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# Undesired properties of the European Commission's refugee distribution key

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**Abstract**

The European Commission has proposed a refugee distribution key, which yields respective quotas for European Union/European Free Trade Association member states. It is based on four quantities: GDP, population, asylum applications per capita in the past, and unemployment rates. I show that the given distribution key has properties which contradict the European Commission's intentions. Exemplarily, states with low (high) unemployment may experience a lower (higher) quota when unemployment is taken into account compared to when it is not. These deviations are single-digit percentages. As a remedy, I propose an alternative distribution key, which avoids the undesired properties. It is modeled in the spirit of the European Commission's proposal and is based on the same four quantities. Deviations between the two distribution keys are up to two-digit percentages.

**Keywords**

Burden-sharing, distribution key, European Commission, refugee crisis

## Introduction

The European Union (EU) is currently dealing with the largest refugee crisis since the Second World War, notably as a consequence of the Syrian Civil War (European Commission, 2015a, 2016). In 2015, Germany alone received almost 1.1 million refugees, close to 480,000 formally applied for asylum (Federal Office for Migration and Refugees, 2016).[1] In the wake of these events, asylum policy has become the dominating issue on the political agenda of the EU and the European

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Free Trade Association (EFTA). The common asylum system of these states (except for Denmark) is governed by the Dublin III Regulation, which essentially obliges refugees to apply for asylum in the state in which they first enter.

Being the entry point for most refugee routes, several Southern European states have faced high numbers of asylum applications under this mechanism, so that a modification of the Dublin III Regulation is currently under debate. On the one hand, Germany, France, and others have proposed that refugees should rather be allocated according to permanent mandatory quotas, warranting a more even and solidary distribution within the EU/EFTA (Guarascio and MacDonald, 2015), amounting to a more equitable '*burden*'-sharing.[2] On the other hand, several Central European states, notably the Visegrád Group, have shown resistance against such plans. They argue for a preservation of the voluntary nature of EU solidarity measures and stated that 'any proposal leading to [the] introduction of mandatory and permanent quota[s] [...] would be unacceptable' (joint communication, Government of the Czech Republic, 2015). The current European asylum debate is thus politically delicate and might only be resolved by a qualified majority decision—contrary to the usual decision-making process in the EU on the basis of compromise and consensus (Agence France-Presse, 2015).

Ideas of collective burden-sharing among states appear in various areas, e.g. defense, finance, or climate (Thielemann, 2012). Applications related to refugees can be dated as far back as the times of the Russian Revolution and the League of Nations (Suhrke, 1998). In recent years, the intensified asylum collaboration within the EU promoting a 'balance of effort' as stipulated by the Treaty of Amsterdam has led to a resurging academic interest in asylum burden-sharing (European Union, 1999: 19; Article 73 k(2b)). Several authors have since demonstrated that refugee distribution within the EU/EFTA indeed still remains rather unequal (Bovens et al., 2012; Czaika, 2005; Neumayer, 2004; Thielemann et al., 2010).

In September 2015, in an attempt to address the current asylum burden-sharing debate, the European Commission issued a proposal for a new refugee distribution mechanism (European Commission, 2015b). It contains a distribution formula (distribution key) that determines the number of asylum applications that each state in the EU/EFTA has to process. The respective shares are computed on the basis of four quantities: GDP (40% weight; I will show below that the actual weighting is different), population (40% weight), a corrective factor based on the average number of asylum applications per one million inhabitants over the preceding five years (10% weight), and a corrective factor based on unemployment (10% weight).

The European Commission stated in its press release that the 'corrective factors for the average numbers of asylum applications and unemployment rate are applied inversely, meaning that *high existing asylum application numbers and a high unemployment rate would result in fewer individuals being relocated to a member state*' (2015d).

The present article has two goals: first, I demonstrate that the above quoted conclusion is not correct and second, I construct an alternative distribution key.[3]

As for the first goal, I will show that with the European Commission's distribution key, the very opposite of their intended allocation may happen: some states with comparatively high unemployment and high numbers of past asylum applications per capita would have a lower quota if the two corrective factors were not taken into account. Conversely, states with relatively low unemployment and few past asylum applications per capita may actually benefit from a diminished asylum burden due to the corrective factors. In other words, the European Commission's proposal is internally inconsistent.

Concerning the second goal, I stress that my critique is only aimed at the particular construction of the distribution key and not at the use of mathematical methods in policy matters in general. On the contrary—'*policy engineering*' can contribute to an objectification and a de-emotionalization of complex and sensitive issues such as the current refugee crisis. Notably, several authors have argued for the necessity of an asylum policy that is more internationally coordinated (e.g. Hatton, 2015; Schuck, 2013; Thielemann, 2014), distribution keys being a prominent option to achieve that. I therefore develop an alternative distribution key with the constraint that it shall be modeled in the spirit of the original proposal, but without its undesired properties. As such it will allow for a more equitable burden-sharing.

With respect to the scholarly literature on burden-sharing, it should be noted that many of the above cited references carry out a descriptive statistical analysis that compares a given legislation with its state of implementation. Another interesting question is the investigation of the political mechanisms which explain how and why a regulation proposal, such as the one considered here, is created in the first place and how it may be enforced. An extensive account of tools for such an analysis was given by Thomson et al. (2006) and Wallace et al. (2010). In contrast to these contributions by other authors, the approach of the present article is a different one: I consider the European Commission's proposal as a given and focus on its internal logical structure.

## Proposal of the European Commission

### *Application scenarios and legal basis*

The European Commission's distribution key was published as part of one specific regulation proposal. There are however at least three different scenarios for its application—the first is already a reality while the second and the third are currently under discussion.

*Scenario 1.* The distribution key is the basis for a *temporary emergency measure*: Article 78(3) of the Treaty on the Functioning of the European Union (TFEU) allows the adoption of provisional measures for a member state which is in an 'emergency situation characterized by a sudden inflow of nationals of third countries' (European Union, 2009).[4] On these legal grounds the European Commission proposed in September 2015 to relocate 120,000 people from Greece, Italy, and Hungary to the other states EU states (except for the United Kingdom, Ireland, and Denmark) according to its distribution key (2015c, 2015e). Relocation only applies to asylum applicants from states of origin which have an EU-wide first instance acceptance rate of at least 75% according to the latest quarterly available Eurostat data (European Commission, 2015c: 9). The proposal was subsequently adopted through a majority vote (European Parliament, 2015), although Hungary has stated that it does not intend to benefit from this emergency measure so the final decision of the European Council only included Greece and Italy (European Council, 2015).

*Scenario 2.* The distribution key could be used as a *permanent modification of the Dublin III Regulation*. In fact, it is in the context of Scenario 2 that the distribution key was made public: it is part of a proposal for a crisis relocation mechanism (European Commission, 2015b). The Dublin III Regulation is based on Article 78(2)e TFEU, which postulates the adoption of 'criteria and mechanisms for determining which member state is responsible for considering an application for asylum or subsidiary protection'. These criteria are primarily based on the national territory where the asylum application is filed as well as family membership and previously issued residence documents (specified in Article 3(1) and Chapter III in the Dublin III Regulation (European Parliament and Council, 2013)). In their proposal, the European Commission states that 'in place of this principle, the proposal establishes, for well prescribed crisis circumstances, a mandatory distribution key for determining the responsibility for examining applications' (2015b: 4).[5] If a state satisfies the criteria for a crisis situation, the European Commission may entitle it through a delegated act to benefit from the crisis relocation mechanism. A maximal number of 40% of persons having applied for asylum in that state during the six months prior to the delegated act may then be relocated to those states that are not benefitting from relocation (European Commission, 2015b: 21). As in Scenario 1, the mechanism only applies to asylum applicants from states of origin which have an EU-wide first instance acceptance rate of at least 75% (European Commission, 2015b: 15).[6] It is important to note, however, that even with this modification of the Dublin III Regulation, Article 78(3) TFEU will remain relevant (Scenario 1), especially in emergency situations where the conditions for relocation of the European Commission's proposal are not met.

*Scenario 3.* The distribution key could be applied so as to *replace the Dublin III regulation completely* (Robinson, 2016a, 2016b). Contrary to Scenario 1 and 2 which only apply to crisis or emergency situations, *all* refugees in the EU/EFTA region are then *always* distributed according to quotas, making the Dublin III regulation obsolete.

## *The distribution key formula*

In this section, I present the European Commission's distribution key. My notation will occasionally differ from the original formulation in order to correct some imprecisions and to make subsequent computations clearer.

I associate with all of the 32 EU/EFTA states an index $i$ ($i = 1, \ldots, 32$) and denote by $I \subseteq \{1, \ldots, 32\}$ the set of indices of those states which participate in the distribution of refugees. In Scenarios 1 and 2, $I$ will be a strict subset of $\{1, \ldots, 32\}$ because states that are in an emergency or crisis situation have to be excluded from $I$: they only '*provide*' the refugees—but they do explicitly *not* participate in their distribution.[7] This is defined in European Council (2015: 14–15) for Scenario 1 and in Article 33b(3) in European Commission (2015b: 21) for Scenario 2. The formula by the European Commission (2015b: 11) misses this point and their $I$ is always simply equal to $\{1, \ldots, 32\}$. This latter choice of $I$ is however only correct in Scenario 3 and if all 32 EU/EFTA states participate in the distribution of refugees. The formulation with the index set $I$ encompasses all three scenarios.

