

Assessing the Level of Undercounting in the International Migration Flows Reported by Eurostat

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Abstract

Assessing undercounting in the official statistics on migration flows at a country level is a crucial step to understand and model international migration data. Here, we discuss different sources of information on country-specific undercounting and we propose a novel data-driven approach for their evaluation as well for combining them into a final classification of each country. The results of this assessment are shown in the [UndercountMigScores](#) Shiny application, which can provide multiple options for estimating undercounting.

1 Introduction

Undercounting is a serious issue related to migration data quality as it may lead to bias in the migration estimates and, as such, it should be accounted for in any migration model. It is commonly believed that undercounting is mainly associated with, but not limited to, emigration flows. In those countries using population registers or other administrative registers as main source of official migration statistics, undercounting can be thought of as the consequence of individuals failing to register when entering a country or to de-register when leaving. In other cases, when surveys are used instead as source of migration data, undercounting can result from individuals who experienced migration failing to answer the survey. In either case, all these individual decisions are likely affected by the varying requirements between and within countries for reporting of migrating individuals, or by the existing difficulties in enforcing such legal requirements (Mooyaart et al. 2021).

A proper assessment of the undercounting in international migration data at the country level is paramount for migration models that not only aim at modelling the flows using variables correlated to them, but also strive to adjust for possible biases and inconsistencies between countries in the data. For this purpose, as a preliminary step to the classical migration model, one can formulate a measurement error model that includes specific parameters capturing the level of undercounting in the data reported by each country (e.g., Raymer et al. 2013). The effect of this parameter is to shift upward the flow estimates for countries affected by undercounting issues, with the change being larger for countries with higher undercounting.

The main source of information on undercounting at the country level is the metadata associated with the official migration statistics, as well as the additional information that may be provided by the national statistical offices (NSOs); the availability of such data is, however, generally limited. Indeed, the recent EU-funded QuantMig project, which aims to assess the migration data quality in Europe between 2009 and 2019 (Mooyaart et al. 2021), was able to collect only few useful variables such as the obligation of registration or de-registration, the time requirements for registration and de-registration, the obligation of de-registration of third-country nationals, the monitoring of third-country nationals, as well as few records on existing sanctions when not registering. These variables came from reports that only cover a very limited time period. Contacting directly NSOs to access current and historical data will be a key step for improving the quality and scope of the metadata.

Another source of information on the undercounting is the expert opinion, which has proved to be very useful in formulating early migration models (e.g., the IMEM model, Raymer et al. 2013). However, this information is rather arbitrary and, according to our view, based on a small number of experts who may not know all the details of migration data shared by different countries (Wiśniowski et al. 2013; Willekens 2019).

Furthermore, the expert opinions elicited in the IMEM model may no longer be relevant as they only covered the years from 2002 to 2008. This is especially true because, firstly, an important change was implemented after 2007 regarding the production of the EU migration statistics: the minimum duration of stay criterion was defined by the EU as 12 months (Reg (EC) 862/2007). This change required the NSOs to update their data collection and processing mechanisms, and, thus, the quality of the produced migration estimates. This most likely affected the classification of countries into groups with ‘low’ and ‘high’ undercounting in the IMEM project, which was based on information available before the new duration criterion was introduced (Wiśniowski et al. 2013).

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Secondly, most of national censuses took place in or close to 2011. Since the national censuses are often used by NSOs to retrospectively update population estimates and migration flows, the assessment of migration data quality provided by the experts may not be valid. For example, Lithuania after 2011 census conducted a retrospective recalculation of the total emigration flows and population estimates backwardly until 2001 census.

In order to obtain a better assessment of the undercounting in migration data at the country level, we present a novel method for the construction of an undercounting score that uses the bilateral migration data to compare flows of the same direction, but reported by different countries. The combination of these scores with the metadata and the expert opinion from the IMEM project will be eventually use to classify countries in terms of their level of undercounting. This paper is accompanied by a Shiny app called *UndercountMigScores* (Daňko 2021), which can greatly extend the options for the calculation of the undercounting scores presented below.

2 Bilateral migration flows ratio model

The bilateral migration flows ratio is constructed by taking flows from country X to a group of high data-quality countries (the reference countries with minimal or very low undercounting according to IMEM, metadata, and the model itself) reported by country X and dividing it by the same flow reported by the the reference countries. Because the minimal duration of stay required for the definition of an international migration may differ among countries, the flows reported by each country should be somehow corrected. Here, as the default correction we use the IMEM (Raymer et al. 2013) model coefficients for the duration of stay. The Shiny app *UndercountMigScores* (Daňko 2021) offers more options for the estimation, such as the choice of no correction or three additional corrections summarized in the paper by Willekens (2019). As reference countries, we selected the Nordic countries (Denmark, Finland, Sweden, Norway, and Iceland), Austria, Belgium, the Netherlands, and Switzerland. Again, our software offers other choices in this respect.

