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Tradable Refugee-admission Quotas and EU Asylum Policy*

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Abstract

The current European Union (EU) asylum policy is widely seen as ineffective and unfair. We propose an EU-wide market for tradable quotas on both refugees and asylum seekers coupled with a matching mechanism linking countries' and migrants' preferences. We show that the proposed system can go a long way towards addressing the shortcomings of the current system. We illustrate this claim using the recent problems regarding relocation faced by the European Relocation from Malta program. (JEL codes: F22, F5, H87, I3, K33, 019).

Keywords: immigration policy, EU policy, tradable quotas, refugee resettlement, asylum seekers, international public goods

1 Introduction

The European Union (EU) is currently experiencing a refugee crisis: thousands of refugees are accumulating on its shores (Lampedusa, Malta, Sicily) and land borders (Greece, Bulgaria), fleeing civil war (in Libya or Syria), armed conflict, or oppression. Even if these numbers are small in comparison to those of refugees hosted by States of first asylum such as Lebanon, Jordan or Turkey, this puts pressure on countries of first arrival, with thousands of persons then wandering in the EU-Schengen space and beyond. At the same time, the existing EU asylum policy is overwhelmingly judged as inappropriate and is criticized not just because of its

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inability to address the challenges posed by the volume of refugee flows but also due to the many legal deficiencies, political inconsistencies and economic inefficiencies that characterize the current asylum system. At a legal and political level, the 'Common European Asylum System' (CEAS), launched in 1999, is increasingly under fire.

For one thing, the so-called 'Dublin-system' (implemented since 1997) whereby an asylum seeker is mainly under the responsibility of the country of first-entry, is more and more regarded as ill-conceived (De Bruycker et al. 2010). Under this system, an asylum seeker who entered the EU say in Greece and got arrested for illegal stay say in Belgium could be transferred back to Greece. Such a system creates disincentives for the Greek government to effectively implement the CEAS norms. Furthermore, the Dublin system prevents asylum seekers from choosing their country of asylum within the EU, creating incentives for them to circumvent legal restrictions to mobility before their asylum claims have been examined.

A second major issue with the current system is that of 'burden sharing'.[1] Indeed, the current system places (at least in theory) a disproportionate burden on the countries of first entry (such as Malta, Greece, or Italy) that are responsible for many asylum seekers due to their geographic position. The Guidelines adopted by the European Council on 27 June 2014 underline that 'the Union needs an efficient and well-managed migration, asylum and borders policy, guided by the Treaty principles of solidarity and fair sharing of responsibility, in accordance with article 80 of the Treaty on the Functioning of the European Union and its effective implementation' (Guideline 5) and that 'The Union's commitment to international protection requires a strong European asylum policy based on solidarity and responsibility' (Guideline 7; European Council 2014).

Under this general process, many attempts of improvements have been initiated: further harmonization of asylum law, creation of a European agency as the European Asylum Support Office (EASO), continuation of EU funding through the new Fund for Asylum, Migration and Integration, relocation of refugees across receiving countries (on the last issue, see the 'Malta example' below). However, it is fair to say that progress in practice has been rather limited (see Hatton 2011, 2012, 2013; Thielemann et al. 2010).

In this article we propose a new perspective using market-based solutions to deal with the externality/free riding problem among EU Member

[1] This terminology is controversial but we keep it here because of its widespread use. Some authors, and the European Council (2014), prefer to use the concept of 'responsibility sharing'.

States, taking advantage from the already existing institutional frameworks. We apply the idea of tradable immigration quotas (TIQs) proposed by Fernández-Huertas Moraga and Rapoport (2014) to the case of refugees and asylum seekers in the EU context. Indeed, providing refugee protection and asylum is a well-recognized international public good, and there is an understanding that the costs incurred should be shared more fairly, at least within the EU. Building on this idea, we explore the potential for a Tradable Refugee Quotas (TRQs) system to better coordinate national asylum policies. We supplement this system with a matching mechanism allowing for taking refugees' preferences over destinations as well as countries' preferences over refugees' types into account. This matching component, adapted from the more generic model of Fernández-Huertas Moraga and Rapoport (2014), is shown to address many of the issues that have been raised against the current EU asylum policy. The original paper by Fernández-Huertas Moraga and Rapoport (2014) already introduced an application to the resettlement of long-standing refugees. The present article extends the argument and shows that the same reasoning can be applied both to refugees and asylum seekers arriving at the EU. Refugees and asylum seekers can be interpreted as two different 'migrant types' in the original model.

The rest of the article is organized as follows. In Section 2 we provide the empirical background for the discussion as well as evidence of 'unfair' burden sharing among EU Member States. Section 3 provides the policy background in that it describes generally the evolution of the EU asylum policy over the last two decades and emphasizes the search for harmonized policies. This is followed by an outline of the existing literature on market-based proposals in the field of refugee policy in Section 4. In Section 5 we present the model, first introducing a model of tradable refugees' quotas (TRQs) with refugees being indifferent among the various potential host countries and host countries being indifferent about the type of refugees they receive. We then introduce heterogeneity in refugees' preferences over their destinations and in host countries' preferences over refugees' types. Section 6 serves as an illustration for possible implementation building on the well-documented example of Malta and concludes the article.

2 The Numbers

The EU receives around 300,000 asylum claims per year, about one third of the total registered in the world (see Figure 1). More than three quarters (79%) of the stock of asylum seekers in the EU in 2012 accumulated in only six destinations countries: Germany, France, Greece, Austria, UK, and Sweden. A similar picture emerges from the 2012 numbers on refugees

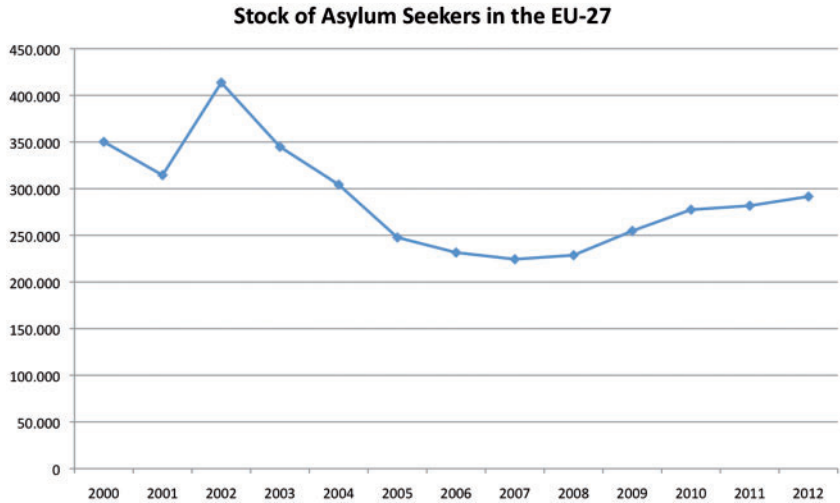

Figure 1 Source: own calculations on end-of-year pending applications from UNHCR (2013).

in Europe (see Figure 2).[2] Of the 1.3 million refugees in the EU, 87% are hosted by Germany, France, UK, Sweden, Italy, and Austria and 44% of them reside only in Germany.

The allocation of immigrants within the EU still seems to present itself as a black box. The lack of information on the mobility of non-EU nationals within the EU has made it difficult to trace back the mechanisms under which refugees and asylum seekers locate themselves. For example, in a recent report, the European Migration Network documents recent trends of intra-EU mobility of third-country nationals (European Migration Network 2013). However, those estimates are not able to capture non-EU citizens that are in a state of transition regarding their legal status. Often, those immigrants vanish from the official figures. This holds especially for rejected asylum seekers willing to avoid removal. For example, only about one fourth of the 22,500 asylum application decisions in Italy in 2012 were positive (UNHCR 2013), the rest being rejected.

Indeed, the accumulation of immigrants in certain locations is disproportional to the capacities of the host countries. In their Statistical Yearbook, the Office of the United Nations High Commissioner for

[2] Refugees are either people who came to Europe as asylum seekers and were granted asylum, or people who were in refugee camps outside of the EU, granted refugee status by the UNHCR and successfully applied for resettlement in one of the EU countries.