I start by introducing the

$$\textit{Population effect}: \qquad \mu_{\text{pop},\, i} := \frac{\text{Population of State } i}{\sum_{j \in I} \text{Population of State } j},$$

where $i$ is an element of $I$; in fact, any state index throughout this article will be contained in $I$ unless stated otherwise and I will thus no longer mention it explicitly in order to simplify notation. To give an example: with $I := \{3, 15\}$ one has

$$\mu_{\text{pop},\, 3} = \frac{\text{Population of State 3}}{\text{Population of State 3} + \text{Population of State 15}},$$
$$\mu_{\text{pop},\, 15} = \frac{\text{Population of State 15}}{\text{Population of State 3} + \text{Population of State 15}}.$$

The population effect measures the relative contribution of a State $i$ to the population of all EU/EFTA states that participate in the distribution $\left(\sum_{i \in I} \mu_{\text{pop},\, i} = 1\right)$.

Similarly, one has the

$$\textit{GDP effect}: \qquad \mu_{\text{GDP},\, i} := \frac{\text{GDP of State } i}{\sum_{j \in I} \text{GDP of State } j},$$

which measures the relative contribution of a State $i$ to the GDP of all EU/EFTA states that participate in the distribution $\left(\sum_{i \in I} \mu_{\text{GDP},\, i} = 1\right)$.

Next, I define $x_i$ to be the average over the five preceeding years of the number of asylum applicants per one million inhabitants, i.e.

$$x_i := \text{Average}_{5\text{ preceding years}}(\text{Applicants per million inhabitants in State } i).$$

This is the quantity mentioned in the proposal of the European Commission (European Commission, 2015b). To enhance comprehensiblity of text, I may often also refer to the number of asylum applications per capita instead. With the $x_i$ at hand, it is possible to define the (pure) asylum effect

$$\textit{Pure asylum effect}: \qquad \mu_{\text{as},i}^{\text{pure}} := \frac{x_i^{-1}}{\sum_{j\in I} x_j^{-1}}, \tag{1}$$

$$\textit{Asylum effect}: \qquad \mu_{\text{as,i}} := \min\left\{\mu_{\text{as},i}^{\text{pure}}, 2\kappa_1 \cdot \mu_{\text{base},i}\Big)\right\}. \tag{2}$$

Here, I have introduced the *base share*

$$\mu_{\text{base},i} := 0.5 \cdot \left(\mu_{\text{pop},i} + \mu_{\text{GDP},i}\right), \tag{3}$$

which will simplify the notation for the discussion below. It can be viewed as the share that a state would receive if distribution was based only on population and GDP. The *pure* asylum effect is a measure for how the number of applicants that a State $i$ faces per capita relates to the whole of EU/EFTA states that participate in the distribution ($\sum_{i\in I} \mu_{\text{as},i}^{\text{pure}} = 1$). Since the $x_i$ enter the formula inversely, the effect is *large (small)* when a state has faced comparatively *few (many)* applications per capita over the preceding five years. The asylum effect itself is a capped version of the pure asylum effect: it is at most as large as $2\kappa_1 \cdot \mu_{\text{base},i}$, where $\kappa_1$ is a parameter of the model; the European Commission proposes $\kappa_1 = 0.3$. The cap is introduced 'in order to avoid that this criterion [the asylum effect] has a disproportionate effect on the entire key' (European Commission, 2015b: 12). Indeed, it will be shown in the next section that without the capping, the asylum effect would have quite a dramatic distorting effect on the refugee distribution, despite its arguably low weight of 10%. The influence of asylum applications per capita from the preceding five years is therefore additionally lowered through the introduction of the cap.

Finally, I define $y_i$ to be the unemployment rate in State $i$ and introduce

$$\textit{Pure unemployment effect}: \qquad \mu_{\text{un},i}^{\text{pure}} := \frac{y_i^{-1}}{\sum_{j\in I} y_j^{-1}},$$

$$\textit{Unemployment effect}: \qquad \mu_{\text{un},i} := \min\left\{\mu_{\text{un},i}^{\text{pure}}, 2\kappa_2 \cdot \mu_{\text{base},i}\right\}. \tag{4}$$

The (pure) unemployment effect is thus constructed analogously to the (pure) asylum effect ($\sum_{i \in I} \mu^{\text{pure}}_{\text{un},\, i} = 1$); the European Commission (2015b) proposes $\kappa_1 = \kappa_2 = 0.3$.

Given the total number of refugees $a_{\text{tot}}$ to be distributed the capped quota for State $i$ is given by the following convex combination of the four effects

$$q_{\text{cap},\, i} = a_{\text{tot}}\big(\alpha_1 \cdot \mu_{\text{pop},\, i} + \alpha_2 \cdot \mu_{\text{GDP},\, i} + \alpha_3 \cdot \mu_{\text{as},\, i} + \alpha_4 \cdot \mu_{\text{un},\, i}\big), \tag{5}$$

where $\sum_{j=1}^{4} \alpha_j = 1$; the European Commission (2015b) proposes $\alpha_1 = \alpha_2 = 0.4$ and $\alpha_3 = \alpha_4 = 0.1$, in which case equation (5) can be rewritten as

$$q_{\text{cap},\, i} = a_{\text{tot}}\Big(0.8 \cdot \mu_{\text{base},\, i} + 0.1 \cdot \mu_{\text{as},\, i} + 0.1 \cdot \mu_{\text{un},\, i}\Big). \tag{6}$$

Note that $\sum_{i \in I} \mu_{\text{as},\, i}$, as well as $\sum_{i \in I} \mu_{\text{un},\, i}$, may be smaller than one due to the cap induced by $\kappa_1, \kappa_2$; hence there may be a nonvanishing residual quota. It is computed as follows

$$q_{\text{res},\, i} = \left(a_{\text{tot}} - \sum_{j \in I} q_{\text{cap},j}\right) \cdot \big(\beta_1 \cdot \mu_{\text{pop},\, i} + \beta_2 \cdot \mu_{\text{GDP},\, i}\big), \tag{7}$$

where $\beta_1 + \beta_2 = 1$;the European Commission (2015b) proposes $\beta_1 = \beta_2 = 0.5$, so that the expression in the second pair of brackets becomes just the base share $\mu_{\text{base},\, i}$. The final allocation quota for State $i$ is then

$$q_i = q_{\text{cap},\, i} + q_{\text{res},\, i},$$

through which all refugees are allocated: $\sum_{i \in I} q_i = a_{\text{tot}}$. To simplify notation in the subsequent discussion, I also introduce the total share of State $i$ as

$$\mu_i := \frac{q_i}{a_{\text{tot}}}.$$

## Undesired properties

In the presentation of the undesired properties of the European Commission's distribution key, I proceed in two steps: First, I analyze the formula and demonstrate the mathematical reasons for its undesired properties. Second, I show how current real data substantiates the analysis.

### *Formal analysis*

A precise statement of the main undesired property reads as follows:

**Undesired Property 1** ***(paradoxical shifts)***: Consider two states, $A$ and $B$, where $A$ has a comparatively large population and high GDP, while the converse is true for $B$. Assume further that $A$ has handled less asylum applications per capita over the past five years than $B$ and has a lower unemployment rate than $B$, i.e. $x_A < x_B$ and $y_A < y_B$ or, equivalently, $\mu^{\text{pure}}_{\text{as},A} > \mu^{\text{pure}}_{\text{as},B}$ and $\mu^{\text{pure}}_{\text{un},A} > \mu^{\text{pure}}_{\text{un},B}$. Then the following holds:

1. It is possible that the incorporation of past application numbers and unemployment rates is more beneficial to $A$ than it is to $B$, i.e. $\frac{\mu_A - \mu_{\text{base},A}}{\mu_{\text{base},A}} < \frac{\mu_B - \mu_{\text{base},B}}{\mu_{\text{base},B}}$.
2. It is even possible that State $A$ sees its share *decreased* after incorporating the two corrective factors, while the share of State $B$ is *increased,* i.e.$\mu_A < \mu_{\text{base},A}$ yet $\mu_B > \mu_{\text{base},B}$.

Obviously, the second assertion implies the first, and both contradict the intentions of the European Commission as stated in the introduction. To understand how Undesired Property 1 arises, I introduce a simplified toy model which only accounts for population size and unemployment rates. I assume that the index set $I$ comprises merely two elements, 1 and 2, i.e. $N = 2$, where $N$ denotes the number of elements in $I$. This corresponds to setting $\alpha_2 = \alpha_3 = 0$ as well as $\alpha_1 = 0.8$ and $\alpha_4 = 0.2$ in equation (5), in analogy to the European Commission's parameter choice. Note that the population effect in this simplified model takes the role of the base share in equation (6). As for the capping parameter $\kappa_2$, I will consider three different regimes in order to carefully explain its effect—no cap, moderate cap, strong cap—the second of which corresponds to the choice of the European Commission. I assume that State 1 has a population of 49 million inhabitants and an unemployment rate of 9% while State 2 has merely one million inhabitants, yet 11% unemployment. The so-defined toy model will serve throughout this section, as it captures all the essentials of the European Commission's distribution key, yet lends itself better to explanations.

The population and pure unemployment effects are readily computed

$$\mu_{\text{pop},1} = \frac{49}{49+1} = \frac{49}{50} = 0.98; \quad \mu^{\text{pure}}_{\text{un},1} = \frac{1/9}{1/9 + 1/11} = \frac{11}{20} = 0.55; \tag{8}$$

$$\mu_{\text{pop},2} = \frac{1}{49+1} = \frac{1}{50} = 0.02; \quad \mu^{\text{pure}}_{\text{un},2} = \frac{1/11}{1/9 + 1/11} = \frac{9}{20} = 0.45. \tag{9}$$

These decimals are exact and I will occasionally add additional zeros below in order to make clear that Undesired Property 1 is not due to rounding errors. The *extent* of paradoxical shifts in the toy model is simply rather small and a consequence of the fact that I consider only two states. The shifts will be numerically more distinct when I analyze real data below.

