"Prediction of future migration flows to the UK and Germany"
Technical exercise, honest study, or convenient obfuscation?

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Abstract. This analysis of Chapter 6 of Home Office Online Report 25/03, (www.homeoffice.gov.uk/rds/pdfs2/rdsolr2503.pdf) reveals that the Report's low predictions of net migration for the UK are not based on any convincing modelling of historical data series. The forecasts are found to be essentially matters of lay judgement that can be made without appeal to mathematical or econometric expertise.

1). **A warning.** The Report's cover page warns the reader that "the views expressed in this report are those of the authors, not necessarily those of the Home Office (nor do they reflect Government policy)". However, since the Report is (at the time of writing) the only item on the RDS website dealing with the important issue of potential migration flow to the UK after EU enlargement, it is clear that the Report is taken seriously and should therefore be subject to detailed public scrutiny and assessment.

2). **The Executive Summary.** Most readers will be either reluctant or unqualified to engage with the technicalities of the statistical method that the authors use to arrive at their predictions of net migration up to 2010. They will either prefer or be obliged to rely on the competence and good judgement of its authors—when they read in the final paragraph of the Report's Executive Summary that :

> "For the period up to 2010, estimates for Germany range between 20,000 and 210,000 net immigrants per year, depending on the underlying scenario. The last estimate assumes that all the CEECs [Central and East European Countries] are high emigration countries, and that there is slow convergence in GDP—within the model structure used, this is very likely to be an overestimate. Estimates for the UK range between 5,000 and 13,000 net immigrants per year. The low estimates are related to the low historical migration rates, which are discussed in the text. In the case that Germany restricts free movement of workers for a longer period than the UK, some of those immigrants to Germany may use the UK as a destination. However, even in the worst case scenario, migration to the UK as a result of Eastern enlargement of the EU is not likely to be overly large. The evidence brought together indicates that net migration from the AC-10 [the 10 Accession Countries, CEEC-10] to the UK will be broadly in line with current migration movements."

How has the Report managed to produce its exceedingly modest predictions for the UK of 5,000 or 13,000 net migrants per annum "depending on the underlying scenario"? This commentary will be able to answer that question without using algebra or any other private language.

3). **Provenance.** The Report was commissioned by the Home Office's Immigration and Nationality Directorate. Its "preparation" was "directed" by the UCL economist Christian Dustmann with the "participation" of four other economists including two Heidelberg econometricians Michael Fertig and Christoph Schmidt. Before tackling the technicalities of the Report itself, it may therefore be useful to look at the predictions for Germany that were published in 2001 in two papers by Fertig and Schmidt. Particularly relevant are the enlightening caveats that these authors then placed on their predictions since these reservations are germane to the techniques deployed in the Report itself.

4). **First paper.** Fertig (2001) derived his prediction formula from historical data from 1960 to 1994—not from any of the ten East European accession counties, CEEC-10, but from 15 other European countries plus Turkey and the United States. The CEEC-10 countries were excluded because migrations from these countries prior to the 1990's were "certainly driven by different factors than the economic determinants establishing the model used in this paper." (The paper does not justify the rejection of the more recent data from these countries—which are the very objects of prediction.) The "economic determinants" were taken to be

(i) year-by-year per capita incomes in these 17 countries of origin and in Germany itself (expressed in terms of purchasing power)

(ii) the corresponding unemployment rates

(iii) the numbers (stocks) in Germany of previous migrants from each country of origin

(iv) for each year and country, whether or not there was a treaty in operation allowing "free movement within EU"

(v) the UN Human Development Index

(vi) the distances between the "economic" capitals of Germany and the origin countries.

With such inputs, reality can only be modelled if you are prepared to make some crucial theoretical assumptions. In this respect, econometricians habitually display more audacity than most statisticians can muster. The paper does not tell us much about how well the theoretically-motivated formula of the model fits the historical data for 17 countries and 35 years, and there are no graphs to allow the reader to get a feel for that question. The model assumes that, apart from changes arising from the listed economic determinants and random disturbances, things "do not change with time" i.e. during the whole period of 56 years from 1960 to 2015. It also assumes that things "do not change with space" i.e. if we move to Eastern Europe. The author is engagingly open about the need for these and other assumptions—that are largely untestable except by the eventual success or failure of the predictions the model purports to justify. The assumptions are:

> "crucial for the quality and validity of the forecasting results. Any violation of these assumptions may result in a serious loss of forecasting quality and may eventually render the predicted immigration flows completely invalid."

Such a *caveat emptor* must dampen any interest in the superficially precise estimates that follow for "migration potential" from the CEEC-10 to Germany during 1995-2015:

◦ 66,740 immigrants per annum without free movement but with some economic convergence,
◦ 67,101 with free movement,
◦ 73,583 with free movement but without economic convergence.

