	1	2	1,10	22,3294	0,6473	0,07	0,0023	0,9524	0,8185	0,0860	0,2395	0,6902
0,20	1	3	1,10	19,1096	0,5829	0,07	0,0023	0,9569	0,7473	0,0872	0,2422	0,6926

Table 7 shows outcomes with $S = 0.1$ instead of $S = 0.2$ as in Table 6. A comparison of the two tables thus give information on the effects of an income fall in the country of origin. According to column 7, under non-cooperation migration is slightly higher (0.003-0.006) with the lower S. Migration is held down by both a substantial cut in benefits (slightly less than 10 percentage points) and an increase in aid of 0.001-0.003 of pre-tax incomes.

Table 7 Outcomes when $S = 0.1$

					Non-Cooperation				Cooperation			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
α	β	γ	δ	$\bar{C}$	b	r	A	$Y-T$	b	r	A	$Y-T$
0,10	1	2	1,11	5,5765	0,2228	0,0761	0,0052	0,9778	0,3275	0,0946	0,2613	0,7077
0,10	0.5	1	0,55	22,3294	0,5662	0,0729	0,0039	0,9548	0,7389	0,0891	0,2415	0,6927
0,10	1	1	1,09	8,9251	0,2956	0,0762	0,0044	0,9731	0,4079	0,0918	0,2517	0,7108
0,20	1	1	1,10	25,5190	0,6327	0,0729	0,0037	0,9501	0,8098	0,0877	0,2392	0,6897
0,20	2	1	2,16	10,5874	0,3318	0,0762	0,0041	0,9706	0,4465	0,0904	0,2491	0,7106
5	20	1	22,3	36,4538	0,8545	0,0723	0,0035	0,9346	1,0631	0,0859	0,2334	0,6753
5	50	1	54,0	12,1754	0,3664	0,0763	0,0038	0,9682	0,4824	0,0891	0,2471	0,7099
10	50	1	55,1	28,6159	0,6974	0,0729	0,0036	0,9456	0,8767	0,0865	0,2375	0,6867
0,20	1	2	1,10	22,3294	0,5662	0,0729	0,0039	0,9548	0,7389	0,0891	0,2415	0,6927
0,20	1	3	1,10	19,1096	0,4991	0,0729	0,0041	0,9595	0,6654	0,0904	0,2444	0,6954

6. Conclusions

I have developed a theoretical model designed to highlight various aspects of the recent refugee migration to Europe. The assumption is that there is one country of origin and two symmetric countries of destination. I analyse explicitly the migration decision of refugees, i.e., the supply side of migration. This is an addition to the earlier research literature on migration to Europe. Another contribution is the analysis of how destination countries determine policy variables that influence the magnitude of migration: benefits to migrants (as a proxy for the general conditions offered to refugee migrants) and aid to the country of origin (as a proxy for both monetary aid and other efforts, including diplomatic and military interventions, to alleviate the situation in the

country of origin). The model is calibrated so as to bear some resemblance to actual conditions and serves as the basis for numerical simulations. This should not be taken as an attempt literally to explain migration to Europe but only to illustrate important mechanisms and to give some indications of orders of magnitude.

Two main cases are analysed: (1) corner solutions for aid (zero aid) and interior solutions for benefits (positive benefits) and (2) interior solutions for both aid and benefits (positive aid and benefits). In both cases, there is either non-cooperation or cooperation between destination countries. Corner solutions with zero aid can serve as a stylised explanation of the real-world situation where European countries have offered only very little aid to the countries from which most of the recent large refugee flows have come (Syria, Afghanistan and Iraq).

In case (1) with corner solutions for aid and interior solutions for benefits, cooperation always results in both higher benefits and more migration than non-cooperation. This is because a positive externality on the other country of receiving more migrants is internalised. The difference may be very substantial. The numerical simulations indicate that migration could be 40-60% higher under cooperation than under non-cooperation. With cooperation, destination countries also choose to give aid in the majority of cases, i.e., the corner solutions for aid under non-cooperation are turned into interior solutions under cooperation.

A deterioration in living conditions in the country of origin (due, for example, to the outbreak of war and modelled here as an income fall), causes migration to increase at the same time as benefits to migrants in the destination country are reduced. The benefit reduction is always smaller than the income fall in the country of origin. Still, it is so large that there is only a limited increase in migration. Even if the income fall in the country of origin is as large as 80%, migration only increases by 20-30%. With the broad interpretation here of benefits (as a proxy for general conditions of admittance), this result has a real-world counterpart since the large refugee flows in 2015 (which followed from the drastic deterioration of living conditions mainly in Syria) triggered more restrictive refugee policies throughout Europe. In the model, the reduction in benefit levels is in fact so large that the total tax costs for benefits to migrants fall.

