

Goods and Factor Market Integration: A Quantitative Assessment of the EU Enlargement*

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Abstract

The economic effects from labor market integration are crucially affected by the extent to which countries are open to trade. In this paper we build a multi-country dynamic general equilibrium model to study and quantify the economic effects of trade and labor market integration of the 2004 European Union enlargement. In our model, trade is costly and households of different skills and nationalities face costly forward-looking relocation decisions. We use the EU Labour Force Survey to construct annual migration flows by employment status, skill, and nationality across EU countries for the period 2002-2014. We exploit the timing of the changes in policies due to the EU enlargement to identify the changes in migration costs. We apply our model and use these estimates, as well as the observed changes in tariffs, to quantify the effects from the enlargement. We find that new member state countries are the largest winners, with heterogeneous effects across skill groups. We find smaller welfare gains for EU-15 countries. However, in the absence of changes to trade policy, the EU-15 would have been worse off after the enlargement. We study even further the interaction effects between trade and migration policies, the importance of the timing of migration policy, and the role of different mechanisms in shaping our results. Our results highlight the importance of trade for the quantification of the welfare and migration effects from labor market integration. We also use our framework to quantify the general equilibrium effects of imposing migration and trade restrictions due to Brexit.

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1 Introduction

The aggregate and distributional consequences of economic integration are a central theme of debate in many countries, especially regarding the effects of trade and labor market integration. In this paper we study the general equilibrium effects of both goods and labor market integration and provide a quantitative assessment of the 2004 European Union enlargement. We do so by first constructing a new micro-data on gross migration flows by nationality, skills, and employment status to study the migration effects associated to an actual change in policy. Second, we exploit a unique policy variation associated to the 2004 EU enlargement: the sequential changes to migration costs that each European country followed in the enlargement process. We use this timing variation in the changes to migration policy to identify policy-related changes in migration costs. Finally, given the sequential nature of the change in migration policy following the EU enlargement, migration decisions associated to the policy were inherently forward looking and dynamic. Accordingly, we develop a multi-country quantitative general equilibrium model of trade and migration policy with dynamic migration decisions.

The model features households of different skills and nationality with forward-looking relocation decisions. Households can be employed or non-employed. In each period, households consume and decide whether to relocate in the future to a different country or not. The decision to migrate depends on the households location, nationality, skill, labor force status, migration costs that are affected by policy, and an idiosyncratic shock à la Artuç, Chaudhuri, and McLaren (2010).¹ As mentioned above, taking into account the dynamic decision of households on where and when to migrate is particularly important in the context of the EU enlargement since countries reduced migration restrictions sequentially over time. Moreover, it turns out that the possibility to move in the future to another country whose real wages have increased adds to the welfare of a worker by raising her option value of being in a given location. In fact, even if migrants and natives obtain the same real wage they value each location differently since they face different continuation values as a result of different migration costs.

The production side of the economy captures the large degree of heterogeneity between old and new EU member states in terms of technology, factor endowments, and fundamentals more broadly. It features producers of differentiated varieties in each country with heterogeneous technology as in Eaton and Kortum (2002). In addition, we allow technology levels to be proportional to the size of the economy in order to capture the idea that there are benefits from firms and people locating next to each other.² Production requires high-skilled and low-skilled labor. Firms also demand local fixed factors (structures, land) and, as a result, increases in population size put upward pressure on

¹Keeping track of each household's nationality is relevant in the context of changes to migration policies. For instance, if the U.K. eliminates migration restrictions to Polish nationals, Polish households can freely move to the U.K. regardless of the location they are currently residing in. However, unless other EU countries drop migration restrictions to Polish nationals, Polish nationals can't migrate from the U.K. to another EU country as British nationals can.

²In this sense, we follow Krugman (1980), Jones (1995), Kortum (1997), Eaton and Kortum (2001), and Ramondo, Rodríguez-Clare, and Saborío-Rodríguez (2016).

factor prices that can mitigate the benefits from having a larger market. Goods are traded across countries subject to trade costs which depend on geographic barriers and trade policy (tariffs) as in Caliendo and Parro (2015). As a consequence, a change to trade policy impacts the terms of trade which in turn influences the effect of a change to migration restrictions.

All these features shape the economic effects of trade and migration. Countries that experience a net inflow of migrants can be better off because of higher productivity (agglomeration effects) and from an increase in the supply of high- and low-skilled households. However, they can also suffer from congestion effects associated to the straining of the local fixed factors, and from a worsening of the terms of trade associated to a downward pressure on wages. Changes in trade policy have the standard gains from trade effects, but in addition they also affect migration decisions. Understanding the overall contribution of these channels, as well as the role played by each channel in shaping the aggregate results, is a quantitative question that we answer in the context of an actual change in policy.

We apply our framework to quantify the welfare and migration effects of the 2004 EU enlargement. The 2004 EU enlargement is an agreement between member states of the European Union (EU) and New Member States (NMS) that includes both goods market integration, and factors market integration. On the integration in the goods market, tariffs were reduced to zero starting in 2004, and the NMS countries resigned to previous free trade agreements (FTAs) and joined EU's FTAs.³ On factor market integration, migration restrictions were eliminated although the timing of these changes to migration policies varied across countries.⁴

Evaluating the effects of the EU enlargement requires information on how trade and migration costs changed due to the policy. For the case of trade policy one can directly observe the change in tariffs; however, policy-related changes in migration restrictions are not directly observable. Guided by the theory, our estimating strategy uses migration flows before and after the change in policy, and exploits the cross-country variation in the timing of the adoption of the new migration policy. Our identification strategy has a difference-in-difference-in-differences flavor, and relies on the assumption that the trend in migration costs between countries that change migration policy and those that do not would have been the same in the absence of the EU enlargement. We confirm our identifying assumption by running a placebo exercise and checking pre-treatment trends. This method allows us to identify migration policy changes, and not the level of the policy or non-policy component of migration costs. Crucially, our methodology to compute the effects of the EU-enlargement that we describe later on only requires information on the migration policy changes, but not on the levels of migration costs. This connection between our estimation strategy of policy changes and our solution method to compute the general equilibrium effects of such policy changes

³While tariffs applied to many goods were already zero by 2004 between the EU and NMS states, the average tariff rates applied across countries were far from zero. Section 2 documents the effective applied rates across countries before and after the enlargement.

⁴EU countries eliminated migration restrictions to NMS nationals sequentially. The United Kingdom (henceforth U.K.) in the year 2004, followed by Greece, Italy, Portugal, and Spain in 2006, France in 2008, Belgium and Denmark in 2009, and finally Austria and Germany in 2011. Section 2 describes in more detail the sequence of migration policy changes.

is an important aspect of our analysis.

To estimate the changes in migration costs due to the EU enlargement and to compute our model we require data on bilateral gross migration flows by nationality, skill, and labor force status. We use raw data from the European Labour Force Survey (EU-LFS) to construct these yearly migration flows for a group of 17 EU countries and the rest of the world for the period 2002-2014. To evaluate the changes to trade policy, we collect tariff data over the period 2002-2014.

To compute the effects of the EU enlargement we also need estimates of the migration cost elasticity, the elasticity of substitution between low and high-skilled workers, and the trade elasticity. We estimate the migration elasticity across countries using the two-step PPML estimation approach developed by Artuç and McLaren (2015) to study occupational mobility within the United States. We use our data on gross migration flows and wages across countries to estimate the international migration elasticity across European countries. In order to estimate the elasticity of substitution between low and high-skilled workers, guided by our theory, we use cross-country and time series variation in wages and factor allocations in the spirit of Katz and Murphy (1992) applied to the EU. Finally, we obtain the trade elasticity from Caliendo and Parro (2015).