*Regime I (no cap, $\kappa_2 = \infty$):* This regime illustrates already the main problem behind the paradoxical shifts. In absence of a cap, the residual quotas are zero and the total shares of State 1 and State 2 are

$$\mu_1 = \alpha_1 \cdot 0.98 + \alpha_4 \cdot 0.55 = 0.8 \cdot 0.98 + 0.2 \cdot 0.55 = 0.8940 < 0.9800,$$

$$\mu_2 = \alpha_1 \cdot 0.02 + \alpha_4 \cdot 0.45 = 0.8 \cdot 0.02 + 0.2 \cdot 0.45 = 0.1060 > 0.0200.$$

Thus, State 1 experiences a lower share if its unemployment rate being accounted for than when it is not—despite the fact that its unemployment rate is lower that that of State 2 (second point in Undesired Property 1). The reason is simple: the $\mu_{\text{un},i} = \mu_{\text{un},i}^{\text{pure}}$ define a division of one (a 'share') which is 'more even' (0.55 versus 0.45) than the one defined by the $\mu_{\text{pop},i}$ (0.98 versus 0.02). The total shares $\mu_i$ are a convex combination of these two—a 'compromise'. As a consequence, the $\mu_i$ define a more even division than the $\mu_{\text{pop},i}$ and hence $\mu_1$ is smaller than $\mu_{\text{pop},i}$ while the opposite is true for State 2—a paradoxical shift (see Figure 1).

This insight is readily generalized to the model of the European Commission with $\kappa_2$=$\infty$ (no cap) and general $N$: mathematically, a distribution being 'more even' means that its standard deviation is lower: the standard deviation measures

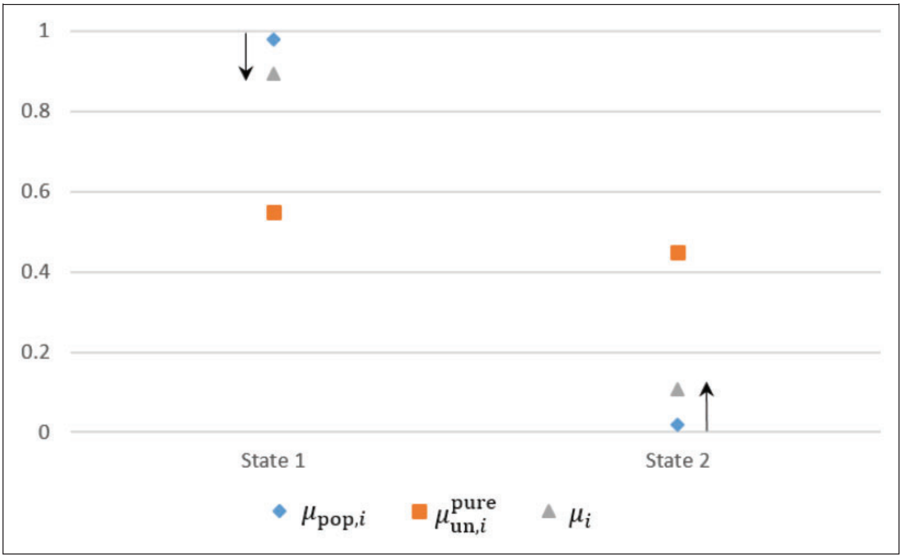


**Figure 1.** Population effect, pure unemployment effect, and total shares for the toy model.
*Note:* The resulting paradoxical shifts are indicated by the two arrows: after incorporating unemployment State 1's share decreases while State 2's share increases.

the deviation from the mean, i.e. the deviation from a perfectly even distribution. I will argue in an instant that there is a conceptual reason that the unemployment effects $\mu_{\mathrm{ni},i} = \mu_{\mathrm{ni},i}^{\mathrm{pure}}$ and the asylum effects $\mu_{\mathrm{as},i} = \mu_{\mathrm{as},i}^{\mathrm{pure}}$ have a lower standard deviation than the base shares $\mu_{\mathrm{base},i}$. Given this, the convex sum of all four effects in equation (6) (the 'compromise') will have a lower standard deviation than the mere base shares and will thus be more evenly distributed (see Proof 1 in the web appendix). As a consequence, the tails of the resulting distribution $\mu_i$ move toward the mean, increasing the share of states with low population/GDP and decreasing the share of states with high population/GDP. Putting $\mu_{un,i}$, $\mu_{as,i}$ and $\mu_{pop,i}$, $\mu_{GDP,i}$ on an equal footing by simply adding them up is thus *the core problem of the refugee distribution key as proposed by the European Commission*.

The reason for the difference in standard deviations is fundamental: in contrast to GDP and population size, the unemployment rate and the number of asylum applications per capita are both quantities which *do not scale with any notion of the size of a state*.[8] This fundamental structural difference explains why the standard deviations of the $\mu_{\mathrm{un},i}^{\mathrm{pure}}$ (resp. $\mu_{\mathrm{as},i}^{\mathrm{pure}}$) are considerably lower than those of the $\mu_{\mathrm{pop},i}$ (resp. $\mu_{\mathrm{GDP},i}$): the latter account also for scale dependencies while the former do not. Note that this phenomenon cannot be circumvented by a simple rescaling, since $\mu_{\mathrm{un},i}^{\mathrm{pure}}$, $\mu_{\mathrm{as},i}^{\mathrm{pure}}$, $\mu_{\mathrm{pop},i}$, and $\mu_{\mathrm{GDP},i}$ are all divisions of one ('shares').

Scale-dependent quantities such as population size or GDP can reasonably serve as a basis for the determination of a distribution quota in *absolute* terms. Scale-independent quantities such as past asylum applications per capita $x_i$ or unemployment rates $y_i$, should, however, only be used to modulate a quota in *relative* terms. This can also be seen from the following heuristic argument: with the sole knowledge that two States $A$ and $B$ have unemployment rates of 10 and 5%, respectively, one cannot legitimately deduce any notion of the order of magnitude of their total share—State $A$ might have population size and GDP of the order of magnitude of Germany, while State $B$ might be as small as Malta.

*Regime 2 (moderate cap, $\kappa_2 = 0.3$):* For the choice of $\kappa_2$ as in the proposal of the European Commission, the toy model yields

$$\mu_{\mathrm{un},1} = \min\left\{\mu_{\mathrm{un},1}^{\mathrm{pure}}, 2\kappa_2 \cdot \mu_{\mathrm{pop},1}\right\} = \min\{0.55, 2 \cdot 0.3 \cdot 0.98\} = 0.5500,$$

$$\mu_{\mathrm{un},2} = \min\left\{\mu_{\mathrm{un},2}^{\mathrm{pure}}, 2\kappa_2 \cdot \mu_{\mathrm{pop},2}\right\} = \min\{0.45, 2 \cdot 0.3 \cdot 0.02\} = 0.0120,$$

i.e. the cap has only an effect on $\mu_{\mathrm{un},2}$, while $\mu_{\mathrm{un},1}$ is unaffected: $\mu_{\mathrm{un},1} = \mu_{\mathrm{un},1}^{\mathrm{pure}}$. Thus, there is now a residual quota which is nonvanishing and which is distributed according to $\mu_{\text{pop},i}$, cf. equation (7). As a result, the following total shares are obtained

$$\mu_i = 0.8 \cdot \mu_{\text{pop},i} + 0.2 \cdot \mu_{\text{un},i} + \left(1 - \sum_{j=1}^{2}\left[0.8 \cdot \mu_{\text{pop},j} + 0.2 \cdot \mu_{\text{un},j}\right]\right) \cdot \mu_{\text{pop},i}$$
$$= \left(1 - 0.2 \cdot \sum_{j=1}^{2} \mu_{\text{un},j}\right) \cdot \mu_{\text{pop},i} + 0.2 \cdot \mu_{\text{un},i},$$

which, using equations (8) and (9), yields the following numerical result

$$\mu_1 = 0.9798 < 0.9800,$$
$$\mu_2 = 0.0202 > 0.0200.$$

Hence the comparison with the respective numbers in absence of a cap, equations (8) and (9), shows that a cap *does not avoid* the paradoxical shifts—it only *attenuates* them. Roughly speaking, the reason is that the cap introduces a hidden effective undervaluation of the $\mu_{\text{un},i}^{\text{pure}}$ in two ways: first, the cap induces a nonvanishing residual quota, which is computed solely on the basis of $\mu_{\text{pop},i}$ and does not depend on $\mu_{\text{un},i}^{\text{pure}}$ at all; second, in the presence of a cap the pure unemployment effects $\mu_{\text{un},i}^{\text{pure}}$ are replaced by the $\mu_{\text{un},i}$ which are based on *both* $\mu_{\text{un},i}^{\text{pure}}$ and $\mu_{\text{pop},i}$. To understand the influence of the $\mu_{\text{pop},i}$ on the $\mu_{\text{un},i}$ I compare the two distributions. Some care is however in order: since the $\mu_{\text{un},i}$ do not add up to one—i.e. they are not a division of one, a 'share'—a direct comparison with the $\mu_{\text{pop},i}$ is meaningless. Instead one needs to look at the effective distribution which is the renormalized version of the $\mu_{\text{un},i}$, i.e.$\mu_{\text{un},i}/\left(\mu_{\text{un},1} + \mu_{\text{un},2}\right)$. This is a share by construction and a computation shows

$$\mu_{\text{un},1}/\left(\mu_{\text{un},1} + \mu_{\text{un},2}\right) = 0.9786,$$
$$\mu_{\text{un},2}/\left(\mu_{\text{un},1} + \mu_{\text{un},2}\right) = 0.0214.$$

The resulting distribution is in fact much more reminiscent of the $\mu_{\text{pop},i}$ than it is of the $\mu_{\text{un},i}^{\text{pure}}$. To say that the $\mu_{\text{un},i}$ represent the unemployment effect is therefore misleading. I formulate these results as a second undesired property for the full distribution key of the European Commission with $N$ states.

