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Conceptualisation and Analysis of Migration Uncertainty: Insights from Macroeconomics

Deliverable 9.1

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Background Paper:
Conceptualisation and Analysis of Migration Uncertainty: Insights from Macroeconomics*

QuantMig Deliverable 9.1

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Abstract

In this paper, we provide a background discussion and a proposal of methods for quantifying migration-associated uncertainty across a range of time horizons, which cover both prediction and scenarios of migration in the mid- to long-term, as well as early warning systems in the short term. Following a brief review of the state of the art in forward-looking migration studies, we explore the analytical possibilities offered here by macroeconomic approaches, such as the Dynamic Stochastic General Equilibrium (DSGE) models. While such models have been used to model the impacts of migration on the wider economy, we propose to look at their potential in addressing the influence of drivers on migration flows, with particular focus on the reactions of migration to economic and political shocks. Even though both the methods and presented examples are mainly macroeconomic, given their origins and most of the literature base, the usefulness of the approach for setting migration scenarios under uncertainty and for constructing early warning systems goes beyond economic applications. We argue that such models can serve as a blueprint for modelling complex macro-level migration processes, with explicitly acknowledged micro-foundations and uncertainty.

Keywords: International migration, Forecasting Migration, Open Economies
JEL Classification: C52, C53, E32, F22, F42, J11

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1 Introduction

Migration is increasing in prominence, both economically and politically, with migration volumes steadily increasing since at least the 1990s (United Nations, 2017). Knowing the exact size and type of these flows is important for understanding the societal, labour market changes and wider effects of migration flows. Still, the existing data on international migration has many gaps and inaccuracies due to different definitions and collection methods which introduces uncertainty into analysis. In the context of prediction, the uncertainty is amplified by the many unknowns surrounding the future developments of migration and its drivers, many aspects of which are *aleatory* – unknowable and irreducible (Bijak and Czaika, 2020). Inaccurate estimates and predictions of migratory flows, particularly to countries for which migration is a sizeable political issue, can result in the implementation of policies with unintended consequences. A number of attempts have been made to improve forecasting methods of migration, however, there are events or shocks which could not be foreseen such as the so-called European migration crisis of 2015 (Bijak, 2016).

At the same time, the studies of possible migration futures and their potential policy and planning uses span a range of time horizons: from very short-term, operational responses, through mid-term forecast horizon of a few years, to long-term migration scenarios up to several decades ahead. For the very short-term horizons, where rapid reaction may be needed – such as in the case of asylum-related migration – there is a need for appropriate early warning models based on the previous experience with the trends and possible 'leading' indicators. For short- to mid-term horizons, some migration forecasts still seem plausible, as long as their uncertainty is acknowledged and properly calibrated. For long-term horizons, there is a need for probabilistic and other comprehensive scenarios, tailored for strategic analysis of underlying migration trends. The methodological state of the art involves statistical change-point detection approaches, econometric and statistical (e.g. time series) modelling and formalised elicitation of expert judgement, including for scenario-setting. Still, the regularities and the relationships between migration and its drivers – macroeconomic and other – are not sufficiently explored in the context of prediction, leading to the conclusions on low migration predictability, especially in the

short- and mid-range horizons (van Wissen, 2012).

Important gaps remain in the current literature and methodological approaches. Existing early warning and predictions are mostly based on statistical properties of time series of data. The known relationships – even in qualitative sense – between migration and other variables are not fully explored. Likewise, the long-term regularities, such as the inertia of migrant stock variables, which are less volatile than flows, are not fully used either as a check, and neither are other, more stable features of the migration realm, such as spatial patterns, life course-based links with age schedules, or remittance flows.

The aim of this paper, building on a conceptual typology of migration uncertainty in Bijak and Czaika (2020), is therefore to provide a deeper understanding of the uncertainty in the context of the tools used for forward-looking studies of migration, and to propose methods for analysing the uncertainty of complex migration processes across the different time horizons, with an explicit acknowledgement of their micro-foundations. As the types of migration uncertainty are discussed elsewhere (*idem*), the focus of this report is on the analytical possibilities offered by approaches stemming from contemporary macroeconomics. Unsurprisingly, given their origins and the focus of most of the relevant literature, most of the discussion in this report also takes a macroeconomic slant, and focuses on immigration (or net migration) rather than emigration. Still, as we argue throughout this report, the proposed approach for setting migration scenarios under uncertainty and for constructing early warning systems goes beyond economic applications. In this way, the methods and models we discuss could go some way to addressing the suggestions of van Wissen (2012) to include explanatory factors and more complex models to deal with the apparent low predictability of migration flows. The outputs of the approach proposed in this paper can then be either standalone, providing insights into migration responses to shocks or policy changes across a range of time horizon, or serve as input for setting migration scenario assumptions that would include such shocks or changes as a part of their underlying narrative.

In subsequent sections of this report, we look at again at the limits of predictability of different types of migration flows (Section 2), the development of methods to improve the forecasting of migration (Section 3), and on studying the effects of migration and its place in the wider economy by using empirical and Dynamic Stochastic General

Equilibrium (DSGE) models (Section 4). We then offer suggestions for translating the conceptualisation of migration uncertainty into analytical approaches (Section 5), with a classification of countries by their migration and macroeconomic profile as a basis to examine the feasibility of the proposed methods (section 6). Finally, in Section 7, we conclude by reflecting on the applicability of presented methods, with special focus on DSGE models, for dealing with uncertainty across a range of time horizons, depending on the ways of engaging conceptually with uncertain migration futures.

2 Predictability of Migration and its Drivers

Migration to and within EU+ countries (32 countries of the European Union and EFTA, plus the United Kingdom) a is largely economic, with family or social migration closely associated. Economic migration depends on the health of the macroeconomy so a short-run predictability is possible with long-term forecasts dependent upon macroeconomic forecasts. Forced migration - political and environmental - is less predictable and on average makes up for a much smaller proportion of migration flows. In this section we discuss the predictability of migration drives and challenges with predicting migration.

2.1 Migration Drivers and their Predictability

Migration is known to be complex and driven by a wide range of interacting drivers, which differ with respect to their levels of predictability. The drivers can be broadly classified into demographic, economic, political, social, environmental, and other groups, which do not operate in isolation, but rather jointly influence migration processes as components of broader and multi-dimensional *driver complexes* or *driver environments* (Czaika and Reinprecht, 2020). A number of attempts have been proposed to put together comprehensive theories of migration (Arango, 2000), but as acknowledged for example by Bijak (2010) and Disney et al. (2015), forecasting migration on that basis is difficult as there are a number of social, economic, and political factors underpinning migration decisions that are difficult to operationalise and predict (see also e.g. Willekens, 2018). This is also one reason why it is not feasible to disentangle ideal migration 'types', especially as the conventional dichotomies of migration (such as voluntary-forced, or internal-international) no longer hold in simplistic forms, each becoming more akin to a spectrum of options

between two polar extremes (King, 2002).

Still, such idealised 'types' often exist in statistical reporting of migration flows, as they are associated with the declared and available routes of entry which become convenient – if imperfect – proxies for different migrant categories, for example, with work visas and permits standing in for labour migration, university enrolments for study migration, asylum applications for political migration, and so on. Despite obscuring somewhat the true conceptual picture of migration complexity, such simplifications offer an important pragmatic advantage: different 'types' of migration processes defined in this way have different statistical features, and vary according to their levels of predictability (Bijak et al., 2019). This means that forecasting them separately can improve their predictability, to the extent this is possible given the nature of individual series (de Beer, 2008; Wilson, 2017). This idea goes back at least to Keyfitz (1985), who argued for identifying stable demographic processes by disaggregating more complex ones into sub-components, with shared characteristics.

The migration drivers operate on different time scales, which translates into the behaviour of the corresponding migration 'types'. Demographic drivers have large inertia, and are unlikely to change rapidly in the short term, except by migration itself. On the other hand, political drivers can change abruptly, generating large waves of migration and mobility in very short time, as often witnessed during armed conflicts or just after natural disasters. Part of the challenge then becomes to assign the assessments of uncertainty (or its flip-side, predictability) to drivers and, by extension, to migration 'types' (Bijak et al., 2019). In this section, we first offer a brief categorisation of countries in the European migration system, before looking at the some of the drivers corresponding to different migration 'types', in order to assess their effects in short and longer term horizons.

2.1.1 Categorising European Countries

European countries are highly economically integrated. Economic classifications of European countries are relatively simple to obtain based predominantly on macroeconomic factors such as GDP, GDP per capita, and labour force statistics. The macroeconomic integration of countries can be examined through spillovers. For instance, Ilori (2019) examines fiscal spillover effects on euro area countries prior to the expansion of the euro

area in 2007. These countries have been classified into two groups, with the first group including those with significantly higher sovereign risk than Germany: Greece, Ireland, Italy, Portugal and Spain, and the second one including the remaining countries (less Luxembourg) - Austria, Belgium, Finland, France, and the Netherlands. This is one type of classification for the higher macro-economically developed countries. Following a 1% increase in German government spending results, GDP was found to increase for the second group and Italy, while having a negative effect for the higher-risk countries. This is potentially due to the limited fiscal expansions that can occur in the already highly indebted countries. The spillover effects can support or stimulate the economies, alternatively make them more attractive destinations if the countries are less economically co-dependent. Expanding these classifications beyond the economics to include migration is a foundation of our research as we can find patterns, commonalities and differences that allow us to model migration efficiently. Interdependence typically occurs when a shock affects the members to a similar measure, such as members of a common currency (Belke and Osowski, 2019).[1] Whereas co-dependence is more of an isolated or country specific factors.

If there is a high degree of economic spillover then the state of the business cycle will be closely linked as and the gain from moving to another country due to the state of the business cycle offers less of a gain.

To what degree there are spillover effects or interdependence from the larger economies to smaller ones will have an effect on migratory flows.

To simplify the analysis, we group the EU+ countries by taking into account their economy size, currency, and migratory characteristics. One economic classification system as show in Table 1 uses the classification of countries within Europe as different degrees of 'core' and 'periphery' using a model put forth by Bartlett and Prica (2016). We have reclassified the 'outer core' for those pre-2004 members the European Union with higher GDP per capita. The spillover effects and economic co-dependence of European countries can be seen in the financial contagion evidenced by the global financial crisis of 2007–09. Some countries managed to escape recessions or significant negative economic effects, such

[1] Belke and Osowski (2019) find that spillover effects of fiscal policy from France and Germany affect euro area members more than non-euro area members.

as Poland (see Section C.2 for discussion), while Austria and Germany have remained an important destination for Central and Eastern European (CEE) migrants, and Finland for the flows from the Baltic nations (d'Artis Kancs, 2005). The direction of migration flows is predominantly from outer core 2, outer periphery and super periphery to inner core, outer core 1, and inner periphery. Skilled migrants are predominantly attracted to inner core and outer core 1.

Table 1: Categories of European Countries

Category	**Countries**
Inner core - EA & EU	Austria, Belgium, Finland, France, Germany, Luxembourg Netherlands
Outer core 1 - EU & Non-EA	Denmark, Sweden, UK
Outer core 2 - EU & EA or Non-EA	Czechia, Estonia, Latvia, Lithuania, Poland, Slovakia
Inner periphery - EA & EU	Cyprus, Greece, Ireland, Italy, Portugal, Spain
Outer periphery - EU & Non-EA	Bulgaria, Hungary, Romania
Super periphery - Non-EU, Non-EA & pegged currency	Albania, Croatia, North Macedonia*, Serbia

EA = euro area. Correct as of November 2020.
*Previously FYR Macedonia. Country name updated from original publication.
Source: Bartlett and Prica (2016). Adapted to have two classifications of outer core for purposes of GDP per capita.

An alternative classification, shown in Table 2, is based on an updated version of the previous one, with added focus on migration. Countries described as a net receiver of migrants are ones that consistently experience positive net migration flows whereas net senders of migrants observe consistently negative net migration flows. The original model by Bartlett and Prica (2016) only included the EU and candidate countries with currency pegs. Here, the 'inner core' consists of countries which have higher GDP per capita figures and are large destinations for migrants. The 'outer core' includes countries of higher GDP per capita, with the UK also reclassified due to no longer being a member of the EU from 31st January 2020. The countries that were previously in 'outer core 2' have been reclassified as 'outer periphery' for our purposes, as they have lower GDP per capita than the core countries and are net senders of migrants within the EU+. The 'inner periphery' includes countries which are highly indebted, tend to be net senders of EU+ migrants but a net receiver of all migrants, with slightly lower GDP per capita than

the core countries, but higher than outer periphery. Furthermore, as Croatia has joined the EU in 2013, it has now been added as a part of the outer periphery. Finally, we introduce the other candidate countries to the 'super periphery' classification, excluding Turkey as the United Nations does not classify Turkey as a European country even though part of the land mass is in Europe. Notably, none of the super periphery countries report migration figures to Eurostat, and the migration flow data for these countries are generally sparse.

Table 2: Categories of European countries using GDP per capita and migration flows

Category	**Countries**
Inner core - EA & EU	Austria, Belgium, Finland, France, Germany, Netherlands
Inner core - Non-EA & Non-EU	Norway, Switzerland, UK
Inner core - EU & Non-EA	Denmark, Sweden
Inner periphery - EA & EU	Cyprus, Greece, Ireland, Italy, Portugal, Spain
Outer periphery - EU, EA or Non-EA	Bulgaria, Croatia, Hungary, Romania Czechia, Estonia, Latvia, Lithuania, Poland, Slovakia
Super periphery - Non-EU & Non-EA	Albania, Bosnia and Herzegovina, Kosovo Montenegro, North Macedonia, Serbia

Euro area countries are correct as of November 2020

2.1.2 Economic Drivers of Migration

Economic drivers of migration – chiefly differences in relative or absolute income (wages) or employment prospects – influence many migration flows to a greater or lesser extent[2].

In considering the reasons behind economic migration choices, it is important to consider the macroeconomic or large scale decisions and the microeconomic or individual-level decisions. The scale or level (loosely) conceptualises the number of people affected or involved in the decision-making process. Beyond wages, the neoclassical macroeconomic theory identifies wage differentials, human capital return, and the labour market as being the main driver of international economic migratory flows. As for the government,

[2]One notable exception is forced migration. Examples include the so-called European migration crisis of 2015-2016, where in some countries political migration exceeded economic flows, or previous instances of mass-conflict related displacements, such as after World War II, the break-up of Yugoslavia, or genocide in Rwanda, to name but a few.

they can control migration through their influence on the labour market. Where a free movement labour market is present, as in EU+, this is somewhat more challenging than the use of typical controls, such as visas. Here, the EU and domestic laws prohibit discrimination between natives and EU migrants, however, this is not to say it does not occur.[3]

Our research scope has a primary focus on the macroeconomics, however, theoretical macroeconomic models have important microeconomic foundations. The microeconomic foundations are primarily the optimal decisions made by agents; for example, individual people want to maximise their utility or lifetime satisfaction and firms want to maximise their profits. Decisions by individuals are focuses on consumption patterns and labour market decisions (being in the labour force or out of the labour force). Firms make choices such as whether to increase investment and output, or hire a new worker. In particular, neoclassical microeconomics considers earning differentials, participation rates, unemployment rates and human capital characteristics.[4] They also study social conditions, expected net returns, and psychological considerations (Massey et al., 1993). Some of the other theories summarised by Massey et al. (1993) include economic dualism and world systems. Economic dualism results from the imperfect substitutability of workers. In early macroeconomic models, migrants and natives were treated as perfect substitutes of labour, in contrast to microeconomic research.[5] The primary reason for that was the interaction of labour and capital, where the jobs that are complements of capital are relatively stable, whereas labour intensive jobs are less so. Given that the average migrant profile relative to natives across EU+ countries differs, it is not possible to make a simplifying assumption here. However, characteristics of low-skill work is less attractive to natives so immigrants often fill these gaps in the labour market as some immigrants are more reliant on labour income meaning that they are willing to skill-downgrade.[6]

[3]Labour market differences between natives and immigrants in Germany and the UK is studied in Dustmann et al. (2010).

[4]See Barker (2020*d*) for the macroeconomic use of the differences in participation rates, unemployment rates, and wages in the context of migration.

[5]Perfect substitutes would indicate that natives and immigrants compete for the same job. Microeconomic research finds natives and immigrants to be *im*perfect substitutes for example, Chiswick et al. (1985); Docquier et al. (2010); Ottaviano and Peri (2012)

[6]Skill-downgrading is the process of a high-skill migrant taking up employment in a low(er)-skilled occupation.

The theory of world systems, in turn, is driven by the location of physical capital which migrants are attracted to – this is often a driver of internal migration. Macroeconomic theories can help partially explain migration, though full reviews of existing studies are lacking, especially with regard to the contemporary tools for modelling whole economic systems, equipped with micro-level foundations. At the same time, the models that are likely to perform well in explaining migration patterns often include aspects from the microeconomics, as opposed to purely neoclassical macroeconomics.

There are many examples of macroeconomic and macroeconometric studies looking at the impacts of economic variables on migration flows and migrant stocks (Gorbey et al., 1999; Fertig and Schmidt, 2000; Alecke et al., 2001; Brücker and Siliverstovs, 2006; Cappelen et al., 2015; Docquier, 2018). Another strand of applied macroeconomic work has concentrated on the impact of migration on the economy, although the existing studies are largely restricted to a small number of countries that publish migration data with a long enough time ranges. Examples include Canada (Barker, 2020*d*), France (d'Albis et al., 2016), Germany (Barker, 2020*a*), New Zealand (Smith and Thoenissen, 2019), Norway (Furlanetto and Robstad, 2019), and the United States (Kiguchi and Mountford, 2019). d'Albis et al. (2016) data does not account for intra-EU+ migration, using only immigration visas.[7] There are limitations on the macroeconomic effects of migration due to the data constraints. Even for these countries, limits on the analysis result from inaccuracies of migration flows and length of time series. A time series of 40 periods is considered to be the minimum number to cover business cycles and account for degrees of freedom. For annual data, that requires 40 years which limits a number of countries for migration time length.[8]

As for the definition of migration recorded by national statistics offices, there are significant differences as to the exact definition of a migrant which is highlighted by the differences in data reported by national statistics agencies to Eurostat (as one example). From a macroeconomic analysis perspective the data would be available for working-age

[7]The sample is monthly 1994–2008 and uses industrial production index as a proxy for GDP.

[8]Even though 40 annual data points is four times the length as 40 quarters, a lot of information is lost by using annual rather than quarterly data. For instance, a recession is defined as two consecutive quarters of negative growth which might be not be captured in annual data (theoretically). The degrees of freedom is an important factor within this consideration.At a quarterly frequency, the length would ideally be longer to cover more business cycles.

as well as total which is rarely available. Both of these matters make cross country comparisons challenging.

One of the aims of this paper is to provide foundations for developing a way of forecasting European migration, acknowledging its uncertainty in a realistic way. Within Europe, the migration profile of each country differs. Some are net receivers, while some are net senders plus the source and skill level of migrants differ. There are a number of factors that need to be considered when evaluating the role of migration on a particular country, or region. Within the EU itself, there are a countries that are net migrant hosts and ones that are senders. Some of the net migrant hosts are net migrant senders when only intra-EU migration is considered (Spain/Italy). Similarly, there are countries which are net migrant senders but exclusion of intra-EU migration would be hosts (Poland). We discuss case studies of countries in Section 6.

In terms of the spatial and temporal dimensions of the predictability of migration, one key factor to consider is business cycles, which can last anywhere between 4-12 years. Some changes can be localised (on a country level) or more widespread. For example, the Great Financial Crisis (GFC) 2007-09 had a dramatic effect globally but there were countries that were more affected than others. Migratory flows from Poland to Germany was large before the crisis but return migration was so large that it turned Germany's total net migration figures negative. The return migration was due to the positive economic conditions in Poland and fewer opportunities in Germany (see case study in Section C.2). As identified by Dustmann et al. (2010), migrants experience larger unemployment responses in response to shocks where low-skilled migrant workers experience a higher volatility. Uebelmesser (2005) examined emigration from Germany from economic and non-economic perspectives by using data from the German Socio-Economic Panel Survey (GSOEP) based on gender, individual, household and regional characteristics.[9]

Additionally, the language barrier can become an issue. Higher-skilled workers are more likely to have a greater command of English and perhaps other languages. Notably, German is an official language in Germany, Austria, Belgium, Liechtenstein and Lux-

[9]There are long lasting effects from the split of Germany, with the East having generally worse social and economic conditions. As noted by Smolny and Kirbach (2011) the wage differences are not strongly related to people, but rather to the locations. Inna and Christian (2016) show that life satisfaction is lower in the East Germany than West which is largely down to household income and unemployment status.

embourg and parts of Switzerland.[10] Already being a migrant in Germany increases the openness for further international migration.Another example of language links is Estonia to Finland as their languages are similar, and a number of Estonian migrants are able to grasp the Finnish language following migration (Anniste et al., 2017).[11]

Having considered the drivers, we need to consider what can help forecast economic migration. As a primary basis, business cycles and their drivers, which are not perfectly predictable, can form early warning systems to alert policy makers. One of the key indicators of a business cycle change is any deviation in the nominal interest rate set by the central bank. Interest rates rise during expansionary years and fall during contractionary years. Some shocks are not predictable, such as the COVID-19 pandemic, during which monetary policy makers were quick to act with interest rates being cut early on.[12] Monetary policy is usually set by central banks that are independent from the government – in the case of the euro area countries monetary policy is directed by the European Central Bank rather than national central banks.[13] The idea of central bank independence is to free monetary policy from controls of government.

Migration research is also considered by central banks, as it has been looked at by the Bank of England and one of its key research areas in recent years. Professor Blanchflower made a notable speech, mentioning research on the impact of EU enlargement on the UK, in Blanchflower et al. (2007).[14] Their research included the analysis of the output gap (actual output as measured by the GDP, minus expected output) created by immigrants; the additional demand (private consumption, investment, and use of services), they create versus the additional supply they offer (labour supply). Their research showed that immigration from the accession 8 countries (A8) countries increased supply more so than demand in the UK. These migratory flows also reduced inflation and the natural rate of

[10]There are a number of regions in Eastern European countries which use German as their first language but not on a national basis.

[11]Both languages belong to the Finno-Ugric language group with Hungarian being the most widely spoken.

[12]Interest rates fall during economic slow downs and contractions to help stimulate the economy (for instance through cheaper borrowing), but increase during expansionary years as a way to prevent the economy expanding too quickly. It is generally assumed that in the long run there should be a return to trend so that a bigger boom would lead to a bigger crash or bust.

[13]The ECB decides the interest rate for Germany rather than the Bundesbank, for instance.

[14]A transcript of his speech "Fear, Unemployment and Migration " from 30th October 2007 is available at Bank of England Speech

unemployment. However, this research covered May 2004 to the end of 2006 i.e. before the global financial crisis.

The field of macroeconomics and finance received negative attention due to their failure to predict the GDP. However, the GFC was predicted by a number economists including Dr Nouriel Roubini (Roubini, 2007) and Baker (2006), though their predictions were evidently ignored. In reality, this research was published too late to make much of a difference. The housing bubble had started and investors believed it would never burst. In more recent forecasts, Roubini predicted a US recession in 2020 as far back as 2018 (purely based on the business cycle considerations that had nothing to do with the coronavirus, which had not been foreseen). The UK economy had been slowing down since the Brexit referendum in 2016, until at least the double disruption of exiting the EU in January 2020 and the coronavirus pandemic. Economic data in the run up to the pandemic indicated a slowing economy and the UK would probably have experienced a negative first quarter growth and recession by the summer anyway, even in the absence of the pandemic.