The paper nevertheless concludes on a note of greater confidence that:

> "The predictions are far too small to justify the large concern expressed in the media. They reflect the experience of the EU-enlargement to Spain, Portugal, and Greece in the middle of the 1980's. Furthermore, the results of the different scenarios are apparently in line with what the potential migrants would say themselves. In the words of a Polish official in the negotiations of EU enlargement: 'the idea of a mass exodus of Poles is nonsense. Some of us actually enjoy living at home.' "

5). **Second paper.** Fertig and Schmidt (2001) could well have begun their paper with a Pythonesque "And now for something completely different!" One merit of the new approach is that the basic model can now be readily visualised—for the 38-year record of net capita immigration to Germany from the same 17 countries as in Fertig (2001). Draw 17 horizontal lines against a vertical scale at levels that represents the supposed long-run averages of the country-specific immigration. These levels are modelled as a random sample from some population of levels. For the first data year 1960, give the *same* jolt or "shock" (drawn at random from some population of shocks with zero expectation) to each of the 17 values. Do the same for 1961 using the same population but so that there is a certain positive correlation between the 1960 and 1961 shocks, representing a persistence of a fraction of the shock. Do exactly the same for 1962 in relation to 1961, with the same the correlation coefficient—and so on for all the years up to 1997. Finally, add a zero-expectation random disturbance to each of the $17 \times 38 = 646$ points thus envisioned: without these disturbances the 17 country lines would be absolutely parallel in their deviations around their individual horizontal levels. Note that there are just five parameters in the model when it is described in terms of only means, variances, and covariances: the mean (or "common intercept") and variance ("country-specific component") of the population of immigration levels, the variance ("time-specific component) of the population of shocks, the variance ("unsystematic component") of the random disturbances, and the correlation coefficient ("persistence parameter") of adjacent shocks. Perhaps the most significant feature of the model is that it is "stationary" over time i.e. for none of the 17 countries is the time-series of immigration rates allowed to show any systematic trends up or down—for all of 38 years!

For a second "scenario" that refines this model, the authors choose to reject the use of the "economic determinants" of Fertig (2001) in favour of demography—on the grounds of "the typical migrant being a young male worker" and that "migration activity is crucially determined by the size of young cohorts at the origin"—a conclusion reasonably held to be "unlikely to change when considering future migration potential from the EU accession countries". For each country, the paper makes clever use of German life-tables and censuses to estimate an alternative variable to be predicted—the net per capita immigration rates in the 0-39 years age band.

For their third "scenario", the authors use demography not to change the predictand, but to add to the model a

supposed linear dependence of the all-ages immigration level on the proportion of the population of the origin country in the 0-39 years band.

How well are the 1960-1997 figures (the *recorded* aggregates over all immigrant ages or the *estimated* aggregates for the 0-39 years band) fitted by the envisaged model? As was the case for Fertig (2001), the paper gives the reader no real help in answer to this question—there are no exploratory data analyses, no graphs, no correlograms. The model is fitted in two ways neither of which would appeal to statisticians: one method uses five statistics to estimate "exactly" the five parameters; the other method uses six statistics and is preferred because its inexactness allows one particular feature of the data to be used as a test of the model's fit. (The paper misleadingly describes these methods as "models": until an extra regressor is introduced, there is only one model.) For both measures of immigration, the model passes this "overidentification test", and this is taken to indicate "a satisfactory performance of the model specification".

The paper does not recognise that all the tabulated numbers used to suggest that the model fits the data could have resulted from data showing systematic trends up and down in the net immigration time-series for each of the 17 countries. In the absence of any description of the data, the reader is unable to judge whether such trends can be seen in the time-series. If the model is true, any departure from completely random series would stem from the action of the persistence parameter. With a value of this parameter of only 0.64 (as estimated) acting only on the minor part of the variation associated with the time-specific components of the model, it would be difficult to distinguish any series generated by the model from complete randomness. So any trends that *were* clearly visible would be contra-indicative to the validity of the model. In short, the evidence presented in the paper does not allow one to judge whether or not the authors' model is admissible as a basis for future prediction, even if prediction is confined to the countries that have provided the data. Nevertheless, the paper sets out to forecast up to 2017 the net immigration from the CEEC-4 East European countries (Czech Republic, Estonia, Hungary, and Poland) that make up 80% of the total population of the CEEC-10 countries. The necessary reservation about doing that, even if the model is accepted, is squarely faced by the authors:

> "Since the CEEC-4 have no previous record of migration to Germany, choosing the likely location of the country-specific intercepts [the "levels" in our visualisation of the model] in the distribution whose variance has been estimated from the data for those countries which actually had such a migration record is of crucial importance for the validity of the results."