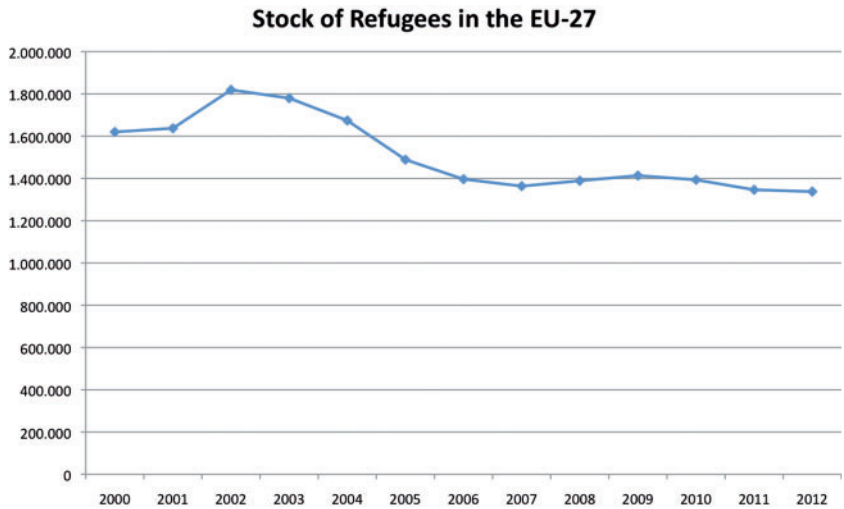

Figure 2 Source: own calculations from UNHCR (2013).

Refugees (UNHCR) ranks host countries regarding certain indicators: the refugee to Gross Domestic Product (GDP) ratio or refugee per 1000 inhabitants or per 1000 sq km. Even among the big six host EU Member States there are tremendous differences regarding their financial, demographic, and geographic capacities. Whereas Germany's refugees to GDP (Purchasing Power Parity: PPP) per capita ratio amounts to $15.31, comparable countries such as France have a ratio of only $6, or even as low as $0.57 in the case of Belgium (UNHCR 2013). Compared to their geographic and population size, Germany, Sweden, and Switzerland host a relatively large number of refugees. These numbers reveal that the allocation of refugees does not reflect the 'fair burden sharing' concept put forward by the EU, as we show in more detail in Section 3.2.

3 EU Asylum Policy

The Dublin Convention of 1990 established the principle of asylum in the country of first entry as a cornerstone of the EU asylum policy. Since then, the 'Dublin System' has been under attack. Its initial aim was to 'clearly allocate responsibility for the examination of asylum application'. However, the past two decades have shown that the resulting regulation (i) was unable to cope with the striking inequality of refugee treatment across the EU, (ii) did not improve the integration prospects of asylum seekers, and (iii) failed to implement safeguards to protect them. In addition, the Dublin System inherently counteracts the 'fair sharing

perspective' and operates in a highly ineffective and costly manner (De Bruycker et al. 2010). In this section we briefly review the evolution of the EU asylum policy of the last two decades or so, which can be characterized by a quest for elusive harmonization and no real interest for fair burden-sharing procedures.

3.1 Harmonization

In recognition of the shortcomings of the Dublin system and in an attempt to harmonize EU policies, many reforms have been initiated in particular since 1999. Two generations of directives have been adopted in order to harmonize the EU asylum policy. The Asylum Procedures Directive sets out rules on the whole process of claiming asylum, including on how to apply, how the application will be examined, what kind of assistance can be provided to asylum seekers, how to appeal and whether the appeal will allow the person to stay on the territory or how to deal with repeated applications (De Bruycker et al. 2010). These instruments try to ensure a coherent procedural system within the EU. The Reception Conditions Directive attempts to deal with the divergence in the practice of treating asylum seekers. It ensures that applicants have access to housing, food, employment, as well as medical and psychological care. The Qualification Directive specifies the grounds for granting international protection.

De Bruycker et al. (2010) explain how difficult it becomes to monitor the implementation of these directives by individual countries. Existing assessments are problematic due to lack of data but they tend to point out at Member States circumventing the spirit of the directives by taking advantage from its vagueness in crucial points. For example, regarding the Asylum Procedures Directive, De Bruycker et al. (2010) note 'as regards survivors of torture, the Directives silence on the special needs of this category of applicants in combination with provision allowing Member States to treat cases as manifestly unfounded and omit a personal interview, have the potential to produce errors upon the asylum decision making'.

Additionally, some of the shortcomings of the Dublin System have been revised not only to take into account the interests of asylum seekers but also to better address situations of particular pressure of Member States' reception capacities and asylum systems. The Temporary Protection Directive was introduced in 2001 with the ambition to create a common EU basis to manage in case of a large influx of displaced persons fleeing their country of origin. However, this directive has never been implemented (in contrast to the similar-in-spirit Temporary Protected Status in the USA, which has been invoked, for example, to prevent deportation of undocumented immigrants following the earthquakes in El Salvador in 2001 or Haiti in 2010).

Finally, the EU has set up systems to promote informational exchange across Member States. The Eurodac regulation registers the fingerprints of all asylum seekers to prevent multiple claims. The Visa Information System facilitating information exchange across Member States and tracing back visa applications can also be used for the purpose of the asylum policy.

3.2 Burden sharing

In addition to attempts to harmonize EU refugee policies, there is also an increasing demand for fair 'burden sharing'. The EU has taken some initiatives to address this issue since the early 2000s. In December 2011 the European Commission issued a communication 'on enhanced intra-EU solidarity in the field of asylum' (European Commission 2011) that has been followed by conclusions on a 'Common framework for genuine and practical solidarity towards Member States facing particular pressures on their asylum systems' adopted by the Justice and Home Affairs Council in March 2012 (Council of Ministers of the European Union 2012). The European Refugee Fund covered the financial component of the distribution problem. Created in 2000, the fund hoped to increase the financial solidarity among member countries with an annual budget of 105 million Euros for 2008–2013. Recently, the European Refugee Fund has been reorganized for the years 2014–2020 and is now replaced by the Asylum, Migration, and Integration Fund and the Internal Security Funds whose annual budget amounts to approximately 10.9 million Euros.

In December 2013 the European Council emphasized the importance of the EU Resettlement Program, following an initiative of the EU Parliament in 2012. This initiative was created to encourage resettlement of refugees by EU Member States. Despite its declared importance, the EU has failed to implement the program on a large scale. For example, up until December 2013, only 0.54% of all Syrian refugees benefited from the initiative (Balleix 2014). Nevertheless, in 2012 about 4500 refugees were able to benefit from the Resettlement Program (see Table 1), which meant just above 5% of the total number of refugees resettled in the world and 9% of the number of asylum applicants that were granted refugee status in the EU that year.[3]

A lot of attention has been paid to the external borders of the EU. In addition to direct measures of border control (see below) the EU tries to support Member States that are under particular pressure. For example, the EASO started operating in Malta in 2011. Most of the instruments that promote solidarity are in fact means to help guarding Member States at the

[3] Percentages are based on data from UNHCR (2013) for the total number of refugees resettled in the world and from EASO (2013) for the total number of asylum applicants granted refugee status in the EU in first instance (37,335) plus final decisions (13,345): 50,680.

Table 1 EU Member States resettlement quota 2012 and 2013

Member State (pro year)	2012 total quota	2013 total quota
Belgium	–	100
Czech Republic	40	40 (tbc)
Denmark (multi-year programme 2012–2013)	500	500
Finland	750	750
France	100	100
Germany	300	300
Hungary	10	10
Ireland	–	80
The Netherlands (multi-year programme 2011-2014)	500	500
Portugal	30	30
Romania	0	40
Spain	–	30
Sweden	1900	1900
United Kingdom	750	750
Total	4580	4580

Source: EASO (2012).

external border of the EU, such as Italy or Greece. In 2004, the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union (FRONTEX) was created as an operational support mechanism for Member States in their management of border controls. FRONTEX has a budget of 90 million Euros. Additionally, the EU Border Surveillance System (EUROSUR) created in 2013 offers a system of organized operational information exchange in order to 'reduce the number of migrants entering the EU illegally and to prevent cross border criminality' (Balleix 2014). Moreover, the Smart Borders Package, which is still under discussion, serves as an additional mean to design border controls in a more efficient manner. Thus, border controls have been at the center of attention over the last decade. Ultimately, those measures may tackle the issues at the external borders of the EU but they do not deal with the question of internal solidarity regarding the allocation of refugees. All those measures may be a first step towards a more solidary union, but they do not suffice to align the needs of all, especially not the preferences of the asylum seekers themselves.

In any event, improving the balance across the EU first requires a proper assessment of the burden carried by each Member State. And indeed, a number of attempts have already been made to assess the current

extent of financial burden sharing between EU countries with respect to EU asylum policy. Most prominently, Thielemann et al. (2010) estimate the total amount to be distributed in 2008–2013 by the European Refugee Fund to represent only 14% of the total asylum costs for the EU-27 for the single year 2007. These costs include reception, accommodation, administrative procedures, deportation, integration measures, and so on. They do not however include the opportunity cost of these expensive and inefficient procedures, which would drive up the cost even more, given that it would not be hard to think of more productive uses for these resources. Also, the European Commission (2010) reports that the average cost per relocated refugee can amount to 8000 Euros, of which selection and travel is just over 1000 Euros and the rest is accommodation and other support costs.[4] This is double the actual per refugee budget allowed for relocations under the European Refugee Fund (ERF). Thielemann et al. (2010) even suggest that, under different rules, equal burden sharing implies transferring 33–40% of the asylum seekers currently within the EU to other countries, a large share going to the new Member States. In contrast to the UNHCR 'capacity assessment', Thielemann et al. (2010) create a 'combined capacity index' that aims to capture whether a country takes in a sufficient amount of asylum seekers according to its potential ability to accommodate them. They show that there is a tremendous discrepancy across EU members with respect to their actual vs. 'fair share' intake of asylum seekers.