The global financial crisis is an example of a negative shock to the economy, which can be modelled as operating initially via financial shocks to private investment then on to private consumption as incomes are lowered, and people lose their jobs, rather than purely a GDP shock. The coronavirus pandemic has been argued to be a negative labour supply shock, as many people were unable to do their jobs due to stay at home or closure orders. The use of fiscal policy, which is arguably at its most important since WWII, provided financial means for firms to retain staff and the employees to maintain their standard of living. During economic downturns, it is likely to be lower-skilled workers who are the most vulnerable and with respect to natives and immigrants, Dustmann et al. (2010) show that it is immigrants who are more likely to be made unemployed.[15] One important consideration is the expected length of the economic downturn: a short-lasting economic change will change little in terms of effects to trend, but a long lasting one such as the GDC and likely coronavirus.[16]

The volatility of macroeconomic drivers is hard to quantify but some are greater than

[15] Dustmann et al. (2010) study Germany and the UK.

[16] See Figure C.6 where there are permanent shocks to trend, most notably Greece and Italy which no longer see upward trends, or growth in real GDP.

others. Fiscal and monetary policy changes tend to occur in response to changes in the macroeconomy - GDP, private consumption, private investment, labour market, debt-to-GDP ratios, and the exchange rate. The largest changes in the labour market tend to lag behind GDP so these cannot necessarily be singular indicators, however the growth rates can be. If the growth of jobs is slowing along with other macroeconomic indicators it can provide an indicator of emigration as migrants who lose their jobs may return to their home country, particularly if their immediate re-employment prospects are low. As for immigration, the growth rates and number of vacancy postings can be a leading indicator of immigration increasing. Matches between would be employee and employer may take a number of months to form, however, a growth in employment opportunities will precede immigration in net migrant host countries. The time lag will be extended, as natives tend to be the first ones to find employment. This can form the foundations for early warnings in the economic form.

Research by Ahearne et al. (2009) examine the role of migration around the crisis with special focus on the new member states and Ireland. The result presented suggest that the crisis reduced migration in the short-term but migration would increase in the long-run due to the longer lasting effects on slowing economic growth or recovery in the sending country so in the long-run migration would increase further than expectations without the crisis. If this research using econometric methodology was is reflected in the actual data, then a firm link between business cycles in the A8 and EU15 is formed.

2.1.3 Social Drivers of Migration

The second type of migration typically covers family reunion and other similar social processes. Such flows are especially important for countries with former colonies, such as France, Spain, and the United Kingdom, which historically had and continue to have links with many potential countries of origin of migrants. Modern social migration is frequently about partners with children joining the economic migrant, but could also be linked to other, not purely economic and political pursuits, such as education. These types of migration drivers are somewhat better predictable than political or economic ones – family reunion is closely linked with the presence of migrants who are already settled in the destination country, while study migration is limited by the places available in the

educational institutions, although the latter can expand at relatively short notice, leading to higher volatility of the associated flows[17].

For each migrant within a social network (family or friend) to the host country, the migration process becomes financially less expensive and the associated psychological costs. For instance, housing is available on arrival (even if only temporary). The original migrant(s) is (are) knowledgeable of the local area. This form of migration can be associated with colonial links, notably African and South Asian in the case of France and the UK, or based on proximity and wealth or wage gap of the neighbours, Mexico and the US as an example (or a mix of economic disparities, policies and past migration, as in the flows from Turkey to Germany). The wage gap is a notable cause of migration, as shown in the range of theories reviewes by Massey et al. (1993). In addition, Massey and España (1987) explain that there is a level at which the cost of migration falls such that the probability of international migration increases and where illegal migration exists, as blending into the host community reduces the fear of deportation. When an existing migrant is knowledgable of the area and the systems, it gives the new migrant a sense of security thanks to the presence of existing networks of earlier migrants.

Setting migration as family joining (or migrating with) an existing migrant as the standard definition we can use in the macroeconomic analysis as a method of forecasting. Friends or family of an existing migrant joining them in the host country contribute to the economy in that they increase the demand side of the economy. On the other hand, the situation of friends or family members who join the labour market soon after arrival is more akin to economic migration. At the same time, family-related migration flows belong to some of the better predictable ones, given that they are closely associated with the presence of migrants and migrant communities in the destination countries.

2.1.4 Political Drivers of Migration

Political drivers are typically linked – in the extreme form – with forced migration and displacement, typically caused by armed conflict or political persecution (either of individuals or group level). Other forms can be linked to changes in the political climate or

[17]See, for example, Bijak et al. (2019), where the uncertainty of study migration was classified as 'high', while of the family-reunion migration, falling under channels linked to entry visas and permits, as 'medium'.

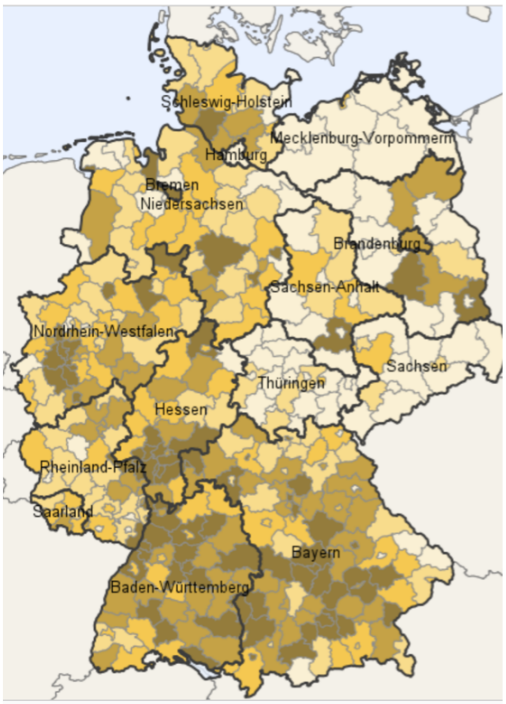
circumstances – relatively recent examples, unlikely to be replicated on such a scale, is the collapse of the Soviet Union and to a lesser extent the reunification of Germany (although in the latter case, mainly resulting in internal migration). Still, the magnitudes of such migration flows differ depending on the nature of the drivers: following the collapse of the Soviet Union, an estimated 1.2 million citizens of the former USSR emigrated, 59% of whom ended up in Germany, 25% in Israel, and 11% in the United States (Heleniak, 2004). On the other hand, the so-called European migration crisis of 2015–16, chiefly linked to the civil war in Syria, was one of the largest single shocks to hit the continent in the past 30 years, with 6.6 million Syrian living outside their home country at the end of 2019, of whom 3.6 million in Turkey, 910,000 in Lebanon, and over 600,000 each in Jordan and Germany, according to the UNHCR Statistics[18]. In the last 75 years, there have been more conflicts where people have migrated to claim asylum or refugee status, some have greater effect on Europe than others – for example Latin American conflicts tend to affect other Latin American countries, the US, Canada and to Spain and Portugal through colonial links. Relatively smaller conflicts by number of citizens can be predominantly localised to neighbouring countries. The separation (partition) of India and Pakistan forced over 14 million people to relocate (DePillis et al., 2015; Perkins, 2017). Generally, political and policy-related drivers can be very uncertain, which then translates into high volatility and hence low predictability of migration flows associated with such drivers.

In terms of shock events, other recent example influencing European migration include German reunification and the collapse of the Soviet Union. The economic effects of a reunified Germany are modelled and discussed in Canova and Ravn (2000), which shows that it will be be more than 30-40 years following reunification that the economy is below steady state levels as East Germans tend to be a lower skill level and financially poorer. In 2017, there are still distinct levels of inequalities between West and East Germany as shown by the GDP per employee data which is graphically displayed in Figure 1. The darker colour indicates a higher GDP per employee in that region.

Additionally, the location of headquarters of various companies, predominantly in the former West Germany, indicates that capital is less mobile and labour is more mobile.

[18]Data from https://www.unhcr.org/refugee-statistics, accessed on 25 October 2020.

The signs are positive as the gap is closing, GDP per capita of East Germany to West Germany was 42% in 1991 which is now 82%.[19] Besides, Stähler (2017) highlighted the issues of incorporating the refugees into the Germany society and labour market. The refugees in Germany are primarily located in the three most populous regions, all of which were in the former West Germany: North Rhine-Westphalia, Baden-Württemberg, and Bavaria. However, the rise of support for the anti-immigrant Alternative für Deutschalnd (AfD) party has occurred a lot in East Germany where the part experiences twice the level of support as in the West at 21.9% and 10.7% respectively (Weisskircher, 2020). The failure to integrate the regions and slowness at which the East Germany has been able to economically progress into a reunified state offers can raise some concerns to the ability for refugees to fully integrate into the local economies.



Colour	Value	Number
	0<€<61,297	80
	61297≤€<65,004	80
	65,004≤€<68,463	81
	68,463≤€<74,751	80
	74,751≤€<163,592	80
	No data	0

Figure 1: GDP per employee by region for 2017
Map generated at Regional Atlas
Source: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany.

Despite the generally weak predictability of political drivers of migration, indicators of conflicts that might be potentially forthcoming such as escalations in violence or po-

[19]Source https://www.ft.com/content/e9fde68c-c8cd-11e9-a1f4-3669401ba76f - accessed on 3 November 2020

litical problems could help create an early warning systems for asylum migration. For example, the Syrian conflict and Arab Spring began in 2010 but the European refugee crisis occurred in 2015–2016 whilst a number of refugee or asylum seekers arrived before, a trend of increasing asylum or refugee applications could be used as an indicator for such an early warning systems (Bijak et al., 2017).

2.1.5 Environmental Drivers of Migration

Environmental migration is understood here as the internal or international migration of people who for progressive or sudden damaging changes in the local environment are required to move temporarily or permanently, although permanent environment-related migration is more likely to be international than temporary. The exact definition of environmental migration has been debated (Black et al., 2011), while first perceptions focus on environmental disasters: hurricanes, tornadoes, and earthquakes, indeed more developed definitions extend to deforestations, desertification, declining quality of land, loss of livelihood due to climate change, and other environmental problems.

Myers (2002) highlights the importance of environmental migration other than environmental disasters and considers the future role of environmental migration. He cites the example of Haiti where environmental emigration occurs because of the exhausted agricultural land that is no longer able to support the heavily agricultural dependent economy - it is noted that at the time, there were political migrants too. There were 25 million environmental refugees in 1995 (compared to 27 million political refugees), which he noted the expectation for this to double by 2010 and reach 200 million by 2050.[20]

The scale of environmental migration is something that is less quantifiable at the present time, not only because it is difficult to delineate environmental drivers from economic and other ones, but also because it is largely internal (Warner, 2020). However, as climate change becomes more extreme, it is an important consideration for the longer term horizons (Black et al., 2011). The levels of predictability will vary depending on the exact type of the drivers: on the one hand, extreme climatic and weather events, as well as environmental catastrophes, are often unpredictable, and can generate high volumes of migration flows, on par with political events. On the other hand, long-term climate

[20]Though the figure of 200 million is disputed in the literature (Black et al., 2011).

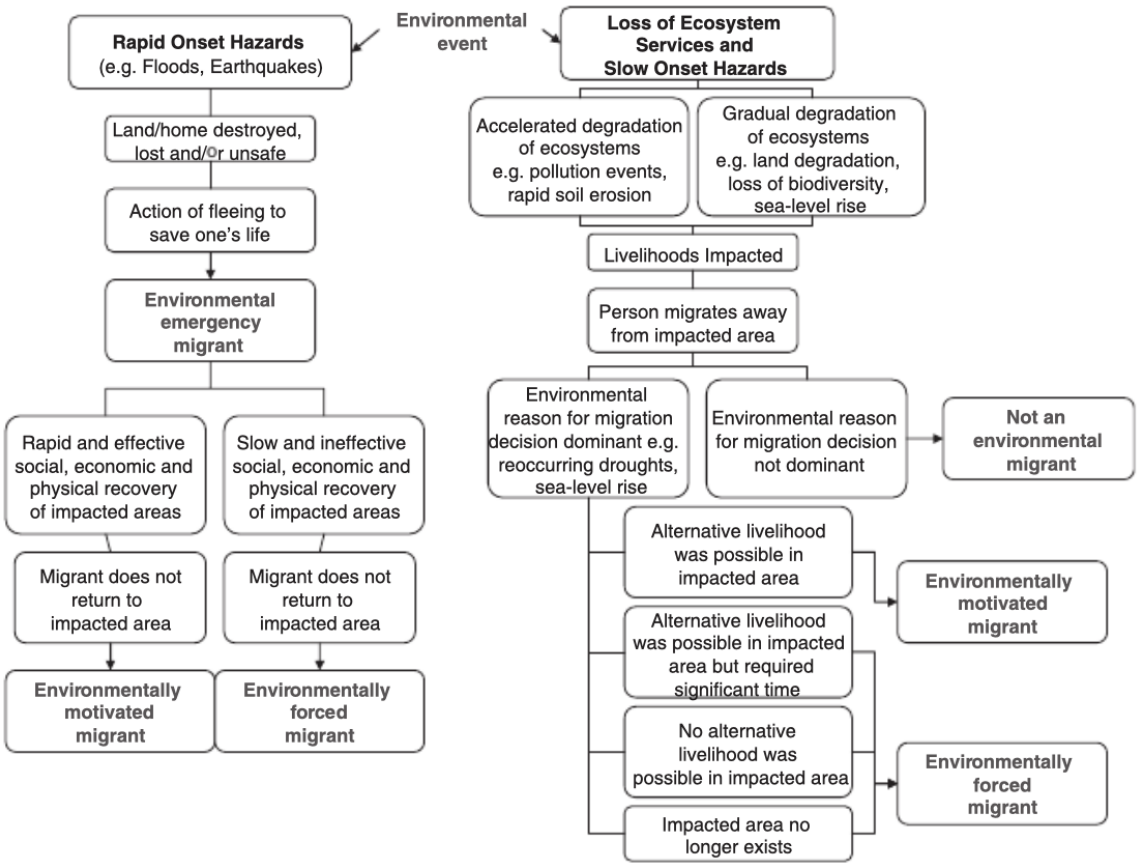


Figure 2: Classification of causes for environmental migration
Environmental processes and migration, rapid- and slow-onset events.
Source: Renaud et al. (2011)

changes operate at a slower pace than socio-economic drivers, leaving more space for adaptation to the changing circumstances – and here, migration is indeed one of possible adaptation strategies (*idem*).

Obokata et al. (2014) provide a review of empirical research on international environmental migration, where much of the existing research focuses on internal migration. As to whether environmental migration is temporary or permanent depends largely on the environmental reason for leaving. If the area is no longer inhabitable then it will be permanent. However, even if the damage takes a long-time to repair, some people do return. In the case of Hurricane Katrina (2005), the population decreased significantly in the short term, recovering to 85% of the pre-Katrina levels by 2019.[21] Rowlands (2004) anal-

[21]Source US Census Bureau https://www.census.gov

yses South to North migratory flows and the influences of which extend beyond purely the environment. His results indicate that citizens experiencing poverty are more likely to migrate in the case of environmental hardship. Of the research examined by Obokata et al. (2014) the majority indicated that environmental factors influenced migratory decisions and the three main drivers were drought, land degradation, and flooding (p. 119).

These studies are mainly based on historical events which originate in less developed countries, however, with climate change becoming an ever bigger issue and environmental migration on the rise the role of intra-EU+ environmental migration may come to the fore. Environmental disasters are hard to predict, but as the number of environmental events increases, as shown by the EM-DAT database, the number of migrants will almost certainly increase.[22]

2.1.6 Demographic Drivers of Migration

A number of efforts have been made to forecast populations as well as migration. The methods used, despite some commonalities (see e.g. Wiśniowski et al., 2015), are somewhat different as there are three components of demographic change: births, deaths, and migration. Of these three, mortality rates typically are subject to the smallest levels of error, with migration being subject to a much greater volume of externalities that make errors greater, and fertility being somewhere in the middle. At the same time, births and deaths are unique and well-defined demographic events, which are, at least in the developed countries, generally well registered, migration on the other hand is much less so. One remarkable feature of demographic processes is their inertia (*population momentum*), whereby a lot of information about the future age size and structure of a given population is already encoded in the present ones (see Keyfitz, 1985) – most of the people who will be alive in a given country 20 or 30 years from now, are already born and living there. This makes demographic drivers, such as the population size and structure, which both are linked to other life-course events and age-selective propensity to migrate (Rogers and Castro, 1981; Courgeau, 1985), typically more predictable and changing at the slower rate than migration. This allows these factors to be used as important migration predictors, as long as the endogeneity of migration can be acknowledged and taken care of – and an

[22]EM-DAT is a database of environmental disasters which is available at www.emdat.be

obvious exception is when population mostly changes through migration itself, when the circularity of the underpinning driver mechanism can become a problem.

2.2 The Challenges of Predicting Migration

There are a number of applications that migration predictions can be used for. The first is an event that policy makers and researchers are aware about far in advance, such as the expansion of the European labour market or change in migration policy. The second is one with shorter notice, or one of a predicted scenario such as the collapse of the Soviet Union, or reunification of Germany. Finally, there are migration shocks, which operate on a very short horizons, such as in the case of the European migration crisis of 2015. The exogenous migration shocks cannot be predicted from a longer term perspective.

Even with some knowledge about the drivers of migration, as discussed above, there is still a large uncertainty around forecasting migration flows. Within this, there are issues related to the predictability of migration processes, the lengths of horizons and the migration statistics concerns. Any predictions of migration are limited by the accuracy of the models. In this section, we aim to improve on the existing methods. A number of methods have been used to forecast migration in the past. Here we present a brief discussion as a background to lay the foundations for our proposed improvements.

2.2.1 Predictability of Migration Processes

There are different ways of measuring the predictability of migration processes, but all involve some assessment of prediction errors. Here, we distinguish between *ex ante errors*, telling us how large we expect the errors to be, given the predictive model, and *ex post errors*, informing us about the actual magnitude of the differences between the predictions and observations, once the latter become available. Minimising the ex ante errors alone is not a valid aim in forecasting, as it can lead to overconfidence in a prediction that ultimately turns out to be biased. A much better choice is to calibrate the predictions first, for example based on a sub-sample of a part of the historical data series, to ensure that the ex ante and ex post error distributions are aligned. On that basis, several options for measuring the predictability exist, such as those employing various *scoring rules*, combining the magnitude of errors and calibration properties, for example by minimising

well-calibrated errors (for a detailed discussion, see Gneiting and Raftery, 2007).[23]

An additional consideration is related to the consequences of prediction errors – by involving so-called *loss functions*, measuring the losses incurred by over- or under-predicting compared to hypothetical no-error situations, and by using the methods of statistical decision theory, we can assess the impact of errors on actual policy, planning or operational decisions (see also Bijak, 2010). In particular, such loss functions need not be symmetric: depending on the circumstances and specific users and uses, the consequences of underprediction may be either more or less costly than of overprediction - and of course in some specific circumstances the losses can be similar for both directions of error (*idem*). As an example, consider operational preparedness for migration arrivals that is easily scalable - such as integration services that can be outsourced to external providers. In such case, overprediction can be more costly than underprediction: keeping idle reserves 'just in case', when the required resources can be brought in at a short notice, is not efficient. On the other hand, some strategic migration-related decisions may require investments in infrastructure (for example, related to border protection and enforcement) that are not easily scalable and require substantial expense upfront. In such cases, underprediction may prove more costly, as the expense of further expanding the existing infrastructure is likely to be greater than preparing this infrastructure for dealing with higher migrant numbers by design.

2.2.2 Prediction Horizons

In addition to the intrinsic unpredictability of migration processes, the predictability levels of different migration streams are additionally limited by the availability of long-enough series of data employed in forecasting. In most cases, the data are annual, with at most 30–40 observations, spanning a historical period with many idiosyncratic events and shocks. Examples of good-quality quarterly data for relatively stable flows, such as the trans-Tasman migration between Australia and New Zealand (Gorbey et al., 1999), are a rare exception rather than the rule. In most other cases, the coarse temporal granularity

[23] A migration-related application of such an approach is offered in Bijak et al. (2019). Calibration alone of course does not reduce the forecast uncertainty, nor there is any guarantee that the alignment of ex post and ex ante errors in the testing (*holdout*) sample will remain valid beyond it. (With thanks to Nico Keilman for these observations.)

of the data, coupled with the volatility of the underpinning migration processes, leads to the prediction horizons of five to ten years at most (Bijak and Wiśniowski, 2010; Bijak et al., 2019), unless the predictions serve as *de facto* long-term scenarios, with an additional assumption of stationarity, as in the projections proposed by Azose and Raftery (2015). Classification of different migration flows according to their levels of predictability and potential societal or policy consequences can open up the possibility of employing a risk management approach, juxtaposing uncertainty and impact of individual migration processes, offering decision-makers a handy tool for managing them. At the same time, especially the long-term assessment of uncertainty in migration scenarios remains an open scientific as well as policy challenge.

2.2.3 Measurement Concerns

There are a number of matters that arise when trying to predict migration. As with economic and political cycles, there is a number of endogenous variables which may be restricted by the number of variables modelled to save degrees of freedom and others which are not as simple to model.[24] Even for countries that have been recording migration for many years the data can have low accuracy. Better predictions are typically achieved with a greater existing sample size (length of the series). Another notable issue is the recording of emigration, which is often worse than immigration.

The quality of data, in terms of their bias and variance, contributes yet another source of uncertainty. This uncertainty is typically *epistemic*, meaning that at least in principle it can be measured and possibly reduced through enhanced data collection efforts, but as a minimum, it needs to be acknowledged in any predictive analysis (Bijak and Czaika, 2020). There exist probabilistic estimates of migration flows that describe uncertainty in a probabilistic manner and combine several data sources, such as those proposed by Raymer et al. (2013) and Azose and Raftery (2019). In particular, a number of issues arise when considering the existing data, which differ in terms of their definitions, levels of coverage, accuracy of data collection mechanisms, the levels of undercount and other biases, and other quality characteristics.

A well known example of data problems is the mismatch in migratory flows between

[24]For modelling of macro-political dynamics see Brandt and Freeman (2009).

Germany and Poland. The scale of the data discrepancies is shown in Figure 3. The flows reported by the Statistisches Bundesamt (Destatis) far exceed those by Główny Urząd Statystyczny (GUS) (Statistics Poland). One important issue arises in the definitions of migration which countries use different ones making it hard to categorise – a notable difference is the exclusion of temporary migrants, especially in the case of Polish statistics, relying on a 'permanent migration' concept. An additional challenge within the continental Europe, insofar as the Schengen free-travel zone is considered, and also between the UK and Ireland with respect to the Common Travel Area, is that residents can live in one country but work in another. This is highlighted in the national accounts where the labour market statistics can be defined as domestic and national concepts.

Countries experience different issues when measuring migration including a relevant definition. In continental Europe it some people live in one country but work in another. Some countries do not enforce the requirement for migrants to register in the host country. Even seemingly simple to measure population statistics can have significant errors – the German census of 2011 revealed that the population had been overestimated by more than 1.4 million.[25] The exact reasons for the large adjustment are likely to do with migration rather than natural population change – in Europe, births and deaths are mostly accurately recorded. For both migrant host and sending countries, emigration is harder to record as it depends on a flow of information from the emigrant or from the host country to inform the sending country of an arrival.

The role of this discrepancy is evident in the scale of reported migration, while each country has an incentive to be somewhat biased in their reporting as well as the definitions being slightly different. Poland emphasises permanent migration flows while Germany does not. Using the study by Raymer et al. (2013) we adjust the flows for Germany by 0.5 and Poland by 2.2. The results are shown in Figure 4.

[25]Source: Statistisches Bundesamt (Destatis) – Federal Statistics Office Germany table 12411-0020. Population estimate 31/03/2011: 81,723,952 – population based on census 30/06/2011: 80,233,104.