Using our model, estimated changes in migration costs, observed changes in tariffs, and estimated migration, trade, and substitution elasticities we proceed to our empirical analysis. We compute our model using the structural differences-in-differences approach (*dynamic hat algebra*) developed in Caliendo, Dvorkin, and Parro (2019). The method, which consists on expressing in time-differences the equilibrium conditions of a counterfactual economy relative to a baseline economy, has two main attractive properties. First, one can solve the model and perform counterfactual analyses without needing to estimate the set of exogenous state variables, (hereafter referred to as fundamentals). In our application, we solve for a counterfactual economy where we hold trade and migration policy unchanged relative to a baseline economy which contains the actual evolution of policies (i.e. the EU enlargement). Second, since the baseline economy is calibrated using time series, when feeding into the model the actual changes in policy we match exactly the observed gross migration flows, trade flows, as well as the observed labor market allocations and wages. This also means that in our application, fundamentals like technology and the non-policy component of trade and migration costs are time varying. Concretely, we apply this method to answer the following question: how would the economy look like if everything would have happened as in the data (changes in fundamentals, other policies, etc.) except for the EU enlargement?

We find that the full impact of the EU enlargement on the stock of NMS nationals in EU-15 countries is realized very gradually over time. For instance, three years after the EU enlargement (that is, in 2007) the stock of NMS nationals in EU countries increases by 0.05 percentage points, while ten years after the implementation, the stock raises by 0.27 percentage points. In order words, we find that EU enlargement increases the stock of NMS nationals in EU-15 countries by approximately 1 million by 2015. We find that in steady state, the stock of NMS nationals in EU-15 countries increases by 1.65 percentage points. Across skill groups, we find that the EU enlargement primarily increases migration of low-skilled NMS households to EU-15 countries, and

to a lesser extent the migration of high-skilled households. We also find that migration would have been larger in the absence of changes to trade policy. Our quantitative framework also takes into account transitions between employment and non-employment for stayers and migrants. We find that the EU enlargement leads to an overall decline in the share of non-employment in NMS countries and in EU-15 countries. In particular, NMS countries experience a larger decline in non-employment, and the fall in non-employment is also larger for low-skilled households than for high-skilled households.

Turning to the welfare effects, we find that on aggregate all groups of countries gain, and NMS countries are the largest winners from the EU enlargement. In particular, NMS countries welfare increases by 1.17 percent, EU-15 countries welfare increases by 0.04 percent, while for Europe as a whole welfare increases by 0.23 percent. We further study the aggregate welfare effects along three dimensions. First, we show that the welfare effects of the EU enlargement are heterogeneous across countries and skills. Second, we show that the timing of changes to migration policy has important distributional effects. Third, we show that the level of trade integration has a quantitative impact on the welfare effects of changes to migration policy. We discuss each of these three findings in turn.

Focusing on the welfare effects across skill groups, we find that high-skilled households are the largest winners. The average welfare of low-skilled households in NMS countries increase by 1.1 percent, and the welfare of high-skilled households increases by 1.7 percent. EU-15 countries experience smaller welfare gains, that are mostly concentrated on high-skilled households as well: welfare increases by 0.14 percent for high-skilled and 0.02 percent for low-skilled households. When looking at the welfare impact on specific countries, we find that the only group of households that experiences a welfare loss are the low-skilled households in the U.K., with a welfare loss of 0.14 percent. This is mainly due to the increase in labor market competition due to the relatively larger inflow of low-skilled migrants. The losses from migration policy more than offset the welfare gains associated to the reduction in tariffs for this group.

The simultaneous reduction in migration and trade costs that characterized the enlargement is crucial for EU-15 countries: we show that, in the absence of changes to trade policy, the EU-15 countries would have been worse off. Overall, we find that in NMS countries trade policy contributed to about 30 percent of the overall gains from the EU enlargement, while migration policy contributed to about 68 percent. Moreover, the timing of changes to migration policy matters. We find that opening to trade and delaying opening to migration would have benefited EU-15 low-skilled households more compared to EU-15 high-skilled households. We also find that NMS countries would have been worse off compared with the actual gains; yet welfare gains are still positive.

We find that the level of trade integration has a quantitative impact on the welfare effects of changes to migration policy. Countries that receive migrants gain more under costly trade than under free trade while the reverse happens to the countries that experience an outflow of households. For instance, welfare gains from reductions in migration restrictions for NMS countries would have

been 6 percent higher under free trade compared to autarky. The intuition is that the net outflow of workers puts upward pressure to domestic factor prices in the NMS countries, and the terms of trade move in favor of NMS countries and against the EU-15 countries as a result, an effect that is absent under trade autarky. For individual countries, the role of trade openness is even more striking; for instance, U.K. welfare losses from migration policy would have been one-third larger under free trade than under autarky.

We also extend our model to account for potential congestion effects from publicly-provided consumption services. We find that in the presence of publicly-provided consumption services migration effects from the EU enlargement are somewhat lower as immigration strains publicly-provided consumption services and reduces incentives to migrate. Welfare gains are larger in NMS countries that experience a net outflow of households that help decongest publicly-provided consumption services, and smaller in EU-15 countries that experience a net inflow of households. We also evaluate the quantitative importance of the mechanisms that operate in the model and find that abstracting from trade, congestion effects, and agglomeration effects results in a significantly different welfare evaluation of migration policies. We also present a series of extensions and robustness exercises under different assumptions on the modeling of public goods, the scale effects, ownership structure of the fixed factor, and elasticity of substitution between high-skilled and low-skilled workers.

One of the biggest events concerning the European Union in recent years is the decision of the U.K. to leave the economic block, the so-called Brexit. We also apply our framework to quantify the general equilibrium effects of Brexit, and in particular, the effects of imposing restrictive trade and migration policies between the U.K. and the other EU countries. We consider five Brexit counterfactual scenarios with varying degrees of changes to tariff, non-tariff barriers (henceforth, NTB) and migration restrictions. In general, we find that Brexit would lead to a decline in welfare in the EU-14 countries (EU-15 excluding the U.K.), and a larger welfare decrease in NMS countries. On average, these welfare losses are generalized across skills in both group of countries, but losses are smaller for low-skilled households. The U.K. experiences welfare losses from trade restrictions, but welfare gains from migration restrictions. However, welfare losses from trade policy more than offset the welfare gains from migration restrictions, and both high-skilled and low-skilled households are worse off as a result. Finally, we find that Brexit would undo about one-third of the computed migration effects of the EU enlargement.

Overall, our paper brings together two different but complementary elements in the analysis: on the one hand, we use a reduced-form analysis that exploits migration policy changes to identify changes in migration costs associated to the EU enlargement; on the other hand we use a rich dynamic general equilibrium model that includes all the mechanisms described above to quantify the migration and welfare effects of actual changes to trade and migration policies. We now discuss the connection of our paper to the literature.

Our research is complementary to studies that have employed static models of trade and migration to investigate different mechanisms in which trade and migration are interrelated. For instance, the effects of immigration in a Ricardian model with technology differences across countries studied

in Davis and Weinstein (2002), the welfare effects of migration through remittances in di Giovanni, Levchenko, and Ortega (2015), and crowding out effects and labor market adjustments to immigration across tradable and non-tradable occupations in Burstein, Hanson, Tian, and Vogel (2020). In addition, our result extend the key insight of Davis and Weinstein (2002) that in a Ricardian model with technology differences countries experiencing immigration always loose with respect to a free trade baseline.