Beyond their quantitative analysis, Thielemann et al. (2010) compare EU countries' Internal Dispersal Systems with those of the USA. The UK, for example, agrees on the allocation of asylum applicants with local authorities, depending on various parameters, including asylum seekers per person. Conversely, Germany decides upon the dispersal of asylum seekers on the federal level. Regional governments, the *Länder*, are not involved in the decision-making process, which is mainly population-based. In Finland, the main authorities are the municipalities that decide how many asylum seekers they are voluntarily willing to accept. As compensation they receive a small lump sum that however does not cover the actual costs that are incurred by taking in an additional asylum seeker. Sweden and France take an approach that is more asylum-seeker oriented. There, asylum seekers choose freely where to stay. State funds are subsequently transferred to regional governments, according to the total number they host. Compared to the USA, EU Member States base their decision on governmental directives, may they be at the federal, regional, or municipal level. In the USA, however, non-governmental organizations (nine agencies plus the State of Iowa) decide how to disperse the resettled refugees across the States.

[4] This is calculated from a pilot study of transfers between Malta and France.

In general, the policy initiatives of the EU seem to only alleviate the symptoms of the refugee reception problem, directing their main efforts towards border controls and lump-sum transfers, which do not stand in proportion to the real cost occurring in the host country. Additionally, the burden-sharing assessment has so far only made use of direct costs of refugees, like accommodation or administrative efforts but they do not reveal the true cost (direct costs, indirect costs, and opportunity costs) and above all not the underlying benefits, such as the potential economic efficiency gains from receiving immigrants in general or the welfare increase generated by the granting of protection positively valued by public opinion in host countries. These policies thus fail to tackle the problem at the root. In order to adequately assess the cost of refugees and to reveal the preferences of Member States and refugees equally, there is a need for a market-based approach that will efficiently and at a low cost lead to the desired social optimum.

4 Related Literature

This article is closely related to two strands of recent literature on the (in)effectiveness of the current EU asylum policy, mostly to Hatton (2011, 2012), for economics, and Thielemann et al. (2010), for political science, and on market-based proposals to address the refugee issue.

Hatton (2012) investigates this question by examining the basis upon which a joint EU policy can be justified and by asking whether a more efficient outcome can be achieved by harmonization alone or a more centralized decision-making process is necessary. He does so by charting the progress of harmonization and burden sharing in the CEAS, exploring its costs and benefits, and also analyses the evolution of public attitudes towards refugees. He also develops a model where asylum is a locally provided public good, thus in its nature underprovided unilaterally. Consequently, this creates the need for a joint policy that ensures an optimal distribution of asylum seekers across Member States. In this case, however, a harmonized policy is not sufficient since it does not account for refugees' preferences that may be disproportionately biased towards one destination country. In order to avoid accumulation of refugees in 'immigration darlings', there needs to be a joint EU policy that matches supply and demand and prevents oversupply in some and under-provision in other countries. Hatton proposes two different tools to reach (or at least move towards) the social optimum: first, an asymmetric subsidy depending on lack or excess supply of refugees in certain countries, and second, an active redistribution of refugees.

As already indicated in Section 3.2, Thielemann et al. (2010) calculate fair burden-sharing rules according to population size, population density, and current stocks of refugees hosted. Any of these suggest a disproportionate distribution of burdens across Member States. In contrast to Hatton (2012), the authors do not suggest a radical shift in the paradigms of asylum policy but, rather, an expansion and enhancement of existing policy tools. Based on surveys asking Member States about their preferences for possible solidarity mechanisms, Thielemann et al. (2010) call for (i) a harmonization of the costs for asylum seekers, (ii) a financial compensation for over-burdened countries, and (iii) a voluntary movement of asylum seekers from more to less affected states, avoiding costly forced movements.[5]

Overall, the literature has not paid enough attention to market-based solutions. Schuck (1997) and Hathaway and Neve (1997) were first to discuss a system of bilateral negotiations over tradable refugee resettlement quotas. In the words of Schuck (1997, p. 248), 'the proposal consists of two main elements. First, a group of states would (...) arrange for an existing or newly-established international agency to assign to each participating state a refugee protection quota. (...) Second, the participating states would then be permitted to trade their quotas by paying others to fulfill their obligations.' through bilateral exchange (Schuck 1997, pp. 283–4). However, Schuck (1997) fell short of proposing a system of tradable quotas as he mostly envisioned the possibility for countries to trade refugees for money on a strictly bilateral basis. Bubb et al. (2011) supplement this system of bilateral exchange with a screening device to separate refugees from economic migrants. However, the bilateral nature of these proposals limits the scope for trade and, thus, implies an inefficient outcome.

Finally, Fernández-Huertas Moraga and Rapoport (2014) develop a multilateral system of TIQs which includes a mechanism to match immigrants to destinations. One of the main applications they envision for their proposed system is the resettlement of long-standing refugees. This would seem a particularly well-suited context for implementing a TIQs system, for a number of reasons. First, refugee protection is a paragon example of international public good, with refugee protection being recognized as a moral and legal obligation by the countries signatories of the 1951 Geneva

[5] They emphasize how forced relocations of refugees or asylum seekers are much more expensive than voluntary relocations (10 times more expensive according to a UK report on return that they quote) and this is why they propose that any relocation should be voluntary. From the same report, an example on how to promote voluntary movements is by 'better promoting the options available to those due for removal and by establishing better contacts with community groups'.

Convention (and its 1967 extended Protocol)—that is, virtually all the countries of the world. Second, there is also an obvious incentive to free-ride, and not less obvious evidence of ensuing under-provision of refugee resettlement. Third, it is quite common among policymakers to consider refugee protection as a 'burden' and there is a general understanding that this burden is not fairly shared at the international level (UNHCR 2013). And fourth, the institutional framework for international policy coordination is already largely in place, with widely ratified treaties such as the Geneva Convention and existing well-established international organizations such as UNHCR.

All these reasons would seem all the more true in the European context, as demonstrated in the previous section. In what follows, therefore, we adapt Fernández-Huertas Moraga and Rapoport (2014) to the context of the EU asylum policy by proposing an EU Tradable Refugee-admission Quotas (TRQs) System that takes into account the specifics of the EU context and addresses many of the inefficiencies of the current system. It builds on existing understandings that fair burden-sharing rules should be adopted—this is analogous, in our model, to the stage of initial quotas determination—and shows how a TRQs system can allow for (i) truthful revelation of the country-specific costs of accommodating asylum seekers and refugees, (ii) exploitation of differences in such costs among EU countries to generate cost-effective outcomes (that is, minimizing total cost for a given number of refugees or maximizing the number of refugees for a given budget constraint), and (iii) taking refugees' preferences over destinations into account, therefore reducing their incentives to move between countries. Last but not least, the mechanism also allows for taking countries' preferences over refugees' types into account. This can be understood as preferences over refugees' characteristics (such as language, skills, and country of origin) as well as over refugees' legal status (such as asylum seekers in wait for a decision, refugees whose asylum request has been accepted, or internationally resettled refugees), allowing for compensation among countries across refugees' types.

5 The Model

Our model is a simple extension of the one presented in Fernández-Huertas Moraga and Rapoport (2014) for the case of both asylum seekers and refugees in the context of the EU.

The model has two building blocks. On the one hand, providing protection to refugees and to asylum seekers with valid claims is considered an international public good. On the other hand, providing protection both to refugees and to asylum seekers, with or without valid claims, is costly so

that it can be considered a 'burden', which European countries will be sharing through the market.

We proceed in three steps. First, we introduce a basic model for TRQs when refugees' and asylum seekers' preferences are not taken into account. Second, we add refugees' and asylum seekers' preferences through a matching model. Finally, we also consider receiving countries' preferences over the number of the refugees and asylum seekers. We concentrate on an intuitive exposition of the model while relegating the mathematical details to the appendix.

5.1 TRQs without matching

Suppose each EU country decides how many refugees and asylum seekers to receive given the net perceived total cost (or benefit) of receiving them. This cost refers to a set of 'direct' costs, such as:

- reception and accommodation;
- administrative procedures;
- potential removal; and
- potential integration measures.

There are also 'indirect' net costs associated with the admission of refugees and asylum seekers. These include the immigration surplus associated with refugees and asylum seekers (efficiency gains from migration), their net fiscal contribution, their social and political costs, etc.