I also make calibrations where initially the destination countries *do* give aid under non-cooperation, i.e., there are interior solutions for both benefits and aid also in this situation (case 2). This would correspond to a situation where the potential region of origin of refugees to Europe is much larger than just neighbouring countries in the Middle East. Since the EU countries give substantial aid primarily to Africa, it then makes sense in the model to assume positive aid also

under non-cooperation. In this case, an income fall in the country of origin results in both a reduction in benefits and an increase in aid. Cooperation would imply huge amounts of aid. This is unrealistic if aid is interpreted in a narrow sense as just monetary transfers. However, a broader interpretation could be that the increase in aid in the model represents also military efforts to end, for example, the war in Syria, which would impose large human sacrifices for destination countries (modelled as taxes here).

I have provided a stylised model of how migration of the type that we have recently seen in Europe is affected by living conditions in regions of origin and policies in destination countries. To my knowledge this has not been done before. The model illustrates that more cooperation regarding refugee policies among EU countries would likely result in both more generous migration policies and more aid to countries of origin. It also explains the policy reactions to the recent migration that we have seen. This would not have been possible without modelling both the supply side of migration and the effects on it of various policy instruments as I have done.

My numerical analysis could be developed much further by taking into account that the EU consists of many countries (not two) of different sizes. This could be important in order to explain why refugee policies have differed so much among EU member states and why it has been so difficult to achieve cooperative solutions. One could also experiment with other functional forms than the simple ones used here. Still, I hope that my contribution can provide inspiration for the development of more advanced models to help policy makers make better informed decisions and this way reduce human suffering.

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Appendix

A.1 MIGRATION EQUATION

When $\sum A_k = 0$, the migration equation (1) simplifies to:

$$r_i = (b_i - S)(m_s/2\,\bar{C}) \tag{A1}$$

If $\sum A_k > 0$, the migration equation is a second-degree equation with two roots. This raises the question of whether or not given values for the population in the country of origin, the own per-capita income in the country of origin, the maximum cost of migration, the benefits in the destination countries and aid from the destination countries could give two different levels of migration and thus multiple equilibria.

The definition set for migration in equation (1) is $r_i \in [0, \ m_s/2]$, $i = 1, 2$. The upper bound for migration to destination country i is half the population in the country of origin since the population there is divided in two halves, where each half only contemplates migrating to one of

the destination countries. Due to symmetry between the two destination countries $b_1 = b_2 = b$ and $r_1 = r_2 = r$. Let $b - S = \omega$ and $m_s/2\bar{C} = 1/\alpha$. Then, equation (1) is

$$r = \left(\omega - \frac{\sum A_k}{m_s - 2r}\right)\frac{1}{\alpha},$$

and can be rewritten

$$2\alpha r^2 - (2\omega + \alpha m_s)r + \omega m_s - \sum A_k = 0.$$

The two roots are

$$r_{A,B} = \frac{2\omega + \alpha m_s}{4\alpha} \pm \frac{\sqrt{(2\omega - \alpha m_s)^2 + 8\alpha \sum A_k}}{4\alpha}.$$

The first root, r_A, is rejected as it falls outside the definition set for r_i. This is seen since

$$r_A = \frac{2\omega + \alpha m_s}{4\alpha} + \frac{\sqrt{(2\omega - \alpha m_s)^2 + 8\alpha \sum A_k}}{4\alpha} < \frac{m_s}{2} \quad \Leftrightarrow$$

$$2\omega - \alpha m_s < -\sqrt{(2\omega - \alpha m_s)^2 + 8\alpha \sum A_k} \quad \Leftrightarrow$$

$$2(b - S - \bar{C}) < -\sqrt{\left(2(b - S - \bar{C})\right)^2 + 8\alpha \sum A_k}. \qquad (A2)$$

According to equation $(A1)$, $r_A < m_s/2$ when $\sum A_k = 0$ requires that $b - S - \bar{C} < 0$. Imposing this condition on $(A2)$, it follows that

$$4(b - S - \bar{C})^2 > 4(b - S - \bar{C})^2 + 8\alpha \sum A_k \quad \Leftrightarrow$$

$$8\alpha \sum A_k < 0.$$

This proves that $r_A < m_s/2$ cannot hold when aid is given, i.e., when $\sum A_k > 0$. Hence the root is discarded. The only relevant root is r_B. This is seen as:

$$r_B = \frac{2\omega + \alpha m_s}{4\alpha} - \frac{\sqrt{(2\omega - \alpha m_s)^2 + 8\alpha \sum A_k}}{4\alpha} < \frac{m_s}{2} \quad \Leftrightarrow$$

$$2\omega - \alpha m_s < \sqrt{(2\omega - \alpha m_s)^2 + 8\alpha \sum A_k} \quad \Leftrightarrow$$

$$2(b - S - \bar{C}) < \sqrt{\left(2(b - S - \bar{C})\right)^2 + 8\alpha \sum A_k}. \qquad (A3)$$