Our paper also complements studies that focus on the impact of immigration on wages and employment of native workers, a question that has been extensively studied in the literature (e.g. Hanson and Slaughter (2002), Hanson and Slaughter (2016); Ottaviano and Peri (2012); Ottaviano et al. (2013); Hong and McLaren (2016); and many more).

We also build on quantitative trade literature for trade policy analysis, such as Costinot and Rodriguez-Clare (2014), Ossa (2014), and Caliendo and Parro (2015). We depart from these studies by adding labor market dynamics and policy-dependent mobility frictions. In this sense, our paper relates to studies that evaluate the impact of trade shocks on labor markets, like Artuç et al. (2010); Dix-Carneiro (2014); Dix-Carneiro and Kovak (2017); Cosar (2013); Coşar et al. (2016); Kondo (2018); Menezes-Filho and Muendler (2011), McLaren and Hakobyan (2015), and Galle, Rodriguez-Clare, and Yi (2017). For a recent review with the advances in this literature, see McLaren (2017).

Our paper also relates to quantitative research where labor reallocation plays an important role in order to analyze the spatial distribution of economic activity, such as in Ahlfeldt, Redding, Sturm, and Wolf (2015), Redding and Sturm (2008), Redding (2016), Allen and Arkolakis (2014), Caliendo, Parro, Rossi-Hansberg, and Sarte (2018), Fajgelbaum, Morales, Suarez Serrato, and Zidar (2018), Monte, Redding, and Rossi-Hansberg (2018), Tombe and Zhu (2019).⁵

There is a fast-growing literature using spatial dynamic general equilibrium models that we also contribute to. Our framework with labor market dynamics builds on Artuç et al. (2010), and it is particularly close to the general equilibrium model of trade and labor market dynamics developed in Caliendo et al. (2019) (hereafter CDP). CDP focus on studying the dynamic adjustments of labor markets to a trade shock, while in this paper we focus on quantifying how counterfactual dynamic responses to migration and trade policies change the distribution of economic activity. Also, different from CDP, we bring into the analysis households of different skills and nationalities, and policy-dependent migration costs. Other papers, notably Desmet and Rossi-Hansberg (2014), employ spatial dynamic models to understand how the distribution of economic activity shapes the dynamics of local innovation and growth by determining the market size of firms. Following this research, Desmet et al. (2018) study how migration shocks shape the dynamics of local innovation and growth.⁶

Our paper also connects with studies that have used the EU enlargement (as an ex-ante and ex-post evaluation) to study the economics implications of the integration (e.g. Baldwin (1995),

⁵For a review of new developments in quantitative spatial models see Redding and Rossi-Hansberg (2017).

⁶See also Klein and Ventura (2009), who study the effects on output, welfare, and capital accumulation of removing labor mobility barriers in a neoclassical growth model.

Baldwin et al. (1997), Dustmann and Frattini (2011), and Kennan (2017)). Our approach departs in several ways, and in particular by employing new quantitative techniques to study the general equilibrium effects of the enlargement in a model of costly trade and migration.

Finally, we mention other mechanisms in the literature that will not be part of our analysis. Some studies have focused on the substitution between migrants and natives in production, although the results on the value of the elasticity of substitution are contrasting, as documented by Borjas et al. (2012). As explained above, in our paper natives and migrants are perfect substitutes in production but they still value locations differently as a result of facing different migration restrictions. That is, when deciding to migrate and where to live, the option value for a migrant and a native vary and as a consequence migrants could in fact trade-off lower wages for a higher option value.

We will also abstract from explicitly modeling selection effects in the migration decisions coming from unobserved heterogeneity in labor market skills. Selection effects could lead to an increase in productivity by better sorting migrants across location (e.g. Borjas (1987), Young (2013), Lagakos and Waugh (2013), Bryan and Morten (2019)). In our model, immigration fosters productivity through agglomeration forces as explained later on. Diamond (2016) has also found that the internal migration of college graduates leads to increases in amenities in U.S. higher skill cities over the period 1980-2000. We abstract from endogenous amenities, but understanding the relevance of this mechanism at the country level in the context of international migration, as in the the EU enlargement, is a promising avenue of future research. Finally, with our methodology we quantify the effects of once and for all unexpected changes to policies and fundamentals (for example the effects from agents expecting the EU enlargement to happen and it did not end up happening). Therefore, we abstract from considering aggregate uncertainty in the model, which would require modeling the stochastic process of fundamentals, departing from our perfect foresight assumption. Extending the analysis and our methodology to accommodate a stochastic process for the fundamentals and policies is also an interesting avenue for future work on the topic.

The rest of the paper is structured as follows. Section 2 describes the main migration and trade policy changes as a consequence of the EU enlargement. We also describe the data to construct gross migration flows across European countries by skill, nationality, and labor force status, and present some reduced-form evidence on the change in migration flows after the 2004 EU enlargement. In Section 3 we develop a dynamic model for trade and migration policy analysis that accounts for the main features of the EU enlargement and the migration data. Section 4 describes other data construction and sources needed to compute the model, the estimation of changes to migration costs due to the EU enlargement, and the estimation of the relevant elasticities of the model. In Section 5 we compute the migration and welfare effects from the EU enlargement and discuss the results. Section 6 quantifies the general equilibrium effects of Brexit. Finally, Section 7 concludes. All the derivations and detailed explanations of the data, and methodologies employed throughout the paper are relegated to the Appendix.

2 The 2004 Enlargement of the European Union

On May 1st 2004 ten countries with a combined population of almost 75 million officially joined the European Union (EU) bringing the total number of member states from 15 to 25 countries.⁷ The New Member States (NMS), are: Czech Republic, Cyprus, Estonia, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, and Slovakia. Country size and the relative endowment of skilled workers were very heterogeneous within NMS countries and between NMS and EU-15 countries. For instance, the NMS countries were very heterogeneous in terms of population size, ranging from 0.4 millions in Malta to 38 millions in Poland in 2004. In addition, the relative endowment of low-skilled worker was much higher in NMS countries than in EU-15 countries. In particular, on average, the ratio of low-to-high-skilled labor was 3.8 in EU-15 countries, and 5.2 in NMS countries in 2004.⁸

In this section we highlight the features of the 2004 enlargement that directly affect the international migration of workers within Europe and international trade both between the enlarged set of EU members and between the EU and the rest of the world.⁹

2.1 Migration Policies

The freedom of movement of workers is considered as one of the four fundamental freedoms guaranteed by EU law (*acquis communautaire*), along with the free movement of goods.¹⁰ EU law effectively establishes the right of EU nationals to freely move to another member state, to take up employment, and reside, as well as protects against any possible discrimination in employment-related matters, on the basis of nationality, skill and labor forces status.¹¹

The Accession Treaty of 2003 allowed the “old” member states to temporarily restrict, for a maximum of 7 years, the access to their labor markets to citizens from the accessing countries, with the exception of Malta and Cyprus. These temporary restrictions were organized in three phases according to a 2+3+2 formula. During an initial period of 2 years, member states, through national laws, could regulate the access of citizens from all new member states; member states could then extend their national measures for an additional 3 years, and an additional extension for other 2 years was possible. The transitional arrangements were scheduled to end irrevocably seven years after accession, i.e. on April 30th, 2011. The decision about the timing to eliminate

⁷The EU-15 member states are Austria, Belgium, Denmark, Finland, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, and the United Kingdom.

⁸Throughout the study, we define high-skills as individuals with at least some tertiary education, and low-skills as all other individuals (please refer to Appendix B.2.4 for further details).

⁹Appendix A describes the steps of the EU membership process, and reports additional information on the accessing countries.