The international public good aspect is introduced by considering that the inhabitants of the EU receiving countries or at least their governments care about refugees and asylum seekers hosted by other countries. The number of refugees and asylum seekers hosted by one EU country generates a positive externality for the other EU destination countries. This makes the non-cooperative equilibrium that would obtain in the absence of cooperation different from the optimal levels of refugees and asylum seekers that should be accepted from the viewpoint of the EU as a whole.

If there is no coordination and EU countries act unilaterally, each of them will equalize the marginal cost of accepting one additional refugee or asylum seeker to zero. However, more refugees and asylum seekers would be hosted if countries took into account how other countries care about providing international protection. The optimal solution would be to equalize the marginal net cost of hosting one additional refugee or asylum seeker across countries but not to zero. In a sense, refugees would be hosted where it is 'cheapest' to host them from the point of view of cooperative receiving countries. In the presence of cooperation, there would be no need for a 'race to the bottom' in terms of each country

unilaterally adopting excessively strict policies from the point of view of the EU.

This optimal solution can be replicated by creating a market for TRQs. Suppose each country is assigned an initial quota that can be filled both with refugees and asylum seekers. These quotas can be traded in a market in which there is a price received for accepting one additional refugee or asylum seeker into a country in excess to the assigned quota and a price paid for accepting fewer refugees or asylum seekers than those assigned by the initial quota.

Three points must be emphasized. First, this would be a non-traditional market in the sense that participation would be restricted, at least initially, to EU governments. Second, the market would not apply to all refugees or asylum seekers at the doors of the EU but only to a predetermined number that Member States would need to agree upon. Third, the system presupposes that the initial distribution of quotas must also be agreed upon at the EU level through some commonly accepted 'burden-sharing' rules. This would certainly be a politically sensitive issue and focusing on one particular rule, such as the ones enumerated by Thielemann et al. (2010), is out of the scope of this article. We only describe briefly below (Subsection 5.1.1) some desirable properties for this initial distribution of quotas.

Then, the market would operate in the following fashion:

- Supply of visas (demand for quotas). At a given visa price (higher than their marginal cost), some countries would be willing to get paid to receive refugees in excess of their quota.
- Demand for visas (supply of quotas). At a given visa price (lower than their marginal cost), some countries would be willing to pay to receive less refugees than their quota.

A simple example with two destination countries can illustrate how this market would work. Suppose Australia and New Zealand agree on hosting a given quantity of refugees from Kiribati, denoted by the distance $O_A - O_{NZ}$ in Figure 3. They also agree initially that Australia will host Q refugees while New Zealand will take care of the rest. Figure 3 also depicts the marginal net perceived costs of both countries on the vertical axis, with Australia counting refugees from left to right, so that the net marginal cost increases in the number of received refugees, and New Zealand counting them in the opposite direction. If a market for tradable quotas opened between both countries, they would reach an equilibrium quota price at the intersection of both marginal cost curves. At the price marked by this intersection, Australia is willing to get paid to receive more refugees than its allocated quota while New Zealand is willing to pay not to receive them.

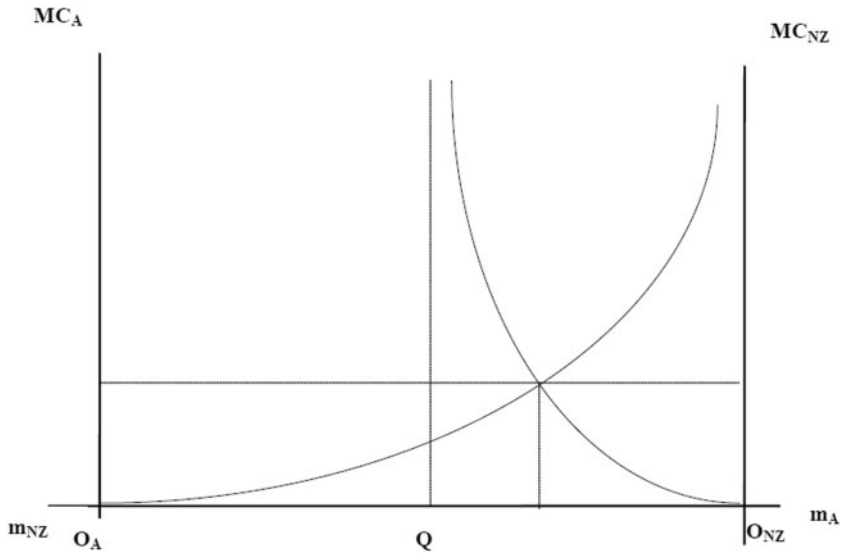

Figure 3 A TRQs market for Kiribati refugees in Australia and New Zealand (example).

The initial distribution of quotas does not affect the efficiency of the mechanism and it only has redistributive consequences as long as the market is competitive. As discussed in Fernández-Huertas Moraga and Rapoport (2014), this can be achieved through a computerized continuous double auction mechanism, which converges to competitive equilibrium outcomes even when there are very few buyers and sellers thanks to the Bertrand-type competition it promotes (Casella 1999; Friedman and Ostroy 1995).

5.1.1 *Taking participation constraints into account*

In addition to its efficiency properties, the market can also be made individually rational for every country through the manipulation of initial quotas. Individual rationality would ensure that every country has an incentive to participate in the market, since it can achieve a better result than by staying out of it.

In order to satisfy participation constraints, the countries benefitting the most from the externality should get higher initial quotas whereas those who deviate most from their individually optimal allocations because of the market should get lower initial quotas.

It could be argued that the informational requirements for establishing such a quota are unrealistic so that countries could be unwilling to participate. However, participation constraints are even less clear in the case

of signatories of the 1951 Geneva Convention or its 1967 Protocol for the protection of refugees and still 145 countries have signed the former and 146 the latter. They are less clear because they imply countries must host as many individuals as they arrive in their soil as long as they are in danger of persecution in their origin countries. As a result, the potential cost of signing the Convention is not bounded. In our model, the potential cost is bounded by the actual number of refugees and asylum seekers to which the market is applied. Hence, it looks like the externality derived from the provision of this public good is large enough for countries to be willing to enter into this type of multilateral agreements.

5.2 Taking refugees' preferences into account

Taking the preferences of refugees and asylum seekers into account is a straightforward task. From a theoretical point of view, the problem is analogous to assigning houses to tenants with existing rights, studied, among others, by Abdulkadiroglu and Sonmez (1999). The existing rights can either refer to the country of first asylum in the EU or to a refugee camp.

Technically, the problem is to assign indivisible items (rights for a refugee or an asylum seeker to enter a given destination country, or 'visas') to agents (refugees or asylum seekers) taking into account their preferences.

The solution proposed by Abdulkadiroglu and Sonmez (1999) is the use of the top trading cycles mechanism:

(1) Each refugee/asylum seeker ranks all potential destination countries, specifying those to which she would not want to go at all.
(2) An ordering of refugees and asylum seekers is randomly chosen from a given distribution of orderings. A question remains whether the EU would want to prioritize refugees over asylum seekers.
(3) For any given ranking of countries done by the refugees and ordering of refugees, the outcome is obtained using the following algorithm:

    (a) Assign the first refugee (from the ordering obtained in Step 2) her top choice, the second refugee her top choice among the remaining visas, and so on, until someone requests a visa for which the quota (resulting from the market) is filled. It is as if the first refugee with a visa in that quota is requested to exchange her visa.
    (b) If at that point, the refugee whose visa is requested has already chosen before, then go to the second refugee in that quota. If this one has also chosen, go to the third and so on. If the quota is filled with refugees who have already chosen before, then do not disturb the procedure (there is no room for Pareto improvement).

Otherwise, modify the remainder of the ordering by inserting the refugee who did not choose yet to the top of the line and go on with the procedure.

(c) Similarly, insert any refugee who is not already served at the top of the line once her visa (to stay in her first asylum country) is requested.

(d) If at any point a loop forms, it is formed exclusively by refugees with a visa each of them requesting the visa of the refugee who is next in the loop (a loop is an ordered list of refugees $(j_1, j_2, \ldots, j_k)$ where refugee j_1 requests the visa of refugee j_2, refugee j_2 requests the visa of refugee $j_3 \ldots$, refugee j_k requests the visa of refugee j_1). In such cases, remove all refugees in the loop by assigning them the visas they request and continue the procedure.

A key ingredient of this mechanism is that a refugee whose visa is requested is upgraded to the first place at the remaining of the line before her visa is allocated. As a result, the top trading cycles mechanism is individually rational, as it assures every refugee a visa that is at least as good as the possibility of staying in her first-asylum country or her refugee camp. It is also incentive compatible (no refugee has an incentive to misrepresent her preferences whatever the strategies others use[6]) and Pareto efficient. This is a direct application of Abdulkadiroglu and Sonmez (1999) following directly the exposition in Chen and Sonmez (2002) and substituting word by word house for visa and refugee for tenant. The relevant point for the case of refugees studied here is the possibility that the final allocation determined by the market might not be achieved.