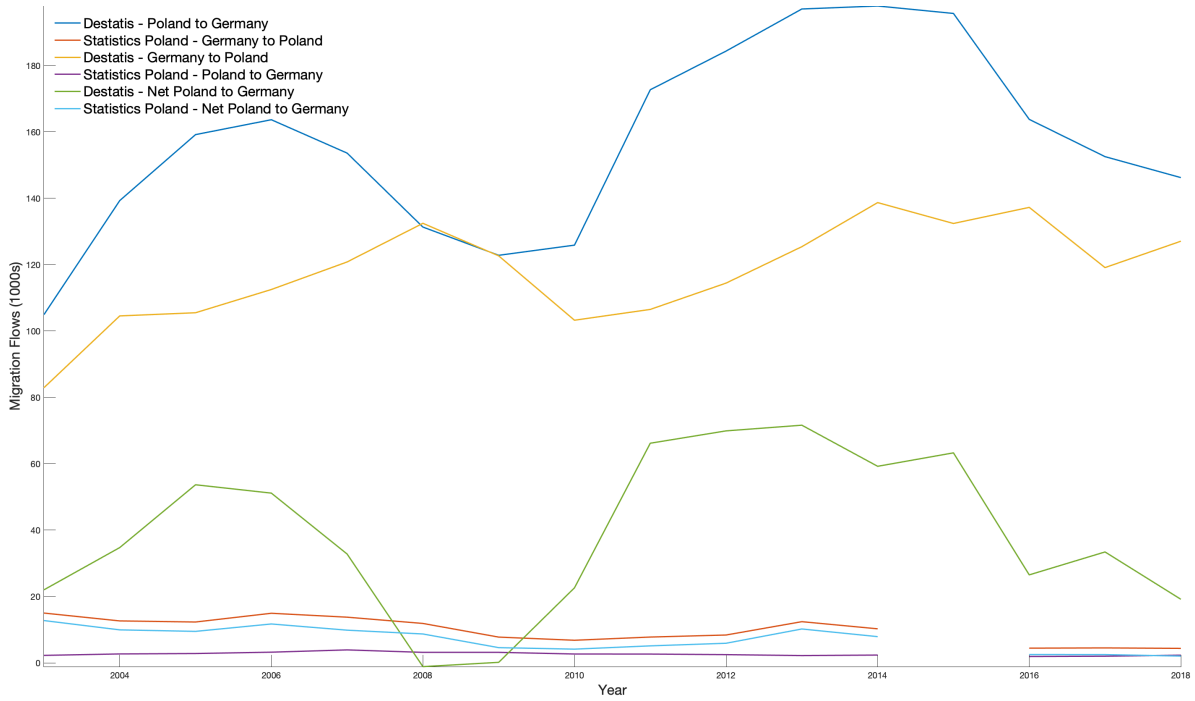


Figure 3: Migratory flows between Germany and Poland
The annual migration flows as reported by Destatis and Statistics Poland. The figure highlights the discrepancies in reporting migration. No data is available from Statistics Poland for 2015.
Sources: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany and Główny Urząd Statystyczny (GUD) - Statistics Poland

3 Review of Methods for Migration Forecasts and Scenarios

Existing methods for forecasting migration and for setting long-term scenarios are reviewed in detail in several studies, notably in Bijak (2010), and recently in Sardoschau (2020), and Sohst et al. (2020), with additional conceptual challenges and insights offered in Bijak (2016) and Willekens (2018). With the exception of Willekens (2018), which aims at laying the foundations for micro-level causal forecasting based on knowledge of migrant decision making, all other reviews are chiefly focused on macro-level methods, which is also the perspective taken in this study. The taxonomies of methods proposed in different reviews vary subtly, but for the current – necessarily brief and high-level – overview, we distinguish two main group of methods: deterministic and probabilistic, depending on whether they include a formal description of forecast error or uncertainty that can be expressed in the language of probabilities. These two groups are discussed in turn, and

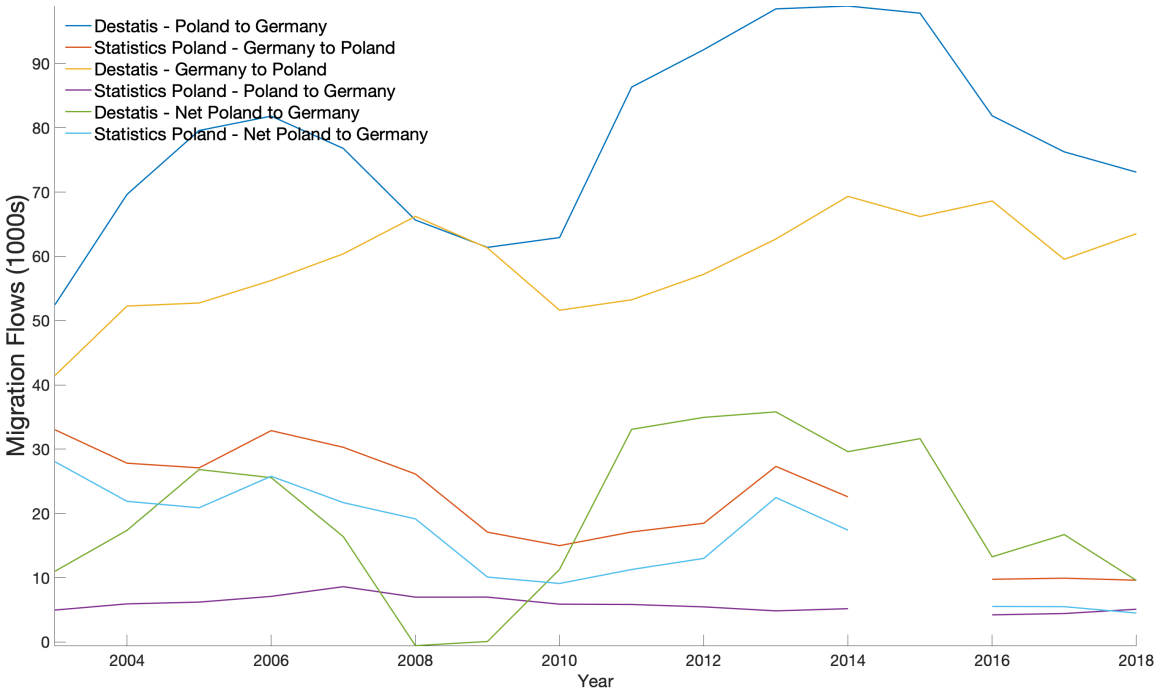


Figure 4: Migratory flows between Germany and Poland with Correction Factors
The annual migration flows as reported by Destatis and Statistics Poland. The figure uses the correction factors put forth by Raymer et al. (2013). No data is available from Statistics Poland for 2015.
Sources: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany and Główny Urząd Statystyczny (GUS) - Statistics Poland

in each case, we look at examples of methods used for assessing migration futures across different time horizons.

3.1 Deterministic and Expert-Based Approaches

3.1.1 Short term: Migration intentions

Some often-used tools to ascertain the possible size of the future migration streams include surveys of migration intentions, aimed at measuring the 'migration potential' (e.g. Fassmann and Hintermann, 1997; van Dalen and Henkens, 2008; Laczko et al., 2017). Of course, intentions do not necessarily predict the actual migration behaviour – they are a necessary, but not a sufficient element of migration decision making – but well-constructed surveys, which can then be calibrated to past outcomes, as done by van Dalen and Henkens (2008) can offer useful insights into the number of people who might migrate in the near future. One important desirable feature of such surveys is that they should recognise migration decision making as a staged process (Willekens, 2018), and

ask several questions about intentions, decisions, and concrete steps made for preparing for migration, with each subsequent group being conceptually a subset of the previous one (see Laczko et al., 2017). Only then the mechanism of migrant decision making can achieve its predictive potential.

3.1.2 Long term: Delphi surveys and scenarios

Another group of largely deterministic attempts at shedding light on the future migration involves creating narrative scenarios, illuminating the probable, plausible and alternative pathways of migration processes. This can be done either directly, through a qualitative assessment of the possible changes in the driver environments and mapping some – usually quantifiable – migration trajectories onto these alternative worlds, or involve formal elicitiation of expert opinion on future migration, for example through single- or multi-stage surveys, such as in the Delphi approach. Examples of scenarios include Black et al. (2011) for environment-related migration, Abel (2018) for scenarios linked to the Shared Socioeconomic Pathways framework of the Intergovernmental Panel on Climate Change (IPCC), or Ariely et al. (2011) and Frontex (2016) for scenarios of mobility across the external border of the EU. Participatory frameworks include surveys (e.g. Lutz et al., 2014), discursive approaches (e.g. de Haas et al., 2010; Vezzoli et al., 2017) and structured multi-stage Delphi surveys (e.g. Lachmanová and Drbohlav, 2004; Bijak and Wiśniowski, 2010; Acostamadiedo et al., 2020).

The key challenge of narrative approaches is that the narratives themselves need to be imaginative enough, to “stretch" the scan of the possible futures widely enough, and they need to be internally coherent, not including internal contradictions. At the same time, it is of worth stressing that the expert judgement itself is uncertain, and its uncertainty – for example across the group of experts included in a particular study – needs to be formally acknowledged, for example through probability distributions (Bijak and Wiśniowski, 2010), which can later serve as inputs into quantitative forecasts, or just discrete probability functions – probability distributions over a discrete space of possible scenarios (Acostamadiedo et al., 2020).

It is worth stressing that the scenarios themselves typically either do not have probabilities attached to them, recognising that the probability of a single migration trajectory

under any continuous probability measure equals zero, or that those probabilities are limited to a predefined, discrete and small set of possible worlds. At the same time, scenario trajectories can be seen as representative of wider ranges of possible futures, and in that way, convey additional information to the users that is not included in probabilistic distributions, by illuminating the consequences of particular inputs or assumptions[26]. Besides, stochastic extensions, offering full probability distributions of possible migration pathways, are discussed in the next section, alongside other statistical and econometric models.

3.2 Probabilistic and Econometric Models

3.2.1 Very short term: Nowcasting and early warnings

In the very short term, where information about the current state of affairs is crucial for operational reasons, such as providing humanitarian relief or response to shock-related displacements, the focus in on so-called 'nowcasts', aiming to predict the present numbers from past data, or early warnings, trying to detect changes in underlying processes with just enough advance notice. The methods that have been proposed here include early warning techniques based on statistical signal detection, flagging deviations from past trends as quickly as possible (Bijak et al., 2017), or nowcasts based on high-frequency data sources, such as digital trace data, and similar (Spyratos et al., 2018; Rampazzo, 2021; Alexander et al., forthcoming). In either case, the methods assume some underlying stability of migration trends and patterns, and attempt to identify deviations from these to identify the changes to the process levels and numbers of migrants.

3.2.2 Short and mid term: Statistical and econometric models

A relatively broad group of methods for forecasting migration in the horizon of a few years, up to a decade or so, consists of statistical and econometric models, chiefly comprising time series and regression-based approaches. The models can be either frequentist or Bayesian, with the contemporary examples of time series-based and hierarchical models mainly located in the latter group (Bijak and Wiśniowski, 2010; Azose and Raftery, 2015; Bijak et al., 2019), or can alternatively involve the propagation of past forecast errors

[26] With thanks to Frans Willekens for this interpretation

(e.g. Alho et al., 2006). These approaches can also be effectively combined, as proposed in the Uncertain Population of Europe (UPE) project, where past error propagation was combined with time series extrapolations and expert opinion (Alders et al., n.d.; Alho et al., 2008). Autoregressive features of the time series models conceptually reflect the self-perpetuating mechanisms of migration processes, although of course, the assumption of self-perpetuation under a shock or change to the fundamentals of the migration processes can be questioned. Given the length of the available migration time series, where as mentioned before at least some 30–40 observations are typically needed to make meaningful inferences, migration processes and their drivers are likely to substantially change in that horizon, especially if they exhibit non-stationary features[27] This is a clear limitation of the time-series based approach. Still, more complex models with micro-foundations, such as DSGE, can help explore the extent to which the self-perpetuation mechanism may hold.

Econometric models of migration flows or migrant stocks, in turn, typically involve a range of socio-economic covariates as proxies for the drivers of migration (e.g. Fertig and Schmidt, 2000; Alecke et al., 2001; Sinn et al., 2001; Alvarez-Plata et al., 2003; Brücker and Siliverstovs, 2006; Cappelen et al., 2015). Alternatives include gravity models (e.g. Cohen et al., 2008), although in this case, some of the variables used (such as distance) are time-invariant and do not add much information into the prediction model. A common criticism of such models is that the covariates need to be predicted (or assumed) first, and the predictability of such drivers can be similarly limited as the predictability of migration as the dependent variable (for a critical perspective, see e.g. Kupiszewski, 2002). In some cases, for example when using population as a migration driver, there is also no escape from endogeneity: populations change through migration as well. Some of these issues can be resolved by applying structural equations models (SEM), as for example in Greenwood (1973), or vector autoregressions (VAR), as in Gorbey et al. (1999), Bijak (2010) or Wiśniowski et al. (2015), where the different variables are modelled jointly and identity relationships can be preserved. The VAR models also need some structure on their parameters, or otherwise the uncertainty of predicted migration flows (and its covariates) becomes overpowering Bijak (2010).

[27] With thanks to Frans Willekens for these arguments.

Of course, the time series and econometric models also assume stability of the underlying migration trends. At the same time, there are strong indications that migration exhibit non-stationary features, at least in the short- and mid-term horizons, which is related to the weak predictability of the drivers and processes (e.g. Bijak and Wiśniowski, 2010). Non-stationarity has important implications for prediction: first, migration shocks bring about new equilibria, all the time, and second, the uncertainty increases with the time horizon, rendering the predictions useless beyond a few years, up to maximally a decade ahead. Once longer series of better data become available, it may be feasible to use more complex models, such as the DSGE, to explore the causal mechanisms in more detail and to ascertain, whether the 'stylised fact' of the low predictability of migration holds (van Wissen, 2012).

3.2.3 Long term: Probabilistic scenarios

In some instances, the long-term scenarios – or other types of projections that can be conceptualised as scenarios – can also be based on probabilistic models. A prime example is the stochastic net migration input to the World Population Prospects of the United Nations, utilising Bayesian hierarchical models for projecting migration until the end of the 21st century (Azose and Raftery, 2015). Similarly, econometric approaches that use mainly long-range drivers as covariates, such as demographic change, can be classified into this group (e.g. Docquier, 2018). Another promising avenue, built from micro-foundations upwards, is the use of microsimulation models for migration scenario setting, possibly in juxtaposition with other dimensions of interest, such as education or labour force participation (see e.g. Bélanger et al., 2019). Such models are also typically heavily driven by assumptions and have high data requirements, but at the same time offer greater analytical flexibility in terms of answering 'what-if' questions than purely macro-level approaches. Microsimulations, to some extent alongside with agent-based models, despite the non-predictive character of the latter, can offer promise in terms of moving towards causal forecasting and representing mechanisms driving migration processes (Willekens, 2018).

3.3 Methodological gaps and opportunities

As argued elsewhere (Bijak and Czaika, 2020), different predictability of migration across a range of time horizons brings about various implications for decision makers. At the same time, there are still unexplored methods (as well as data sources), which can be used for filling some of the current knowledge gaps on prospective migration, from now-casting and early warnings to long-term scenario setting. In particular, very short-term operational decisions requiring numerical input, which can be supported by early warning and nowcasts, can benefit from the use of 'digital traces' and similar sources of 'big data' such as information from mobile phones, social media and so on, also in conjunction with statistical signal detection methods, as long as they are subject to appropriate ethical and privacy safeguards, and their inherent biases can be ignored for the particular purpose. High volatility of such sources means that they are only useful in short horizons, and ideally would need coupling with more traditional data, such as registers, censuses or surveys, to aid the understanding of the 'new' data, which do not need to be transparent from the points of view of the underlying concepts, definitions, and collection methods Rampazzo (2021). At the same time, the lack of representativeness of these sources on their own for the general population makes them useful more for early detection of changes in trends rather than for estimating volumes or other population-level characteristics. A recent review of the potential of such data for analysing European migration has been offered by Spyratos et al. (2018).

The planning decisions made in the short- to mid-term horizons, possibly up to a decade ahead, also require numerical input. As mentioned above, one option in that respect, which has not been formally applied in practice, consists in employing methods of the statistical decision analysis, based on the probabilistic description of future migration, as well as the loss function (costs) associated with over- or under-prediction (Bijak, 2010). A separate challenge concerns the methods for long-term migration scenarios and uncertainty to aid strategic decisions and policy planning. Even though such decisions do not typically require specific numerical input, calibrated time series methods, originally designed as input to long-range population projections, offer one possibility here (Azose and Raftery, 2015). At the same time, there is a need for exploring formal methods for

assessing long-term impacts of the changing driver environments on migration, to better reflect the complexity of the underlying processes. One unexplored path is to use complex dynamic approaches, such as the DSGE models, originating in macroeconomics, the possible applications of which we explore in the further parts of this report.

In terms of possible disaggregations, de Beer (2008) argued that political migration, i.e. refugees and asylum seekers, should be forecasted separately to other types of migration. Similarly, if it were possible to operationalise it, environmental migration – or indeed other types – should be also forecasted separately due to the different timescales at which the related drivers operate (see the stability argument of Keyfitz, 1985).

By using forecasts for each type of migratory flows, it should enable more accurate forecasts. We look to improve forecasts with new approaches. In terms of environmental migration forecasting, we can also use various climate-related indicators as proxies for environmental pressures, and attempt to isolate environment-related flows by looking at countries most at risk from climate change. Incorporating research from political economics literature, we examine ways of forecasting political cycles. While most of the existing research focuses on developed countries in relation to the political system such as Aguiar-Conraria et al. (2012) uses wavelet analysis for political cycles, we can employ variables and proxies with extensions to link political cycle forecasting with migration.

3.4 Mixed Frequency Analysis

An important issues which arises when using multivariate regressions for migration modelling and prediction is the frequency of available data and the persistence, or rather length of time for which the data on migration and its drivers remain relevant. When considering economic migration, the response of migratory flows is not immediate, as jobs are generally found before relocation as reasoned in the mixed frequency analysis of migration in Germany by Faccioli and Vella (2020). Even with an efficient job matching process, these adjustments operate on short-term horizons (a month to a quarter), which is in contrast to industrial productivity, responsive in the short run.

The frequency of data available also varies: migration flows reported by national statistics offices or equivalent are reported usually at an annual frequency, and some

countries have begun to report it by quarter.[28] This is in contrast to the national accounts which are reported quarterly, even though revisions are often applied. Using a mixed frequency vector autoregressive (VAR) models allows us to integrate these aspects into the forecasting of migration. One option is to use the approach and programme code by Ferroni and Canova (2020*a*) which are available at Ferroni and Canova (2020*b*).

Higher frequency data allows greater precision as to when the shock occurs (Ferrari and Ters, 2017) and its volatility (Corsi et al., 2001). Employing mixed frequency data allows us to take advantage of the higher frequency variables which are available while using data that is only at an annual frequency. This is particularly relevant for environmental migration where these indicators are available at an annual frequency only. Economic data is typically available at a quarterly or monthly frequency.

4 Macroeconomic Shocks and Migration

The analysis into the macroeconomics of migration can use both empirical and theoretical models. We can split our theoretical analysis into two forms - migration as an exogenous shock, and business cycle shocks that are the driver of migration. The empirical analysis can be similarly split into an analysis of a migration shock and of the migration responses to other shocks where a positive shock is defined as an unexpected increase to the growth rate.[29] In this section, we discuss some possible macroeconomic shocks that have effects on migration, illustrated by three case studies: EU expansion, job automation, and changes to international trade.

4.1 Expansion of the Common Labour Market

The expansion of the EU in 2004 had potential to be one of the largest shocks to EU15 and EFTA individual countries' labour markets. For that reason, only Ireland, Sweden, and the UK fully opened their labour markets to the (A8) countries with the other countries requiring citizens from the A8 to gain a permit for seven years until the host countries would then have to fully open up their labour market.

[28] One exception is Germany that has reported flows on a monthly frequency by country since 2006. The data is available from Destatis.

[29] An increase to the growth rate of net migration thus increases the existing stock of migrants.

Some future expansions of the European labour market are also likely, especially in the horizon of a few decades ahead. Currently there are five candidate countries and two potential candidate countries to the EU. The UK will leave the labour market in 2020, ending freedom of movement, but will still remain a large destination and current host of EU+ migrants. The future relationship with the UK is unknown in detail but it is not an impossibility that the UK will not rejoin the bloc in the long run. There is existing research on EU expansion by Kennan (2017) who provides a general equilibrium analysis of a common labour market with a focus on factor price equalisation for the EU. Other research on expansion of labour markets include Klein and Ventura (2009) who found that the removal of labour barriers gave gains in output and welfare in the case of the European Union and a hypothetical North American common labour market. A driver of migration is the wage, or output per worker, which due to the inequalities in productivity are higher in the richer country. The removal or migration barriers could see GDP increase by 8% in the long-run. While the expansion of labour markets would seem draining to the sending country through loss of human capital and labour, factor price equalisation can help improve the economic standing of the sending country in the long-run, as shown with Puerto Rico and the US. Factor price equalisation is the convergence in returns to capital and labour. As shown in the real GDP per capita for the European countries reporting data to Eurostat, the A8 countries continue to experience strong growth after joining the EU and increases in emigration.[30]

The expansion, exit of the UK, candidate countries, and potential candidate countries is shown in Table 3.

The most sizeable of the candidate and potential candidate countries is Turkey, with a population of 82 million (similar size to Germany), but the likelihood of Turkey joining in the short or medium run is low, as convergence with national laws and a number of other factors would take a considerable number of years, even in the absence of political obstacles. Albania has a population of approximately 2.8 million (2020), North Macedonia has 2 million (2019); Montenegro 622,000 (2019), Bosnia and Herzegovina 3.3 million (2019); Kosovo 1.8 million (2020); and Serbia 8.7 million (2020). [31] Even though accession

[30]Real GDP per capita in chain linked volumes (2012) euros sourced from Eurostat table SDG_08_10 and growth rates by own calculation.

[31]For comparison, according to the Eurostat estimates, the joining of the A8 countries the approximate

Table 3: Expansion of the European Union

Expansion of the EU								Brexit	CC	PCC
1958	**1973**	**1981**	**1986**	**1995**	**2004**	**2007**	**2013**	*2020*		
BEL	DNK	GRC	PRT	AUT	POL	BUL	HRV	-UK	ALB	BIH
FRA	IRE		ESP	FIN	CZE	ROU			MKD	KOS
DEU	UK			SWE	EST				MNE	
ITA					HUN				SRB	
LUX					LVA				TUR	
NED					LTU					
					SVK					
					SVN					
					CYP					
					MLT					

CC: candidate countries ; PCC: potential candidate countries. The development of the European Union and the possible future members. Iceland, Liechtenstein, Norway, and Switzerland form European Free Trade Association (EFTA) countries.
Source: European Union and European Commission

talks are in progress with some of the candidate countries, sometimes strong political opposition exists, for example, in the case of Kosovo, some EU member countries still do not recognise it as an independent state, which is a prerequisite for any accession talks.

Whilst the effects of an EU expansion is of interest, particularly to analyse whether previous forecasts on the A8 and other CEE countries were correct, now having some data enables an evaluation on the candidate countries and potential candidate countries.[32] There will also be an effect on the euro area, which the new members of the EU are likely to join at some future point – this would be of interest for macroeconomics but beyond the scope of our initial research. The notable factor is that these (potential) candidate countries all have GDP per capita lower than the EU15 average just as the A8 countries

population sizes were: Poland 38.2 million; Czechia (then Czech Republic) 10.2 million; Slovakia 5.37 million; Estonia 1.37 million; Latvia 2.28 million; Lithuania 3.7 million; Hungary 10.1 million and Slovenia 1.99 million. Cyprus had a population of 722,900 and Malta had a population of 399,900 In 2007 Bulgaria had a population of 7.75 million and Romania 21.1 million. Finally, when Croatia joined in 2013 it had a population of 4.26 million.

[32]There are, however, caveats to the existing data. There are issues surrounding the estimates of true flows and potential bias in reporting figures. Baldwin-Edwards (2004) examines the case of Greece's poor reporting standards and Raymer et al. (2013) note that Greece is one of the countries who do not report the country of origin for immigrants or emigrants. Additionally, Wiśniowski et al. (n.d.) take into account for their estimations of migration flows accuracy of data collection, length of stay to be classified as a migrant, under-count and coverage of migrants as well as noting that a large number of countries have reporting systems which are less reliable.

did when they joined. The expansion of the euro area is shown in Table 4.