¹⁰As effectively and concisely defined by Article 45 (ex Article 39 of the Treaty Establishing the European Community) of the Treaty on the Functioning of the European Union, the freedom of movement of workers entails “*the abolition of any discrimination based on nationality between workers of the member states as regards employment, remuneration and other conditions of work and employment*”.

¹¹Once an individual has been admitted to a particular member state, Article 45 guarantees that community law on equal treatment as regards to remuneration, social security, other employment-related measures, and access to social and tax advantages is valid.

migration restrictions was mainly political, and therefore, the potential migration effects unlikely influenced this timing. For instance, initially and until only three months before the enlargement, EU-15 countries had decided to eliminate migration restrictions all in 2004. In addition, this was an unprecedented enlargement given that it was the first one to include countries at very different stages of development. As a result, at the time of the enlargement there was no consensus on the potential migration effects of the enlargement, with a large range of estimates.¹²

We now briefly summarize the phase-in period of the accession. Appendix A presents further details.

Before 2004. Individuals could flow freely within the EU-15 member states but not between EU-15 and NMS as well as between NMS countries.

Phase 1. In 2004, the U.K., Ireland, and Sweden open their borders to NMS countries, which reciprocate by opening their borders to British, Irish and Swedish citizens. All the other EU-15 countries keep applying restrictions to NMS countries, except to Cyprus and Malta. All NMS countries decide to open their borders to EU-15 member states, except for Hungary, Poland, and Slovenia which apply reciprocal measures. NMS countries lift all restrictions among each others.

Phase 2. In 2006, Italy, Greece, Portugal, and Spain lift restrictions on citizens from NMS countries. As a consequence, Hungary, Poland, and Slovenia drop their reciprocal measures towards these four member states. Slovenia and Poland dropped the reciprocal measures altogether in 2006 and 2007, respectively, while Hungary simplified them in 2008. During phase 2, The Netherlands and Luxembourg (in 2007), and France (in 2008) also lift restrictions on households from NMS countries.

Phase 3. Belgium and Denmark opened their labor market to NMS countries in 2009, while Austria and Germany opened their labor markets at the end of the transitional period, in 2011.

As we can see, there is considerable variation in terms of which countries open to which over time across the phases. This variation is going to result useful for us in order to identify the changes in migration costs due to migration policy. We now briefly describe the change in trade policy.

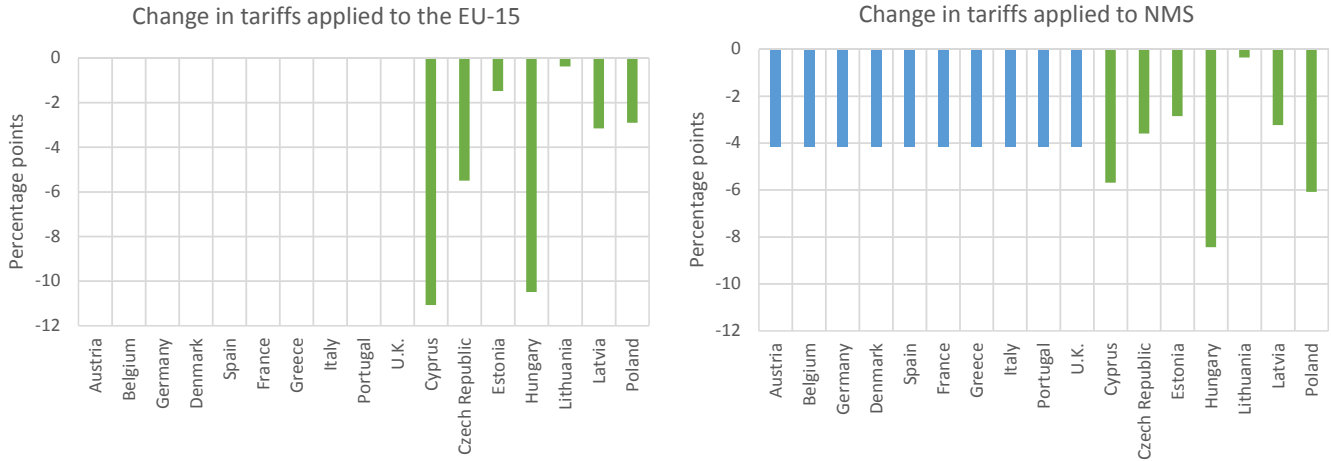
2.2 Trade Policies

As part of the enlargement process, NMS became part of the European Union Customs Union, and of the European common commercial policy. As a result, tariffs between NMS and EU-15 countries were reduced to zero starting in 2004. Figure 1 presents the change in tariffs applied to EU-15 countries and to NMS countries as a consequence of the EU enlargement.¹³ The average tariff rate before the enlargement was about 4.9 percent between NMS countries, the average tariff applied by NMS to EU-15 countries was about 4 percent, and the average tariff applied by EU-15 to NMS countries was about 3.6 percent. After the accession, from 2004 on, tariffs between all EU-25 countries are zero. Also, as a consequence of the EU enlargement process, NMS automatically

¹²For a report on the studies conducted at the time, see Fihel et al. (2015).

¹³Appendix B describes the data and the sample of EU-15 and NMS countries we use in the quantitative analysis.

Figure 1: Average tariff changes due to the EU enlargement



Note: Average (trade weighted) tariff changes from 2003 to 2004. The figures show the set of EU-15 and NMS countries used in our empirical analysis. Source WITS.

entered into the trade agreements to which the EU already belonged to, and resigned their own existing agreements.¹⁴ This resulted in additional changes in trade policy for NMS. We use all these tariff changes in our quantitative assessment later on.

2.3 Gross Migration Flows by Nationality, Skill, and Labor Force Status

In order to quantify the migration and welfare effects of changes in migration policy, data on migration flows across European countries before and after the EU enlargement are needed. In particular, we need migration flows by nationality and skill since, as discussed above, the mobility restrictions that EU15 and NMS nationals face are quite different, and the level of educational attainment is very heterogeneous across all the countries involved in the enlargement. In addition, in order to understand how changes in mobility frictions impact households with different labor force status (employment, non-employment), we also need to consider migration flows with labor force status. Given that the existing migration data are mostly based on census sources and contain information only on stocks of migrants, we proceed to construct gross migration flows by nationality, skill, employment status across European countries.

We construct bilateral gross migration flows for European countries from 2002 to 2015 using information contained in the European Labour Force Survey (EU-LFS), a large household survey providing confidential quarterly or annual results on labor participation of people aged 15 and over, as well as on persons outside the labor force from 1983 onward. The EU-LFS is currently conducted in the 28 member states of the European Union, two candidate countries and three countries of the European Free Trade Association (EFTA).¹⁵ The main strength of the EU-LFS is to use the same

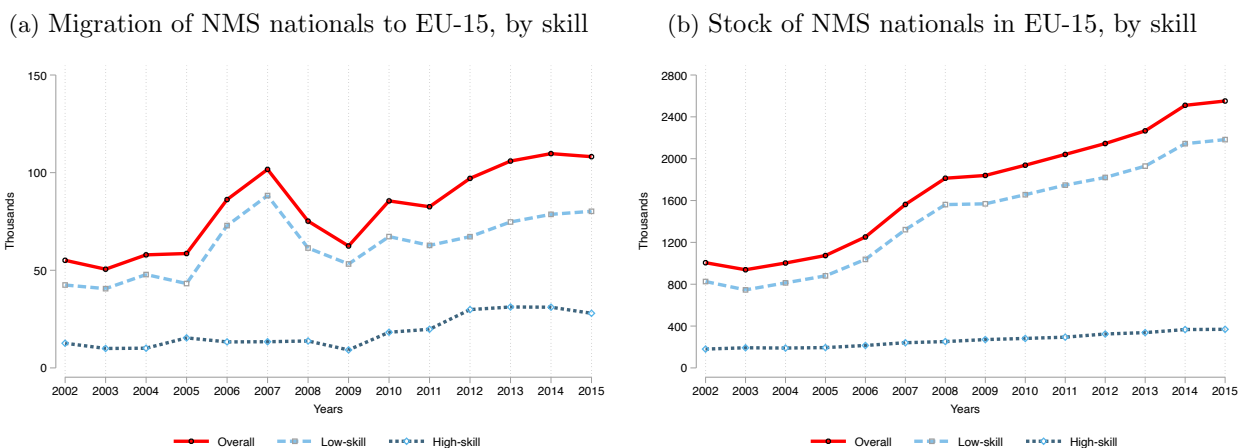
¹⁴In Appendix A.2 we provide more detail on the trade policy implemented after the EU enlargement.