The condition $b - S - \bar{C} < 0$ implies that the inequality $(A3)$ always holds. This means that the root r_B belongs to the definition set for migration. Using the definitions of ω and α the root can be written:

$$r_B = \frac{m_s}{4\bar{C}}\left[b - S + \bar{C} - \sqrt{(-b + S + \bar{C})^2 + \frac{4\bar{C}\sum A_k}{m_s}}\right]. \qquad (A4)$$

A.2 DERIVATION OF dr_i/db_i, dr_j/db_i AND dr_i/dA_i IN THE NON-COOPERATIVE CASE

Differentiation of the migration equation (1) w.r.t. b_i gives:

$$\frac{dr_i}{db_i} = M\left[1 - P\left(\frac{dr_i}{db_i} + \frac{dr_j}{db_i}\right)\right], \qquad (A5)$$

where

$$M = \frac{m_s}{2\bar{C}}$$

$$P = \frac{\sum A_K}{(m_s - \sum r_K)^2}.$$

Differentiation of the corresponding migration equation (1) for r_j w.r.t. b_i gives:

$$\frac{dr_j}{db_i} = -MP\left(\frac{dr_j}{db_i} + \frac{dr_i}{db_i}\right). \qquad (A6)$$

Due to symmetry $dr_j/db_i = dr_i/db_j$ and $dr_i/db_i = dr_j/db_j$. Using this and combining $(A5)$ and $(A6)$ gives:

$$\frac{dr_i}{db_i} = \frac{M(1 + MP)}{1 + 2MP} > 0 \qquad (6)$$

$$\frac{dr_j}{db_i} = -\frac{M^2 P}{1 + 2MP} < 0. \qquad (7)$$

Differentiation of migration equation (1) w.r.t. A_i gives:

$$\frac{dr_i}{dA_i} = -M \left[\frac{m_S - \sum r_k + \sum A_k \left(\frac{dr_i}{dA_i} + \frac{dr_j}{dA_i} \right)}{(m_S - \sum r_k)^2} \right]. \quad k = 1, 2$$

Symmetry implies that $dr_i/dA_i = dr_j/dA_i$. Then it follows that

$$\frac{dr_i}{dA_i} = -M \left[\frac{1}{(m_S - \sum r_k)} + \frac{2 \sum A_k}{(m_S - \sum r_k)^2} \frac{dr_i}{dA_i} \right].$$

Solving for dr_i/dA_i gives

$$\frac{dr_i}{dA_i} = \frac{-m_S(m_S - \sum r_k)}{2\bar{C}(m_S - \sum r_k)^2 + 2m_S \sum A_k} < 0. \tag{9}$$

A.3 DERIVATION OF dr_i/db, dr_j/db AND dr_i/dA IN THE COOPERATIVE CASE

In the cooperative case, the same benefit and aid levels are chosen for both destination countries, i.e., $b = b_i = b_j$ and $A = A_i = A_j$. It follows that migration to both countries is the same, i.e., $r = r_i = r_j$. Therefore, the migration equation (1) can be written:

$$r = M \left(b - S - \frac{2A}{m_S - 2r} \right). \tag{A7}$$

Differentiation of equation (A7) w.r.t. b gives:

$$\frac{dr}{db} = M \left[1 - 2P \frac{dr}{db} \right],$$

and thus,

$$\frac{dr}{db} = \frac{M}{1 + 2MP} > 0. \tag{14}$$

Differentiation of equation (A7) w.r.t. A gives:

$$\frac{dr}{dA} = -2M \left[\frac{m_S - 2r + 2A \frac{dr}{dA}}{(m_S - 2r)^2} \right],$$

and

$$\frac{dr}{dA} = \frac{-m_S(m_S - 2r)}{\bar{C}(m_S - 2r)^2 + 2m_S A} < 0. \tag{15}$$

A.4 STABILITY OF NASH EQUILIBRIUM

Equation $(4b)$ is the optimum condition for country i. Thus, there are two such equations. Together the two equations determine the Nash equilibrium for benefits. Writing in general form, it holds because of symmetry that:

$$\frac{\partial U_i}{\partial b_i} = \Phi(b_i, b_j, l) = 0 \tag{4c}$$

$$\frac{\partial U_j}{\partial b_j} = \Phi(b_j, b_i, l) = 0, \tag{4d}$$

where $l = [m, m_S, S, \bar{C}]$ is a vector of the exogenous variables. The SOC for utility maxima is $\Phi_1 < 0$, where Φ_1 is the partial derivative of the Φ-function w.r.t. the first argument.