**Undesired Property 2** ***(lack of transparency)***: The cap attenuates the influence of unemployment rates and asylum applications per capita on the total share beyond their respective putative weights of 10%:

1. The weights of the population effect and GDP effect are at least 44% each. As a consequence, the weights of the pure unemployment effect and of the pure asylum effect are at most 6% each.

2. The cap deforms the distributions of the $\mu_{\text{as},i}^{\text{pure}}$ and the $\mu_{\text{un},i}^{\text{pure}}$ so that the resulting effective distributions $\frac{\mu_{\text{as},i}}{\sum_{j\in I}\mu_{\text{as},j}}$ and $\frac{\mu_{\text{un},i}}{\sum_{j\in I}\mu_{\text{un},j}}$ look more like $\mu_{\text{base},i}$.

Note that the introduction of a cap does not resolve Undesired Property 1. It merely has the positive effect of attenuating it. Moreover, the label '*Undesired* Property 2' is still justified as the undesirability arises for a different, independent, reason: communicating only respective weights of 10% for the asylum effect and the unemployment effect becomes meaningless. This is due to the fact that the effective weights can be lowered arbitrarily simply by chosing ever smaller caps $\kappa_1, \kappa_2$ while keeping $\alpha_3 = \alpha_4 = 0.1$ fixed (cf. Regime 3 for an extreme case). In a transparent distribution key, the effective weights of the asylum effect and the unemployment effect should therefore only be controlled by a single parameter each.

To see point 1, I combine equations (6) and (7) in order to write the $\mu_i$ as an explicit convex combination of the four (effective) distributions (i.e. $\mu_{\text{pop},i}$, $\mu_{\text{GDP},i}$, $\frac{\mu_{\text{un},i}}{\sum_{j\in I}\mu_{\text{un},j}}$, $\frac{\mu_{\text{as},i}}{\sum_{j\in I}\mu_{\text{as},j}}$):

$$\begin{aligned}
\mu_i &= \underbrace{0.4\cdot\mu_{\text{pop},i} + 0.4\cdot\mu_{\text{GDP},i} + 0.1\cdot\mu_{\text{as},i} + 0.1\cdot\mu_{\text{un},i}}_{=:\, s_i} + 0.5\cdot\underbrace{\left[1-\sum_{j\in I}s_j\right]}_{=:\, r} \\
&\quad\cdot\left(\mu_{\text{pop},i}+\mu_{\text{GDP},i}\right) \\
&= \underbrace{\left(0.4+\frac{r}{2}\right)}_{=:\, w_1}\cdot\mu_{\text{pop},i} + \underbrace{\left(0.4+\frac{r}{2}\right)}_{=:\, w_2}\cdot\mu_{\text{GDP},i} + \underbrace{\left[0.1\cdot\sum_{j\in I}\mu_{\text{as},j}\right]}_{=:\, w_3}\cdot\frac{\mu_{\text{as},i}}{\sum_{j\in I}\mu_{\text{as},j}} \\
&\quad+\underbrace{\left[0.1\cdot\sum_{j\in I}\mu_{\text{un},j}\right]}_{=:\, w_4}\cdot\frac{\mu_{\text{un},i}}{\sum_{j\in I}\mu_{\text{un},j}}.
\end{aligned}\tag{10}$$

This yields explicit expressions for the respective weights $w_j$ $\left(\sum_{j=1}^{4} w_j = 1\right)$. To estimate $r$ it should be noted that

$$\sum_{j\in I}\mu_{\text{as},j} \le \sum_{j\in I}\min\left\{\mu_{\text{as},j}^{\text{pure}}, 2\kappa_1\cdot\mu_{\text{base},j}\right\} \le 2\kappa_1\cdot\sum_{j\in I}\mu_{\text{base},j} = 2\kappa_1$$

and similarly $\sum_{j\in I}\mu_{\text{un},j} \le 2\kappa_2$. It follows that $r \ge 1-(0.4+0.4+0.1\cdot 2\kappa_1 + 0.1\cdot 2\kappa_2) = 0.08$ from which the claimed estimates follow

$$w_1 \ge 0.44; \quad w_3 \le 0.1\cdot 2\kappa_1 = 0.06;$$

$$w_2 \ge 0.44; \quad w_4 \le 0.1\cdot 2\kappa_2 = 0.06.$$

As for point 2, it has already been shown in the toy model above that $\mu_{\text{base},\, i}$ has a strong impact on the distribution of the renormalized unemployment effects. It is moreover instructive to put this to an extreme and to consider an even stronger cap:

*Regime 3 (strong cap, $\kappa_2 \leq 0.2$):* In the extreme case where the caps affect *all* $\mu_{\text{as},\, i}$ and *all* $\mu_{\text{un},\, i}$, so that $\mu_{\text{as},\, i} = 2\kappa_1 \cdot \mu_{\text{base},\, i}$ and $\mu_{\text{un},\, i} = 2\kappa_2 \cdot \mu_{\text{base},\, i}$, it follows that $\sum_{j \in I} \mu_{\text{as},\, I} = 2\kappa_1$; $\sum_{j \in I} \mu_{\text{un},\, i} = 2\kappa_2$ and thus

$$\frac{\mu_{\text{un},\, i}}{\sum_{j \in I} \mu_{\text{un},\, j}} = \frac{\mu_{\text{as},\, i}}{\sum_{j \in I} \mu_{\text{as},\, j}} = \mu_{\text{base},\, i},$$

equation (10) then reduces to

$$\mu_i = \mu_{\text{base},\, i}.$$

As a consequence no paradoxical shifts occur in this regime, but with the downside that unemployment rates and the number of asylum application per capita have just no influence at all: their effective weight is zero.

## Data analysis

For the sake of a general illustration, I assume now that $N = 32$. This is in line with the example given by the European Commission (2015b: 11) and corresponds to Scenario 3 from the section on the legal basis of the distribution key.

Table 1 offers substantive illustration of the two undesired properties. The last column shows the relative comparison of the total share $\mu_i$ and the base share $\mu_{\text{base},\, i}$ considered in Undesired Property 1. The most striking examples of the paradoxical shifts are the following:

1. Germany's total share is 0.99% *lower* than its base share. Both its unemployment rate and its number of asylum applications per capita in the past five years are, however, lower than those of Belgium, Hungary, Sweden, Austria, Denmark, Cyprus, Luxemburg, and Malta. All of these states have a final share which is *higher* than their base share, with the exception of Sweden whose decrease is though lower than that of Germany and is due to its exceptionally low pure asylum effect.
2. France's total share is even 1.89% *lower* than its base share. Both its unemployment rate and its number of asylum applications per capita in the past five years are, however, lower than those of Cyprus which receives a total share which is 2.06% *higher* than its base share.
3. Similarly, Italy's total share is 1.15% *lower* than its base share. Both its unemployment rate and its number of asylum applications per capita in the past five years are, however, lower than those of Greece and—again—Cyprus which both exhibit a total share which is 2.06% *higher* than their base share.