¹⁵The national statistical institute of each country in Europe conducts surveys that are centrally processed by Eurostat; each national institute is responsible for selecting the sample, preparing the questionnaires, conducting the

concepts and definitions in every country, follow International Labour Organization guidelines using common classifications (NACE, ISCO, ISCED, NUTS), and record the same set of characteristics in each country. Because of these features, the EU-LFS is the basis for unemployment and education statistics in Europe.¹⁶

The survey contains information on a representative sample of households in each country. Individuals are assigned a weight to represent the share of people with the same characteristics in the country. For each individual in a specific year, we have information on age, nationality, skills, labor force status (employed, non-employed) and, crucially for our purpose, country of residence 12 months before. We use the information on country of residence in the previous year to construct bilateral gross migration flows by year, country of origin, nationality and skill for a group of 17 EU countries.¹⁷

Figure 2: Migration flows and stocks of NMS nationals in the EU-15, 2002-2015



Note: The data on gross migration flows is described in Section 4 and Appendix B.2. The figure includes all the set of EU-15 and NMS countries in our sample. High-skill includes all individuals with at least some tertiary education, while low-skills include all other individuals (please refer to Appendix B.2.4).

We group migrants in three broad nationality categories that follow immediately from the 2004 European enlargement: EU-15 nationals, NMS nationals, and Other nationals (rest of the world).¹⁸ We define high-skill labor as individuals with at least some college education and low-skill

direct interviews among households, and forwarding the results to Eurostat in accordance with the requirements of the regulation.

¹⁶The EU-LFS helps monitor the main European policies and strategies for employment, and forms the basis for the EU's monthly harmonized unemployment rate, a key Eurostat short-term indicator.

¹⁷As an example, looking at the U.K. survey in 2004, we know if a Polish high-skilled worker moved to the U.K. from Poland in the previous 12 months. Migration shares are computed as the share of migrants that moved to a specific destination country over a population defined by country of origin, nationality, skills, and labor force status at the origin and destination. Appendix B.2 describes in greater detail how we construct the gross migration flows.

¹⁸With the EU-LFS data we can compute flows by broad nationalities; NMS nationals, EU-15, and Others, and not by individual country nationalities. As a result, we can use these flows to estimate policy changes between NMS and EU-15 countries. The changes in migration costs from NMS to NMS would require us to distinguish between flows of NMS natives that are not subject to policy changes, and flows of other NMS nationals that are affected by migration policy, a distinction that we cannot make in the data.

labor as individuals with high school degree or less using the International Standard Classification of Education (ISCED) codes. We constraint our sample to include only individuals of working age—between 15 and 65 years old—and only countries with consistent information on nationality, skills and country of origin over the period 2002-2015. We end up with a total of 17 countries, ten former EU members, Austria, Belgium, Germany, Denmark, Spain, France, Greece, Italy, Portugal, and the United Kingdom, and seven NMS, Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Our group of countries covers 91 percent of the 2004 EU-25 population.¹⁹

As an illustration, the left panel in Figure 2 plots the gross flows of NMS migrants in EU15 countries using the gross migration flows data. As we can see from the panel, the largest fraction of migrants was low-skilled and after 2009 there is also a pickup in high-skilled migration of NMS nationals. This differential response to migration policy by skill group will be captured in the quantitative analysis later on. The right panel of Figure 2 plots the stock NMS nationals in the EU-15 countries. The data shows a gradual increase in the stock over the years and what seems to be like changes in the overall trend in 2004, 2006 and after 2009. These years are concurrent with the phase-in period of the changes in migration policy of the EU-15 countries, and most of the focus on our analysis is to determine to what extent these changes in the stock of NMS nationals are a consequence of the enlargement.

Using the information on labor force status we can also take a look at the differential flows for employed and non-employed households. As an illustration, we compute the non-employment and employment weighted average annual transition rates of stayers and migrants by skill group in our sample period. Focusing first on NMS nationals that do not migrate (stay from one year to the other in the same country), employment and non-employment are persistent states, especially for low-skilled households. In particular, about 90 percent of the non-employed low-skilled NMS nationals remain non-employed after a year, and about 73 percent for the case of high-skilled households. For the case of employed households, about 93 percent of the employed low-skilled households, and 96 percent of the high-skilled households remain employed after a year. Second, the transition from non-employment to employment is higher for NMS migrants than for non-migrants (stayers). In particular, 49 percent of the low-skilled and 46 percent of the high-skilled NMS migrants transition from non-employment in the NMS countries into employment in the EU-15 countries. The transition from employment to employment is even higher for NMS migrants; 82 percent of the low-skilled and 76 percent of the high-skilled NMS nationals remain employed after migrating to the EU-15. Therefore, non-employed NMS nationals who migrate are more likely to change employment status relative to non-migrants, something that we take into account in our quantitative framework. In Appendix C we provide further description of the transition rates between employment and non-employment in NMS and EU-15 countries.

¹⁹Country surveys for Ireland, Malta, Netherlands, Sweden, Slovenia, Bulgaria, Slovakia, Luxembourg, Romania and Finland do not contain sufficient information to compute migration flows consistently between 2002 and 2015, so we assign these countries to the rest of the world (RoW). More information on each case is contained in Appendix B.

2.4 Reduced-Form Evidence

With the constructed gross migration flows, we can now proceed to provide a first evidence on the migration effects of the EU enlargement by presenting reduced-form evidence on the change in migration flows of NMS nationals to EU-15 countries after the 2004 enlargement. In particular, we explore whether there was a significant change in migration flows after 2004, controlling by country characteristics and time effects. As an example, we use our constructed data on bilateral gross migration flows to estimate a simple difference-in-difference model to evaluate the change in the flow of NMS nationals migrating to the U.K. after 2004. We choose the U.K. since it is the only EU-15 country in our sample that eliminated migration restrictions immediately in 2004. We estimate the differential impact on migration flows for NMS nationals relative to EU-15 and Other nationals, by running the following specification

$$\log F_{n,t}^{i,UK} = \lambda_{i,t} + \alpha_{NMS} + \beta_{03}\mathbb{I}(n = NMS; t \geq 2003) + \beta_{04}\mathbb{I}(n = NMS; t \geq 2004) + \varepsilon_{n,t}^i,$$

where the dependent variable $\log F_{n,t}^{i,UK}$ is the (log) flow of migrants (of all nationalities n) from NMS country i to the U.K. in year t . The indicator function, $\mathbb{I}(\text{condition})$, takes the value of one when the given condition is satisfied, $\lambda_{i,t}$ is a set of origin-year fixed effects that captures origin-time-specific factors, and α_{NMS} is a fixed effect that captures possible differences between NMS nationals and the control group prior to the EU enlargement. The coefficients $\{\beta_{03}, \beta_{04}\}$ capture the change in the flow of NMS nationals migrating to the U.K. after the year t relative to all other nationalities. We expect β_{04} to be positive and significant, pointing to an increase in the flow of NMS nationals migrating to the U.K. after the EU enlargement, controlling by country characteristics and time effects. Table 1 reports the results. Column (1) reports the estimate of β_{04} and β_{03} .²⁰ Column (2) presents a specification that excludes β_{03} . We find β_{04} to be positive and statistically significant in both specifications.