Table 4: Expansion of the euro area

Expansion of the Euro Area 1999-2015									
	1999		**2001**	**2007**	**2008**	**2009**	**2011**	**2014**	**2015**
AUT	FRA	LUX	GRC	SLV	CYP	SLK	EST	LVA	LTU
BEL	DEU	PRT		MLT					
NED	IRE	ESP							
FIN	ITA								

Source: European Central Bank (ECB) and European Commission. New members to the European Union should adopt the Euro as their national currency within due course. Of the nations that joined in 2004, Czechia, Poland, and Hungary have not yet adopted the Euro. EU countries not using the Euro include Croatia, Denmark, Sweden, Romania, Bulgaria.

However, as Dominguez-Mujica et al. (2012) explain, Spain's economic expansion 1995–2007 was due firstly to an increase labour force through immigration and increased participation by women and secondly by reduced costs of financing by joining the euro area, also noted in Amuedo-Dorantes and de la Rica (2011). The most recent financial data is heavily skewed due to the coronavirus pandemic, however, in general, securities issued by euro area countries are considered safer – as evidenced by the bailouts or securitisation of the heavily indebted countries during the GFC. If joining the euro area enables a country to access less expensive financing, and replicate a part of Spain's economic growth then it could end up reducing migration flows as the economies begin to converge as per Solow growth theory with lower incentives such as the wage premium.[33]

One area of research will be with the United Kingdom following its exit from the EU. At time of writing, the UK is in the transition stage with no formal agreement on the future relationship with the EU. The UK Government pledged to end freedom of movement, on the basis that it does so, this will raise questions on what were to happen should the UK rejoin the EU, or at least the EEA in the future. In contrast to other candidate countries, which are either small or have a significantly lower GDP per capita than the rest of the original EU15 (EU14 less the UK), the impact of potential rejoining on migration flows would require a separate, detailed analysis. On the whole, however, the

[33]Sovereign debt ratings are available at Sovereign Risk Indicators 2020 Estimates by S&P Global Ratings

uncertainty related to the changes of the future composition of the EU and the common market would need to be considered in the scenarios of EU+ migration.

4.2 The Developing Automation of Industries

In the future, a greater number of jobs will have been automated. How will this affect the labour market and consequently migration? In the past seventy years, the labour share in the economy has significantly reduced; where labour share is defined as the amount of GDP spent on employee income. Some countries have automated quicker than others; this could be associated with scarcity of other imports, as put forward by Acemoglu (2010), who found that a shortage of labour or wages above equilibrium encourages adaptation of productive technologies. If the labour scarcity is a catalyst for automation, would migration then have any effect on the process and would it affect trade relationships, for example with CEE countries? One issue would be that the countries with higher levels of automation capital such as Germany will experience greater returns and as such, any convergence of factor prices is harmed.

Kugler et al. (2020) examine the use role of automated technologies in the US and effects on the Colombian labour market – does the use of robots in the US lower the demand for Colombian produced goods. Their results show that Colombian workers, in essence, compete for jobs with US robots, so increases in automation decreases Colombian employment at a rate of 1 more robot results in 1.2–1.4 formal Colombian workers losing their job. Faber (2020) similarly found negative results on the Mexican employment when US firms increase the number of robots, or automise tasks. Automation would then indicate a process or reshoring of tasks and negative effects on imports. However, these results consider the effects once a job has been automised not what causes the automation decision by a firm. If it is the case that shortage of labour induces automation, then increases in labour supply through migration should decrease the rate of automation. Hence, the link between automation and migration is quite evident, with possible spillovers: for example, some studies have identified the rise in automation and support for far-right political parties supporting tighter migration restrictions across Europe and in the US (Gamez-Djokic and Waytz, 2020).

To discuss this process in more detail, let us look into three skill categories, high-

skill labour, medium-skill and low-skill labour. Since 1980, the relative number of jobs posted for the low-skill and high-skill occupations in the US have increased while the medium-skill jobs had lost out causing labour market polarisation (Mandelman, 2016). Whilst this was initially due to offshoring, a lot of this can then be aligned with the increases in automation (Mandelman and Zlate, 2019). Research by Mandelman and Zlate (2019) indicates that offshoring and automation negatively affects the middle-skill but benefits the high-skill occupation in terms of employment and wages whilst low-skill employment is relatively unaffected but no wage gains are experienced due to the low-skill immigration in the US. The low and high-skill occupations tend to be complements to automation but substitutes for medium-skill occupations. With automation roles being of greater significance in Germany than the US, the effects of automation firstly on trade relationships and then on the labour market is another opportunity for research, and an important consideration for scenario setting.

Automation is defined as a labour-saving technology such that automation services differ to physical capital services as per Leduc and Liu (2019). The role of automation in macroeconomics, and in particular business cycle macroeconomics, is relatively unexplored – even more so than migration. Leduc and Liu (2019) have find that automation is able to partially explain the Shimer (2005) puzzle, with observed differences of volatilities between models and data for unemployment and job vacancies.

4.3 International Trade and Migration

How much does trade relate to migratory flows? Immigration and international trade are two important factors in globalisation. Since forecasting migration ideally requires estimation of the flows of emigration and immigration separately, we can also study the role of bilateral trade exchange in these flows, based on some ideas from the previous studies. For example, Bowen and Wu (2013) show that trade and immigration are complementary across 22 OECD economies including the EU-15, Norway and Switzerland, with Akkoyunlu and Siliverstovs (2009) finding complimentary trade and migration between Turkey and Germany. Genc et al. (2011) showed that immigration and trade flows are complements of one another, and the estimates of the elasticities suggest that a 10% increase in the number of immigrants may increase the trading by 1.5%. The elasticity

does decrease over time and elasticities can vary depending on countries. Interestingly, the elasticity of imports is greater than exports in half of the sample of countries. This elasticity is likely to increase as economies open up. The sample under observation in this study was 1994–2010, which covers the start of the international migration boom, so since the rate of international migration has increased in the intervening years, it is likely that the effects are greater.

The analysis of global value chains based on gravity models can also help demonstrate the development of migratory flows with labour and capital mobility. Vandenbussche et al. (2019) analyse global value chains in an application to Brexit and the effect on the EU-27 in a number of scenarios that introduce trade barriers, which highlights the importance of international trade as the final consumption good uses components from different countries. In the example of consumer goods, a component for a German-produced good may use components from Belgium, which has sourced inputs from the UK, as well as another component directly sourced from the UK. The introduction of trade barriers can be both direct and indirect, and imposing trade barriers only seeks to increase costs which are ultimately passed onto the consumer. The changes in trade patterns can therefore form an important part of the scenarios of future migration flows, especially where some of the related aspects, such as the emergence of new trade barriers, such as those imposed by the UK's departure from the EU, can be envisaged ahead of time.

Trade and automation can be linked through future expectations and initiatives to re-shore practices which are then done by robots instead (Kugler et al., 2020). Two possibilities exist for automation and trade: is automation part of a reshoring process, removing jobs in the offshore country (as in the case of Colombia), or is automating jobs in the rich country due to labour shortages? In reality, it is likely a combination of both.

Such analysis typically assumes positive migration shocks, however, we can also consider negative ones, as in the case of trade or automation. If trade or automation lead to a decline in migration, either through advancements of the sending economy or high levels of automation of migrant jobs, this will lead to a reduction in migration. Similar argument can be made for the reversal of the refugee flows, who can return home once their origin areas have seen a decrease in violence. There are a number of countries who have offered financial incentives for refugees to return home as described in Gerver (2017).

5 Modelling the Uncertainty of Migration

As mentioned before, there are occasions when migration shocks occur which can occur in two forms. One form is an isolated event as evidenced in the 2015–16 'asylum crisis' which is relatively short lasting, alternatively shocks can be a change in immigration policy which increases migration over a longer period of time. The existing empirical research based on time-series models identifies migration either as a random walk (Keilman et al., 2001; Bijak, 2010), or as an autoregressive process (e.g. de Beer, 1997), where a measured migration variable is related to its value from the previous period, and any shocks that might occur (for a discussion, see Alho and Spencer, 2005). Depending on the exact type of the model, the implications of shocks are different – for random-walk processes, which are not stationary, the process moves to a new equilibrium, which happens every time a shock occurs. On the other hand, stationary autoregressive processes exhibit a tendency to return to equilibrium levels (see e.g. Bijak, 2010). In this section we discuss the impact of migration shocks, in contrast to section 4 which looked at the effect of economic shocks on migration.

5.1 Migration in the Economy and Society

In this section we describe the potential roles of different types of migration on the economy, by using the broad classifications of migration as economic, social, political, or environmental. Table 5 summarises the effects of different types of migration identified in a range of studies within macroeconomics that uses migration as a shock. the overall effect of migration usually reflects that of economic migration. For some variables, research has not been observed by an individual type of migration. The evaluations in sections macroeconomy and fiscal policy, are given in per capita terms to aid analysis. Social migration is defined as the movement of family members who are not active the labour market on arrival. Cross-country comparisons are not simple to make as the average migrant profile differs between country and this status relative to natives, for instance Germany and the United States are host to a large number of low-skill migrants whilst Canada and the United Kingdom are home to high-skill migrants (Lisenkova and Sanchez-Martinez, 2016; Hilgenstock and Koczan, 2018).

Table 5: The effects on the macroeconomy by different types of migration

		Type of Migration		
Area	**Overall**	**Economic**	**Societal**	**Forced**
Macroeconomy				
GDP	↑ EBa, EBd, ST, FR ↓ KM, S, W	↑	↓	↓
Private consumption	↓EBa, ↑EBd, ST	↑	↓	↓
Private investment	↑	↑	↓	↓
House prices	↑ CT, ∅ FR			
Capital intensity	↓ FR			
Labour Market				
Participation rate	↑ FR	↑	↓	↓
Unemployment rate	↓	↓ EBd	↑	↑
Labour supply	↑	↑	[↓ SR, ↑ MR]	
Real wage	↑*	↑*EBa	↓	↓
Hours worked	↓ W, ↑ EB		↓	↓
Fiscal Policy				
Labour taxes	↑	↑	↓	↓
Consumption tax	↑	↑	↓	↓
Government investment	↓			
Government consumption	↓			
Household transfers	↓			↑
Government net liabilities	↓ EBd	↓	↑S	↑S
Monetary Policy				
Interest rate	↑			
Inflation	↑** FR			
Central bank assets	↑			

Dynamics taken from author's own calculations and existing research using empirical and theoretical modelling . For results taken from research articles: EBa = Barker (2020*a*) (Germany), EBd = Barker (2020*d*) (Canada), ST = Smith and Thoenissen (2019) (New Zealand), W = Weiske (2019) (US), KM = Kiguchi and Mountford (2019) (US), FR=Furlanetto and Robstad (2019) (Norway), S = Stähler (2017) (Germany), dA = d'Albis et al. (2016) (France).

* The type of economic migration can affect this, high-skill generally increases the real wage while low-skill would reduce it. However, an increase in low-skill workers can also increase employment of high-skill workers. Further detail is available in Section 5.1.4.

** In the short run there is an insignificant effect but in the medium run there is a small increase to CPI.

It is noteworthy that these results for societal and forced migration are valid in the short term. If the migrants are integrated into the economy, there is a possibility that the benefits would be the same as for economic migrants. In contrasting societal and forced migrants, it is more likely that social migrants will be active in the labour market than

political migrants. As shown in Hilgenstock and Koczan (2018) and Eurostat (2011) that women who arrived as social migrants are more likely to become active in the labour market after a period of time whereas the participation and unemployment rates of political migrants generally struggle to integrate into the labour market (Brell et al., 2020). In Germany, there is a lower return to human capital for those who gained education in their home country than in Germany - a form of brain waste and foreign labour market experience yields insignificant returns (Basilio et al., 2017). However, immigrants from other high-income countries are able to have higher returns to their human capital.

Brell et al. (2020) analyse the integration of refugees into the labour markets of a number of high-income countries. The results are concerning, as the refugees typically fail to integrate into the labour market fully. For the employment rate, not only do they lag behind natives but also other groups of immigrants, the exception being the US, where refugees tend to have caught up with other immigrants after two years on average, and with natives after ten years. One issue for refugees on arrival is that their skillset may not be fully adapted to the host nation. Allowing the refugee to be equipped or re-skilled for the host labour market can be a long process. The critical period for integrating the refugees into the labour market comes in the first two to three years after arrival as this is when employment grows fastest – slightly later than for other types of immigrants.

Given that there are several groups of migrants, a number of factors needs to be considered for immigration and emigration individually (see Barker, 2020*b*) The number of issues to consider when analysing the causes and effects of immigration include the relative (rather than absolute) size of net migration, the average age and skill-level of the immigrants (their human capital), the legal requirements for migrants to work in the host country, and from a longer term perspective, the need to consider the proportion of population growth that can be attributed to migration.

Starting with the size of migration, this can be demonstrated by the net migration rate which is defined as annual net migration (flows) per 1000 people of the destination country.[34] Table 6 shows the net migration rates for the countries featured in the United Nation's Europe category which is divided into north, east, south, and west. Across these

[34]From a demographic point of view, this is of course not a 'proper' occurrence-exposure rate, but in macroeconomic applications it makes sense to talk about net migration as a way to measure changes to the labour supply and population as a whole.

regions, there are significant differences, although it has to be borne in mind that the UN estimates have only approximate character and may not be accurate or comparable.

Table 6: Net Migration Rate 2015-2020

Region/Country	Rate	Region/Country	Rate
Eastern Europe	**0.41**	**Southern Europe**	**0.84**
Belarus	0.92	Albania	-4.85
Bulgaria	-0.68	Bosnia and Herzegovina	-6.43
Czechia	2.07	Croatia	-1.92
Hungary	0.62	Greece	-1.52
Poland	-0.78	Italy	2.46
Republic of Moldova	-0.34	Malta	2.06
Romania	-3.78	Montenegro	-0.77
Russian Federation	1.25	North Macedonia	-0.48
Slovakia	0.27	Portugal	-0.58
Ukraine	0.23	Serbia	0.45
Northern Europe	**3.24**	Slovenia	0.96
Channel Islands	7.96	Spain	0.86
Denmark	2.65	**Western Europe**	**3.97**
Estonia	2.96	Austria	7.35
Finland	2.54	Belgium	4.20
Iceland	1.13	France	0.56
Ireland	4.92	Germany	6.57
Latvia	-7.64	Luxembourg	16.33
Lithuania	-11.60	Netherlands	0.94
Norway	5.27	Switzerland	6.14
Sweden	4.03		
United Kingdom	3.90		

Source: United Nations, Population Division, Department of Economic and Social Affairs World Population Prospects 2019 https://population.un.org/wpp/Download/Standard/Migration/
The net migration rate is the net migration flow per 1000 people. Net migration flows are defined as immigration minus emigration, and for periods between population censuses can be also estimated as the difference between total population change and natural change (births minus deaths). In the table above, the numbers are based on the reported statistics, and so the definitions of migrants used by individual countries may vary (see e.g. Raymer et al., 2013).

The percentage of foreign-born residents is also important for conceptualising the existing relative 'stock' (number of migrants) within a country. Table 7 shows the numbers for 2018 and 2019. There are outliers in the sample, notable Liechtenstein and Luxembourg who have very small populations, and unique circumstances, accounting for these figures. On the other end of the scale, Romania, Bulgaria and Poland are the three countries with the smallest official migrant counts, some of which can, however, be attributed

to accuracy of statistical reporting or to the applied definitions of resident populations. Still, even if approximate, these statistics are of significance because they scale the relevance of a migration shock or how much migration matters macroeconomically to a country. Across the EU+, the weighted average (by country population size) is 12.03% for 2018 and 12.47% for 2019.

Table 7: Percentage of Foreign-born Residents

Country	**2018**	**2019**	**Country**	**2018**	**2019**
Austria	19.16	19.45	Latvia	12.72	12.59
Belgium	16.81	17.18	Liechtenstein	65.85	66.60
Bulgaria	2.22	2.46	Lithuania	4.66	4.94
Croatia	12.88	12.94	Luxembourg	46.54	47.34
Cyprus	20.99	21.18	Malta	17.53	20.17
Czechia	4.41	4.76	Netherlands	12.90	13.30
Denmark	11.94	12.19	Norway	15.53	15.79
Estonia	14.87	14.94	Poland	1.83	2.00
Finland	6.60	6.84	Portugal	8.84	9.33
France	12.19	12.47	Romania	2.60	3.15
Germany	16.60	17.92	Slovakia	3.50	3.57
Greece	11.90	12.19	Slovenia	12.11	12.74
Hungary	5.48	5.78	Spain	13.29	13.93
Iceland	15.37	16.81	Sweden	18.53	19.10
Ireland	16.79	17.22	Switzerland	28.67	28.90
Italy	10.21	10.43	United Kingdom	14.35	14.21

The percentage of the population who were born in another country on the 1st January 2018 and 2019. Source: Eurostat. Figures calculated using [TPS00001]-Population on 1 January and [TPS00178] Foreign-born population

It is important to consider the role of age and skill-level of migrants as this has the potential to effect the economy in both the long and short term as highlighted by Barker (2020*d*). One notable example is Germany, whose only source of population growth has been through migration due to the negative natural population change. A number of countries are predicted to experience this in the next decade, and given the ageing population, migration can sustain the size of the working-age population. Figure 5 shows the causes for population change in Germany. The natural population change is negative (apart from 2016Q3), as deaths have continuously exceeded births. The total population change has only become consistently positive since 2011, since when it has been driven by an increase in net migration. Notably, the strong upward trend of positive

net migration began before the migration 'crisis' of 2015, when net migration exceeded 1 million annually.

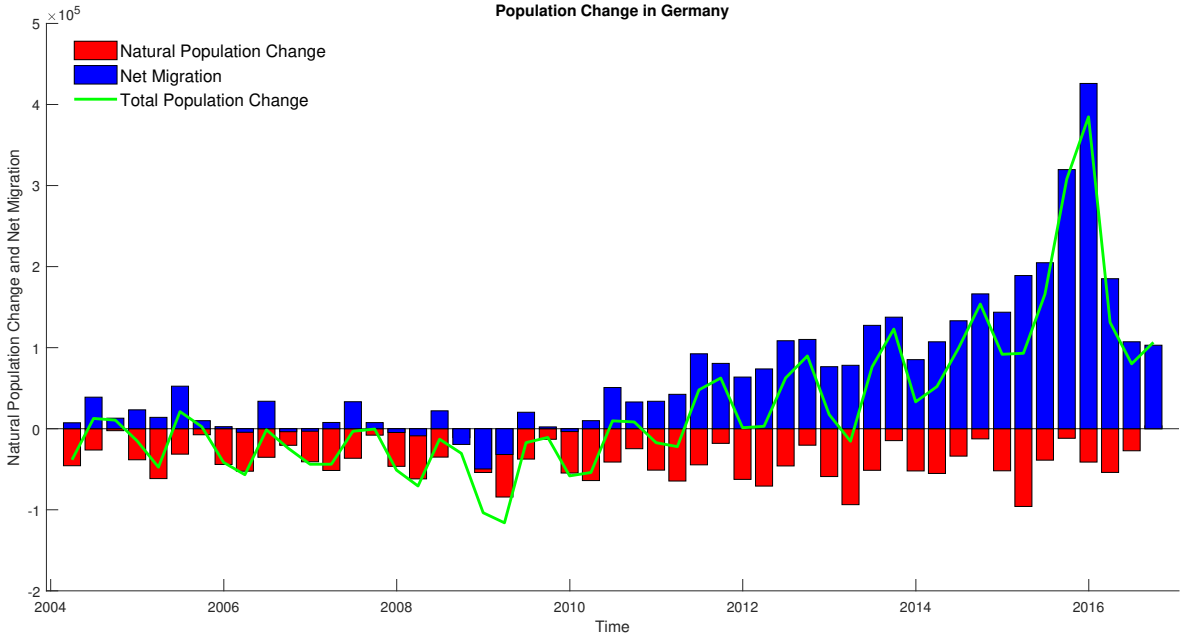


Figure 5: Population Change in Germany
Net Migration is shown by blue bars, Natural Population Change by red bars, and Total Population Change by green line (100,000s people).
Source: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany.

5.1.1 Economic Immigration

An economic migrant contributes to the workforce and increases the overall participation rate. In the case that they are unable to find employment, this increases the unemployment rate. In macroeconomic research, immigrants or foreign-born residents are considered to be imperfect substitutes or complement to native workers, with new immigrants to be substitutes for existing immigrants. Using the microeconomic findings of imperfect substitutability such as Ottaviano and Peri (2012), who show that immigration flows in the US 1990-2006 resulted in small but significant long-run wage increase for low-skill (0.6-1.7%) and high-skill (0.6%) natives where as a larger negative effect of -6.7% on existing immigrants.

Further studies on substitutability include: Spain, where immigrants are complementary to natives as identified by Amuedo-Dorantes and de la Rica (2011), Germany and

the UK by Dustmann et al. (2010), and Canada by Islam (2009). Fromentin et al. (2017) examine the labour markets of France, Germany, Spain, and the UK where the results show that any effect of immigration on native-born employment is weak and that natives and migrants are not competing for the same job in the sample studied 2008Q1 to 2012Q2 for covering the economic crisis.

One of the concerns relating to immigration is that of brain waste as highlighted both in macroeconomics and microeconomics. Barker (2020*d*) analysed brain waste in Canada where the experiences of brain waste are notable such that government programmes have been set up to tackle some of the foundation issue for brain waste such as non-skill recognition. Brain waste occurs with the underemployment or relatively higher unemployment rates of migrants at equivalent skill levels (Barker, 2020*c*,*d*). Underemployment occurs when an immigrant works part-time when full-time is desired, a job for which they are overqualified, receive a lower wage relative to natives and experience higher labour market frictions such as ones described in Dustmann et al. (2010). The case of Rome, Italy is examined in Brandi (2001) who finds evidence of underemployment with problems such as lack of recognition of qualification for non-EU citizens, the and language barrier. Clarke and Skuterud (2013) examine the reasons why immigrants in Australia perform better than in Canada, with language proficiency identified as an important barrier, with emphasis on English (and French in the case of Quebec) being smaller in Canada than in Australia. This consideration is relevant across Europe, as the knowledge of languages differ. In a number of countries, the second language learned after their mother tongue is English, which apart from in very high-skill professions or certain types of employment or in the UK and Ireland, may limit employment prospects at the correct skill level.[35] After English, the languages most spoken as a second or third language are German and French (European Commission, 2012).

There are, however, differences in results for the United States, as evident for example in the Borjas (2006) and Card (2005) debate. With focus on wages, Borjas (2006) found that the wages of the general population were unaffected but there was a decrease in unskilled wages, whereas Card (2005) did not find a negative effects on American workers'

[35]There are exceptions to this at a national where there are multiple official languages (e.g. Switzerland) and a regional level such as areas close to borders.

wages (Castles and Miller, 2000). When considering the effects on highly-skilled wages, Borjas and Doran (2012) studied the effect of highly-skilled migration on the United States in a specific field of mathematics, and found that there were declines in productivity for native mathematicians where their research overlapped with that of former Soviet mathematicians. Though as Kerr et al. (2015) pointed out, the employment of immigrants in the United States requires a visa, which in turn requires firm to support an application. Kerr et al. (2015) found that there are increased skilled employment opportunities when skilled immigrants are employed, though the expansions are for younger natives. Borjas (1995) found migration to have an overall positive impact on income (other studies, such as Ottaviano and Peri (2012), also found positive results). The studies which yield such different results make conclusions difficult as to how well economic theories explain migration. However, as Dustmann et al. (2016) explain, the issues arises through different modelling techniques.

The SVAR model results for the United States indicated negative or insignificant responses (Kiguchi and Mountford, 2019; Weiske, 2019). Dungan et al. (2013) examined the macroeconomic effects in Canada where the increase to immigration flows would make annual net migration the equivalent of a 1% increase in the population. In the case where brain waste does not exist, real GDP increases, but real GDP per capita initially increases then falls and unemployment is unaffected, though there are higher levels of investment and productivity increases. Notably, government spending increases, however, less than the increase in tax receipts.