**Table 1.** Quantities needed for the computation of the base and final shares.

| State | $\mu_{\mathrm{GDP},i}$ | $\mu_{\mathrm{pop},i}$ | $y_i$ | $\mu^{\mathrm{pure}}_{\mathrm{un},i}$ | $\mu_{\mathrm{un},i}$ | $x_i$ | $\mu^{\mathrm{pure}}_{\mathrm{as},i}$ | $\mu_{\mathrm{as},i}$ | $\mu_{\mathrm{Base},i}$ | $\mu^{\mathrm{pure}}_i$ | $\mu_i$ | $\frac{\mu^{\mathrm{pure}}_i-\mu_{\mathrm{base},i}}{\mu_{\mathrm{base},i}}\cdot 100\%$ | $\frac{\mu_i-\mu_{\mathrm{base},i}}{\mu_{\mathrm{base},i}}\cdot 100\%$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DE | 0.1960 | 0.1552 | 4.6% | 0.0461 | 0.0461 | 1258 | 0.0058 | 0.0058 | 0.1756 | 0.1457 | 0.1739 | −17.05% | −0.99% |
| FR | 0.1434 | 0.1265 | 10.7% | 0.0198 | 0.0198 | 925 | 0.0079 | 0.0079 | 0.1349 | 0.1107 | 0.1324 | −17.95% | −1.89% |
| UK | 0.1495 | 0.1236 | 5.3% | 0.0400 | 0.0400 | 452 | 0.0162 | 0.0162 | 0.1365 | 0.1149 | 0.1368 | −15.88% | 0.18% |
| IT | 0.1087 | 0.1168 | 12.0% | 0.0177 | 0.0177 | 530 | 0.0138 | 0.0138 | 0.1127 | 0.0933 | 0.1114 | −17.21% | −1.15% |
| ES | 0.0712 | 0.0894 | 22.3% | 0.0095 | 0.0095 | 81 | 0.0907 | 0.0241 | 0.0803 | 0.0742 | 0.0805 | −7.52% | 0.24% |
| PL | 0.0278 | 0.0730 | 7.3% | 0.0290 | 0.0151 | 249 | 0.0294 | 0.0151 | 0.0504 | 0.0462 | 0.0514 | −8.42% | 2.06% |
| RO | 0.0101 | 0.0383 | 6.8% | 0.0312 | 0.0073 | 81 | 0.0902 | 0.0073 | 0.0242 | 0.0315 | 0.0247 | 30.15% | 2.06% |
| NL | 0.0446 | 0.0323 | 6.8% | 0.0312 | 0.0115 | 961 | 0.0076 | 0.0076 | 0.0384 | 0.0346 | 0.0388 | −9.91% | 1.04% |
| BE | 0.0270 | 0.0215 | 8.8% | 0.0241 | 0.0073 | 2350 | 0.0031 | 0.0031 | 0.0243 | 0.0221 | 0.0244 | −8.80% | 0.34% |
| GR | 0.0120 | 0.0210 | 25.0% | 0.0085 | 0.0050 | 847 | 0.0086 | 0.0050 | 0.0165 | 0.0149 | 0.0169 | −9.63% | 2.06% |
| CZ | 0.0104 | 0.0202 | 5.1% | 0.0415 | 0.0046 | 137 | 0.0534 | 0.0046 | 0.0153 | 0.0217 | 0.0156 | 42.05% | 2.06% |
| PT | 0.0116 | 0.0200 | 12.3% | 0.0172 | 0.0048 | 48 | 0.1539 | 0.0048 | 0.0158 | 0.0298 | 0.0162 | 88.05% | 2.06% |
| HU | 0.0069 | 0.0190 | 6.8% | 0.0312 | 0.0039 | 1367 | 0.0054 | 0.0039 | 0.0130 | 0.0140 | 0.0132 | 8.18% | 2.06% |
| SE | 0.0290 | 0.0185 | 7.3% | 0.0290 | 0.0071 | 5056 | 0.0014 | 0.0014 | 0.0237 | 0.0220 | 0.0237 | −7.17% | −0.33% |
| AU | 0.0221 | 0.0163 | 5.8% | 0.0365 | 0.0058 | 2096 | 0.0035 | 0.0035 | 0.0192 | 0.0194 | 0.0194 | 0.80% | 0.88% |
| CH | 0.0356 | 0.0156 | 3.1% | 0.0683 | 0.0077 | 2819 | 0.0026 | 0.0026 | 0.0256 | 0.0276 | 0.0256 | 7.72% | 0.08% |
| BG | 0.0028 | 0.0139 | 9.8% | 0.0216 | 0.0025 | 592 | 0.0124 | 0.0025 | 0.0084 | 0.0101 | 0.0085 | 20.61% | 2.06% |

(continued)

**Table 1.** Continued

| State | $\mu_{GDP,i}$ | $\mu_{pop,i}$ | $y_i$ | $\mu^{pure}_{un,i}$ | $\mu_{un,i}$ | $x_i$ | $\mu^{pure}_{as,i}$ | $\mu_{as,i}$ | $\mu_{Base,i}$ | $\mu^{pure}_i$ | $\mu_i$ | $\frac{\mu^{pure}_i-\mu_{base,i}}{\mu_{base,i}}\cdot 100\%$ | $\frac{\mu_i-\mu_{base,i}}{\mu_{base,i}}\cdot 100\%$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DK | 0.0173 | 0.0108 | 6.3% | 0.0336 | 0.0042 | 1320 | 0.0055 | 0.0042 | 0.0141 | 0.0152 | 0.0144 | 7.86% | 2.06% |
| FI | 0.0138 | 0.0105 | 9.5% | 0.0223 | 0.0036 | 589 | 0.0124 | 0.0036 | 0.0121 | 0.0132 | 0.0124 | 8.62% | 2.06% |
| SK | 0.0051 | 0.0104 | 11.2% | 0.0189 | 0.0023 | 94 | 0.0782 | 0.0023 | 0.0077 | 0.0159 | 0.0079 | 105.60% | 2.06% |
| NO | 0.0253 | 0.0098 | 4.3% | 0.0493 | 0.0053 | 2085 | 0.0035 | 0.0035 | 0.0176 | 0.0193 | 0.0178 | 10.02% | 1.06% |
| IE | 0.0127 | 0.0088 | 9.5% | 0.0223 | 0.0032 | 287 | 0.0255 | 0.0032 | 0.0108 | 0.0134 | 0.0110 | 24.34% | 2.06% |
| HR | 0.0029 | 0.0082 | 15.6% | 0.0136 | 0.0017 | 179 | 0.0409 | 0.0017 | 0.0055 | 0.0099 | 0.0056 | 78.55% | 2.06% |
| LT | 0.0024 | 0.0057 | 9.6% | 0.0221 | 0.0012 | 111 | 0.0659 | 0.0012 | 0.0040 | 0.0120 | 0.0041 | 197.40% | 2.06% |
| SL | 0.0025 | 0.0040 | 9.5% | 0.0223 | 0.0010 | 150 | 0.0487 | 0.0010 | 0.0032 | 0.0097 | 0.0033 | 199.57% | 2.06% |
| LV | 0.0016 | 0.0038 | 10.1% | 0.0210 | 0.0008 | 116 | 0.0633 | 0.0008 | 0.0027 | 0.0106 | 0.0028 | 288.54% | 2.06% |
| EE | 0.0013 | 0.0025 | 6.7% | 0.0316 | 0.0006 | 64 | 0.1139 | 0.0006 | 0.0019 | 0.0161 | 0.0020 | 732.04% | 2.06% |
| CY | 0.0012 | 0.0016 | 15.2% | 0.0139 | 0.0004 | 2199 | 0.0033 | 0.0004 | 0.0014 | 0.0029 | 0.0014 | 102.23% | 2.06% |
| LU | 0.0033 | 0.0011 | 5.9% | 0.0359 | 0.0007 | 1559 | 0.0047 | 0.0007 | 0.0022 | 0.0058 | 0.0022 | 165.44% | 2.06% |
| MT | 0.0005 | 0.0008 | 5.2% | 0.0407 | 0.0002 | 3692 | 0.0020 | 0.0002 | 0.0007 | 0.0048 | 0.0007 | 612.41% | 2.06% |
| IS | 0.0009 | 0.0006 | 4.3% | 0.0493 | 0.0002 | 326 | 0.0224 | 0.0002 | 0.0007 | 0.0078 | 0.0008 | 943.00% | 2.06% |
| LI | 0.0004 | 0.0001 | 2.1% | 0.1009 | 0.0001 | 2033 | 0.0036 | 0.0001 | 0.0002 | 0.0106 | 0.0002 | 4275.32% | 2.06% |

*Note:* All relevant quantities needed for the computation of the base shares and the final shares (with and without cap) are displayed. On this basis, the paradoxical shifts are calculated in the last two columns. Data base is the raw data as specified in the web appendix (essentially Eurostat): Unemployment rates are from July 2015, GDP and population numbers from 2014, and asylum applications numbers from the period 2010 to 2014.

Similar conclusions may be drawn for the United Kingdom, Spain, the Netherlands, Austria, and Norway. To get a feeling of the order of magnitude: under the assumption of one million asylum applications in the EU/EFTA, a reduction of the French base share by 1.89% then corresponds to an absolute reduction of 2544 asylum applicants.

The second to last column in Table 1 reveals the 'disproportionate effect on the entire key' if capping were absent (European Commission, 2015b: 12), i.e. if $\mu_i$ were replaced by

$$\mu_i^{\text{pure}} := 0.4 \cdot \mu_{\text{pop},i} + 0.4 \cdot \mu_{\text{GDP},i} + 0.1 \cdot \mu_{\text{as},i}^{\text{pure}} + 0.1 \cdot \mu_{\text{un},i}^{\text{pure}}.$$

Most notably, Liechtenstein would have a total share that is 4275.32% bigger than its base share, compared to a mere 2.06% in presence of a cap. This attenuation is an illustration of how strong the cap is—first, because it reduces the effective weight of the $\mu_{\text{un},i}^{\text{pure}}$, $\mu_{\text{as},i}^{\text{pure}}$; second, because it replaces them by distributions $\mu_{\text{un},i}/\sum_{j\in I}\mu_{\text{un},j}$, $\mu_{\text{as},i}/\sum_{j\in I}\mu_{\text{as},j}$ that look more like $\mu_{\text{base},i}$ rather than $\mu_{\text{un},i}^{\text{pure}}$, $\mu_{\text{as},i}^{\text{pure}}$: the latter point is illustrated in Figure 2. If the cap was so strong that it would replace *all* $\mu_{\text{un},i}^{\text{pure}}$, $\mu_{\text{as},i}^{\text{pure}}$ by $2\kappa_2 \cdot \mu_{\text{base},i}$, $2\kappa_1 \cdot \mu_{\text{base},i}$, respectively, as seen in Regime 3, then the total share would again just be equal to the base share.