Partial differentiation of equation $(4c)$ w.r.t. b_i gives:

$$\Phi_1 = \frac{\partial \Phi}{\partial b_i} = \left(\frac{m_S}{2\bar{C}}\right)^2 V'' + \frac{m_S}{2\bar{C}}\left[-Z'\frac{1}{m} + Z''\frac{b_i}{m^2}\left(r_i + \frac{b_i m_S}{2\bar{C}}\right) - W''\frac{m_S}{2\bar{C}}\right]$$
$$- Z'\frac{1}{m}\frac{m_S}{2\bar{C}} + Z''\frac{r_i}{m^2}\left(r_1 + \frac{b_i m_S}{2\bar{C}}\right) < 0. \tag{A8}$$

Hence, the SOC for a maximum is fulfilled. Partial differentiation of equation $(4c)$ w.r.t. b_j gives:

$$\Phi_2 = \left(\frac{m_S}{2\bar{C}}\right)^2 V'' < 0. \tag{A9}$$

Equations $(4c)$ and $(4d)$ define the two countries' reaction functions. Due to symmetry the intersection of the two reaction functions in the b_i, b_j-plane must lie on a $45°$-line from the origin. Differentiating $(4b)$ gives the slope of country i's reaction function as $db_i/db_j = -\Phi_2/\Phi_1$. Differentiating $(4c)$ gives the slope of country j's reaction function as $db_i/db_j = -\Phi_1/\Phi_2$. As $\Phi_1, \Phi_2 < 0$, both reaction functions are negatively sloped. This implies that a benefit increase in one country causes the other country to reduce its benefit. The intuition is that an increase in one destination country's benefit increases migration there. This reduces the altruistic marginal utility of migration to the other country (which depends on the sum of migration to both countries). Hence, there is an incentive to reduce the benefit in the other country so that migration to it is reduced. For dynamic stability, the relative slopes of the reaction functions must be as in Figure

2. This implies that $|\Phi_2| < |\Phi_1|$.[23] A comparison between equations $(A8)$ and $(A9)$ shows this to hold.
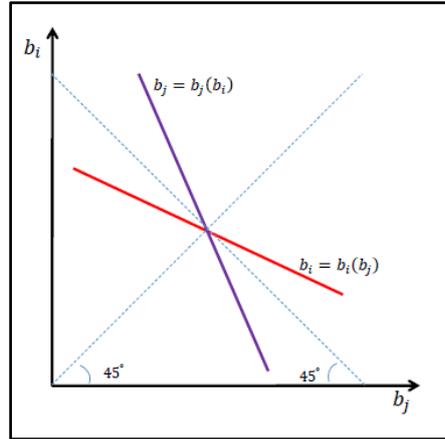

Figure 1 The reaction functions are negatively sloped

A.5 THE EFFECT OF A CHANGE IN INCOME IN THE COUNTRY OF ORIGIN ON THE BENEFIT LEVEL IN THE CASE WITH NO AID

The partial derivative of the Φ-function $(4b)$ w.r.t. S is:

$$\Phi_S = -\frac{m_s}{2\bar{C}}\left[V''\frac{m_s}{2\bar{C}} - Z'\frac{1}{m_1} + Z''\frac{b_1}{m_1{}^2}\left(r_1 + \frac{b_1 m_s}{2\bar{C}}\right) - W''\frac{m_s}{2\bar{C}}\right] > 0. \qquad (A10)$$

From equations $(A8)$ and $(A9)$ it holds that:

$$\Phi_1 + \Phi_2 = \frac{m_s}{2\bar{C}}\left[V''\frac{m_s}{\bar{C}} - Z'\frac{1}{m_1} + Z''\frac{b_1}{m_1{}^2}\left(r_1 + \frac{b_1 m_s}{2\bar{C}}\right) - W''\frac{m_s}{2\bar{C}}\right] - Z'\frac{1}{m_1}\frac{m_s}{2\bar{C}}$$

$$+ Z''\frac{r_1}{m_1{}^2}\left(r_1 + \frac{b_1 m_s}{2\bar{C}}\right) < 0. \qquad (A11)$$

A comparison of $(A10)$ and $(A11)$ gives:

$$-(\Phi_1 + \Phi_2) = \Phi_S + Z'\frac{1}{m_i}\frac{m_s}{2\bar{C}} - Z''\frac{r_1}{m_1{}^2}\left(r_1 + \frac{b_1 m_s}{2\bar{C}}\right)$$

and thus

$$-(\Phi_1 + \Phi_2) > \Phi_S.$$

Therefore

$$0 < -\Phi_S/(\Phi_1 + \Phi_2) < 1.$$

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[23] The condition is $-\Phi_2/\Phi_1 > -\Phi_1/\Phi_2$. Thus, $\Phi_2/\Phi_1 < \Phi_1/\Phi_2 \Leftrightarrow (\Phi_2)^2 < (\Phi_1)^2 \Leftrightarrow |\Phi_2| < |\Phi_1|$.