Formally, the undercounting ratio $U_{X,Y,t}^E$ for emigration data between country X and set of countries Y in year t , can be estimated as follows:

$$U_{X,Y,t}^E = \frac{\sum_c M(X_t \rightarrow Y_{c,t}, X_t) R_{X_t}}{\sum_c M(X_t \rightarrow Y_{c,t}, Y_{c,t}) R_{Y_{c,t}}}, \quad (1)$$

where $M(X_t \rightarrow Y_{c,t}, X_t)$ is the emigration flow from country X to country Y_c reported by country X in year t , $M(X_t \rightarrow Y_{c,t}, Y_{c,t})$ is the immigration flow from country X to country Y_c reported by country Y_c in year t , R_{X_t} is the IMEM correction for duration of stay of country X in year t , and $R_{Y_{c,t}}$ is the IMEM correction for duration of stay of country Y_c reported in year t . The undercounting ratio for immigration data is calculated analogically.

Examples of bilateral flows ratios are shown in Figure 1. The figure shows that undercounting may decrease over time (e.g., Spain (ES), Bulgaria (BG)), increase (e.g., Germany (DE)), remain roughly constant at very low (e.g., Finland (FI)) or moderate level (e.g., Italy (IT)), or fluctuate with a tendency to decrease (e.g., Slovakia (SK)).

3 Combining multiple source of information on undercounting into a final score

The migration model used in the IMEM project used the same undercounting classification for all years. However, as previously mentioned, after 2007 there was a significant breakthrough in migration data collection due to the harmonization of the definition of the duration of stay (Reg. (EC) 862/2007) and possibility of using censuses that took place in subsequent years to update migration estimates. For this reason, we decided to split the undercounting classification into two periods, namely, before 2008 and after 2007. This cut-off is defined by a threshold parameter (2008, by default) that can be easily changed in the *UndercountMigScores* (Daňko 2021) app to investigate model sensitivity.

Finally, we combined the three data sources on undercounting (the metadata, the IMEM expert opinion, and the bilateral migration flows ratios) to summarize the whole information in an undercounting numerical score between 0 and 1. We used the same weights for immigration and emigration, although we differentiated them between the two periods. On the one hand, for the years prior to 2008, the weights were arbitrarily set to 25% for the IMEM score, 10% for the metadata score, and 65% for the model score. On the other hand, from 2008 onward, the weight of the metadata remained at 25%, the weight for the IMEM score decreased to 5%, and the model score increased to 70%. We chose rather low weights for the metadata because this information is currently limited. In the future, as we plan to directly collect more precise metadata from the NSOs, these weights might increase. We also decreased the IMEM weights in the second period, because the IMEM classification focuses on the years prior to 2008 years and

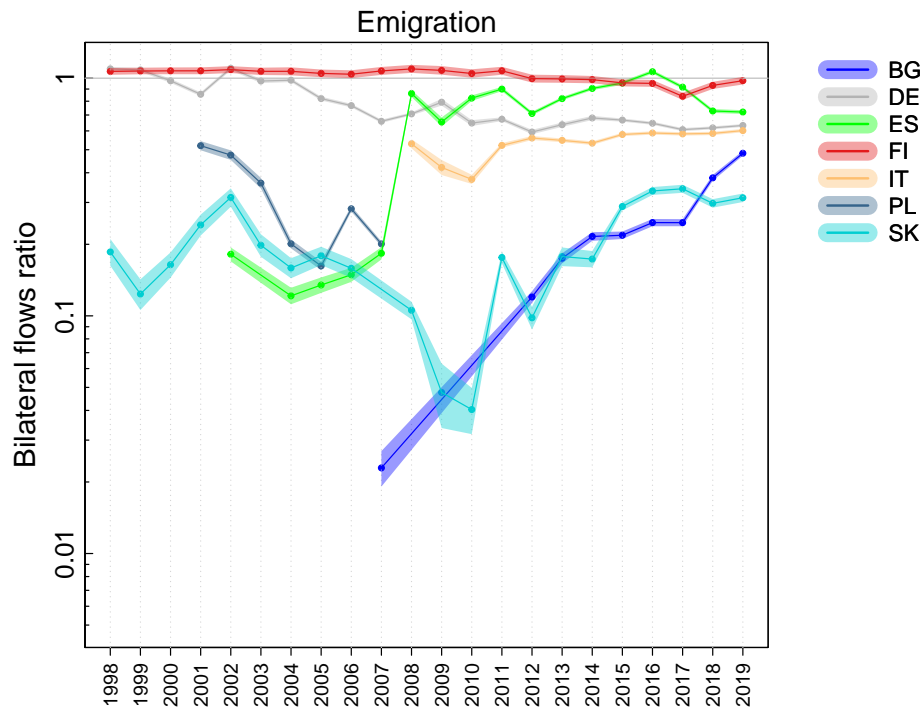


Figure 1. Selected bilateral flows ratios for emigration data. The ratio is calculated by dividing flows from country X to a group of good data-quality countries (the reference group of countries) reported by country X by the flows in the same direction reported by the reference group of countries. Ratios higher than 1 indicate overcounting, while ratios lower than 1 indicate undercounting of emigration flows. The lower the ratio, the higher the undercounting. The confidence intervals are calculated using the percentile bootstrap method on the simulated sample (see help in the Shiny app *UndercountMigScores* (Daňko 2021) for further details).

may not be relevant anymore for more recent years. Finally, the obtained numerical scores were classified arbitrarily into three-level scores: low, medium, and high (Table 1).