It turns out that the addition of the matching mechanism to the market for TRQs described in the previous section does not alter its efficiency properties as long as it is properly designed. If participating countries were compensated on the basis of the number of refugees and asylum seekers they bid for in the market, they would have an incentive to bid for a large quota and later on discourage refugees and asylum seekers from going there. This way, they would be compensated by the market in addition to not actually incurring the cost of hosting the refugees and asylum seekers, who would use the matching mechanism not to go to an undesirable destination. In order to prevent this perverse incentive from happening, the solution is to make countries be compensated on the actual numbers of refugees and asylum seekers they host rather than on those they bid for.

[6] This follows directly from individual rationality. Given that an individual whose visa is rejected is upgraded to the first place at the line, there is no incentive to misrepresent preferences since it can only result in a worse outcome for whoever does it.

This amounts to forcing destination countries to pay the market price for the unfilled part of their quotas. This is a penalty unattractive countries would have to pay for not being able to attract as many refugees and asylum seekers through the matching mechanism as they would bid for in the market. In equilibrium, the penalty would always be zero but it is needed so that countries do not have incentives to become unattractive from the point of view of refugees and asylum seekers. In practice, the EU could be in charge of collecting this penalty in case of some off-equilibrium behaviour.

In terms of enforcement, the penalty would generate incentives for countries to abide by their agreements and actually host the number of refugees they accept to host. Of course, collecting the penalty would be an additional enforcement issue but we do not think it different from the enforcement problems associated with the collection of other payments at the EU level, whose discussion is out of the scope of this article.

5.3 Taking countries' preferences into account

Not only do refugees and asylum seekers have preferences over the countries to which they can go, but receiving countries also have preferences both between hosting refugees or asylum seekers and possibly about the type (nationality, skill level, etc.) of refugee or asylum seeker they will be hosting as well.

Satisfying these preferences can make hosting refugees and asylum seekers more attractive for host countries. Either the market could be expanded or the same market size could achieve a more cost-effective allocation.

There are at least two ways to introduce countries' preferences into the model. The first and less interesting one would imply creating one market for each type of refugee and asylum seeker there is. For example, if countries only had preferences between refugees and asylum seekers, the EU would just need to create a market for refugee quotas and a market for asylum seekers' quotas.

A second possibility, which we followed in the previous section, is to group refugees and asylum seekers into the same market even if they are heterogeneous. This methodology can be extended to the case where there are many different types of refugees or asylum seekers over which countries can have preferences in terms of, for example, their language, their nationality or their skill level.

Adding a matching mechanism that assigns both destinations to their preferred refugees and refugees to their preferred destinations to the market for TRQs has no effect on the efficiency properties of the market. Marginal cost equalization across migrant types and across countries would still be optimal.

The choice of the appropriate matching mechanism is a different issue. In this case, the preference over one particular mechanism is not that clear. The problem is similar to the allocation of students to colleges (Gale and Shapley 1962; Roth 1985) although the market and the penalty make it a bit different. Still, Fernández-Huertas Moraga and Rapoport (2014) establish the impossibility of having a stable Pareto-efficient matching mechanism in which countries (colleges) reveal their preferences truthfully over the type of refugees (students) they want, following Roth's (1985) result for the college admissions problem.[7]

Among the many possible matching mechanisms that would be compatible with the market for TRQs, we follow Fernández-Huertas Moraga and Rapoport (2014) in arguing for the country-proposing deferred acceptance mechanism, on the basis that it is less manipulable than the refugee-proposing one, as defined by Pathak and Sonmez (2013).

The way the mechanism works is by countries submitting their preferences over refugees and asylum seekers first. Refugees and asylum seekers accept their most preferred visa among the countries willing to accept them and reject the unacceptable ones (countries where they would not want to go). Rejected countries would then offer visas again to their preferred refugees and asylum seekers among those who had not rejected them yet. Refugees and asylum seekers with several visa offers would then hold to their most preferred one and reject their unacceptable ones. The process would repeat until no country would have visas left to offer.

Even though this mechanism attains the most preferred stable matching for countries,[8] taking into account countries preferences could introduce a trade-off. On the one hand, cost-efficiency is increased (Fernández-Huertas Moraga and Rapoport 2014). On the other hand, the matching mechanism can generate some additional uncertainty over its outcome. However, it must be noted that the first effect can be proved while the second would be an empirical question.

6 The Malta Example

This section makes use of a pilot program by the EU that aimed to implement the principle of solidarity and burden sharing in the context of refugee and asylum policy. Particularly, a European Council Conclusion initiated the European Relocation from Malta (EUREMA) program in

[7] Azevedo and Budish (2013) argue that manipulation incentives disappear in deferred acceptance mechanisms as the market grows, though.

[8] Azevedo and Leshno (2013) show that it would also be the preferred mechanism for refugees and asylum seekers with a large number of participants.

2009 at the initiative of Commissioner Barnier in order to alleviate the disproportionate burden accruing to the Island of Malta. In fact, Malta was under great pressure regarding the large influx of refugees and other asylum seekers in 2009, as well as in 2011 and 2012. The EASO, whose main objective is to coordinate Member States policies in view of the development of the CEAS, was inaugurated in Malta in 2011 as a response to these developments and with the objective of evaluating the EUREMA program. EASO (2013) states that:

> The Maltese Office of the Refugee Commissioner received a total of 2,114 applications for international protection in 2012 (...). 86.3% of applications received by the Office of the Refugee Commissioner in 2012, as in previous years, were lodged by third country nationals (TCNs) who entered Malta irregularly by sea.
> In view of the significant pressures facing Malta, and following an inter-Ministerial pledging conference organised by the European Commission in May 2011, relocation of protected persons from Malta to other Member States took place during 2012 (...). Relocation activities were organised either as part of the EU pilot project on Intra-EU relocation (EUREMA), or through bilateral projects.

EUREMAs success in 2009 led to the extension of the program in 2011 (EUREMA II). EASO divides EUREMA into Phase I, initiated in 2009 and ultimate relocation in 2011, and Phase II, brought to life in 2011 and relocation partly still in process. Tables 2 and 3 show the participating Member States, the pledges, and the final distribution of asylum seekers.

In Phase I, Germany and France relocated most of the immigrants: 197 out of 227, even more than they had pledged initially. In contrast, other countries eventually did not commit to the number of relocations they had pledged at the beginning. In Phase II only 217 out of 306 pledged allocations had effectively taken place by January 2013.

Table 3 shows that participation extended to more countries in this second phase, although this was achieved by allowing some of the new participating countries to sign their own bilateral agreements to relocate refugees and asylum seekers.

The relevance of the EUREMA program for this study is 3-fold. First, it sets the context for possible applications of the matching model proposed above. Second, the program applies a simplified matching procedure between Member States and asylum seekers and thus uncovers possible shortcomings and challenges faced by Member States and administrators. Third, it reveals how the proposed matching technique can deal with problems that occur if the relocation is uncoordinated and at which points it is more efficient.

Table 2 EUREMA Phase I: Places pledged and number relocated

Member State	Places pledged	Number relocated
France	90	95
Germany	100	102
Hungary	8–10	0
Luxembourg	6	6
Poland	6	0
Portugal	6	6
Romania	7	0
Slovakia	10	0
Slovenia	10	8
United Kingdom	10	10
Total	253–5	227

Source: EASO (2013).

For this purpose, the lessons learned from the EUREMA pilot are of major importance. EASO (2012) analyses the results in a fact-finding exercise and describes participation, matching procedure, and feedback of the Member States.

Participation in EUREMA was voluntary and, still, 12 EU countries agreed to participate at some point since 2009, when the need of some measure to assist Malta was first brought to the attention of the European Commission. The benefit for participating countries consisted of funding for relocation activities as well as access to the expertise from the designers of the EUREMA framework. This level of participation would be a good sign for a similar pilot experience with a system of TRQs like the one presented above.

In addition to the 12 European Member States participating through EUREMA, Phase II also allowed individual countries, both Member States or Associated Countries such as Switzerland, to reach bilateral agreements with Malta for the relocation of refugees or asylum seekers. Eight additional countries chose this alternative.

The selection of potential beneficiaries that would be relocated was made in two steps. First, UNHCR counseled potential beneficiaries through a registration exercise that took place in 2009. In a second step, participating countries sent missions to Malta to make the final selection.