To sum up, as a first undesired property, I have shown that generally states with small population, low GDP, high unemployment and a high number of past asylum applications will see their situation exacerbated if the latter two factors are taken into account. The contrary is true for states satisfying the opposite conditions. I have demonstrated that these *paradoxical shifts* originate from a neglect of the structural difference of GDP and population size on the one hand side (absolute/extensive quantities) and unemployment rates and asylum applications per capita on the other hand side (relative/intensive quantities). A second undesired property of the European Commission's formula is its *lack of transparency*: the actual weight of unemployment and asylum applications per capita is at most 6% each, i.e. below the 10% indicated by the European Commission. Moreover, the effective distributions of the asylum and unemployment effects are strongly influenced by the distribution of population and GDP effects. This underweighting attenuates the paradoxical shifts but does not make them disappear. The first goal of this article, namely the exhibition of the undesired properties inherent to the proposal developed by the European Commission, is thus achieved.

## An alternative distribution key

### *Construction*

As a starting point for the engineering of an alternative distribution key, I consider the base rate, equation (7), and incorporate unemployment rates, $y_i$. I will deal with the incorporation of asylum applications later. Instead of adding a further

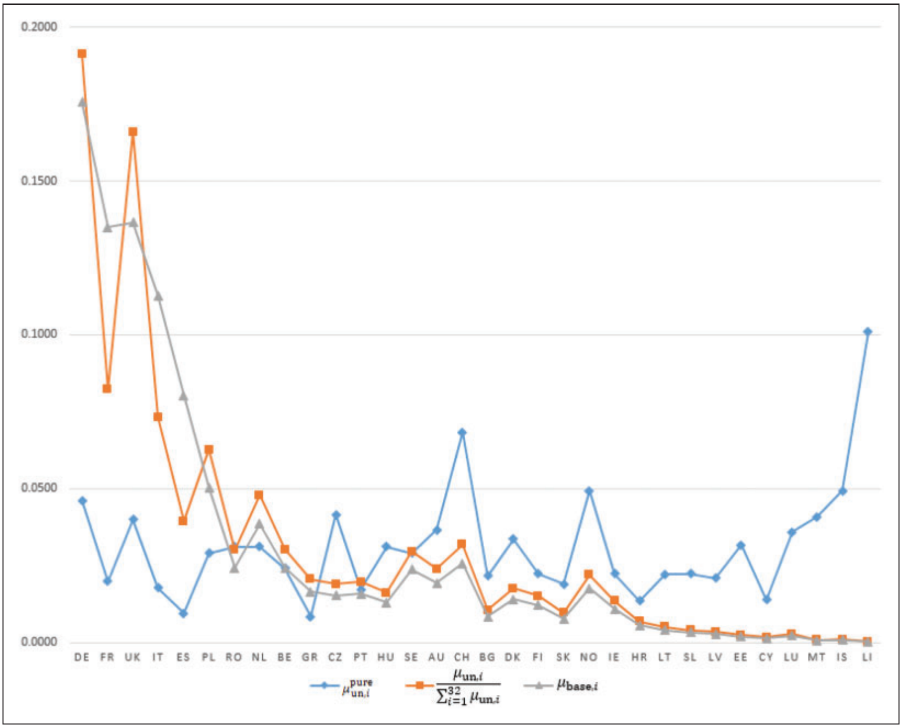


**Figure 2.** The distribution of the pure unemployment effects, the renormalized unemployment effects, and the base shares.

*Note:* The renormalized unemployment effects mimic the base shares whenever $\mu_{\text{un},i}^{\text{pure}} > 2 \cdot \kappa_2 \cdot \mu_{\text{base},i}$ and the pure unemployment effects otherwise—however, with different scaling due to normalization. As a result, the renormalized unemployment effects are more reminiscent of the base shares than of the pure unemployment effects. A similar figure could be drawn for the asylum effects.

summand in the form of $\mu_{\text{un},i}$ I introduce a *modulating factor* $\lambda_{\text{un},i} = \lambda_{\text{un},i}(y_i)$ and propose that the share of State $i$ be

$$\mu_i^* := \frac{\lambda_{\text{un},i} \cdot \mu_{\text{base},i}}{\sum_{j \in I} \lambda_{\text{un},j} \cdot \mu_{\text{base},j}}, \tag{11}$$

where the denominator has simply been introduced in order to ensure normalization. Note that absolute/extensive quantities (GDP, population) and relative/intensive quantities (unemployment) are no longer treated equally. I will define a specific form for $\lambda_{\text{un},i}(y_i)$ below—for the moment I only assume it to be monotonically decreasing in $y_i$. Given this, paradoxical shifts can no longer occur: with definition (11) it follows that

$$\frac{\mu_i^* - \mu_{\text{base},i}}{\mu_{\text{base},i}} = \frac{\lambda_{\text{un},i}}{\sum_{j\in I}\lambda_{\text{un},j}\cdot\mu_{\text{base},j}} - 1.$$

Thus, for any two states $A$ and $B$ it holds that whenever $y_A > y_B$, one has $\lambda_{\text{un},A} < \lambda_{\text{un},B}$ by monotonicity and hence $\frac{\mu_A^* - \mu_{\text{base},A}}{\mu_{\text{base},A}} < \frac{\mu_B^* - \mu_{\text{base},B}}{\mu_{\text{base},B}}$. In other words, State $B$ is more severely affected by the incorporation of unemployment than State $A$ *if and only if* its unemployment rate is less than that of State $A$. This resolves Undesired Property 1.

As for the specific form of $\lambda_{\text{un},i}(y_i)$ I propose a simple linear function

$$\lambda_{\text{un},i}(y_i) := 1 + \gamma_{\text{un}}\cdot\left(1 - \frac{y_i}{\bar{y}}\right) \tag{12}$$

where $\bar{y} = \frac{1}{N}\cdot\sum_{j\in I} y_j$ and $\gamma_{\text{un}} > 0$ is an external model parameter. The modulating factor $\lambda_{\text{un},i}$ is well-defined and it is replaced by zero in case it becomes negative. For the value of $\gamma_{\text{un}}$, I allude to the 10% weight of the unemployment effect in the proposal of the European Commission and define: choose $\gamma_{\text{un}}$ such that the variation coefficient of the modulating factors $\lambda_{\text{un},i}$ is *one-tenth* of the variation coefficient of the unemployment rates $y_i$. A simple computation establishes that this amounts to

$$\gamma_{\text{un}} = \frac{1}{10}.$$

In order to not distract from the main line of argument, the proofs of the above statements have been deferred to the web appendix (Proofs 2 and 3).

It can readily be seen that $\lambda_{\text{un},i}(y_i)$ in equation (12) is indeed monotonically decreasing in $y_i$ and as such satisfies the assumption above—Undesired Property 1 can thus not occur. Moreover, the effect of the parameter $\gamma_{\text{un}}$ is transparent: the larger its value, the bigger the influence of unemployment rates on the share $\mu_i^*$. This is in contrast to the European Commission's proposal where a seeming weight $\alpha_4$ for the unemployment effect $\mu_{\text{un},i}$ can effectively be lowered through a second parameter, namely the cap $\kappa_2$. In my proposal, $\gamma_{\text{un}}$ is however the only parameter and its value alone determines the influence of unemployment rates on the total share. This resolves Undesired Property 2.

The additional incorporation of asylum applications per capita is straightforward. One simply constructs another modulating factor based on equation (12) with the $y_i$ being replaced by the $x_i$

$$\lambda_{\text{as},i} = \lambda_{\text{as},i}(x_i) := 1 + \gamma_{\text{as}}\cdot\left(1 - \frac{x_i}{\bar{x}}\right) \tag{13}$$

where $\bar{x} = {}^{1}/_{N} \cdot \sum_{j \in I} x_j$ and $\gamma_{\mathrm{as}}$ is proposed to be set to one-tenth by the same reasoning that was applied for $\gamma_{\mathrm{un}}$. The resulting distribution key is then

$$\mu_i^{**} := \frac{\lambda_{\mathrm{un},\,i} \cdot \lambda_{\mathrm{as},\,i} \cdot \mu_{\mathrm{base},\,i}}{\sum_{j \in I} \lambda_{\mathrm{un},j} \cdot \lambda_{\mathrm{as},j} \cdot \mu_{\mathrm{base},j}} \tag{14}$$

Again, as a consequence of the monotonicity of the $\lambda_{\mathrm{as},\,i}(x_i)$ as well as the $\lambda_{\mathrm{un},\,i}(y_i)$, the larger $x_i$ and $y_i$ the more beneficial it is to consider $\mu_i^{**}$ instead of $\mu_{\mathrm{base},\,i}$ for State *i*—*no paradoxical shifts* occur. Moreover, just like $\alpha_4$ and $\kappa_2$ in the original proposal are replaced by a single parameter $\gamma_{\mathrm{un}}$, the parameters $\alpha_3$ and $\kappa_1$ therein reduce to $\gamma_{\mathrm{as}}$. *Transparency* is warranted: 'hidden' interactions between different parameters for the same effect can no longer occur.

The parameter reduction also increases the acceptability of my proposal, a crucial aspect when engineering a policy: in addition to an increased transparency, equations (11) and (14) admit fewer degrees of freedom for potential disagreement: given the European Commission's proposal, states might agree on the magnitude of impact of asylum applications and unemployment, but disagree on the specific parameter combination achieving this impact (increasing $\alpha_3$, $\alpha_4$ can be compensated by lowering the caps $\kappa_1$, $\kappa_2$ and vice versa). Having only a single parameter for each effect ($\gamma_{\mathrm{as}}$ resp. $\gamma_{\mathrm{un}}$) avoids this problem.