The predictions are produced by taking the chosen "location" as a constant net per capita immigration rate for the whole population of CEEC-4 for the whole period 1998-2017 (or for the 0-39 years age band for the alternative predictand). The chosen level is then combined with life-table estimates of the size of that population (using the German life-table for the cohort born in 1936!) to give a forecast of the average annual net inflow for the period. The forecasts range from 15,000 to 63,000 per annum according to scenario. The low value is for the 0-39 years band when the chosen level is 0.04% (the average of the 17 country-specific levels). The higher value is for the whole population when the level is chosen to be about 0.1% (one standard deviation, the square root of 0.005, above the average level

0.03%). In their comments on these forecasts, the authors move confidently from treating the 0.1% figure as a purely conceptual "high immigration" figure to treating it as representing in reality what would be considered a region of high-immigration:

> "While we explicitly refrain from any more concrete speculation on the impact that the large initial differences in economic prosperity between the CEEC-4 and the rest of the EU might have on the country-specific components to be realized [e.g. the postulated 0.04% and 0.1%], the high-immigration scenarios are likely to provide an upper bound on what to expect after EU accession of the CEEC-4."

However, some may think that the science in all this comes close to begging the question or, if not that, at least to engaging in circular argument.

6). **The Home Office Report.** Chapter 6 kicks off with a helpful description of the sources of the data on net per capita migration rates from which the predictions are to be made for the AC-10 countries. For Germany, the origin countries were the 17 used in the two papers already looked at, but with the data period now extended to the 40 years 1960-1999. For the UK, immigration statistics are collected with a lighter touch: the authors explain in an interesting appendix the caveats that have to be placed on the figures they use, from the International Passenger Survey for 26 years 1975-2000. The flimsiness of the survey data necessitates the amalgamation, into only nine regional time-series, of the small sample numbers from a multitude of countries around the world (35 countries and areas are named), offering $234 = 9 \times 26$ net migration rate values in nine time-series for statistical analysis. Fig.6.1 allows us a peek at these series after their further amalgamation into two time-series—roughly, the developed origin countries versus the rest. (The authors observe that in one of these "there seems to be a slightly increasing trend": the "slightness" is a matter of judgement but it should be noted that any real trend is inconsistent with the model that is finally adopted to give the 5,000 to 13,000 estimates.)

Having made the effort to understand the mathematical modelling underlying the two papers, it is now relatively easy to get to the same level of understanding of the Home Office Report. That is because the problem is here approached using a model that is simply a hybrid cross of the very different methods used in the above two papers. The underlying model (now labelled "Specification 1") is none other than the one visualised for the first "scenario" of the second paper, without any demographic refinement. The rejection of "economic determinants" by Fertig & Schmidt is then ignored, and room is found to study the explanatory power of one such variable—GDP per capita in the destination country relative to that of the origin country—as a replacement of the demography variable used by Fertig & Schmidt in their third "scenario" (this becomes "Specification 2").

Fitting Specification 1 to the German data gives parameter estimates not far from the values found for the first "scenario" of Fertig & Schmidt, which is to be expected since the only difference is the extra three years data, 1998-2000.

Fitting Specification 1 to the nine time-series that constitute the UK data results in a "persistence parameter" (see our para.5) estimate of 0.5 which is not even significantly different from zero (the paper gives it a "t-value" of 0.58).

Even if it were truly 0.5, given that it is influential only via the "time-specific" shocks which are estimated to be a relatively minor component of the variation, the time-series should be visually almost indistinguishable from purely random series—*if the model is true*. The apparent trend already noted in Fig.5.1 suggests that there probably *are* distinguishable features above the level of random noise. Whether or not these could be convincingly modelled, they would add an extra level of uncertainty to the predictions. The authors actually invoke the apparent trend in Fig.5.1 as an explanation for the statistically significant *inverse* relationship between net immigration and the relative GDP variable of Specification 2. A relationship that goes against expectation is unacceptable, and the problem it raises is avoided by dropping the offending variable and basing the UK forecasts on Specification 1.

7). **Momentous discovery?** The method used to fit Specification 1 is documented in the technical Appendix 2, which is mainly "copy and paste" from Fertig & Schmidt (2001). The method is here described as a "powerful approach to the estimation of unknown population parameters in non-standard situations", presumably on the grounds that it is a "distribution-free" method using sample moments to bypass any dependence on distributional assumptions. Appendix 2 gives the impression that the forecasts for the UK are the product of some recently invented high-powered generalisation of the Method of Moments that Karl Pearson first exploited in 1894 in the Philosophical Transactions of the Royal Society of London A. With the aid of a few lacunae, Appendix 2 rather obscures the fact that the estimates used for the forecasts simply come from equating five statistics to their expectations determined by the model—which is the essence of Pearson's Method of Moments. In his first statistical paper of 1912, R.A.Fisher proposed the method of maximum likelihood, postulating a distributional model for the data in order to remove the arbitrariness in the choice of the particular statistics involved in Pearson's method. If Fisher could now be presented with the UK data, he would probably use a 9×26 Analysis of Variance with Series and Year as the two factors, to get a Residual Mean Square of 0.00015 (the "unsystematic component of variance " in Table 6.2), the Series Means, and the Year Effects. If the underlying additive model were acceptable (i.e. if the residuals showed no further systematic pattern in their two-way table) speculation about the "location" of the EU countries with respect to the nine regions of the world providing the time-series would be based on rational considerations about the sample of nine Series Means (if any such considerations could be found)—rather than on a somewhat arbitrary use of the Overall Mean and the Overall Mean Plus One Standard Deviation to represent "typical" and "high" migration potential. Speculation about evidence in the UK data of autoregressive behaviour in any of the time-series (in accordance with the action of the "persistence parameter" in the model proposed) would be initiated by detailed inspection and analysis of the 26 Year Effects themselves.