The matching part of the market for TRQs could follow a similar strategy. During the registration exercise, information could also be gathered about the preferred destinations of all of the potential beneficiaries. Then,

Table 3 Intra-EU relocation from Malta by EU Member States: number of pledges in 2011–2012 and actual relocations by January 2013

Member State/Schengen Associated State	Number of relocation places pledged (2011–2012)	Number of beneficiaries relocated (as at 23 January 2013)	Bilateral/EU funded project
Germany	150	153	Bilateral
Poland	50	6	EU-funded Project
Spain	25		Bilateral
The Netherlands	20	20	Bilateral
Denmark	10	10	Bilateral
Romania	10		EU-funded project
Slovakia	10		EU-funded project
Hungary	5		EU-funded project
Ireland	10	20	Bilateral
Lithuania	6	4	EU-funded project
Portugal	6	4	EU-funded project
Bulgaria	4		EU-funded project
Total	306	217	

Source: EASO (2012).

countries could express their preferences about types of refugees and asylum seekers and some authority, either UNHCR or EASO, could perform the matching applying the country-proposing deferred acceptance mechanism to both lists of preferences: those of countries and those of potential beneficiaries.

Generally, the fact-finding exercise of EASO reveals that the approach is rather Member-States oriented. Not only has there been no inquiry about the personal preferences on destinations by refugees and asylum seekers but there is also no or very few information about the satisfaction level of the relocated persons with the EUREMA program. In contrast, there is detailed information about the selection criteria and demands of Member States. Among this detailed information, there is a long list of challenges to be addressed as identified by participating countries. We enumerate a selection of them below, while arguing in which way our market for TRQs could have a useful role in addressing them:

- Time constraints relating to identification of candidates, in particular as some required several rounds of counseling before confirming their 'interest in relocation'. The matching mechanism would prevent this type of problem from happening. If we collect the preferences of

potential beneficiaries during the registration drive, there would be no need in general to confirm the interest in relocation.

- Limitations and constraints of the participating States' selection criteria, in order to 'match' the profile of beneficiaries of international protection in Malta. Again the matching mechanism, would gather the required information beforehand so that this would no longer be a problem. Participating states could express their limitations and constraints when stating their preferences over types of refugees and asylum seekers.
- Assessing the 'willingness' and suitability of potential beneficiaries 'to being relocated'. This challenge is directly related to the first one and, as in that case, the matching mechanism would directly take care of it.
- Target group 'composition' (refugees, subsidiary protection beneficiaries, asylum seekers). In the same way, this challenge is related to the second one so that the part of the matching mechanism that takes care of countries' preferences would address it.
- Setting up clear criteria concerning relatives, especially considering family reunification. This feature is not specifically considered in the current version of the matching mechanism but it can be easily incorporated. For example, Roth (2002) explains how classical matching mechanisms can be modified to take into account the assignment of couples to residency positions in the USA.
- Lack of will by some candidates to commit to relocation offers by 'new' EU Member States where there are few migrant communities. Again, this is a matching problem on the side of potential beneficiaries that could be solved by collecting their preferences at the time of registration.

Most of these selected challenges are related to matching issues that can be addressed by the matching mechanism that we incorporate to the market for TRQs. This quote from EASO (2012) makes it even clearer:

> Some of the selection criteria did not match the characteristics of the beneficiaries of international protection in Malta, making it difficult to carry out the relocation to some of the participating States (...). This sometimes led to a mismatch between the criteria and the pool of candidates (...). Other participating States requested that the beneficiaries be refugees (...).

The last sentence reveals key differences between the admission criteria of several countries. Some preferred already recognized refugees while others were willing to accept asylum seeker waiting for a decision. Figure 4 shows that there was a great deal of heterogeneity in the selection criteria of participating countries.

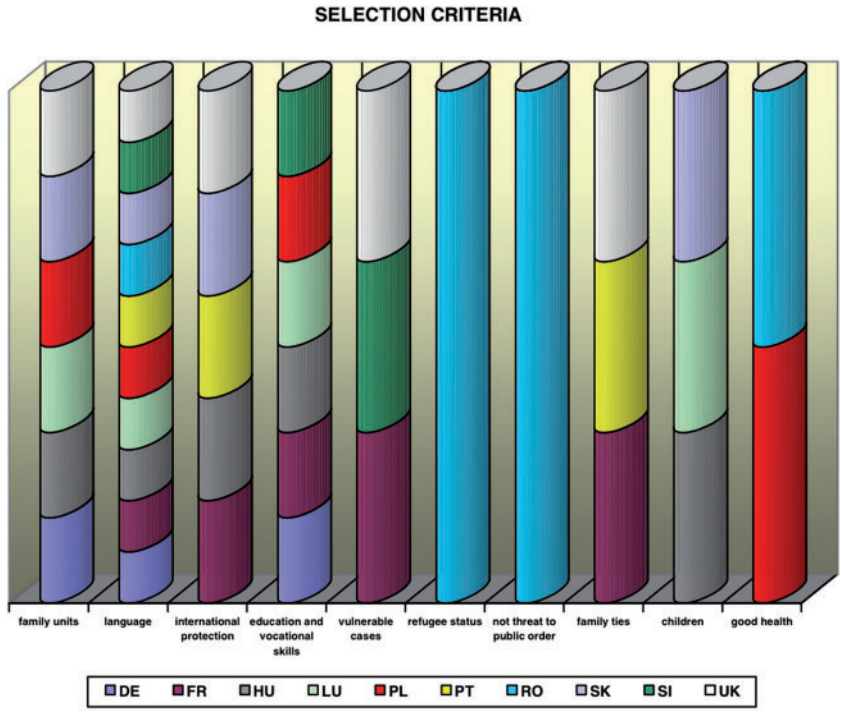

Figure 4 Source: EASO (2012).

Out of the 10 selection criteria listed, only 1 of them (language) was mentioned by the 10 surveyed countries while 2 of them (refugee status and not being a threat to public order) were only mentioned by 1 country (Romania). All in all, this heterogeneity in preferences is good news since it allows exploiting the gains from trade in the market.

We end this section with another quote, this time from EASO (2013):

> . . . there is room for discussing and developing the instrument of intra-EU relocation in the future, as part of a range of intra-EU solidarity measures. The Commission created the scope for Union co-financing of such activities in the Asylum and Migration Fund proposal, which will facilitate action by Member States willing to engage in voluntary projects, with the EASO taking a coordinating role as established in its founding Regulation.

The main advantage of the proposed matching mechanism is that it deals with the heterogeneity in the preferences of the Member States most

efficiently by exploiting the comparative advantage of each participant. Consequently and contrary to conventional EU immigration policies, the matching model embraces heterogeneity rather than trying to find a 'one size fits all' solution. As a general conclusion, we argue that, given the Malta example with EUREMA, our proposed market for tradable refugee-admission quotas combined with a matching mechanism would be a perfect instrument for intra-EU relocation of refugees and asylum seekers.

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A Appendix

A Mathematical Presentation of the Model

A.1 TRQs without matching

Suppose each EU country i decides how many refugees and asylum seekers to receive given net perceived total cost $c_i(r_i, a_i)$, where r_i denotes the number of refugees hosted by country i and a_i refers to the number of asylum seekers. This cost function is a reduced form including the components outlined in the main text. We assume that it is convex and differentiable and that it has an interior positive minimum in both arguments.

Country i inhabitants or their government care about refugees and asylum seekers hosted by other countries through the function $g_i(R_{-i}, A_{-i})$, with $\frac{\partial g_i}{\partial R_{-i}} > 0$, $\frac{\partial g_i}{\partial A_{-i}} \geq 0$, $R_{-i} = \sum_{j \neq i} r_j$ and $A_{-i} = \sum_{j \neq i} a_j$.

Country i would maximize the following welfare function:

$$\max_{r_i, a_i} \; g_i(R_{-i}, A_{-i}) - c_i(r_i, a_i) \tag{1}$$

The first order conditions would be:

$$\frac{\partial c_i}{\partial r_i}\left(r_i^{NC}, a_i^{NC}\right) = 0 = \frac{\partial c_i}{\partial a_i}\left(r_i^{NC}, a_i^{NC}\right) \tag{2}$$

where *NC* stands for the non-cooperative solution. The number of refugees and asylum seekers hosted by one EU country generates a positive externality for the other EU destination countries. This makes the non-cooperative equilibrium different from the optimal levels of refugees and asylum seekers that should be accepted from the viewpoint of the EU as a whole. We denote these levels as (R^{GO}, A^{GO}). They are the solution to the problem:

$$\max_{\{r_i, a_i\}_{i=1}^{N}} \sum_{i=1}^{N} [g_i(R_{-i}, A_{-i}) - c_i(r_i, a_i)] \tag{3}$$

Without loss of generality, we can assume that the functions $g_i(\cdot)$ are such that (R^{GO}, A^{GO}) can also be obtained as the solution to the dual problem:[9]

$$\min_{\{r_i, a_i\}_{i=1}^{N}} \sum_{i=1}^{N} c_i(r_i, a_i) \tag{4}$$

$$s.t. \sum_{i=1}^{N} (r_i + a_i) \geq R^{GO} + A^{GO}$$

The first order conditions would be:

$$\frac{\partial c_i}{\partial r_i}\left(r_i^{GO}, a_i^{GO}\right) = \lambda = \frac{\partial c_i}{\partial a_i}\left(r_i^{GO}, a_i^{GO}\right) \quad \forall i = 1...N \tag{5}$$

where λ is the Lagrange multiplier associated to the constraint. It is easy to see that:

$$R^{NC} + A^{NC} \equiv \sum_{i=1}^{N} (r_i^{NC} + a_i^{NC}) < \sum_{i=1}^{N} (r_i^{GO} + a_i^{GO}) \equiv R^{GO} + A^{GO} \tag{6}$$

This solution can be replicated by creating a market for TRQs. Suppose each country is assigned an initial quota q_{i0} that can be filled both with

[9] See Fernández-Huertas Moraga and Rapoport (2014) for a formulation that solves the maximization problem directly.

refugees and asylum seekers.[10] These quotas can be traded in a market in which the price received for accepting one additional refugee or asylum seeker into a country is denoted by p. The initial distribution of quotas must be agreed upon at the EU level and be such that:

$$R + A = \sum_{i=1}^{N} q_{i0} \tag{7}$$

The market will be a Pareto improvement over the non-cooperative solution as long as $R^{NC} + A^{NC} < R + A \leq R^{GO} + A^{GO}$ (Fernández-Huertas Moraga and Rapoport 2014). It is assumed that the cost functions are expressed in monetary units and that the market is competitive so that all countries behave as price-takers.