Besides an increase in the flow of NMS nationals migrating to the EU-15 countries, the EU enlargement also had heterogeneous migration impacts on individual destinations for NMS migrants. Figure 3 reports a stark example of this diversion effect: Germany had been, for several reasons throughout history, the main European destination for Polish migrants. After the enlargement, the share of Polish migrants moving from Poland to Germany has been constantly decreasing, with the U.K. becoming the top destination for Polish migrants by the year 2007.

We next turn to a structural analysis, where we capture the aspects of the EU enlargement discussed previously. To do so, in the next section we develop a structural model of trade and migration with multiple countries, and households of different nationalities, skills, and employment status making forward-looking migration decisions. Later on, we will also use the changes in migration flows across countries after the enlargement to identify the policy-related changes in

²⁰The coefficient β_{03} allows us to carry on a test for causality in the spirit of Granger (1969): a non-significant β_{03} is consistent with the opening of the U.K. labor market to NMS nationals causing the change in $F_{n,t}^{i,UK}$, but not vice-versa.

Table 1: Reduced-form estimates of change in the flow of NMS nationals migrating to the U.K.

	(1)	(2)
Year \geq 2004*Treatment (β_{04})	3.286* (1.872)	2.824** (1.375)
Year \geq 2003*Treatment (β_{03})	-0.925 (2.202)	
Origin-time fixed effects	x	x
NMS fixed effects	x	x
Observations	126	126
R-squared	0.495	0.490

Note: Parentheses includes robust standard errors, *** p<0.01, ** p<0.05, * p<0.10.

migration costs, not only for the case of the U.K., but also for all countries that changed migration policy. After doing so, we will feed these policy-related changes in migration costs into our structural model to quantify the general equilibrium effects of the EU enlargement.

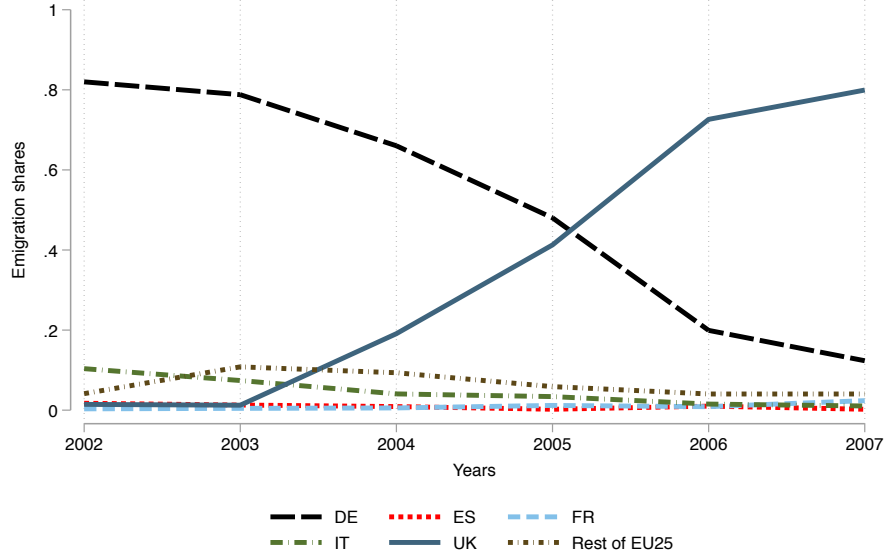
3 A Dynamic Model of Trade and Migration

In this section, we develop a dynamic general equilibrium model for trade and migration policy analysis that accounts for the main features of the EU enlargement and the migration data outlined above. The world is composed of N countries, indexed by i (origin) and j (destination). Each country represents a competitive labor market where a continuum of firms produce goods with heterogeneous productivity. A fraction of goods are traded across countries, and the movement of goods is subject to trade costs. As we will see later on, a component of trade costs is tariffs, which are affected by trade policy in each country. As in Eaton and Kortum (2002) productivities have a Fréchet distribution with a dispersion parameter θ which, as we will see below, is also the trade cost elasticity. Production of goods in a given country requires high-skilled and low-skilled labor, which are imperfect substitutes, and fixed factors that we call land and structures.

In the model, time is discrete and households have perfect foresight. Households make forward-looking labor relocation decisions subject to migration costs and idiosyncratic preferences. Each period they decide whether to stay in the same country or to move to a different country, a decision that depends on real wages and expected continuation values. Migration policy in each country has an impact on migration costs, and therefore on households' decisions.

We start by describing the problem of the households, we then set up the production structure in each country, and finally, we derive the market clearing conditions. After doing so, we define the equilibrium of the model.

Figure 3: U.K. leapfrogging Germany as the top destination for migrants from Poland



Note: The figure reports, for each year, migrants from Poland to EU-25 by country of destination as a share of total Polish migrants.

3.1 Households

Households are forward-looking, observe the economic conditions in all countries and optimally decide where to locate. Households face costs of moving across countries and are subject to idiosyncratic shocks that affect their moving decision. At each moment in time, households in a country i can be either employed or non-employed (status that we denote interchangeably as employment status or labor force status hereafter). We denote the labor force status by ℓ (today) and by o (tomorrow), with $(\ell, o) \in \{e, ne\}$, and where e and ne refer to employment and non-employment, respectively. If they begin the period employed in a country, they work and earn the market wage. Non-employed households consume home production. As described above, households in a given country are of different nationalities indexed by n , and with different skills indexed by s .

The value of a n national of skill s in country i at time t , and with labor force status ℓ , $v_{n,s,t}^{i\ell}$ is given by

$$v_{n,s,t}^{i\ell} = \log(C_{s,t}^{i\ell}) + \max_{\{j,o\}_{j=1,o=e,ne}^N} \{ \beta E[v_{n,s,t+1}^{jo}] - m_{n,s,t}^{i\ell,jo} + \nu \epsilon_{n,s,t}^{jo} \},$$

where $C_{s,t}^{i\ell}$ is the consumption aggregator that we describe below. The term $m_{n,s,t}^{i\ell,jo}$ is the migration cost from country i to country j at time t that depends on non-policy and policy components. Specifically, $m_{n,s,t}^{i\ell,jo} = \tilde{m}_{n,s,t}^{i\ell,jo} + mpol_{n,t}^{i,j}$. The non-policy component, $\tilde{m}_{n,s,t}^{i\ell,jo}$, includes origin-specific components, destination-specific components, and bilateral components, that is $\tilde{m}_{n,s,t}^{i\ell,jo} = \bar{m}_{n,s,t}^{i\ell} + \bar{m}_{n,s,t}^{jo} + \bar{m}_{n,s,t}^{i\ell,jo}$ for all i, j, ℓ , and o , where $\bar{m}_{n,s,t}^{i\ell,io} = 0$. The term $mpol_{n,t}^{i,j}$ is the policy component of

migration restrictions imposed by j to nationals of country n migrating from i .²¹

We assume that idiosyncratic preference shocks $\epsilon_{n,s,t}^{jo}$ are stochastic i.i.d. of a Type-I extreme value distribution with zero mean, and with dispersion parameter ν that later on we will relate to the migration cost elasticity. Finally, β is the discount factor. The presence of migration costs and idiosyncratic preferences generates a gradual adjustment of flows in response to changes in the economy since only the fraction of households with idiosyncratic preference for a location that more than offset the migration cost will relocate each period.