5.1.2 Social Immigration

With respect to intra-European migration, family migrants of working age are eligible to immediately enter the workforce, even though it not their primary reason for migrating. Those of non-working-age are likely to be children rather than elderly dependents as the latter are less likely to move. Children make use of the education system and are more likely to remain in the host country as an adult and are less likely to experience brain waste as the have an education obtained in the host country. Dominguez-Mujica et al. (2012) point out that during the oil crisis of 1973, economic migration in Europe largely stopped but current migrants had their families join them; essentially creating a

long-term social immigration shock.

Some of the economic research on family migration is pre-2000, when the labour market conditions and practices were different, especially for women. In addition, there has been changes to family migration law for non-EU migrants. Unfortunately, there are limited figures on the number of family migrants and on whether and when they join the workforce. A relatively modern study by Cangiano (2014) looks at the labour market outcomes for migrants who are not economic migrants *per se*. The results show a negative correlation between the labour market openness to migrants and the gap in the employment rates between natives and migrants – notably a small gap in the Italy, Spain and the UK compared to France, Germany, and Sweden. Brain waste does extend to social or family immigration as it can deter or limit spouses from entering the labour market at the correct skill level or working full time.

Eurostat (2011) study shows that there is a significant difference across the European reporting countries in all categories. The economic activity rates for migrants aged 25-64 who entered for family reasons (aged 15 or over on entry) increase, the longer they are resident they are in a host country. However, there remains a difference of approximately 30% between men and women. On the other hand, when study is the primary reason for entry, there is a minimal gender difference in the resulting activity rates. The majority of the family migrants do search for a job (Eurostat, 2011; Cangiano, 2014). In the case of Denmark, Wagner (2015) found that EU citizenship of a spouse helps inclusion in communities. Kim and Varanasi (2019) finds that women who are partners of economic migrants are more likely to participate in the labour force if the household is credit constrained.

5.1.3 Political and Environmental Immigration

Both politically and environmentally-motivated flows refer to migrants who have been displaced from situations outside of their control, sometimes at relatively short notice – as table 5 shows, the macroeconomic responses are the same or very similar. In the medium to long-run, it is also necessary to recognise the ultimate goal of such migrants, which may be economic or related to social or family aspects. Importantly, displaced migrants are more likely to originate from non European countries making them ineligible

to work on arrival. Integrating them to the labour market is important for the economy, as otherwise they can increase the need for fiscal spending in the intervening period, as illustrated for Germany by Stähler (2017).

5.1.4 Migration and the Labour Market

One of most frequent questions regarding wages, that is considered mostly in the microeconomics is what happens to wages following immigration? The answer is category dependent as to whether the question regards high or low-skill migration, as an economy aggregate or on a microeconomic level. This question can also be extended to consider employment. In terms of the latter, migrants and natives are most likely to be imperfect substitutes meaning that new migrants are usually competing for jobs that were previously filled or more likely to be filled by previous migrants. Borjas (2003) shows that immigration decreases the wage of workers that the new migrant is competing against, and the effects of immigration on wages varies vastly between skill groups with high school dropout most affected and least affected are college graduates. At the same time, migrants are likely to have lower participation rates and higher unemployment rates though this is dependent on age, gender and skill-level (Hilgenstock and Koczan, 2018; Barker, 2020*c*), and the gender comparisons turn out for worse for the female immigrants than for the natives with equivalent skills. However, there are exceptions on participation and unemployment rates, which go beyond country differences, and relate to the skill levels – the Eurostat (2011) study shows that there is a significant difference across Eurostat reporting countries in all sectors in that regard. To examine the impact of migration on the labour market, in particular the participation rate and unemployment rate, (Bayesian) VAR models can be used.

5.1.5 Emigration and the Economy

Throughout this report, we have focused largely on immigration due to positive net migration to Europe from the rest of the world, as the majority of European countries experience positive net migration, and 24 of the 32 Eurostat reporting countries have more than 10% foreign-born residents (table 7).[36][37] There exists issues in measuring emigration

[36]Positive net migration with the rest of the world is calculated using the IMEM Database.
[37]The EU-27 countries, Iceland, Liechtenstein, Norway, Switzerland, and the UK.

flows which makes the effects more difficult to analyse (Willekens et al., 2016).

One of the largest results from emigration is the flow of remittances which for the A8 countries, Bulgaria, and Romania only amount to around 1–3.4% of GDP, with Croatia being an exception at 6.7%.[38] In terms of the labour market, a positive effect of emigration, particularly in a tight labour market from the workers' perspective, is that there are fewer workers competing for one job. When the A8 countries joined the EU, some of them experienced significant decreases in unemployment rates. The downside is in the human capital loss, as Docquier and Veljanoska (2020) point out, as for low income countries in particular it is the higher educated individuals likely to migrate. However, Docquier and Veljanoska (2020) found that skill-biased emigration is beneficial in three quarters of the countries where the benefits for developed or industrialised countries is small and large in developing countries. The countries not benefiting are primarily located in the Caribbean and sub-Saharan Africa.

Of the existing emigration literature on economic migration, there is an analysis of the effects of brain drain on the sending country's economy. Brain drain is significant as young and more educated individuals are the most likely to migrate (see Uebelmesser, 2005; Cooray and Schneider, 2016). Brain drain is a loss of human capital to a country through emigration. Education, and hence human capital, is a significant contributor to economic growth (Lucas, 1988), the lost of human capital would be detrimental. In particular, Haque and Kim (1995) found that brain drain results in lower income levels and lower growth rates. Docquier and Iftikhar (2019) analyse brain drain where the results show that skilled migration increases income and formal employment for skilled workers while it decreases the low-skilled workers' welfare, however, the results differ significantly between countries. On the other hand, Stark et al. (1997) and Beine et al. (2001) argue that brain drain has the potential to be beneficial to the sending economy. Breaking brain drain into two effects, the brain effect refers to the higher levels of human capital can be gained through an economy open to migration, whilst the negative second effect is the loss or drain of the educated workers. The net effect determines whether brain drain is positive or negative.

Docquier et al. (2014) focus on immigration and emigration in OECD countries, find-

[38]Source The World Bank. Accessed on December 11 2020.

ing that due to emigration of high-skilled workers, the remaining low-skilled workers lose out in terms of wages between 1–6% in Cyprus, Ireland, Malta, New Zealand, and Portugal lose out in terms of wages. Additionally, net emigration contributes to lower productivity of the remaining workers and increased inequality which offers a new perspective. However, this is again, dependent on the economic profile of a country.

With emigration resulting in the loss of workers, concerns are raised on the effects of GDP Using the real GDP per capita data from Eurostat, the highest average growth rates are in the CEE countries and Ireland which suggests that the emigration of CEE nationals has not had, and net effects of joining the EU have not had all negative effects. From a theoretical model, Docquier (2017) shows that emigration is likely to increase income per capita in middle and low-income countries. Based on this, the removal of migration barriers is likely to offer up economic gains. The results on the effects of emigration are mixed, as with immigration, the results depend on the country, age and skill-level of the migrant, the (relative) size of migratory flows and if remittances are sent.

5.1.6 Return Migration

Closely related to emigration is return migration – a previous emigrant moving back to their home country. OECD (2008) identifies four main reasons for return migration which covers failure to assimilate, personal preferences for the home country, the original objective of the migration decision having been achieved, and improvement of opportunities at home. A significant amount of literature assumes migration is permanent, however, OECD (2008) estimates that between 20-50% of immigrants depart within five years of arrival either to another country or return home (country-dependent). This corresponds with the findings of Storesletten (2000) who notes (and models) that return migration is quite high in the first few years but decreases over time. Additionally, Europe is less likely to retain immigrants than Canada, the United States or New Zealand. This is possibly due to immigration systems which are largely visa dependent compared to Europe's freedom of movement, or geographic location. Regarding the diminishing rate of return, the effect is due to settlement and familiarity of the host nation, a further consideration is the second generation which can change decisions of parents, and for those with older children they face the problem of splitting up the family (Djajić, 2003, 2008). Dustmann

and Görlach (2016) explain the limitations of research for return migration, one of the reasons being data source issues.

Within DSGE models, return migration can be accounted for most commonly in two-country models and overlapping generation (OLG) models. In these models, decisions are made on a number of factors. In the DSGE literature, decisions are made on job-finding probabilities and the relative attractiveness of employment prospects at home relative to the host country, although such framing is often not sufficient to fully replicate the preferences. Migrants also need to consider the difficulty in repeat migration to the host country. Borjas and Bratsberg (1996) explain that of the decisions to return home can arise from having accumulated sufficient wealth or the realisation that the migration decision could have been a mistake.

The likelihood of return migration changes depending on the origin of the migrants. For example, Borjas and Bratsberg (1996) found that Asian immigrants are least likely to return to their home nations, whilst North American are most likely to return. Two aspects contribute to decisions, economic and geographic location of the home country. Europe, generally, is economically advanced however the geographic distance can be significant for migrants from other parts of the world. In their study, Borjas and Bratsberg (1996) also found that highly-skilled migrants were less likely to return.

The issues of data and lack of macroeconomic research discussed in Dustmann and Görlach (2016) and OECD (2008) show that the challenges in researching the effects of return migration, which are compounded when the migration rates differ between countries due to geographic and economic factors. The topic is one of interest and future importance for Europe, as a number of Central and Eastern European countries economically develop in such a way that there may be increased levels of return migration.

5.2 Migration in DSGE models

DSGE models are a method of analysing the effect of shocks simultaneously in different areas of the macroeconomy. The foundations of modern DSGE models can be traced to Kydland and Prescott (1982). The dynamics relate to these models being multi-period, with agents making decisions based on past, current, and future knowledge or expectations. Agents make optimal decisions based on individual preferences modelled by

a set of equations, with firms maximising profits and households maximising utility. The stochastic aspect refers to the analysis which requires a shock, typically of one standard deviation, to a sector of the economy, such as the nominal interest rate or a form of the government spending.[39] A shock occurs to a variable, such as technology, or total factor productivity, and is subsequently amplified by the firm output, and propagated by carried-over capital stocks. General equilibrium requires all markets and agents to be balanced. Agents in the model refer to households, firms, monetary policy makers (such as central banks), and the government (with respect to the fiscal policy). The analysis is conducted in *per capita* terms, which is particularly relevant since we are analysing migration which increases or decreases the size of population. An increase in migration, ceteris paribus, in aggregate terms would result in an increase to GDP but in *per capita* terms it could increase or decrease depending on the economic contributions of the migrant relative to natives.

The use of DSGE models is closely linked to business cycle analysis, which evaluates the state of an economy whether it is above trend, either an expansionary time or slow down, or below trend when it is in either a recession or recovery period. A further introduction to DSGE models and business cycles is discussed in Section A of the Appendix.

Figure 6 gives an overview of the areas within macroeconomics that can be analysed with DSGE models. The class of DSGE models that can be used in migration-related research includes the models of real business cycles (RBC), which neutralise monetary policy (as prices are perfectly flexible), there is no inflation and the (real) interest rate is determined by market forces. The model can be calibrated by using real data, an example for the labour market on the participation and unemployment rates, or for physical capital on the depreciation rate. Elasticities of different factors can be calculated from the data. A further empirical contribution can be added through the estimation of model parameters, as well as autoregressive parameters and standard deviations of shocks.[40] An example of the model parameter is the responsiveness of fiscal expenditures. In this log-linearised rule, the parameters ϑ^z, $\zeta^{z,y}$, and ζ^{z,b^g} can be estimated.[41] The parameters are

[39] Shocks are assumed to be positive, unless explicitly stated otherwise.
[40] Shocks are predominantly stationary and modelled as AR(1) process.
[41] Equations are linearised around a steady state and the use of logs to evaluate the responses in

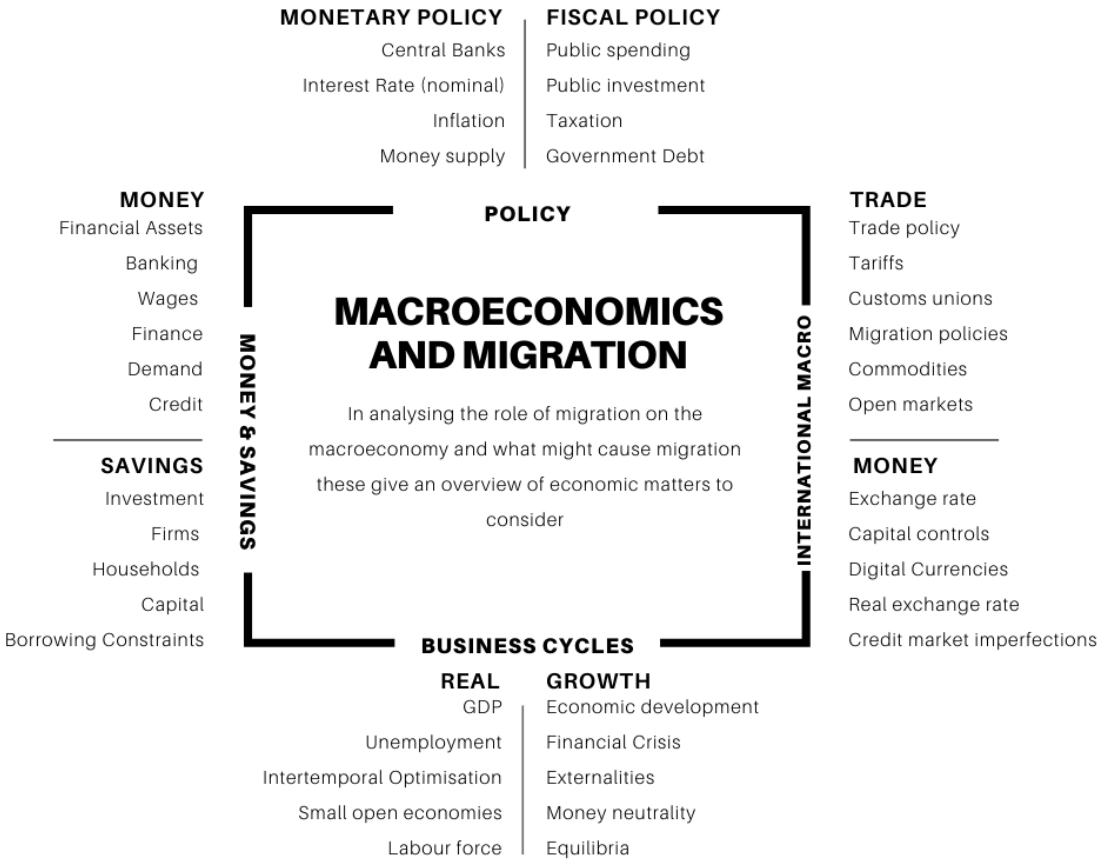


Figure 6: The Macroeconomy and Migration

The relationship between of migration and the rest of the macroeconomy is dynamic, particularly in terms of the labour market. Outside of the labour market, it is important to consider the effects on trade as migration may increase trade with a country which then relates to money through exchange rates. Satisfying all of these markets requires a dynamic general equilibrium.

the output (GDP) and government debt feedback coefficients, and ϑ^z is the persistence parameter on variable z which examples include government investment, government consumption, and household transfers.

$$z_t = \vartheta^z z_{t-1} - \zeta^{z,y} y_{t-1} - \zeta^{z,b^g} b^g_{t-1} + \psi^z_t$$

The variable ψ^z_t is shock which is a representation of an unexpected change in policy.

percentages terms - except for variables already in percentage terms such as the interest rate. The steady state of a variable is the expected value. Some variables are pre-determined, endogenously, or exogenously determined. For example, the real interest rate is pre-determined, and the steady state value of private consumption is calculated by a ratio of consumption to GDP or output (y) which has been solved through a set of equations that are a representation of an economy.

The parameter ρ^z determines the persistence of the shock.

$$\psi_t^z = \rho^z \psi_{t-1}^z + \varepsilon_t^z$$

There are two forms of migration analysis in DSGE models, one where the migration decision is endogenous, and one where there is a migration shock. By following this classification, Kiguchi and Mountford (2019), Smith and Thoenissen (2019) and Barker (2020*d*) looked at exogenous migration shocks to the US, New Zealand, Canada, whilst Canova and Ravn (2000), Barker (2020*a*) and Stähler (2017) looked at shocks related to the reunification of Germany (simulating low-skill migration), work migration, and the 2015 'crisis' migration to Germany, respectively. Papers that assess migration which is an endogenous process include Mandelman and Zlate (2012), Bandeira et al. (2018), Barker (2020*e*), and Clemens (2016). The most common result is that the effect on GDP is small, less than a percent, in response to a migration shock. For the United States, Kiguchi and Mountford (2019) and Weiske (2019), empirically show a small short lasting decrease in GDP/output with statistically insignificant amongst other macroeconomic variables. Kiguchi and Mountford (2019) use a theoretical models which also include migration as an anticipated shock which would increase GDP. The responses for other countries tend to be expansionary, even though small or not different from zero. When migration is endogenous and driven by business cycle shocks, expansionary ones to the host economy attract migrants who fill gaps in the labour market. As Stähler (2017) notes, the refugee influx to Germany had small contractionary effects on per capita GDP, however, in the long-term if the migrants are integrated into the labour market the effect could be expansionary.

In extending these ideas, we proposed to use a DSGE model is closest to Barker (2020*e*) and Bandeira et al. (2018), which uses endogenous choice based on the probability of finding a job in the foreign country. However, we extend this to include a 'third' country which is external to EU+ similar to Gadatsch et al. (2016).[42] The GDP per capita of the 'country A' (Germany), is greater than 'country B' (either the rest of Europe, or

[42] Gadatsch et al. (2016) used Germany as 'country A', the original euro area members less Luxembourg as rest of the euro area, with the rest of the world being a composite of Brazil, Canada, China, India, Japan, Russia, the United Kingdom, and the United States, which was largely exogenous relative to the closely-integrated European nations.

specifically CEE or Southern Europe), which then is greater than for the rest of the world. In such a model, intra-EU+ movements can be separated from those from the rest of the world, with migration barriers used for external flows. In such an approach, the effects of migration can be evaluated by using the business cycle shocks, rather than a migration shock.

5.3 Modelling Migration in Practice

One of the main problems with modelling migration is the lack of reliable and internationally-comparable data with sufficient length of the underlying time series. From the business cycle perspective, the variance (uncertainty) is an important aspect which it would be hoped that the existing data would be able to largely capture. Small samples, often seen in European data, prevent extensive analysis with (Structured) VAR models. Using Bayesian estimation techniques, despite including additional prior information, the results may not converge to attain smooth distributions. A second issue is raised when dealing with data that exhibits visible non-linear properties.

Given a degree of uncertainty around the exact migration flows, we can introduce a shock to the variance of the migration shock (i.e. second-order uncertainty), in a similar way to (G)ARCH or Stochastic Volatility (SV) models (Bijak, 2010; Keilman and Pham, 2004). For example, if migration is observed as an AR(1) process, were ρ is the autoregressive parameter $\rho \in (0, 1)$ and ε_t^m is an i.i.d. shock with a zero mean and constant variance σ_m^2.

$$m_t = \rho m_{t-1} + \varepsilon_t^m \epsilon_t$$

The uncertainty error, ϵ_t can be also modelled as an AR(1) process, where ρ^ϵ, is the autoregressive parameter ε_t^ϵ is an i.i.d. shock with a zero mean and constant variance σ_ϵ^2.

$$\epsilon_t = \rho^\epsilon \epsilon_{t-1} + \varepsilon_t^\epsilon$$

5.4 Further Work: Migration and Fiscal Policy Impacts

One of the unexplored areas within the empirical side of the macroeconomics of migration is the effect on government finances in response to a migration shock. The research is limited, largely due to the lack of available migration data. Of the papers that ex-

ist, d'Albis et al. (2019) is the most extensive though it uses data on an annual basis across 35 OECD countries during 1980–2015. Barker (2020*a*) examined Germany with government investment and consumption listed in the national accounts, taxes received and government debt. Barker (2020*d*) studied Canada government investment and consumption listed in the national accounts, and government net liabilities. Furlanetto and Robstad (2019) examined government spending and public finances (primary surplus). When looking specifically at the role of immigration and fiscal policy Hansen et al. (2015) find that the low levels of integration of migrants into the Danish economy is costly for the government. The calculations for non-Western immigrants in 2014 created a fiscal deficit of €2.2 billion whereas Western immigrants create a €0.5 billion surplus with the expectation that non-Western immigrants will not create a surplus by 2050. The average net contribution to the fiscal budget in 2013 values for natives is €-675, first generation non-Western immigrants €-2238 second generation non-Western immigrants €-1070, where as for Western immigrants the value is €+2546 with second generation at €+47 bringing them closer to natives. Schou (2006) explains that the integration of low-skill immigration (and their descendants) will alleviate the pressure on fiscal finances from immigration. Storesletten (2000) investigates whether changing migration policy United States would relieve pressure on the fiscal budget rising from the ageing generation which is relevant for Europe with regards to non-Western immigration as shown in the issues raised in Hansen et al. (2015). His research suggests that a focus towards increasing the admittance of 40–44-year-old high-skilled immigrants as they have the highest net present value.

As Smith (2018) explains, whether immigration has positive effects on the taxpayer depends on a number of factors including which country, the type of immigrants, the state of the economy, the relative size of government and welfare expenditure is in the economy, and whether it is long-term or short-term analysis. As other literature has seen, if immigrants integrate into the economy, the taxpayer effects are more likely to be (more) positive. OECD (2013) note that employment is the key role as to the net fiscal balance of an immigrant, especially in European OECD countries as they have larger welfare systems. The results of any study is impacted on measurement and assumptions made. Another important role, as found with other research is the age and skill level of

the immigrants, where younger and high-skill is preferable.

One appealing extension of the analysis, with clear implication for the policy impacts of migration scenario, would be to apply this framework to Europe to examine the role of total migration on different aspects of the fiscal budget with the use of quarterly data, which allows greater accuracy. We could also include Australia, Canada, and New Zealand for comparison. The analysis would use a Bayesian VAR model employing sign restrictions on the parameters describing the relationships between different variables.

6 Case Studies

6.1 General Remarks

To outline the different roles of migration that exists in Europe and applications to the areas discussed in Sections 4 and 5, we present a number of case studies. There are different groups of countries which are outlined in Table 2. The first category of country we focus on are net receivers who are net receivers of migrants both of EU+ and. non-EU+ such as Germany, France, and the UK. Net receivers where the non-EU+ positive net migration is greater than the negative EU+ net migration include the some of the highly indebted countries. Net senders who have negative net migration to the EU+ and non-EU+ include some of the Eastern European countries. Within this group, there are countries for who have a changing migration profile – once a net sender, they are becoming a net receiver as their country develops, or once a country of destination and now a net sender of migrants.

We look at a specific set of countries for different motivations. Germany is the largest host of migrants with Europe and largest economy which is an attraction for migrants of high and low skill levels. Poland has been the largest sender of migrants since it joined the European Union in 2004, though as its economy develops emigration has decreased and immigration has increased. We then consider Italy and the other peripheral euro area countries, such as Greece, Ireland, Portugal and Spain. The global financial crisis has had lasting different effects on their economy and consequently migration. Greece, Ireland, Portugal and Spain experienced negative net migration during the crisis, but all have since returned to positive net migration (although for non-EU-15, rather than

within-EU-15 migration). Finally, we consider empirically the effects of migration on the countries, with the aim of informing a model of trade and automation using an inner core country (Germany), a periphery country, and the rest of the world. A brief discussion of each group of countries is offered next, and selected individual case studies are presented in the Appendix.