Individual countries would then need to solve:

$$\min_{\{r_i, a_i\}} c_i(r_i, a_i) - p(r_i + a_i - q_{i0}) \tag{8}$$

The second term means that the cost will be just $c_i(r_i, a_i)$ as long as the quota is filled: $r_i + a_i = q_{i0}$. If country i hosts more refugees and asylum seekers than its quota ($r_i + a_i > q_{i0}$), then its cost will be reduced by this extra amount multiplied by the price p. If, on the contrary, it hosts less than its quota ($r_i + a_i < q_{i0}$), then its cost will be increased by this extra amount multiplied by the price p.

If the market is competitive, the first order conditions are:

$$\frac{\partial c_i}{\partial r_i}\left(r_i^M, a_i^M\right) = p = \frac{\partial c_i}{\partial a_i}\left(r_i^M, a_i^M\right) \quad \forall i = 1...N \tag{9}$$

The marginal costs of accepting one additional refugee or one additional asylum seeker are equalized across destinations through the market, which must clear, so that:

$$R + A = \sum_{i=1}^{N} q_{i0} = \sum_{i=1}^{N} (r_i^M + a_i^M) \tag{10}$$

[10] We can think of alternative formulations in which there would be one quota and one price for each of the categories: refugees and asylum seekers.

Proposition 1 *The market solution to (4) is efficient.*

The proof comes from establishing that $p = \lambda$ (Fernández-Huertas Moraga and Rapoport 2014).

A.1.1 *Taking participation constraints into account*

In addition to its efficiency properties, the market can also be made individually rational for every country through the manipulation of initial quotas. The general formulation of the problem in which the countries participation constraints are satisfied is:

$$\max_{\{q_{i0}\}_{i=1}^{N}} \sum_{i=1}^{N} \left[g_i\left(R_{-i}^M, A_{-i}^M\right) - c_i\left(r_i^M, a_i^M\right) \right] \tag{11}$$

$$s.t. \sum_{i=1}^{N} q_{i0} = R + A$$

$$g_i\left(R_{-i}^M, A_{-i}^M\right) - c_i\left(r_i^M, a_i^M\right)$$

$$+ p\left(r_i^M + a_i^M - q_{i0}\right) \geq g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right) - c_i\left(r_i^{NC}, a_i^{NC}\right) \quad \forall i = 1...N$$

$$\left(r_i^M, a_i^M\right) = \arg\min \left\{ c_i(r_i, a_i) - p(r_i + a_i - q_{i0}) \right\} \quad \forall i = 1...N$$

Denoting by q_{i0}^{PC} the solution to this problem, the first order conditions are:

$$\mu - p\pi_i = 0 \quad \forall i = 1...N$$

$$\sum_{i=1}^{N} q_{i0}^{PC} - R - A = 0$$

$$\pi_i[g_i\left(R_{-i}^M, A_{-i}^M\right) - c_i\left(r_i^M, a_i^M\right) + p\left(r_i^M + a_i^M - q_{i0}^{PC}\right)$$

$$-g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right) + c_i\left(r_i^{NC}, a_i^{NC}\right)] = 0 \quad \forall i = 1...N$$

$$\pi_i \geq 0$$

where μ is associated to $\sum_{i=1}^{N} q_{i0} = R + A$ and π_i is associated to $g_i\left(R_{-i}^M, A_{-i}^M\right) - c_i\left(r_i^M, a_i^M\right) + p\left(r_i^M + a_i^M - q_{i0}\right) \geq g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right) - c_i \ \left(r_i^{NC}, a_i^{NC}\right)$. We are using the fact that $\frac{\partial r_i^M}{\partial q_{i0}} = \frac{\partial a_j^M}{\partial q_{i0}} = 0 = \frac{\partial p}{\partial q_{i0}} \forall i, j$ since the solution to the market problem does not depend on the initial allocation of quotas.

From the first set of conditions, we have:

$$\pi_i = \frac{\mu}{p} > 0 \quad \forall i = 1...N \tag{12}$$

This leaves us with a rule to allocate initial quotas satisfying:

$$\begin{aligned} &g_i\left(R_{-i}^M, A_{-i}^M\right) - c_i\left(r_i^M, a_i^M\right) + p\left(r_i^M + a_i^M - q_{i0}^{PC}\right) \\ &-g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right) + c_i\left(r_i^{NC}, a_i^{NC}\right) = 0 \quad \forall i = 1...N \end{aligned} \tag{13}$$

which implies:

$$\begin{aligned} q_{i0}^{PC} = r_i^M + a_i^M + &\frac{g_i\left(R_{-i}^M, A_{-i}^M\right) - g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right)}{p} \\ &- \frac{c_i\left(r_i^M, a_i^M\right) - c_i\left(r_i^{NC}, a_i^{NC}\right)}{p} \quad \forall i = 1...N \end{aligned} \tag{14}$$

The countries benefitting the most from the externality (higher $g_i\left(R_{-i}^M, A_{-i}^M\right) - g_i\left(R_{-i}^{NC}, A_{-i}^{NC}\right)$) should get higher initial quotas whereas those who deviate most from their individually optimal allocations because of the market (higher $c_i\left(r_i^M, a_i^M\right) - c_i\left(r_i^{NC}, a_i^{NC}\right)$) should get lower initial quotas. Of course, the equality in (14) ensures that the distribution of quotas will obtain the maximum level of total welfare for a given size of the market ($R + A$). More generally, participation can be obtained with any $q_{i0} \leq q_{i0}^{PC}$.

A.2 Taking Refugees' Preferences into Account

We follow Fernández-Huertas Moraga and Rapoport (2014) to show what the central planner's problem looks like in this case:

$$\min_{\{r_i, a_i\}_{i=1}^N} \sum_{i=1}^N c_i\left(r_i^{MM}, a_i^{MM}\right) \tag{15}$$

$$s.t. \sum_{i=1}^N (r_i^{MM} + a_i^{MM}) \geq R + A$$

$$r_i^{MM} = F_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N) \; \forall i = 1...N$$

$$a_i^{MM} = G_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N) \; \forall i = 1...N$$

The matching mechanism is embedded in the last two lines. The sequence $\{F_i\}_{i=1}^N$ of functions $F_i : [0, R]^N \times [0, A]^N \rightarrow [0, R]$ transforms an allocation of visas $\{r_i, a_i\}_{i=1}^N$ decided by the central planner as if countries were homogenous from the point of view of refugees and asylum seekers into an allocation of visas for refugees $\left\{r_i^{MM}\right\}_{i=1}^N$ that does take into account refugees' preferences through the matching mechanism (denoted MM). Similarly, the sequence $\{G_i\}_{i=1}^N$ of functions $G_i : [0, R]^N \times [0, A]^N \rightarrow [0, A]$ transforms the allocation of visas $\{r_i, a_i\}_{i=1}^N$ into an allocation of visas for asylum seekers $\left\{a_i^{MM}\right\}_{i=1}^N$ that does take into account asylum seekers' preferences through the matching mechanism.

We can approximate both sequences by differentiable functions so that it is simple to write the first order conditions of the problem:

$$\sum_{j=1}^{N}\left[\frac{\partial F_j}{\partial r_i}\left(\frac{\partial c_j}{\partial r_j}\left(r_j^{MM}, a_j^{MM}\right)-\lambda\right)+\frac{\partial G_j}{\partial r_i}\left(\frac{\partial c_j}{\partial a_j}\left(r_j^{MM}, a_j^{MM}\right)-\lambda\right)\right]=0 \quad \forall i=1...N \tag{16}$$

$$\sum_{j=1}^{N}\left[\frac{\partial F_j}{\partial a_i}\left(\frac{\partial c_j}{\partial r_j}\left(r_j^{MM}, a_j^{MM}\right)-\lambda\right)+\frac{\partial G_j}{\partial a_i}\left(\frac{\partial c_j}{\partial a_j}\left(r_j^{MM}, a_j^{MM}\right)-\lambda\right)\right]=0 \quad \forall i=1...N \tag{17}$$

where λ is the multiplier associated with the first constraint.