Using the properties of the Type-I extreme value distribution, we can solve for the expected (expectation over ϵ) lifetime utility of a worker of nationality n , skill s , labor force status ℓ , in country i , $V_{n,s,t}^{i\ell} \equiv E[v_{n,s,t}^{i\ell}]$. In particular,

$$V_{n,s,t}^{i\ell} = \log(C_{s,t}^{i\ell}) + \nu \log \left(\sum_{j=1}^N \sum_{o=e,ne} \exp(\beta V_{n,s,t+1}^{jo} - m_{n,s,t}^{i\ell,jo})^{1/\nu} \right). \quad (1)$$

The first term in equation (1) represents the current utility of that households in country i and the second term captures the expected value of staying in that country the next period and the option value of migrating to a different country. Note that the option value of migration varies by employment status, skill and nationality, and captures the fact that households of different nationalities living in the same country face different migration restrictions.

As described above, employed households supply a unit of labor inelastically, and receive a competitive nominal wage $w_{s,t}^i$ that depends on the country of residency, and the skill level. Non-employed households obtain consumption from home production $b^i > 0$. Given this, the indirect utility of a household with skill s in country i is given by

$$C_{s,t}^{i\ell} = \begin{cases} w_{s,t}^i / P_t^i & \text{if } \ell = e \\ b^i & \text{if } \ell = ne \end{cases}, \quad (2)$$

where P_t^i is the local price index.

Using the properties of the extreme value distribution, we also solve for the fraction of households of nationality n , and skill s that migrates from country i to country j at time t , conditional on labor force status ℓ , o , which we denote by $\mu_{n,s,t}^{i\ell,jo}$

$$\mu_{n,s,t}^{i\ell,jo} = \frac{\exp(\beta V_{n,s,t+1}^{jo} - m_{n,s,t}^{i\ell,jo})^{1/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \exp(\beta V_{n,s,t+1}^{ka} - m_{n,s,t}^{i\ell,ka})^{1/\nu}}. \quad (3)$$

²¹Note that while the change in migration policy does not discriminate by skill and labor force status (as described in Section 2.1 this was the case of the EU enlargement), we allow non-policy components of migration cost to vary by nationality n , skill level s , and labor force status ℓ . Assuming $\bar{m}_{n,s,t}^{i\ell,io} = 0$ does not imply that there are no costs of changing employment status. Note that $\tilde{m}_{n,s,t}^{i\ell,io} = \bar{m}_{n,s,t}^{i\ell} + \bar{m}_{n,s,t}^{io}$, which implies that changing employment status and migrating is subject to an additional cost relative to changing employment status and not migrating. Later on we show that with our solution method we can compute the model and conduct counterfactuals without having to restrict the relative magnitude of these costs. We solve the model relative to the data on migration flows which indirectly contains information in the relative magnitude of the costs.

This equation describes gross flows of migrants by nationality and skill across countries. Notice that $1/\nu$ captures the response of migration flows to migration costs, or in other words, the migration cost elasticity. Notice also that the transitions $\mu_{n,s,t}^{i\ell,jo}$ are gross flows across labor force status both within and across countries, conditional on nationality, skill, and over time.

With the initial distribution of households by nationality, labor force status, and skill across countries, and the migration flows at each period, we can solve for the evolution of households by employment status, nationality and skill at each moment in time. Specifically, denote by $L_{s,t+1}^{ie}$ the stock of employed households by skill s in country i , given by

$$L_{s,t+1}^{ie} = \sum_{n=1}^N \sum_{j=1}^N \sum_{\ell=e,ne} \mu_{n,s,t}^{j\ell,ie} L_{n,s,t}^{j\ell}, \text{ for all } s. \quad (4)$$

Similarly, $L_{s,t+1}^{ine}$ denotes the stock of non-employed households by skill s in country i . Finally, the total stock of households in each country is then given by the sum of high-skill (h), low-skill (l), employed and non-employed households of all nationalities,

$$L_t^i = \sum_{s=h,l} (L_{s,t}^{ie} + L_{s,t}^{ine}).$$

We now turn to describe the production structure of each economy.

3.2 Production

A continuum of goods is produced in each country with technology as in Eaton and Kortum (2002). The technology to produce these goods requires both high-skilled and low-skilled labor, and structures. High-skilled and low-skilled labor are imperfect substitutes, and structures a fixed factor. Total factor productivity (TFP) is composed of two terms: an aggregate component (A_t^i), which is common to all varieties in a country, and a variety-specific component (z^i) that is a stochastic realization from a Fréchet distribution. We allow technology levels to be endogenous and proportional to the size of the economy, that is $A_t^i = \phi_t^i L_t^i$, as in Ramondo et al. (2016).²² Note that, although the elasticity of TFP with respect to population size is equal to one under this formulation, the elasticity of real income with respect to population is less than one because of the congestion effects in the presence of local fixed factors.²³ Throughout, we refer to the elasticity of TFP with respect to population size as the agglomeration elasticity and as the scale effects to the combination of the agglomeration and congestion forces in the model.

Since each variety is identified by z^i , we use it to index a variety. Therefore, the production function of a given good in country i is given by

²²As a robustness, in Appendix J.2 we also compute the effects of the EU enlargement by assuming that the agglomeration effect in each country is proportional to employment instead of country size. Results are very similar under this alternative formulation.

²³Given this, the production structure of our model can be mapped into existing static models with scale effects that show existence and uniqueness of the equilibrium (e.g. Kucheryavy et al. (2016)).

$$q_t^i(z^i) = z^i A_t^i \left(\sum_{s=h,l} \delta_{s,t}^i \frac{1}{\rho} (L_{s,t}^{ie}(z^i))^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho(1-\gamma^i)}{\rho-1}} (H^i(z^i))^{\gamma^i}, \quad (5)$$

where $L_{h,t}^{ie}(z^i)$ and $L_{l,t}^{ie}(z^i)$ are the demands for high- and low-skilled labor used to produce good z^i in country i , ρ is the elasticity of substitution between high- and low-skilled labor, $(1 - \gamma^i)$ is the share of labor payments in value added, $\delta_{s,t}^i$ is a fundamental that captures the s -skilled intensity in production and factor-biased technical changes. The demand for the fixed factor (land, structures), is denoted by $H^i(z^i)$.

We refer to rentiers as the owners of the fixed factor H^i . As in Caliendo et al. (2018) we assume that there is a mass one of rentiers in each location and that rentiers consume local goods using the same consumption aggregator as households. Rentiers obtain rents $r_t^i H^i$ from the fixed factor they own and rent to firms. We assume that these rents are sent to a global portfolio and that rentiers obtain a share ι^i of the global portfolio revenues given by $\chi_t = \sum_{i=1}^N r_t^i H^i$, where r_t^i is the rental price of structures in country i . Differences between remittances to the global portfolio and the income transfers from the global portfolio will generate imbalances in each country, and therefore, this assumption on the behavior of the rentiers will allow us, in our quantitative model, to match the observed trade imbalances across nations.²⁴

Goods can be traded across countries subject to trade costs. Specifically the cost of shipping goods from country j to country i is given by $\kappa_t^{i,j} = (1 + \tau_t^{i,j}) d_t^{i,j}$, where $d_t^{i,j}$ is an iceberg-type trade cost, which includes non-tariff trade barriers, and $\tau_t^{i,j}$ is an ad-valorem tariff.