4 Preliminary results and discussion

Previous migration models assumed a time-independent undercounting country classification based entirely on expert opinion. Here we improve such classification by combining the expert opinion with both metadata and a model based on bilateral flows. Since the model offers yearly estimates, we can construct two undercounting time groups defined by a threshold year. In the case of the emigration data (Table 1), the undercounting remains at the same level, although we see a big improvement in Spain and a slight improvement in Slovakia. On the other hand, worsening undercounting patterns were observed for Croatia and the United Kingdom¹.

The IMEM expert opinion on undercounting should be compared with our combined undercounting classification prior to the threshold year (2008) as both measures refer to similar periods. Although the combined undercounting classification before 2008 was similar to the IMEM for many countries, the IMEM overrated the undercounting for countries such as Estonia, Croatia, Liechtenstein, Lithuania, and Slovenia.

In this article, we present the most comprehensive undercounting analysis currently available. While it is based on arbitrary weights and thresholds, we believe it is an important step towards a more objective classification. First, the main component of the classification is a data-based bilateral flow ratio model; second, the developed software presents a sensitivity analysis of the assumptions made about the parameter values. The software will be continuously updated with the new metadata collected from statistical offices.

Including more undercounting metadata in the combined score is quite important, as the bilateral flows ratio model has some limitations. First, it can be applied only for countries with recorded bilateral flows; second, it cannot completely disentangle the issue of undercounting from that of coverage, where the latter is defined as the systematic undercounting of specific population groups in the data collection system. Finally, the values used for the duration of stay adjustment may be not perfect as they are obtained from the IMEM model, which is supported by expert

¹It is worth noting that the UK recently implemented a new method of migration data collection, based on administrative sources (cf. Blake 2020).

opinions based on old migration data and metadata. Future migration models may provide better estimates for these correction parameters.

Table 1. Undercounting classification for emigration data. **iso2**: Eurostat country code; **IMEM**: expert opinion (3-level score); **metadata**: Eurostat metadata (3-level score), **model (B)**: fitted model before 2008 (5-level score); **model (A)**: fitted model from 2008 onward (5-level score); **combined (B)**: combined score before 2008 (3-levels); **combined (A)**: combined score from 2008 onward (3-levels). Extrapolated values are marked with squared brackets. For the rules for constructing the **metadata** scores, please see the help in the [UndercountMigScores](#) Shiny app.

iso2	country	IMEM	metadata	model (B)	model (A)	combined (B)	combined (A)
AT	Austria	low	low	very low	low	low	low
BE	Belgium	low	medium	[very low]	very low	low	low
BG	Bulgaria	high	high	very high	high	high	high
CH	Switzerland	low	low	[very low]	very low	low	low
CY	Cyprus	low	high			low	low
CZ	Czechia	high	high	high	[high]	high	high
DE	Germany	low	medium	very low	low	low	low
DK	Denmark	low	low	very low	very low	low	low
EE	Estonia	high	low	very low	very low	low	low
EL	Greece	high	high			high	high
ES	Spain	high	medium	high	very low	high	low
FI	Finland	low	low	very low	very low	low	low
FR	France	low	high	[very low]	very low	low	low
HR	Croatia	high	medium	very low	low	low	medium
HU	Hungary	high	medium			high	high
IE	Ireland	low	high	very low	very low	low	low
IS	Iceland	low	low	low	very low	low	low
IT	Italy	low	medium	[low]	low	low	low
LI	Liechtenstein	high	low	[very low]	very low	low	low
LT	Lithuania	high	low	very low	very low	low	low
LU	Luxemburg	low	low	very low	[very low]	low	low
LV	Latvia	high	low	very high	[very high]	high	high
MT	Malta	high	high			high	high
NL	Netherlands	low	low	low	very low	low	low
NO	Norway	low	low	very low	very low	low	low
PL	Poland	high	medium	medium	[medium]	high	high
PT	Portugal	high	high			high	high
RO	Romania	high	high			high	high
SE	Sweden	low	low	very low	very low	low	low
SI	Slovenia	high	low	very low	very low	low	low
SK	Slovakia	high	low	high	medium	high	medium
UK	United Kingdom	low	high			low	medium

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