The equalization of marginal costs across countries is just one possible solution. In particular, it will be the solution whenever the matching mechanism does not distort the planner's allocation.

The TRQ's problem can be formulated as follows:

$$\min_{r_i, a_i} c_i\left(r_i^{MM}, a_i^{MM}\right)-p(r_i+a_i-q_{i0})+p\left(r_i+a_i-r_i^{MM}-a_i^{MM}\right) \tag{18}$$

$$s.t. \quad r_i^{MM}=F_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N)$$
$$a_i^{MM}=G_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N)$$

The term $p\left(r_i+a_i-r_i^{MM}-a_i^{MM}\right)$ is a penalty unattractive countries would have to pay for not being able to attract as many refugees and asylum seekers through the matching mechanism as they would bid for in the market. In equilibrium, the penalty would always be zero but it is needed so that countries do not have incentives to become unattractive from the point of view of refugees and asylum seekers. In practice, the EU could be in charge of collecting this penalty in case of some off-equilibrium behaviour.

The objective function can be simplified to $c_i\left(r_i^{MM}, a_i^{MM}\right) - p\left(r_i^{MM} + a_i^{MM} - q_{i0}\right)$. It is then easy to write the first order conditions of the problem:

$$\frac{\partial F_i}{\partial r_i}\left(\frac{\partial c_i}{\partial r_i}\left(r_i^{MM}, a_i^{MM}\right) - p\right) + \frac{\partial G_i}{\partial r_i}\left(\frac{\partial c_i}{\partial a_i}\left(r_i^{MM}, a_i^{MM}\right) - p\right) = 0 \qquad (19)$$

$$\frac{\partial F_i}{\partial a_i}\left(\frac{\partial c_i}{\partial r_i}\left(r_i^{MM}, a_i^{MM}\right) - p\right) + \frac{\partial G_i}{\partial a_i}\left(\frac{\partial c_i}{\partial a_i}\left(r_i^{MM}, a_i^{MM}\right) - p\right) = 0 \qquad (20)$$

The following proposition holds:

Proposition 2 *Let (18) represent the structure of the problem solved by country i participating in a market for TRQs. In particular, the set-up of the market is such that country i pays (is compensated) for the actual number of refugees and asylum seekers received $r_i^{MM} + a_i^{MM}$ rather than by the number bid in the market $r_i + a_i$, so that $p\left(r_i + a_i - r_i^{MM} - a_i^{MM}\right)$ can be considered as a penalty associated to the outcome of the matching mechanism, denoted by $r_i^{MM} = F_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N)$ and $a_i^{MM} = G_i(r_1, r_2, \ldots, r_N; a_1, a_2, \ldots, a_N)$.*

Under this definition of a market for TRQs, at least one of the market solutions to (15) is efficient, specifically marginal cost equalization across countries.

Again, the proof follows simply from showing $p = \lambda$ (Fernández-Huertas Moraga and Rapoport 2014).

A.3 Taking Countries' Preferences into Account

Suppose there are many different types of refugees or asylum seekers over which countries can have preferences in terms of, for example, their nationality or their skill level. We index these different types by k and redefine the total cost function as $c_i(\mathbf{r}_i, \mathbf{a}_i)$ where $\mathbf{r}_i$ and $\mathbf{a}_i$ are vectors of K elements (types). We assume that the cost function is convex in each of the elements of the vectors and such that the global optimal solution implies higher levels of refugees and asylum seekers than the non-cooperative solution. This way we can use total cost minimization as an alternative to utility maximization. The total minimum cost problem would then be:

$$\min_{\left\{\{r_i^k, a_i^k\}_{k=1}^K\right\}_{i=1}^N} \sum_{i=1}^{N} c_i\left(\mathbf{r}_i^{MM}, \mathbf{a}_i^{MM}\right) \qquad (21)$$

$$
\begin{aligned}
s.t. \quad & R + A \leq \sum_{i=1}^{N}\sum_{k=1}^{K}\left(r_i^{k,MM} + a_i^{k,MM}\right) \\
& r_i^{k,MM} = F_i^k(\mathbf{r}_1, \mathbf{r}_2, \ldots, \mathbf{r}_N; \mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_N) \quad \forall i = 1...N; \forall k = 1...K \\
& a_i^{k,MM} = G_i^k(\mathbf{r}_1, \mathbf{r}_2, \ldots, \mathbf{r}_N; \mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_N) \quad \forall i = 1...N; \forall k = 1...K
\end{aligned}
$$

For the solution, we would have $N \times K \times 2$ first order conditions:

$$
\sum_{j=1}^{N}\sum_{l=1}^{K}\left[\frac{\partial F_j^l}{\partial r_i^k}\left(\frac{\partial c_j}{\partial r_j^l} - \lambda\right) + \frac{\partial G_j^l}{\partial r_i^k}\left(\frac{\partial c_j}{\partial a_j^l} - \lambda\right)\right] = 0 \quad \forall i = 1...N; \forall k = 1...K \tag{22}
$$

$$
\sum_{j=1}^{N}\sum_{l=1}^{K}\left[\frac{\partial F_j^l}{\partial a_i^k}\left(\frac{\partial c_j}{\partial r_j^l} - \lambda\right) + \frac{\partial G_j^l}{\partial a_i^k}\left(\frac{\partial c_j}{\partial a_j^l} - \lambda\right)\right] = 0 \quad \forall i = 1...N; \forall k = 1...K \tag{23}
$$

Still, marginal cost equalization across migrant types and across countries remains a solution to the problem in cases where the matching mechanism does not affect the market outcome.

If the EU sets up a market for TRQs in which both countries and refugees and asylum seekers can express their preferences over each other, the formulation of the problem for an individual country would be:

$$
\min_{\{r_i^k, a_i^k\}_{k=1}^{K}} c_i\left(\mathbf{r}_i^{MM}, \mathbf{a}_i^{MM}\right) - p\sum_{k=1}^{K}\left(r_i^k + a_i^k - q_{i0}\right) + p\sum_{k=1}^{K}\left(r_i^k + a_i^k - r_i^{k,MM} - a_i^{k,MM}\right) \tag{24}
$$

$$
\begin{aligned}
s.t. \quad & r_i^{k,MM} = F_i^k(\mathbf{r}_1, \mathbf{r}_2, \ldots, \mathbf{r}_N; \mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_N) \quad \forall k = 1...K \\
& a_i^{k,MM} = G_i^k(\mathbf{r}_1, \mathbf{r}_2, \ldots, \mathbf{r}_N; \mathbf{a}_1, \mathbf{a}_2, \ldots, \mathbf{a}_N) \quad \forall k = 1...K
\end{aligned}
$$

The first order conditions associated with this problem are:

$$
\sum_{l=1}^{K}\left[\frac{\partial F_i^l}{\partial r_i^k}\left(\frac{\partial c_i}{\partial r_i^l} - p\right) + \frac{\partial G_i^l}{\partial r_i^k}\left(\frac{\partial c_i}{\partial a_i^l} - p\right)\right] = 0 \quad \forall k = 1...K \tag{25}
$$

$$\sum_{l=1}^{K}\left[\frac{\partial F_i^l}{\partial a_i^k}\left(\frac{\partial c_i}{\partial r_i^l}-p\right)+\frac{\partial G_i^l}{\partial a_i^k}\left(\frac{\partial c_i}{\partial a_i^l}-p\right)\right]=0 \quad \forall k=1...K \tag{26}$$

The following proposition can be established:

Proposition 3 *Let (24) represent the structure of the problem solved by country i participating in a market for TRQs. In particular, the set-up of the market is such that country i pays (is compensated) for the actual number of refugees and asylum seekers received* $\sum_{k=1}^{K}\left(r_i^{k,MM}+a_i^{k,MM}\right)$ *rather than by the number bid in the market* $\sum_{k=1}^{K}\left(r_i^k+a_i^k\right)$*, so that* $\sum_{k=1}^{K}\left(r_i^k+a_i^k-r_i^{k,MM}-a_i^{k,MM}\right)$ *can be considered as a penalty associated to the outcomes of the matching mechanism.*

Under this definition of a market for TRQs, at least one of the market solutions to (21) is efficient, specifically marginal cost equalization across countries and types.

Once more, the proof follows directly from showing $p=\lambda$ (Fernández-Huertas Moraga and Rapoport 2014). The addition of countries' preferences does not affect the efficiency properties of the market either, just like refugees and asylum seekers' preferences.