8). **Getting the numbers.** With the modelling cut and dried and, in the end, rendered almost irrelevant, the prediction of 5000 per annum is simply obtained by multiplying two numbers—the average 0.0000641 (the Overall Mean) of the 234 net per capita migration rates in the UK data-base (as proportions not percentages of the respective populations) and the estimate of the average of the total AC-10 population for the years 2000-2010. The latter increases slightly from 75.1 million in 2000 to 76.8 million in 2010, so we may take the average as 76 million. The product is 4870 or 5000 to the nearest thousand.

For the "high immigration" prediction of 13,000 per annum, the figure 0.0000641 is increased by the estimate of one standard deviation of the population of "country specific" immigration levels (the Series Means). From Table 6.2, the latter is given by the square root 0.00010 of the estimated variance 0.0000010 (proportions not percentages). The prediction is therefore $0.0001641 \times 76 = 12,500$ which is consistent, allowing for rounding error, with the 12,568 in Table 6.4—13,000 when rounded.
Note that the critical comments on the German forecasts at the end of our para.5 apply with equal force to these forecasts for the UK.

9). **A neglected expression of unease.** The authors seem unable to make up their mind whether they should accept these small numbers as reasonable predictions. Even before modelling the historical data in order to get a predicting formula (which in the end turned out to be no more than a simple average of all the 234 net per capita immigration values), the authors raised an interesting question about the smallness of those values compared with those for Germany:

> "The reason is that the origin countries for immigration to the UK (like India, Pakistan, and the US) have very large populations, and migrants comprise only a small fraction of those populations. This results in small net migration rates."

Clearly an unease is manifested in this quotation but, if there is any logic in the use of the word "reason" or the phrase "results in", it must be a logic that undermines the whole prediction exercise. What may be needed to analyse the unease is a return to a demographic breakdown of the populations, not just by age but also by wealth. Broadly speaking, in any particular country there is not just an age band favouring migration but also a wealth band—the very poor will be unable to gather even the minimal resources (money and motivation) needed to emigrate while those above a certain standard of living will not have any motivation to emigrate. In India and Pakistan the first category may have been in the majority for most of the historical data period, whereas in the US it is the second category. Whatever the reason, we need to have identified the strata in the origin countries that might match the corresponding proportionally larger strata in the AC-10, before even thinking of invoking the strong assumption that "things do not change in space" across countries as well as across time. There is no word of this in very worthy list of caveats with which the Chapter concludes.

10). **Conclusion.** Which is it—technical exercise, honest study, or convenient obfuscation? Paradoxically Ch.6 has the elements of all three. The somewhat arbitrary choice of model and the lack of any serious tests of the model are the hallmarks of an exercise in technique, while the explicit caveats are what we expect in an honest study. The grounds for thinking it might indeed be a "convenient obfuscation" for some political objectives, however, lie outside Ch.6: nothing in that chapter would justify such a pejorative description. But readers who for one reason or another stay with the Executive Summary may find it difficult to get a good feel for the deficiencies of the whole exercise that are so openly conceded in Ch.6. The summary conclusions of Ch.6 are themselves summarised (without explicit mention of the uneasy question about large populations), with the Summary advising impeccably that "the

predictions need to be evaluated with some caution" and offering as a caution the tautology that "if migration rates [to the UK] from [the AC-10 countries] differ substantially from historical migration rates, prediction based on these estimates may be misleading". Readers of the Executive Summary alone may be impressed rather by its blandly assertive final paragraph quoted in our para.2—with its unqualified use of the terms "high immigration", "worst case scenario" diverting attention from the legal loop-hole of the phrase "within the model structure used". There is evidence that this may already have happened in the reference to the Report in a "Daily Information Bulletin" circulated by a London borough:

> "University College London researchers estimate that 5,000-13,000 people annually are likely to come from the 10 new members over the next seven years, and conclude that the evidence suggests that net migration to the UK will be essentially comparable to current migration trends".

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