6.2 Net Receivers

There are a number of countries that are net receivers within the EU+, and they tend to be the largest and most developed countries. Based on the Eurostat data, we define these include Belgium, Denmark, Germany, France, Italy, Luxembourg, Netherlands, Austria, Finland, Sweden, the UK, Norway and Switzerland. Of the A8 countries both Hungary and Slovakia have presented positive net migration figures recently, based on the data reported to Eurostat. Data from Hungary show positive net migration from Europe (including Russia and Turkey) and non-Europe, for foreign citizens since 2000, and for all citizens since 2010[43] For Slovakia, the corresponding figures, available from the Statistical Office annually from 2010 (and for selected years prior), show positive net migration both from European and non-European countries. In the Eurostat reporting sample (1990–2018), these countries have continually reported positive net migration – see Tables B.1 and B.2

Due to the existing or future negative natural population change and ageing population for the host countries, immigration is a necessity to maintain a workforce and sustainable economic growth. In the long-term, however, there number of migrants may decrease, for example due to an increased competition for migrants on the global markets.

6.3 Net Senders

The majority of EU countries are now net receivers of migrants, given that they are (highly) developed countries attracting both economic and political migrants. However, there is a small number of European countries which are still net senders. For many years, this included Poland, yet the post-2015 migration dynamics and returning Polish citizens

[43]Source Hungarian Central Statistics Office. Figures for Hungarian citizens are only available from 2010.

created positive net migration in 2018, at least in the light of the Polish official statistics reported to Eurostat. With the same caveat, in 2018 and 2019, Poland had the lowest percentage of foreign-born residents (Table 7). The countries that remain net senders of migrants include, from the EU, Bulgaria, Croatia, Estonia, Latvia and Lithuania, as well as outside of the EU, Albania, Moldova and Montenegro. Croatia's change to net sender of migrant began in 2010, and increased significantly when the country joined the EU in 2013. In the 1990s, a lot of the migration could be attributed to the conflicts in neighbouring countries, esoecially in Bosnia and Herzegovina.

6.4 The Changing Profiles

Portugal and Spain amongst other southern European countries, typical for being once net senders are now net receivers. However, due to the profile of the immigrants being low-skill and emigrants being high-skill, these countries still experience a loss of human capital. The problem is highlighted by Becker et al. (2004), who show Italy suffers from brain drain, whereas the other large economies of the (then) EU12 (France, Germany, and the UK) experience brain exchange. To try to reverse this, Italy introduced a number of tax breaks for workers who have worked outside Italy for a number of years – for expats and migrants.[44] Similarly, Greece has a variable history in terms of their migratory flows, with the years following the financial crisis causing large emigration and the following brain drain (Lazaretou, 2016). Since 2016, Greece has returned to positive net migration.

7 Conclusion and Future Work

The methodological and analytical suggestions made in this paper offer a platform for which we can study the migration in a number of scenarios in the short and long term horizon. While there are a number of challenges in predicting migration, some of the economic or non-migratory shocks have slight delays in how they influence the migratory flows. The roots of the migration crisis of 2015–16 can be traced back to the Arab Springs largely Syria (for a discussion see Zaragoza-Cristiani, 2015; Bani Salameh, 2019). The migration 'crisis' of 2015–16 had small flows to begin with, in 2011, that only at some later stage accelerated rapidly, and spreading geographically: from the countries

[44] One scheme is titled "Inbound Regime" (Kleven et al. (2020)).

neighbouring Syria (Lebanon, Jordan, Turkey), to Greece, Italy and Spain, and then to the rest of Europe. These developments could indeed have been taken as early warnings for the rest of Europe. What we can do is use these flows and their changes (acceleration of migratory movements) to forecast the growth in migration in the very short term. While the ultimate destination of Syrian migrants within EU+ was largely biased towards Germany and Sweden due to their open policy, it would be expected that the economic and demographic profile of nations would also make an influence, especially given the largest economies (in particular *per capita*), especially in Western and Northern Europe.

There are a small number of early warning systems modelling techniques within the areas of macroeconomics and finance which rose to prominence particularly after the financial crisis as a way to prevent ones from happening in the future. Early warning systems are designed to give an alert of a potential future problem, in a period of time which would give policy makers a proactive opportunity to prevent the event occurring. The aim of the system is thus to detect change in a trend or data series as soon as it happens, but at the same time to ensure that the change is real, rather than being just an effect of some random fluctuations. Hence, there are four outcomes which can occur. The model can detect a change and generate a warning which, if the change really happens, would be a true positive (TP), and if the change does not occur, would be a false positive (FP). However, even if no change is detected, it may still happen, leading to a a false negative (FN), otherwise, the lack of a warning is correct, being a sign of a true negative (TN).

The illustration for possible outcomes using early warning systems models is shown in Table 8. Thus, the system gives a correct response for TP and TN, while an FP is a sign of an over-reaction or of a misinterpretation of the signal suggesting a possible change. Similarly, FN is of concern as it indicates that the model is too 'complacent' and has missed a real change. In such cases, a re-specification of the model would be desirable to prevent future signals of change being missed (see also Bijak et al., 2017).

There are a few existing models which exist for forced migration, however, while early warning systems for forecasting environmental disasters are somewhat successful, those for forecasting migratory flows are less so (Shellman and Stewart, 2007; Bijak et al., 2017). The literature suggests that in developing early warning systems for refugee flows should

Table 8: Matrix for models signals and crises

	Crisis	**No crisis**
Signal	True Positive (TP)	False Positive (FP)
No Signal	False Negative (FN)	True Negative (TN)

Source: Lang et al. (2018)

use groups of factors: firstly, primary factors that would make the migrant consider migrating anyhow such as poor economic conditions or overpopulation (push factors); any secondary issue such as political pressures ; and finally the intervening factor which can help or hinder refugee migration such as transportation or societal network for aiding and increased border patrols or rough terrain for hindering (Schmeidl, 1997). Several messages can be taken from this – high levels of violence gave better predictions than civil rights measures. She also found that there was a strong positive effect of foreign military intervention. (Schmeidl, 2003, p. 137) provides a graphical analysis of the root causes, proximate causes, and any further factors increasing or decreasing the likelihood of migration used in early warning systems. Davenport et al. (2003) provide a cross-sectional time-series data set for 1964–1989, using 129 countries. Their results show that threats to personal integrity are of great importance in the decision to migrate and that democratic countries are ones of destination for forced migrants.

For further research, this notion and the associated methodology could be extended to cover other forms of migration, whenever suitable leading indicators can be identified. In this context, the 'digital trace' data could prove particularly useful, given their timeliness, and the time lags present in the more traditional sources. In particular, scenarios for economic migration can incorporate some aspects of the warning systems for economic crises and the occurrence of migration flows for the global financial crises, however, migration data for 2020 cannot be used in exactly the same way as borders were closed and the nature of the economic shock (caused by a pandemic) was different to previous crises.

For long-term scenarios, there are also parallels between the analysis of the DSGE models and the methods used in mathematical demography, which are worth exploring. In particular, the notion of a hypothetical *steady state* equilibrium in the DSGE framework, where the economy increases or decreases at the constant rate due to constant increase or

decrease of the factors of production, can be seen as a conceptual equivalent of the *stable population* in demography, which is growing or declining at a constant rate due to the interplay of steady increases or declines of births and deaths. With that in mind, many of the tools of the mathematical demography, including those proposed to analyse long-term and transient impacts of migration in terms of its sensitivity and elasticity (e.g. Caswell and Sánchez Gassen, 2015; Caswell, 2019), can be also applicable in the proposed DSGE-based analytical framework. In general, we see these models as a possible blueprint for modelling complex macro-level migration processes, with explicitly acknowledged micro-foundations and uncertainty.

Further extensions include modelling migration not from a perspective of a single country, but two- or three-country systems, where one or more of the countries can be country groups or even the 'rest of the world'. In this way, return migration could be included, alongside differentiating migration in different directions for example by the skill level. Encouraging examples can be found for example in Hauser (2014); Bongersy et al. (2018); Hauser and Seneca (2019); Bandeira et al. (2019) and Barker (2020*e*). This would be the way of bringing emigration, which in the current review (as in the wider literature) has not received as much attention as immigration, more to the forefront of the analysis.

The next steps of the proposed research programme will therefore involve the empirical testing of the applicability of such models for setting migration scenarios across a range of time horizons, in multi-country settings, and including the possible responses to various shock events, as well as assessing the impacts of migration on the broader economy and society. Of course, this will offer but one of the important inputs into evidence-informed European migration policy building. A separate question – and one for policy makers to address – is how much uncertainty and ambiguity in the results of models, predictions, scenarios and early warnings can be tolerated, at at what cost. This consideration goes beyond of the scope of this study, however, we hope that by providing a blueprint for creating and analysing complex and uncertain migration scenarios in a coherent manner, we can offer a valuable addition to the insights and knowledge available for policy making.

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Appendix

A DSGE Models and Business Cycles

DSGE models are a tool used for multi-period analysis in the area of macroeconomics using microeconomic foundations. The theoretical models use microeconomic foundations based on the way that the individual agents make decisions. The dynamic aspect of DSGE models refers to the multi-period horizon and how agents make their decisions based on past information, current knowledge, and future expectations. Stochasticity is a reference to what causes a change to the business cycle in steady state. When shock occurs, it is propagated through the economy, and the analysis uses impulse response to show how different areas of the macroeconomy are effected. The general equilibrium requires all markets to clear or be in an equilibrium. There are a number of markets under consideration here, and the agents make optimal decisions across these markets. The agents include households, firms, governments that set fiscal policy, and central banks who set monetary policy. Households aim to maximise utility, and firms aim to maximise profits.

Fiscal and monetary policy in DSGE models can be modelled in a number of ways. Fiscal policy can be determined by a set of rules based on the state of the economy and whether the government can afford to borrow based on their creditworthiness and limits of existing debt. Extensions of fiscal policy modelling include making net favourable decisions for its citizens. Monetary policy is eliminated in real business cycle models in which prices are perfectly flexible so no inflation occurs and there is only a real interest rate which is determined by financial markets. This form of modelling allows more focus on the core macroeconomics. In a New-Keynesian model, monetary policy sets the nominal interest rate using rules such as through applying the Taylor rule (Taylor, 1993) or similar developments thereof. These rules primarily use information including the nominal interest rate from the previous period, the current gap between the actual output and the potential output (*output gap*), the inflation rate, and a monetary policy shock.

A stage in the business cycle describes the relative health of an economy during a recurring cycle of economic states. Business cycles can last between 4-12 years on average. On the left hand side of figure A.2, there are the descriptions of the four main

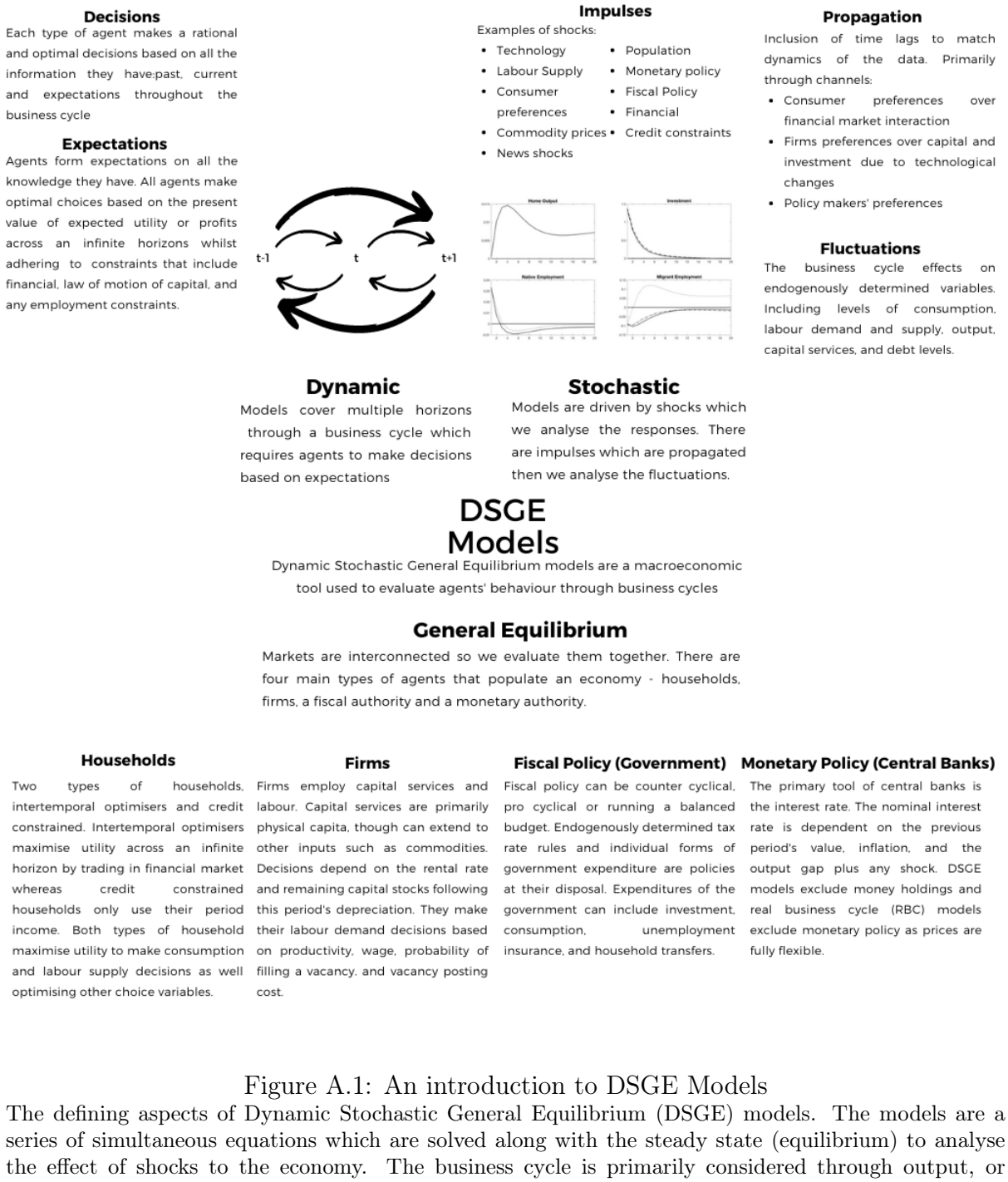

Figure A.1: An introduction to DSGE Models

The defining aspects of Dynamic Stochastic General Equilibrium (DSGE) models. The models are a series of simultaneous equations which are solved along with the steady state (equilibrium) to analyse the effect of shocks to the economy. The business cycle is primarily considered through output, or similarly GDP. To calibrate these models, we take data from sources including the national accounts, labour market surveys, and censuses, as well as existing microeconomic and macroeconomic research.

stages of a business cycle while on the right hand side there are key occurrences during each of those periods. This wave occurs around a trend which is normally on an upwards path (although exceptions exist, such as contemporary Venezuela). The data used to analyse the business cycle are called deviations from trend (the left-hand axis of figure

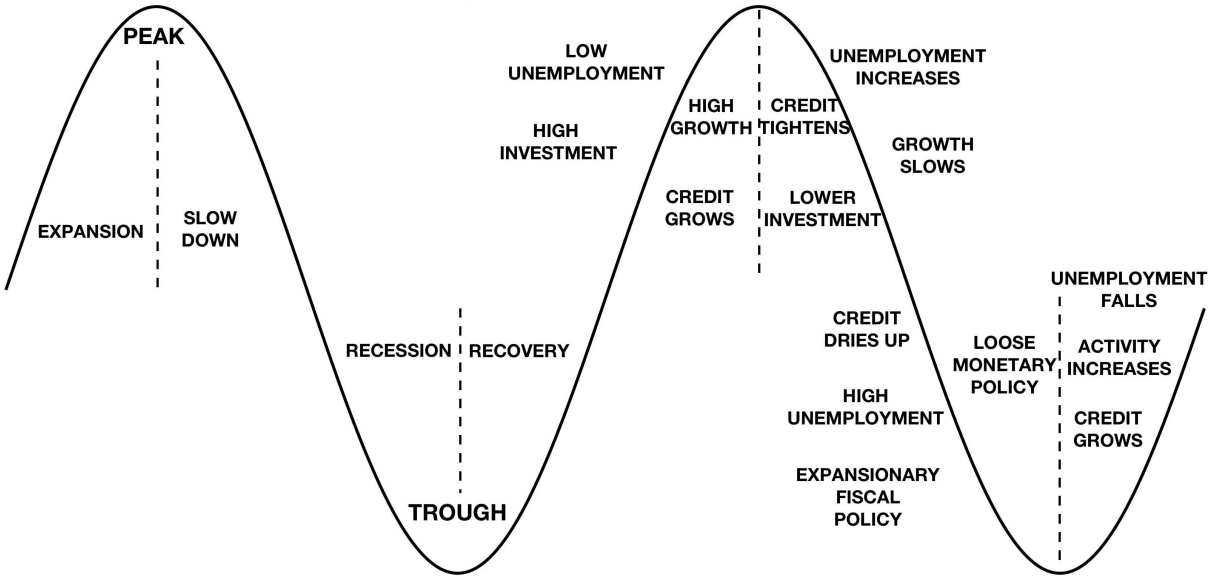

Figure A.2: Stages of the Business Cycle
By using GDP to describe the stylised stages of the business cycle, the diagram displays different processes that occur during these stages

A.3). In the figure, we refer to expansionary fiscal policy which is based on the use of countercyclical fiscal policy. Governments use countercyclical forms of policy, designed to support the economy in a recession through the recovery stage. During the expansionary period, the government tries to balance its books with either increase in taxes or reduction in government expenditures (also known as austerity, especially in the United Kingdom). Figure A.3 shows the business cycle for Germany and the UK for 1993Q4:2019Q4. The cyclical component of the data is based on the deviations from the estimated trends. The main features of the cycle are prominent, especially the global financial crisis, where both countries experience a significant decrease from trend. The trends differ in the period 2003–05, where Germany is below trend while the UK is above trend, and Germany also experiences more deviations prior to and after the crisis.

B Net Annual Migration Flows: Eurostat and IMEM estimates

Tables B.1 and B.2 show the Eurostat data of net migration flows (1990-2018)which are reports from the national statistic offices along a set definition of migration. Table

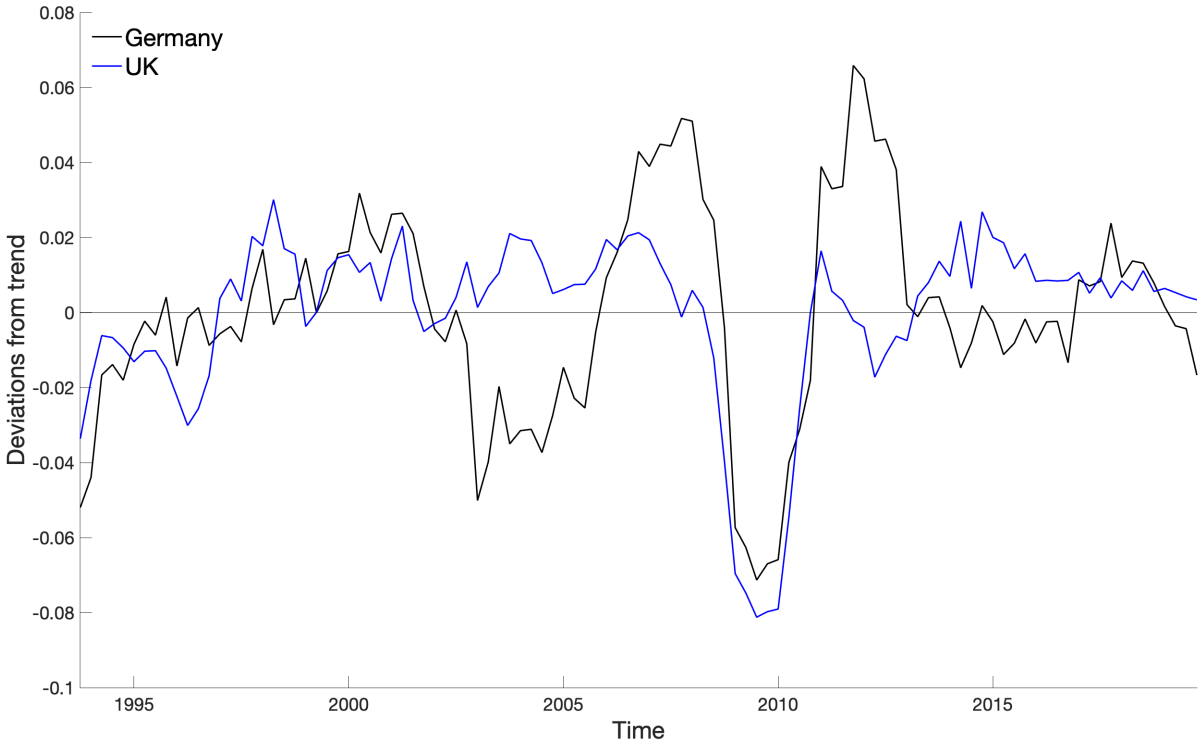

Figure A.3: Business cycles of Germany and The UK 1993Q4:2019Q4
The cyclical component of German and UK real GDP per capita that represents the stage of the business cycle. Cyclical component is computed with the Hamilton (2018) filter.
Sources: GDP OECD ; Population for Germany - Destatis, UK - ONS.

B.3 shows the estimated migration flows (2002-2008) in the database by the Integrated Modelling of European Migration (IMEM) project which was completed in 2012. The role of the IMEM project was to provide a more accurate estimate of migration flows for countries in Europe including net migration to the rest of the world, harmonised to a common definition (12-month usual residence as a qualifying criterion for migrants). The differences between the Eurostat and IMEM estimates are due to a range of factors, notably including undercount in the observed data, especially emigration, differences in the definitions and in the accuracy of data collection mechanisms (Raymer et al., 2013). Note that the IMEM estimates for Croatia are not available.

The aim of the IMEM work was to provide a general framework for modelling migration flows amongst countries in the world in the context of inconsistent, inadequate and missing data. The focus was on international migration flows amongst 31 countries in the European Union and European Free Trade Association, for 2002-2008 period, so EU+ minus Croatia, which at the time was not yet a member of the EU.

Table B.1: Net Migration Flows 1

Year	BEL	DNK	DEU	IRE	GRC	ESP	FRA	ITA	LUX	NED	AUT	POR	FIN	SWE	UK	ISL
1990	30160	8332	645655	-7550				110765	3942	60006			7081	34852		-681
1991	33708	10938	602523	-875	87350			69205	4173	62921		-32829	13017	24986		1007
1992	33056	11462	782071	6325	57945			56931	4257	58092		-9357	8499	19622		-254
1993	18938	11056	462096	125	54533			39119	4243	59932		11423	8390	31998		-203
1994	29617	10251	314998	-3525	40146			33557	4004	38564		24273	2939	50937		-760
1995	26906	28557	397935	6325	51022			53407	4622	32778		31412	3265	11903		-1418
1996	24848	17133	282197	12225	40957			124457	3672	43424	3880	37123	2707	6011		-444
1997	19529	11712	93664	17850	61683			116584	3832	47640	1537	41407	3710	6275		69
1998	11725	11032	47098	17400	56292			110996	4056	61966	8451	45690	3375	10873	133456	880
1999	17527	8896	201975	23850	30520			120179	4719	60128	19787	54257	2778	14134	108737	1122
2000	14068	9498	167120	31100	62258			170367	3644	71649	17204	67108	2584	24568	86804	1714
2001	35149	12004	272723	39175	52562			152175	3311	70086	17274	56213	5802	28654	120837	968
2002	37897	9297	219288	33350	27842	446655		171446	2649	54522	33294	41798	5222	31078	79970	-275
2003	32661	6288	142645	31675	25708	444051		391595	5412	35629	39873	24738	5755	28772	117527	-133
2004	33341	4843	82543	49400	28830	629469		364970	4392	18970	50826	14336	6677	25442	207708	530
2005	45911	6589	78953	67650	32350	651273		251029	6110	8898	44332	15381	8986	27111		3860
2006	49536	9964	22791	95025	24726	698548	112141	221307	5351	10122	24103	17141	10344	50842	159538	5255
2007	55357	23090	43912	74375	22898	731201	73626	476010	6001	25532	22964	21771	13586	54067	209127	5132
2008		19001	-55743	16658	23485	310643	56812	453765	7700	53449	22209	9361	15457	55877	163035	1144
2009		11901	59634	-19068	14927	12841	32339	362343	6583	30092	16051	15408	14548	63040	198337	-2953
2010	69268	10780	151599	-25760	-1579	-42672	37580	380085	7660	30806	19327	3815	13731	49948	251644	-1511
2011	63229	11240	240377	-25757	-32315	-37703	28222	303332	11004	25917	31033	-24331	16821	45288	215341	-739
2012	35877	10746	352174	-20473	-66494	-142553	71509	244556	10036	14135	39745	-37352	17433	51312	176823	202
2013	17421	17002	433385	-11021	-59148	-251531	98939	181719	10348	16803	47795	-36232	18048	65130	209112	2034
2014	28585	23962	560672	2412	-47791	-94976	32280	141303	11049	32423	62771	-30056	16021	75729	312905	1316
2015	56832	33867	1232644	13632	-44905	-1761	39704	133123	11159	54542	109634	-10481	12441	78410	332269	1589
2016	31231	21729	496090	23129	10332	87421	64087	143758	9446	77755	65081	-8348	16823	117127	248553	4551
2017	37013	12176	356409	14431	8920	163272	45490	188330	10548	81415	45657	4886	14824	98869	284544	8475
2018	48925	4288	353471	43977	16440	334158	45490	175364	10659	84671	38421	11570	11965	85621	259606	7458

Migration Flows calculated using Eurostat table migr_imm8 (immigration) and table migr_emi2 (emigration). Blank cells indicate either no data or one of immigration or emigration data is unavailable.