Another point which increases the acceptability of an engineered policy is that mathematical mechanisms should preferably be a 'natural' choice. By this I mean that a formula—rather than being an arbitrary ad hoc construction—can be derived from general principles or properties. It turns out that this is possible for my proposal: while there are many potential candidates for monotonically decreasing functions, the particular choice in equation (12) turns out to be natural in the above sense (similarly for asylum applications, equation (13)). In fact, it is the *only possible choice* under the following two requirements:

1. The average over all modulating factors equals one: $\frac{1}{N} \cdot \sum_{j \in I} \lambda_{\mathrm{un},\,i} = 1$.
   *('On average the modulating factor is one').*

2. The modulating factor is equal to one for average unemployment: $\lambda_{\mathrm{un},\,i}(\bar{y}) = 1$.
   *('Average unemployment yields average modulation').*

The proof of this uniqueness result can be found in the web appendix (Proof 4).

Table 2 presents the implications of the alternative distribution keys for real data. Most notably, $\mu_i^{*}$ brings in comparison to $\mu_{\mathrm{base},\,i}$ significant relief to Spain and Greece, which have the highest unemployment rates in the EU/EFTA region. In contrast, Switzerland and Liechtenstein, on the other end of the spectrum, have the highest share increase after incorporating unemployment. As for $\mu_i^{**}$, since states vary considerably with regard to asylum applications per capita over the

**Table 2.** Quantities needed for the computation of the alternative distribution keys.

| State | $\mu_{\text{GDP},i}$ | $\mu_{\text{pop},i}$ | $x_i$ | $y_i$ | $\lambda_{\text{as},i}$ | $\lambda_{\text{un},i}$ | $\mu_{\text{base},i}$ | $\mu_i^*$ | $\mu_i^{**}$ | $\frac{\mu_i^*-\mu_{\text{base},i}}{\mu_{\text{base},i}} \cdot 100\ \%$ | $\frac{\mu_i^{**}-\mu_{\text{base},i}}{\mu_{\text{base},i}} \cdot 100\ \%$ | $\frac{\mu_i^{**}-\mu_i}{\mu_i} \cdot 100\ \%$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DE | 0.1960 | 0.1552 | 0.00126 | 4.6% | 0.98 | 1.05 | 0.1756 | 0.1844 | 0.1792 | 5.01% | 2.07% | 3.09% |
| FR | 0.1434 | 0.1265 | 0.00093 | 10.7% | 1.01 | 0.98 | 0.1349 | 0.1324 | 0.1327 | −1.85% | −1.62% | 0.27% |
| UK | 0.1495 | 0.1236 | 0.00045 | 5.3% | 1.06 | 1.04 | 0.1365 | 0.1423 | 0.1488 | 4.22% | 8.98% | 8.78% |
| IT | 0.1087 | 0.1168 | 0.00053 | 12.0% | 1.05 | 0.97 | 0.1127 | 0.1090 | 0.1132 | −3.32% | 0.40% | 1.57% |
| ES | 0.0712 | 0.0894 | 0.00008 | 22.3% | 1.09 | 0.85 | 0.0803 | 0.0683 | 0.0737 | −14.91% | −8.15% | −8.38% |
| PL | 0.0278 | 0.0730 | 0.00025 | 7.3% | 1.08 | 1.02 | 0.0504 | 0.0514 | 0.0547 | 1.97% | 8.50% | 6.31% |
| RO | 0.0101 | 0.0383 | 0.00008 | 6.8% | 1.09 | 1.02 | 0.0242 | 0.0248 | 0.0268 | 2.53% | 10.68% | 8.44% |
| NL | 0.0446 | 0.0323 | 0.00096 | 6.8% | 1.01 | 1.02 | 0.0384 | 0.0394 | 0.0394 | 2.53% | 2.45% | 1.39% |
| BE | 0.0270 | 0.0215 | 0.00235 | 8.8% | 0.88 | 1.00 | 0.0243 | 0.0243 | 0.0212 | 0.28% | −12.51% | −12.81% |
| GR | 0.0120 | 0.0210 | 0.00085 | 25.0% | 1.02 | 0.82 | 0.0165 | 0.0136 | 0.0137 | −17.95% | −17.17% | −18.84% |
| CZ | 0.0104 | 0.0202 | 0.00014 | 5.1% | 1.09 | 1.04 | 0.0153 | 0.0160 | 0.0172 | 4.45% | 12.21% | 9.94% |
| PT | 0.0116 | 0.0200 | 0.00005 | 12.3% | 1.10 | 0.96 | 0.0158 | 0.0153 | 0.0165 | −3.66% | 4.29% | 2.18% |
| HU | 0.0069 | 0.0190 | 0.00137 | 6.8% | 0.97 | 1.02 | 0.0130 | 0.0133 | 0.0128 | 2.53% | −1.35% | −3.34% |
| SE | 0.0290 | 0.0185 | 0.00506 | 7.3% | 0.63 | 1.02 | 0.0237 | 0.0242 | 0.0151 | 1.97% | −36.21% | −36.00% |
| AU | 0.0221 | 0.0163 | 0.00210 | 5.8% | 0.91 | 1.03 | 0.0192 | 0.0199 | 0.0179 | 3.66% | −7.17% | −7.97% |
| CH | 0.0356 | 0.0156 | 0.00282 | 3.1% | 0.84 | 1.07 | 0.0256 | 0.0273 | 0.0227 | 6.70% | −11.48% | −11.55% |
| BG | 0.0028 | 0.0139 | 0.00059 | 9.8% | 1.05 | 0.99 | 0.0084 | 0.0083 | 0.0086 | −0.84% | 2.41% | 0.35% |
| DK | 0.0173 | 0.0108 | 0.00132 | 6.3% | 0.98 | 1.03 | 0.0141 | 0.0145 | 0.0140 | 3.10% | −0.37% | −2.38% |
| FI | 0.0138 | 0.0105 | 0.00059 | 9.5% | 1.05 | 0.99 | 0.0121 | 0.0121 | 0.0125 | −0.50% | 2.78% | 0.71% |
| SK | 0.0051 | 0.0104 | 0.00009 | 11.2% | 1.09 | 0.97 | 0.0077 | 0.0075 | 0.0081 | −2.42% | 5.22% | 3.09% |
| NO | 0.0253 | 0.0098 | 0.00209 | 4.3% | 0.91 | 1.05 | 0.0176 | 0.0185 | 0.0166 | 5.35% | −5.55% | −6.54% |

(continued)

**Table 2.** Continued

| State | $\mu_{\text{GDP},i}$ | $\mu_{\text{pop},i}$ | $x_i$ | $y_i$ | $\lambda_{\text{as},i}$ | $\lambda_{\text{un},i}$ | $\mu_{\text{base},i}$ | $\mu_i^*$ | $\mu_i^{**}$ | $\frac{\mu_i^*-\mu_{\text{base},i}}{\mu_{\text{base},i}} \cdot 100\ \%$ | $\frac{\mu_i^{**}-\mu_{\text{base},i}}{\mu_{\text{base},i}} \cdot 100\ \%$ | $\frac{\mu_i^{**}-\mu_i}{\mu_i} \cdot 100\ \%$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IE | 0.0127 | 0.0088 | 0.00029 | 9.5% | 1.07 | 0.99 | 0.0108 | 0.0107 | 0.0114 | −0.50% | 5.52% | 3.39% |
| HR | 0.0029 | 0.0082 | 0.00018 | 15.6% | 1.08 | 0.92 | 0.0055 | 0.0051 | 0.0055 | −7.37% | −0.84% | −2.84% |
| LT | 0.0024 | 0.0057 | 0.00011 | 9.6% | 1.09 | 0.99 | 0.0040 | 0.0040 | 0.0043 | −0.62% | 7.00% | 4.84% |
| SL | 0.0025 | 0.0040 | 0.00015 | 9.5% | 1.09 | 0.99 | 0.0032 | 0.0032 | 0.0035 | −0.50% | 6.77% | 4.61% |
| LV | 0.0016 | 0.0038 | 0.00012 | 10.1% | 1.09 | 0.99 | 0.0027 | 0.0027 | 0.0029 | −1.18% | 6.36% | 4.21% |
| EE | 0.0013 | 0.0025 | 0.00006 | 6.7% | 1.09 | 1.02 | 0.0019 | 0.0020 | 0.0021 | 2.65% | 10.96% | 8.71% |
| CY | 0.0012 | 0.0016 | 0.00220 | 15.2% | 0.90 | 0.93 | 0.0014 | 0.0013 | 0.0012 | −6.92% | −17.52% | −19.18% |
| LU | 0.0033 | 0.0011 | 0.00156 | 5.9% | 0.96 | 1.03 | 0.0022 | 0.0023 | 0.0021 | 3.55% | −2.19% | −4.17% |
| MT | 0.0005 | 0.0008 | 0.00369 | 5.2% | 0.76 | 1.04 | 0.0007 | 0.0007 | 0.0005 | 4.34% | −21.75% | −23.33% |
| IS | 0.0009 | 0.0006 | 0.00033 | 4.3% | 1.07 | 1.05 | 0.0007 | 0.0008 | 0.0008 | 5.35% | 11.36% | 9.11% |
| LI | 0.0004 | 0.0001 | 0.00203 | 2.1% | 0.91 | 1.08 | 0.0002 | 0.0003 | 0.0002 | 7.82% | −2.81% | −4.77% |

*Note:* Based on the same data as used in Table 1, the final shares $\mu_i^*$, $\mu_i^{**}$ are determined according to the proposed alternative distribution keys. Their relative comparison with the base shares and the European Commission's final shares is given in the last three columns: no paradoxical shifts occur. Observe in particular the now correct increase for Germany and the concurrent decrease for Cyprus in contrast to Table 1.

preceding five years, the consideration of $\lambda_{\mathrm{as},\,i}$ accounts for accentuated corrections to the base share, most notably in the case of Sweden which would experience a 36% decrease. The *extent* to which the modulating factors should be considered is a political question and amounts to agreeing on the value of the parameters $\gamma_{\mathrm{as}}$ and $\gamma_{\mathrm{un}}$. The last column compares $\mu_i^{**}$ with the distribution key $\mu_i$ proposed by the European Commission: corrections are up to two-digit percentages. To get a feeling for the order of magnitude, I assume one million applicants in the EU/EFTA. Then the United Kingdom would have to treat 12,016 applications *more* if distribution were done according to $\mu_i^{**}$ instead of $\mu_i$; Sweden however would have to treat 8520 applications *less*.