Table B.2: Net Migration Flows 2

Year	LIE	NOR	CHE	CYP	MLT	BGR	EST	CZE	HRV	LVA	LTU	HUN	POL	ROU	SLN	SLK
1990		1710	56643								-8848		-15814		2167	77
1991		8045	61440						1403	-15045	-10675		-15937		-3071	1225
1992		9942	40156						39465	-53474	-25332		-11603		-387	1978
1993		12808	39512						48533	-32333	-23990		-15452		1355	1751
1994		7436	30883						23263	-22823	-24195		-18997		936	4768
1995		6367	14458						26613	-13713	-23668	12262	-18223		2507	2842
1996			-5807						34569	-10081	-23369	11342	-13111		6510	2255
1997		10700	-6834						33812	-9420	-22421	11620	-11796		2442	1731
1998		13823	1177						44474	-5751	-22122	14210	-13261		-2105	1306
1999		18999	16149						18625	-4085	-20739	18601	-14011		2335	1454
2000		9688	20224				-1749			-16428	-20306	19186	-19668		2615	1463
2001		7955	41843				-1934	-8551	16927	-19163	-23147	19488	-16743		2992	1012
2002		17174	48921	5466			-1463	12290	8598	-9195	-11609	16729	-17945		1865	901
2003		11285	43027	6285			-2106	25789	11921	-11584	-21555	18205	-13765		3412	1409
2004		13211	40462	7090			-1830	18635	11571	-15323	-32138	20478	-9382		1902	2874
2005		18439	36180	8128			-3174	36229		-10952	-51096	24162	-12878		6436	3403
2006		23723	39368	10299			-3293	34720	7286	-8807	-24645	21418	-36134		6267	3854
2007		39652	75459	15222	1562	-1397	-643	83945	5620	-7946	-21774	19861	-20485		14250	6793
2008	88	45147	98167		2324		-735	56789	6245	-22367	-16453	28061	-14865	-163867	18584	7060
2009	129	38881	74587	17784	2293		-774	13838	858	-34477	-32013	17411	-40154	-110782	11508	4367
2010	163	43379	64939	15913	74		-2484	-12752	-4171	-35640	-77944	12154	-62995	-48100	-521	3383
2011	183	49988	52305	18142	1659		-2505	-28796	-4165	-20077	-38178	12918	-108739	-47866	2059	2966
2012	232	47215	45170	-629	4251	-2512	-3682	-11769	-3918	-11860	-21257	10822	-58057	-2920	644	3416
2013	199	41790	53961	-12078	6119	-1108	-2631	4230	-4884	-14262	-16807	4277	-56135	-8109	487	2379
2014	139	37595	45179	-14826	9346	-2112	-733	1429	-10220	-8652	-12327	12368	-46024	-36836	-490	1713
2015	189	31643	36996	-2000	9841	-4247	2410	3918	-17945	-10640	-22403	15119	-40690	-61923	507	3127
2016	85	26766	28652	2499	8748	-9329	1030	25219	-22451	-12229	-30171	13729	-28139	-70123	1051	3885
2017	219	21388	18380	6201	14656	-5989	5258	24531	-31799	-7808	-27557	28241	-9139	-64758	1253	3722
2018	165	20706	14632	8102	17102	-3666	7071	39168	-13486	-4905	-3292	34759	24289	-59083	14928	3955

Migration Flows calculated using Eurostat table migr_imm8 (immigration) and table migr_emi2 (emigration). Blank cells indicate either no data or one of immigration or emigration data is unavailable. HRV = Croatia.

Table B.3: IMEM Estimates of Net Migration Flows

Year	BEL	DNK	DEU	IRE	GRC	ESP	FRA	ITA	LUX	NED	AUT	POR	FIN	SWE	UK	ISL
2002	24317	1769	34887	-1134	14087	207507	100091	175701	2382	-17210	22246	-3244	7305	37656	89899	-214
2003	24586	846	23868	-226	13925	235521	97987	181743	1880	-24027	23013	-3767	7811	37547	100309	194
2004	25272	1383	32774	10391	18186	254912	101370	185233	3239	-28119	29546	-5415	8883	35827	172625	590
2005	26383	1754	29704	12121	16099	270745	108499	184199	2975	-32918	27326	-4653	9712	38572	188799	900
2006	27774	2353	18964	15428	17612	305846	114180	193712	2813	-33434	21848	-8118	10954	50393	204227	1083
2007	28269	5705	6455	18216	21235	350603	122863	210628	3913	-27731	24469	-9324	12678	54322	212427	2056
2008	31281	5528	-22062	16495	22007	289528	125120	208771	1943	-17523	24939	-7448	13892	53289	219382	793

Year	LIE	NOR	CHE	CYP	MLT	BGR	EST	CZE	HRV	LVA	LTU	HUN	POL	ROU	SLN	SLK
2002	128	9847	13438	6059	190	-23493	-2560	-10887	N/A	-4261	-7847	8656	-50831	-81145	12819	55
2003	123	9216	15705	5740	113	-23129	-2430	-11000	N/A	-4127	-7695	9534	-51196	-85171	13776	1045
2004	100	11793	17333	6321	-432	-22703	-4217	-14564	N/A	-6037	-15679	-1925	-142702	-86281	12314	-4014
2005	128	15074	18072	6462	-553	-22097	-4318	-12792	N/A	-6240	-15654	-1793	-154045	-85801	13211	-4328
2006	163	18161	21358	6084	-732	-24425	-5001	-14193	N/A	-6420	-16989	-4080	-179288	-91032	13793	-4261
2007	182	23851	26883	8164	-606	-48051	-5146	-11131	N/A	-6539	-17609	-5307	-166809	-160314	13291	-3534
2008	164	25119	24919	8497	-988	-38171	-5281	-13704	N/A	-6627	-16717	-6001	-153719	-112282	13903	728

Estimate migration flows by the Integrated Modelling of European Migration (IMEM) Database.
Source: IMEM Database

C Selected Case Study Countries

C.1 Germany

Germany is the most populous country in the EU+ and host to the highest number of migrants.[45] Migration plays an important role economically and politically, particularly since the migration 'crisis' of 2015.

We first analyse annual migration in Germany shown in Figure C.1 from 1964–2019 where net migration is driven predominantly by immigration, including the 'Guest worker' (*Gastarbeiter*) schemes, rather than emigration. There are large increases in 1970 and 1980, caused by the changes in migratory patterns in Europe due to their large relative size (see Figure C.2). The period 1988–1991 covers the collapse of the Soviet Union and the reunification of Germany. The increase from 2011 is related to the A8 countries being allowed free access to the German labour market, as a permit system was employed during the intervening period. Germany and Austria did not allow freedom of movement to protect employment and wages of existing residents for the longest possible transitory period of seven years.[46] In this period, some studies have indicated a small positive migration effects for the natives, but small negative effects for existing migrants (Felbermayr et al., 2010). Finally, the migration 'crisis' of 2015 caused net migration to exceed 1 million people for the first time.

Migration is important to maintaining Germany's labour supply, as the working-age population would be decreasing without migration.The majority of migrants are working-age, where the average age of migrants is 37.3 for men and 38 for women, compared to 45.7 for natives (Barker, 2020*a*). Research into the labour market has shown there is an estimated 1.2 million unfilled vacancies in Germany and a VBW (2015) forecasted shortage of 3 million skilled workers by 2030. Fewer workers results in longer working hours for those employed. To counter these negative labour market effects, particularly of skilled workers, the Bundestag introduced *Fachkräftezuwanderungsgesetz* which relaxes constraints on non-EU skilled migrants (Deutscher Bundestag, 2019).

[45]The highest relative figure of foreign-born residents is Liechtenstein, Luxembourg and Switzerland of the Eurostat reporting countries as shown in Table 7

[46]The United Kingdom, Ireland, and Sweden were the only countries who did permit freedom of movement already in 2004.

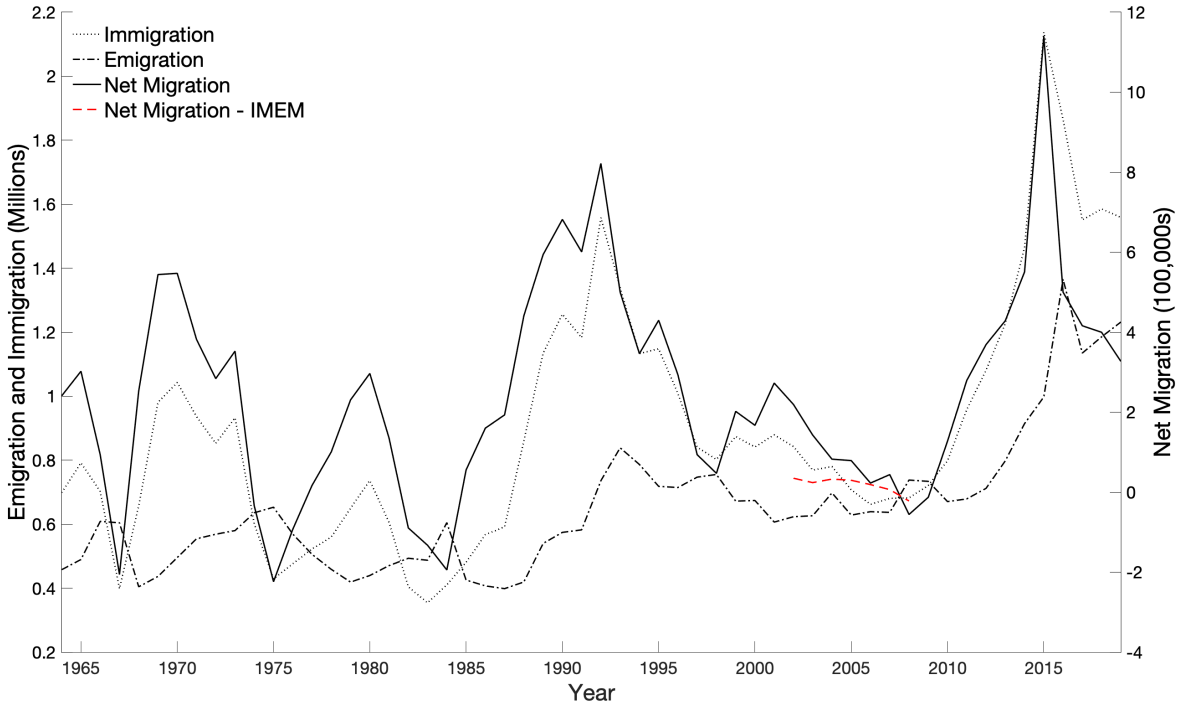

Figure C.1: Annual Migration in Germany 1964-2019

Immigration is identified by the dotted line in millions of people, emigration by the dash dot line in millions of people. Net migration is shown by the solid line in 100,000s of people. Figures prior to 1991 are for West Germany only.

Source: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany. Table 12711-0003

The red line is the net migration estimate by IMEM Database.

Source: IMEM Database

For a relative perspective of the size of migration flows, we examine the net migration rate per 1000 people as shown in Figure C.2. This is also known as the crude rate of net migration. This perspective allows the examination of relative size particularly pre and post reunification.

There has been a substantial change in the origin of migrants, while European migration dominates, there is a rise in the number of migrants from Asia. The percentage of the origin of immigrants and destination of emigrants is shown in figure C.3. Given the diverging trends, predominantly the increasing flows from Asia which covers more than the migration crisis of 2015, we argue that estimating by origin offers potential gains in the accuracy of forecasting. Indeed, Docquier (2018) forecasts that there will be substantial increases in migration from sub-Saharan Africa and MENA (Middle East and North Africa) countries.

Figure C.2: Net Migration Rate - Germany

The net migration rate is defined as annual net migration per 1000 people. Figures prior to 1991 are for West Germany only. Authors' own calculations with data from Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany tables 12411-0001 and 12711-0003

We suggest to focus the macroeconomic research on Germany for a number of reasons: it is the largest economy in Europe, it is has the highest flow of migrants, has detailed migration data, and the study on automation is of great significance to Germany. There also exists some research on migration in Germany such as Barker (2020*a*), Clemens (2016), and Faccioli and Vella (2020) on the macroeconomic side using empirical and theoretical models.

C.2 Poland

Poland has been long known as a migrant sender, the largest in Europe given the population size, however, its migration profile is changing. The country has a long history of emigration to Germany and the US, and of being an immigrant host for Eastern European nationals, especially from the former Soviet Union (Ukraice). Since joining the common labour market in 2004, a popular migration destination became the United Kingdom. Polish is the second highest non-UK nationality group in the UK behind In-

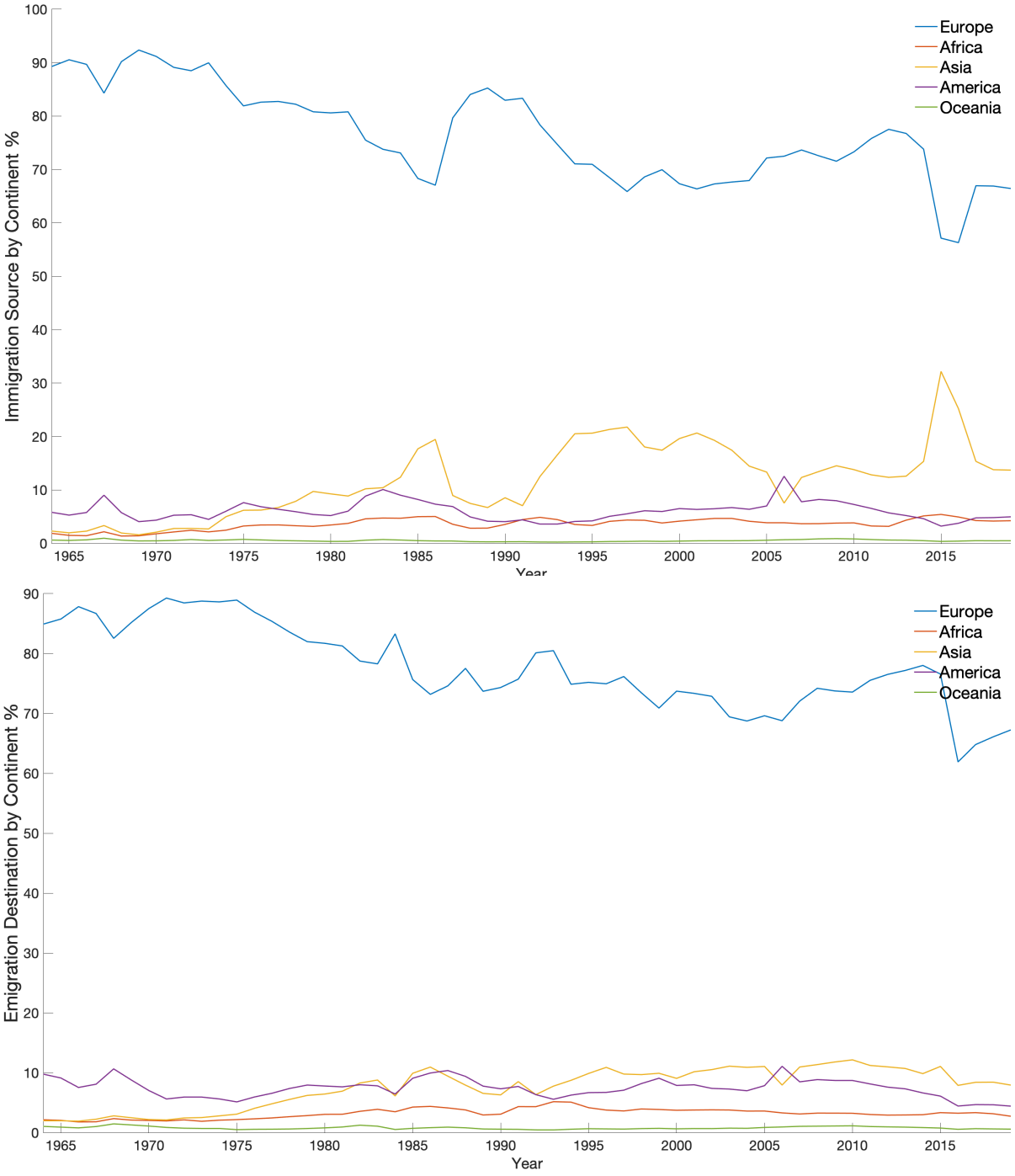

Figure C.3: Source of immigrants and destination of emigrants to/from Germany by continent 1964-2019

The upper panel shows the source continent of immigrants and the lower panel the destination of emigrants in percent. Figures prior to 1991 are for West Germany only. Source: Statistisches Bundesamt (Destatis) - Federal Statistics Office Germany. Table 12711-0003

dia, which overtook Poland only in 2018. [47] The dominant direction of migratory flows

[47] Source ONS accessed on 12 November 2020.

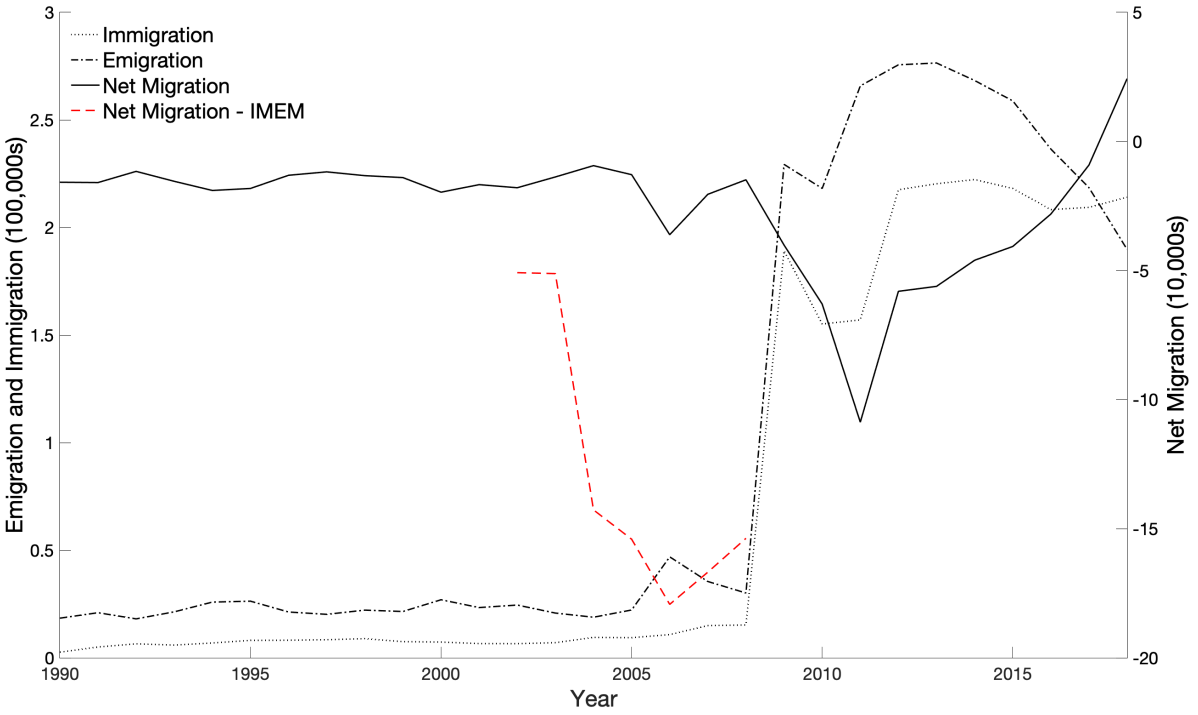

Figure C.4: Annual Migration in Poland 1990-2019

Immigration is identified by the dotted line in 100,000s of people, emigration by the dash dot line in millions of people. Net migration is shown by the solid line in 10,000s of people.
Source: Eurostat.
The red line is the net migration estimate by IMEM Database.
Source: IMEM Database

concerning Poland switched during the financial crisis as many emigrants returned due to the favourable macroeconomic conditions than in countries such as Germany, given that Poland did not experience a recession as shown in Figure C.7 in terms of the real GDP per capita.

The officially-reported Polish net migration has for the first time turned positive as shown in 2018 B.2. The marked increase in immigration can be attributed to Ukrainian workers, with 235,600 work permits issued in 2017.[48] Poland is an attractive destination for Ukrainians given the shared border, historical ties, and a relatively booming Polish economy (at least pre-COVID pandemic). A policy implemented in 2019 was to give a tax break, cutting income tax to 0%, to under 26s earning 85,528 zloty (approx €19,000) to act as incentive for Polish emigrants to return and to reduce the push factor of the

[48] Forbes Ukrainian Immigrants Give The Polish Government An Out On Refugees - Accessed on 12 October 2020.

migration process; equivalently intending to reverse and prevent brain drain[49], where the average annual salary in Poland in 2019 was 58,400 zloty (€12,900)[50]. Encouraging migrants to return to Poland is important for the future of the economy as a low fertility rate, the smallest percentage of foreign-born workers, a large anti-immigrant rhetoric and a shortage of labour present a looming and ever-increasing challenge. Whilst brain drain has negative implications, the large inflow of remittances and benefits of emigration regarding the labour market could have also helped Poland. When Poland joined the EU, there was large unemployment and a reduced number of workers meant less competition domestically, but with an increase in income through remittances. Overtime, the Polish economy has developed, which is notable in its GDP per capita. It is still lower than the EU-15 but has closed the gap significantly.