## Discussion and further developments

The distribution key $\mu_i^{**}$, equation (14), achieves the second goal of this article: it is transparent and exhibits no paradoxical shifts and moreover, it is modeled along the lines of the original proposal of the European Commission. In particular, it is based on the same four quantities as the distribution key $\mu_i$. This constraint, as well as potential deviations from it, will briefly be discussed here.

Conceptually speaking, in order to define an equitable share, one first determines the *entities* that should influence it. In the present case, those are 'population size', 'economic size', 'asylum burden in the past', and 'state of the labor market'. In contrast to population size, the latter three entities are however somewhat abstract and are therefore measured using *proxies*, such as GDP, asylum applications per capita from the preceding five years ($x_i$), and unemployment rates ($y_i$). As a consequence of this, a thorough analysis of the European Commission's distribution key should also address the representational accuracy of the chosen proxies. Both GDP and unemployment rates are standard and pragmatic choices which have limits that are well-known—I will thus not delve into this here. Exemplarily, GDP does not account for non-market goods and services; unemployment rates do not account for labor market peculiarities in a given state. The proxy for the asylum burden in the past is, however, more problematic and less well understood. It therefore deserves a short discussion.

First, it should be noted that refugees that have entered a state five years ago are better integrated than more recent refugees. This could easily be accounted for by considering a weighted average giving less weight to years in the more distant past instead of merely taking the arithmetic mean over the past five years (given by $x_i$). Second, and more importantly, imagine the extreme case of a state which has received a large number of applications per capita in the preceding five years but has rejected them all. While such a state would have a large average of applications per capita, i.e. a large $x_i$, it seems absurd to say that it has faced a substantial asylum burden in the past. Thus, the number of asylum applications per capita is only a good proxy for the asylum burden in past, if acceptance rates are roughly the same in all states. In reality, however, acceptance rates vary considerably among states in the EU/EFTA (Eurostat, 2015a), an observation that several authors have made in the past (see e.g. Bovens et al., 2012; Neumayer, 2005; Toshkov and de Haan, 2013; Vink and Meijerink, 2003). Moreover, Toshkov (2014, see also references therein) has found interesting interdependencies between acceptance rates and application numbers. An accurate proxy for the asylum burden in the past should therefore also account for acceptance rates and not only for application numbers—at least in Scenarios 1 and 2.[9] In Scenario 3, an even better solution is possible and I will briefly sketch its underlying idea: at the latest after a transition period of five years upon its introduction, the asylum burden in the preceding five years is shared equitably because it was the very result of a quota. As a consequence, past asylum numbers should then no longer have an adjusting effect for the current year: if the distributions in the past were fair to begin with, they should not have a corrective effect on the distribution of the present. Mathematically, this means that the $x_i$ should no longer be incorporated in this situation. In other words, instead of using $\mu_i^{**}$, one should then use $\mu_i^{*}$, equation (11), and an asylum burden proxy is not required at all. This idea could be refined so as to better account for the transition period or short-term deviations from given quotas.

If models are considered that deviate more substantially from the European Commission's proposal, many more alternative distribution keys could be constructed. As early as 1992, the EU itself has discussed a distribution key which was inspired by German domestic asylum policy and was based on population size, GDP, and territory size (Thielemann, 2003). More recently, Czaika (2005) proposed a formula which can be viewed as being based on population size with one additional modulating factor given by a 'refugee capacity index'. This index is computed on the basis of economic, societal, and polito-institutional factors and has a different mathematical structure than the modulating factors considered here. Even different modulating factors could be constructed based on a state's integration abilities with respect to education, housing, sectorial demand on labor market, languages, and more. As a concluding remark it should be mentioned that also more dimensional burden-sharing is subject to ongoing research: trading schemes or cost balance through common funds such as the European Refugee Fund have been studied by many authors, e.g. Schuck (2013) and Thielemann (2012, 2014). A detailed discussion is however beyond the scope of this article.

## Conclusion

The current migration crisis has put considerable pressure on the EU and at the moment represents one of its biggest political and coordinative challenges. The EU is confronted with heterogeneous interests and preferences for a common asylum policy among its members and faces the task of finding a functioning solution. The proposal of the European Commission tackles a part of the burden-sharing problem with quantitative means based on objective criteria such as population, GDP, unemployment, and the number of asylum applications per capita. As discussed in the introduction, this is a reasonable approach as there are compelling reasons to argue for a more integrated European asylum policy despite the current political climate. Moreover, a quantitative, formulaic reasoning in political matters—policy engineering—should not a priori be discarded as cynical but rather seen as a solution-oriented approach. Especially for complex negotiation situations, such as the present one, quantitative methods are a useful tool to reach an agreement and have been successfully applied by the EU in various domains in the past.[10] In this article, I have therefore not argued against the introduction of a distribution key formula per se but instead discussed its concrete form. I have demonstrated that the European Commission's refugee distribution key has two undesired properties—*paradoxical shifts* and a *lack of transparency*—that are in contradiction with the intentions of the proposal. As a remedy, I have suggested an alternative distribution key, based on modulating factors, which is still modeled along the lines of the original proposal, yet without its undesired properties.

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## Notes

1. Almost 1.1 million refugees were registered in the EASY-System (*Erstverteilung von Asylsuchenden*—initial distribution of asylum seekers). Registration happens upon first contact with an official in Germany. The formal asylum application may be filed later with the Federal Office for Migration and Refugees.
2. This commonly used terminology is somewhat unfortunate: the acceptance of refugees can also be beneficial to a host state, at least on a long-term timescale (cf. Aiyar et al., 2016).
3. Strictly speaking, the reading of the above quote is somewhat ambiguous because the comparative 'fewer' is not clearly specified. I read it as 'fewer than if the corrective factors were not considered'. This interpretation is suggested by the use of the term 'corrective factors': they are supposed to correct the share computed on the sole basis of GDP and population so that high asylum application numbers and a high unemployment rate have a decreasing effect on it. Note that this also corresponds to a natural fairness condition that one would impose on any reasonable distribution key. For the sake of accuracy, it should be mentioned that the quote could also be read as 'fewer than if – *ceteris paribus* – that state had lower asylum application numbers and a lower unemployment rate'. It then merely expresses the monotonicity property resulting from the inverse application of average application numbers and unemployment rates. This statement would actually be almost correct—a remaining flaw being the fact that it is not the corrective factors themselves which are applied inversely but the underlying measurement quantities, cf. formulas (1) to (4).
4. Scenario 1 is not directly related to the Dublin III Regulation and as such only applies to EU member states; except for the United Kingdom, Ireland, and

Denmark who have opt-outs in the area of freedom, security, and justice (Protocols 21 and 22 in TFEU). The Dublin III Regulation itself has been adopted by all EU and EFTA states except for Denmark (the United Kingdom and Ireland have opted in explicitly).

5. The conditions for a crisis situation are based on (1) the 'increase of the number of asylum applicants in the last six months', (2) the 'increase in the number of irregular border crossings in the last six months', and (3) 'the number of asylum applications per capita, compared to the EU average' (European Commission, 2015d).
6. This constraint is introduced in order 'to ensure that all applicants who are in clear and urgent need of protection can enjoy their right of protection as soon as possible; and to prevent applicants who are unlikely to qualify for asylum from being relocated and unduly prolonging their stay in the EU' (European Commission, 2015d).
7. In Scenario 1, I is even a strict subset of $\{1, \ldots, 25\}$, since this scenario only applies to EU member states (considering the opt-outs of the United Kingdom, Ireland, and Denmark), cf. note 4. In Scenario 2 it would currently be a subset of $\{1, \ldots, 31\}$ since only Denmark has not adopted the Dublin III Regulation. Note however that the proposal will also be offered to Denmark (European Commission, 2015b: 4–5).
8. The physical sciences have the useful distinction between *extensive* quantities (volume, energy, entropy, etc. in analogy with GDP, population size, surface area, etc.) versus *intensive* quantities (pressure, density, temperature, etc. in analogy with unemployment, per capita numbers, etc.) which differ in their behavior with respect to rescaling of the system under consideration (Huang, 2009: 2–4).
9. To prevent a logical fallacy, the restriction to states of origin with at least 75% acceptance rate in Scenarios 1 and 2 is a constraint determining which refugees can be distributed according to the distribution key. This is independent of the assessment of the asylum burden in the past and hence does not attenuate or solve the problem of an inaccurate proxy due to varying acceptance rates.
10. Langenegger and Ambühl (2015) give three examples from this point of view concerning diplomatic negotiations between Switzerland and the EU. The second author draws from his experience as a former practitioner. Switzerland made explicit use of the openness of the EU to a quantitative approach and mutually beneficial agreements were found. Other practitioners have also reported on the often highly technical nature of the European Commission's proposals (Thomson et al., 2006: 15).

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