C.3 Italy

Italy is one of the G7 nations but has a different migration profile from the others, such as Germany, Canada, the UK and US, with a lower real GDP per capita [51]. Prior to the global financial crisis, Italy had a similar real GDP per capita to France, Germany and the UK. Since then, however, it has stalled and regressed as shown in Figure C.6. As one of the highly indebted euro area countries, or peripheral countries, the real GDP per capita in 2000 was marginally smaller than in Ireland, at €33,290 and €27,430 respectively, by 2019 the gap had grown such that Ireland's was more than twice Italy's at €60,170 and €26,920 respectively.[52]

Figure C.5 shows the origin continent of immigrants and destination country of emigrants for Italy. In contrast to Germany, Africa is the second most common origination country behind Europe rather than Asia. Specifically, immigration from Europe accounts for just over one third of the total, with Africa and Asia converging, whereas European immigrants to Germany account for approximately two thirds. As for emigration, the share of emigrants destined for other European countries is increasing for Italy but decreasing

[49]Source Polish Ministry of Finance Accessed on 12 October 2020.
[50]Source: OECD statistics
[51]We exclude Japan from this analysis as net migration is incredibly low in comparison. Japan's net migration rate is typically 0.540–0.580 per 1,000. The US averages 3–4 and above 5.5. The remaining European countries are listed in Table 6.
[52]Source: Eurostat Real GDP per capita [$SDG_0 8_1 0$]

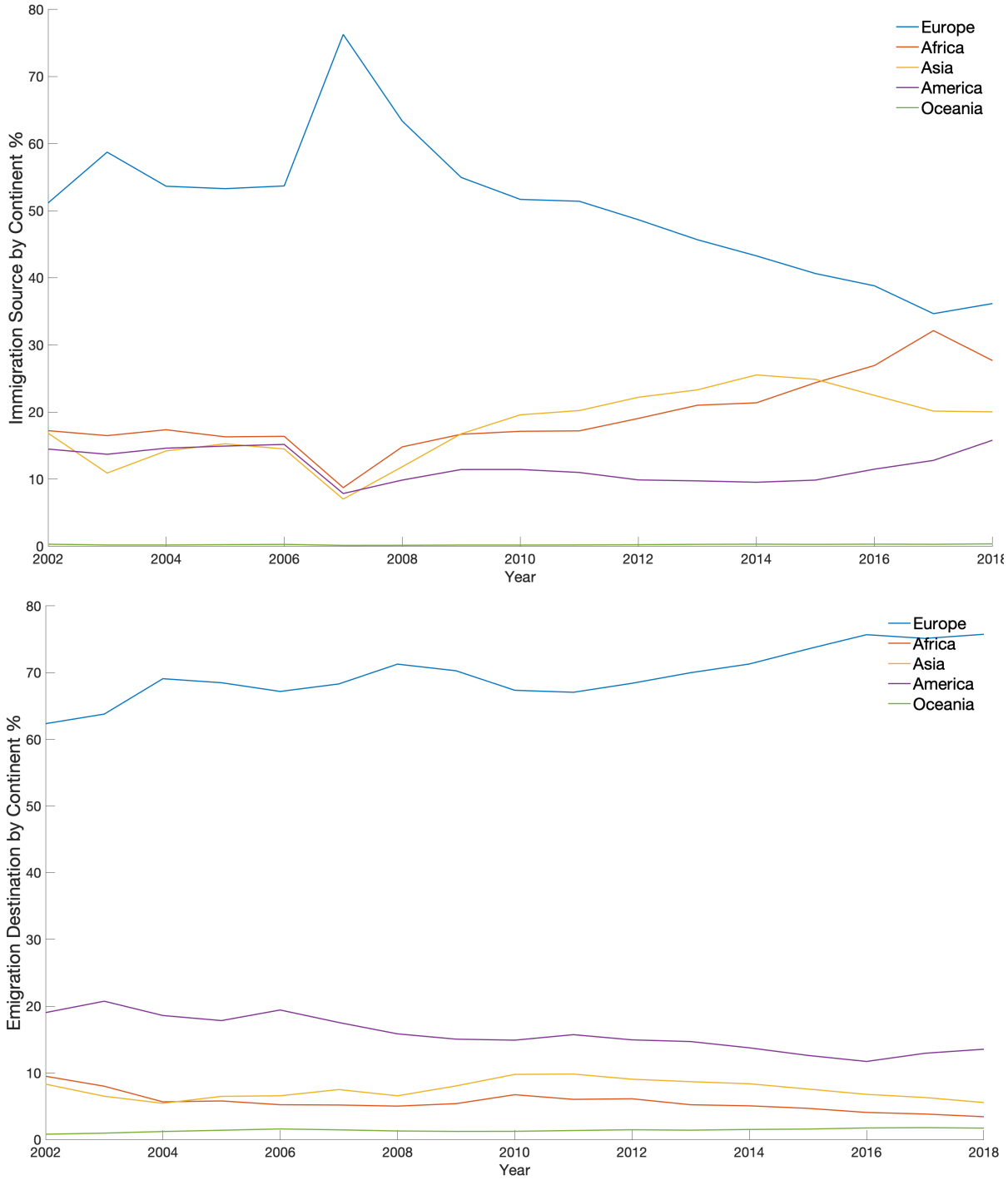

Figure C.5: Source of immigrants and destination of emigrants to/from Italy by continent 2002-2018

The upper panel shows the source continent of immigrants and the lower panel the destination of emigrants in percent.

Source: Istat - Istituto nazionale di statistica (Italian National Institute of Statistics)

for Germany with approximately 75% and 66% respectively. This profile supports the classification of Italy in inner periphery rather than inner core in Table 2. Whereas brain drain could be seen as being in part positive for Poland, it is clearly negative for Italy as the benefits in terms of remittances are not observed, and – as in the case of Poland – Italy is running tax break schemes to get high-skilled migrants and Italian emigrants to come or return to Italy (Kleven et al., 2020). The large flows of low-skill migrants keeps net migration above zero, but the general outlook for the economy is largely not positive as it has one of the lowest birth rates in Europe, ahead of only Spain and Malta at 1.3.[53] A stagnating economy is not one that is also attractive to EU-15 migrants, and the increasing trend in emigration of Italians and non-Italians to Europe and declining immigration illustrates this.

C.4 Peripheral Euro Area Countries

Portugal, Ireland, Italy, Greece and Spain (PIIGS) or the peripheral euro area countries are primarily linked by their similar financial profile of being highly indebted relative to other Euro area countries, and the use of bailouts during the financial crisis. All five are euro area members, which were heavily leveraged prior to the crisis (Italy, though, on a larger absolute scale than the others). Italy, being the third largest euro area country was simply too big to bailout, so alternative arrangements were put in place to secure the debts and protect the Euro currency.

While the financial profile is related, the migratory experiences of the peripheral countries differ, as shown in Figure C.8. For a number of years prior to the crisis, these countries were largely senders of skilled migrants to north and western European countries. However, since the start of the 2010s, the total net migration has gone from negative to positive, as they receive large numbers of migrants from outside of Europe. During the European migration 'crisis' of 2015–16, Greece, Italy and Spain, due to their location, were the arrival countries for many migrants. For Italy and Spain this would entail dangerous crossings from Africa by boat across the Mediterranean. Spain, on the other hand, has received a large number of Venezuelan migrants due to their former colonial links. Figure C.9 shows the net migration rate to analyse their relative sizes. Though Spain and

[53]Source: The World Bank.

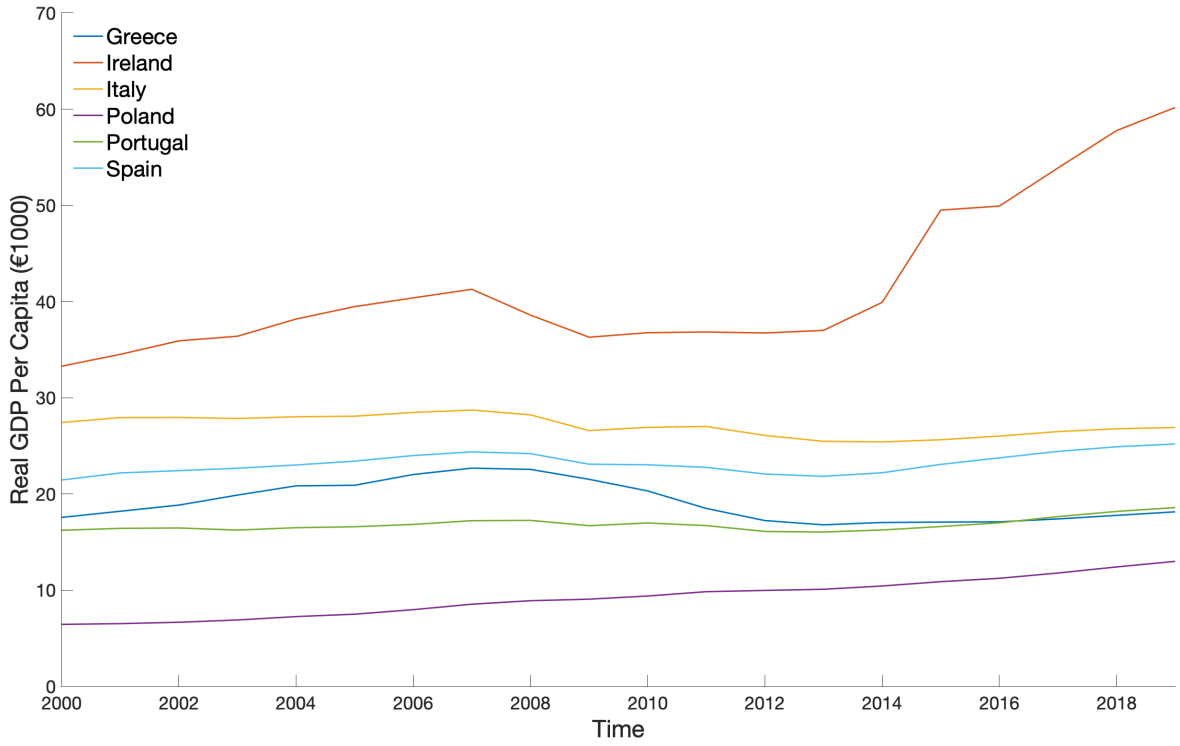

Figure C.6: Real GDP Per Capita 2000:2019

Real GDP per capita for Portugal, Ireland, Italy, Greece, Spain and Poland. Figures in chain linked volumes (2012), euros per capita.
Source: Eurostat SDG_08_10

Italy receive the highest absolute numbers of migrants, Ireland experiences higher relative flows than Italy. Ireland has also experienced high levels of immigration prior to the financial crisis as migrants were attracted by the booming economy. The financial crisis lead to similarly high emigration, as workers moved elsewhere to find favourable labour market conditions, and the emigration had a positive effect in the sense that the unemployment rate was lowered, and the per capita debt increased, ceteris paribus. Ireland only relatively recently experienced a return to positive net migration, which coincides with the positive business cycle effects, suggesting migration to Ireland is procyclical.

For some of these countries, emigration is of greater concern as it is usually their high-skilled workers leaving to experience more favourable economic conditions elsewhere in Europe, in particular, in France, Germany, as well as in Switzerland. Moreover, particularly Spain has a problem with attracting high-skill migrants, not only is there high opposition from trade unions, but also the recognition of skills which are regulated, such as for medical professionals, is problematic (Finotelli, 2013). Non-regulated professions,

Figure C.7: Business cycles of peripheral euro area countries and Poland 2002Q4:2019Q4
Percentage deviations from trend of logged real GDP per (working age) capita 2002Q4:2019Q4. The cyclical component is calculated using the Hamilton (2018) filter. This uses national currency
Source: OECD

on the other hand, such as researchers, are unaffected, as they do not need official Spanish recognition to be employed. Time lags involved in the recognition process can lead to the native workers being employed instead of migrants, and thus Spain's migrant population is largely comprised of low-skill workers. Still, during and following the economic recovery, there was a boost to increase high-skill migration, and even international university student numbers, with hope of attracting them permanently to Spain.

In general, migration flows can obviously impact the activity and employment rates of a country, and there are often differences between these rates for immigrants and natives, and between different groups of migrants. [54] In Figure C.10, we show the quarterly values for Greece, Ireland, Italy, Poland, Portugal, and Spain from 2000Q1 to 2019:Q4.[55]

[54]The activity rate is the number of working-age people in employment or searching for employment relative to the total working-age population, expressed as a percentage. The employment rate is the percentage of the working-age population who are employed (in full or part-time work) expressed as a percentage. The unemployment rate is *not* the difference between the two figures, but is defined as the number of unemployed working-age people relative to those who are unemployed and employed, and expressed as a percentage. This does not include people who are not economically active.

[55]These figures have not been seasonally adjusted, hence the seasonal patterns.

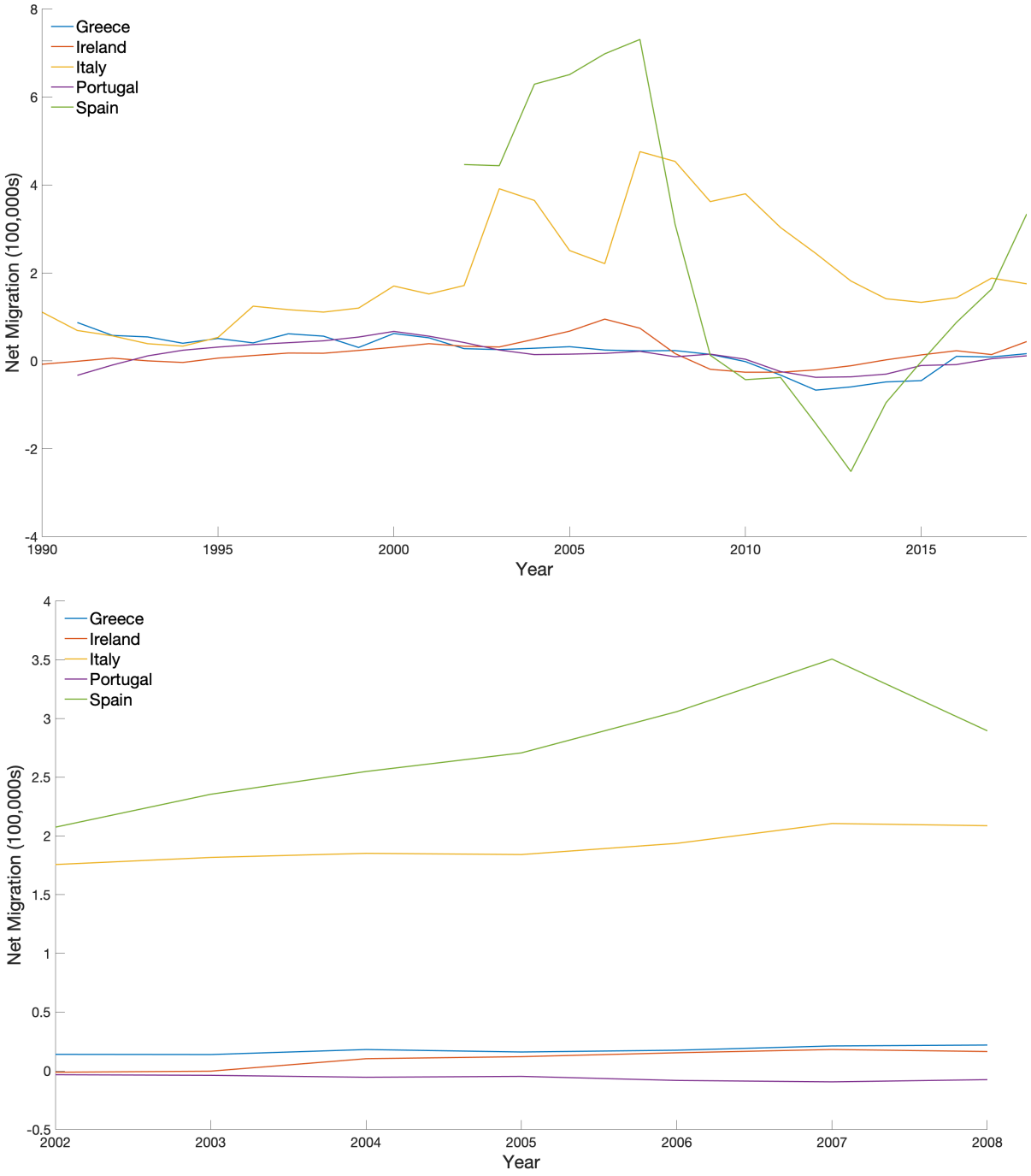

Figure C.8: Annual net migration in peripheral euro area countries
Net migration is shown in 100,000s for Greece, Ireland, Italy, Portugal and Spain. Figures for Ireland and Italy are available from 1990, Greece and Portugal from 1991, and Spain from 2002.
Source: Eurostat. The lower panel shows the estimate by IMEM Database.
Source: IMEM Database

The figures from Eurostat are available in categories for different groups of nationalities and the reporting country (or natives) from 2006Q1; in this selection we show EU-15,

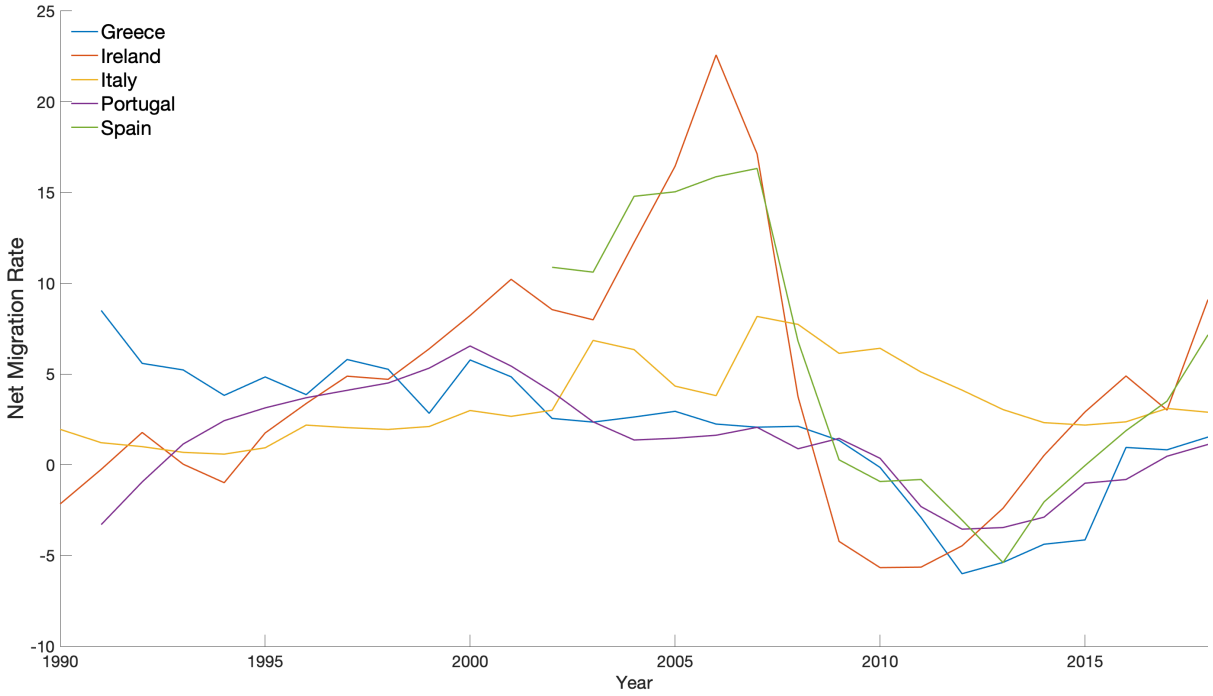

Figure C.9: Net migration rate for peripheral euro area countries
The net migration rate is defined as net migration per 1000 people. Net migration rate is shown for Greece, Ireland, Italy, Portugal and Spain. Figures for Ireland and Italy are available from 1990, Greece and Portugal from 1991, and Spain from 2002.
Sources: Eurostat population and net migration.

EU-28, all foreign nationals, and reporting country as well as the total for the country. It can be noted that he activity of natives is the lowest in Ireland, Spain, Italy, Poland and Portugal but second lowest in Greece. The rates for EU-15 nationals are likely to be close to the corresponding values for natives. The EU-28 migrants have, on average, the highest activity rates in Ireland, Spain and Italy, with the totals for all foreign nationals being the largest in Greece and Portugal. Where the inclusion of all foreign nationals changes the order significantly this is due to the activity rates of non-EU-28 migrants. Their differences to natives are typically in the region of 2–8% with Poland average difference of 10.24% lo EU-28 and 12.25% to EU-12 migrants.

The employment rates for the EU-15 migrants are the highest in Ireland, Spain, and Poland, and for all EU-28 migrants in Greece, Italy, and Portugal. Natives have the lowest employment rates in Ireland, Italy, and Poland; EU-15 is the lowest in Greece and all foreign nationals are lowest in Spain and Portugal which is driven by non-EU-28 migrants. To contrast that with a different migration and country profile, in Germany,

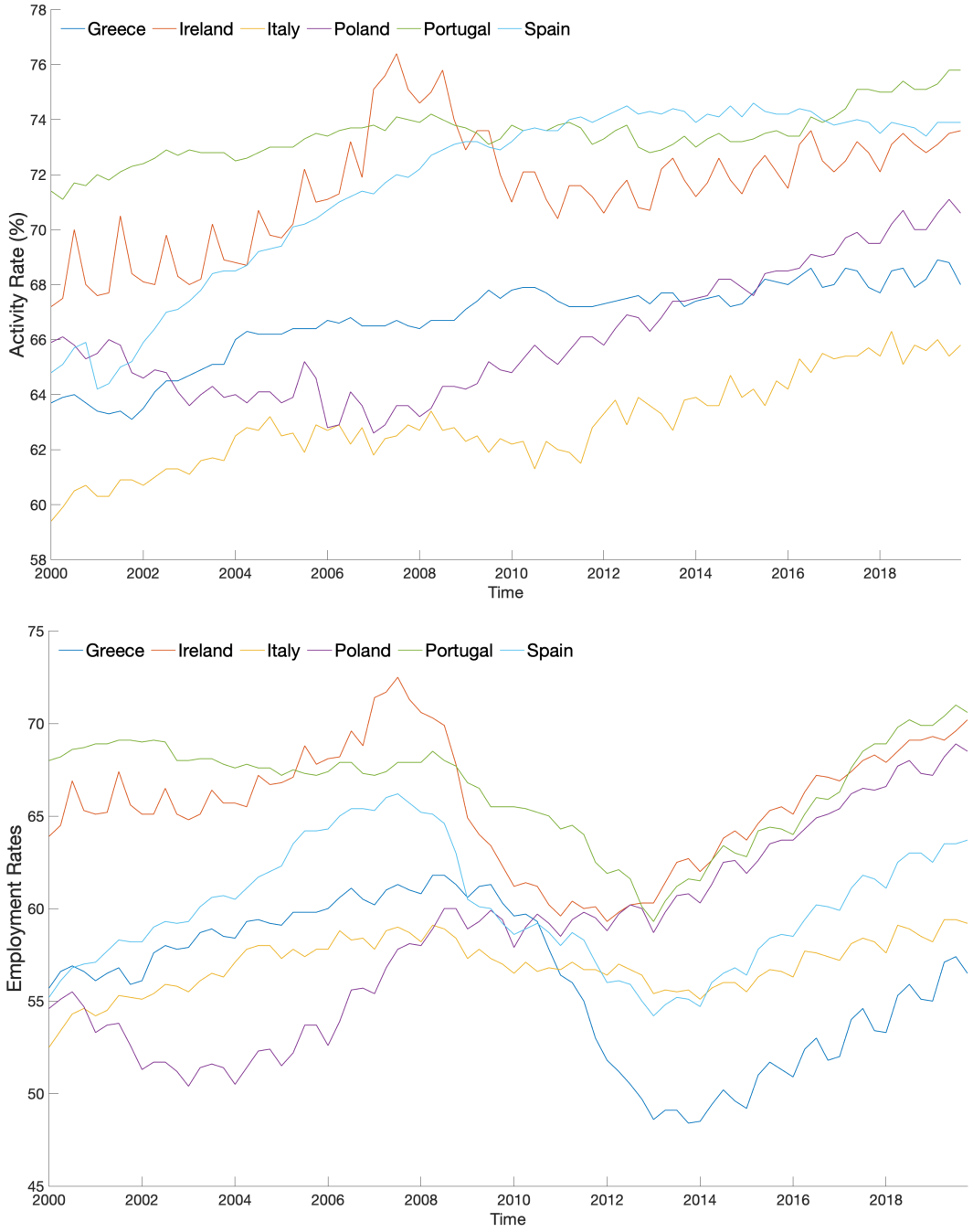

Figure C.10: Activity and participation rates of peripheral euro area countries and Poland 2000Q1:2019Q4

The upper panel shows the activity rates of all persons aged 15 to 64 years in the reporting country in percent and the lower panel the employment rates of all persons aged 15 to 64 years in the reporting country in percent. The reporting countries include Greece, Ireland, Italy, Poland, Portugal and Spain. Source: Eurostat: Activity rate table LFSQ_ARGAN ; Employment rate table LFSQ_ERGAN

natives have the highest activity and employment rate, however, the activity rates for EU-15 and EU-28 are approximately the same.