As in Eaton and Kortum (2002), using the properties of the Fréchet distribution we can solve for the bilateral trade shares $\pi_t^{i,j}$ and the price index P_t^i as a function of factor prices, productivities and trade costs. Specifically,

$$\pi_t^{i,j} = \frac{A_t^j \left(\kappa_t^{i,j} x_t^j \right)^{-\theta}}{\sum_{k=1}^N A_t^k \left(\kappa_t^{i,k} x_t^k \right)^{-\theta}}, \quad (6)$$

$$P_t^i = \left(\sum_{j=1}^N A_t^j \left(\kappa_t^{i,j} x_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}, \quad (7)$$

where x_t^i is the unit price of an input bundle, namely

$$x_t^i \equiv \zeta^i \left(\sum_{s=h,l} \delta_{s,t}^i (w_{s,t}^i)^{1-\rho} \right)^{\frac{1-\gamma^i}{1-\rho}} (r_t^i)^{\gamma^i}, \quad (8)$$

²⁴This assumption on the ownership structure has only an indirect impact on households' welfare through prices, since households are not the owners of the fixed factor. Still, later on in the quantitative section we also compute the effects of the EU enlargement under a different ownership structure to evaluate the quantitative implications of this assumption on allocations.

where ζ^i is a constant.²⁵ We now describe the market clearing conditions and the equilibrium of the model.

3.3 Market Clearing

The total expenditure on goods by country i is given by labor income of workers of all skill levels and nationalities residing in country i , by income of local rentiers and by tariff revenues that are spent by the government in local goods.²⁶ Therefore, the goods market clearing is given by

$$X_t^i = \sum_{n=1}^N \sum_{s=h,l} w_{s,t}^i L_{n,s,t}^{ie} + \iota^i \chi_t + T_t^i, \text{ for all } i, \quad (9)$$

where $\chi_t = \sum_{i=1}^N r_t^i H^i$ is the rent of the global portfolio, and where $T_t^i = \sum_{j=1}^N \tau_t^{i,j} \frac{\pi_t^{i,j}}{(1+\tau_t^{i,j})} X_t^i$ are tariff revenues.

Finally, the labor markets clear, i.e

$$w_{s,t}^i L_{s,t}^{ie} = \xi_{s,t}^i (1 - \gamma^i) \sum_{j=1}^N \frac{\pi_t^{j,i}}{(1 + \tau_t^{j,i})} X_t^j, \text{ for all } i, s, \quad (10)$$

where $\xi_{s,t}^i$ is the share of skill s in the labor payments given by

$$\xi_{s,t}^i = \frac{\delta_{s,t}^i (w_{s,t}^i)^{1-\rho}}{\delta_{h,t}^i (w_{h,t}^i)^{1-\rho} + \delta_{l,t}^i (w_{l,t}^i)^{1-\rho}}, \quad (11)$$

which is time-varying given the CES production structure.

3.4 Equilibrium

We denote by $\Theta_t \equiv \left\{ d_t^{i,j}, \tilde{m}_{n,h,t}^{i\ell,jo}, \tilde{m}_{n,l,t}^{i\ell,jo}, \phi_t^i, \delta_{h,t}^i, \delta_{l,t}^i, H^i, b^i \right\}_{n=1; i=1; j=1; \ell, o=e, ne}^{N, N, N}$ the set of constant and time-varying fundamentals, that is, bilateral non-tariff (iceberg) trade costs, non-policy mobility costs by nationality, skills, and employment status, the exogenous component of productivity across countries, the factor demand shifters, the stock of fixed factors across countries, and consumption from home production. In addition, we denote by $\Upsilon_t \equiv \left\{ \tau_t^{i,j}, mpol_{n,t}^{i,j} \right\}_{n=1; i=1; j=1}^{N, N, N}$ the different economic policies of a country: tariffs and migration policies that impact migration costs $m_{n,s,t}^{i\ell,jo}$. The state of the economy is given by the distribution of households across each market at a given

²⁵Note that equilibrium condition (6), and (7) are isomorphic to a model with free entry of heterogeneous firms as in Melitz (2003) with Pareto distribution of productivity where instead of A_t^j we would have the mass of firms which are proportional to labor.

²⁶An alternative formulation is to include tariff revenues directly in the consumption basket of the households. Doing so will have a direct impact on migration decisions since households might move to locations with larger tariff revenues. Instead, we model migration decisions to be dictated by real wages and the option value of migrating, and include a local government that collects tariff revenues and spends them in local goods. Of course, changes in tariffs have effects on revenues and also on real wages effects. This is due to the fact that tariff revenues affect the expenditure on local goods which in turn impacts the demand for local labor. Later on, in Section 5.3.1, we allow local governments to produce publicly-provided consumption services financed by tariffs and taxes.

moment in time $L_t = \left\{ L_{n,h,t}^{i\ell}, L_{n,l,t}^{i\ell} \right\}_{n=1;i=1;\ell=e,ne}^{N,N}$. We now seek to define the equilibrium of the model given fundamentals, trade policies, and migration policies. First, we formally define the *static equilibrium*, which is given by the set of factor prices that solve the static trade equilibrium.

Definition 1. *Given $(L_t, \Theta_t, \Upsilon_t)$, the **static equilibrium** is a set $\{w_{h,t}^i, w_{l,t}^i, r_t^i\}_{i=1}^N$ of factor prices that solves the static sub-problem given by the equilibrium conditions (6), (7), (8), (9), (11) and (10).*

We denote by $\omega_{s,t}^i \equiv w_{s,t}^i/P_t^i$ real wage and by $\omega_{s,t}^i(L_t, \Theta_t, \Upsilon_t)$ the solution to the real wages in the static equilibrium given factors of production, fundamentals and policies. We now define the sequential competitive equilibrium of the model given a sequence of fundamentals and policies:

Definition 2. *Given an initial allocation of labor L_0 , a sequence of fundamentals $\{\Theta_t\}_{t=0}^\infty$, and a sequence of policies $\{\Upsilon_t\}_{t=0}^\infty$, a **sequential competitive equilibrium** of the model is a sequence $\left\{ \left\{ L_{n,s,t}^{i\ell}, \mu_{n,s,t}^{i\ell,jo}, V_{n,s,t}^{i\ell}, \omega_{s,t}^i(L_t, \Theta_t, \Upsilon_t) \right\}_{n=1;i=1;j=1;\ell=o=e,ne;s=h,l}^{N,N,N} \right\}_{t=0}^\infty$, that solves the households' dynamic problem, equilibrium conditions (1), (3), (4), and the temporary equilibrium at each t .*

Definition 2 illustrates the equilibrium of the model given an initial condition on the state of the economy and for a given sequence of fundamentals and policies. Our goal now is to use the model to study the general equilibrium effects of changes to trade and migration policies. We do so in the multi-country version of the model calibrated to the EU economies and a constructed rest of the world. Taking a large scale model to the data requires estimating a large set of unknown parameters—technologies, iceberg trade costs, the non-policy component of migration costs, and the endowments of fixed factors—that before we refer to as fundamentals. We use the method proposed by CDP, dynamic hat algebra (henceforth DHA), to take the model to the data to study the effects of changes to trade and migration policies. The key advantage of DHA is that we can conduct our quantitative analysis without estimating the fundamentals of the economy. We now express the equilibrium conditions of the model in relative time differences and show how we can use the model and data to study the effects of the EU enlargement.

3.5 Solving for Policy Changes

Consider quantifying the effects of changes in policy from an actual sequence of policies to a counterfactual sequence of policies denoted with “prime”, $\{\Upsilon_t\}_{t=0}^\infty \rightarrow \{\Upsilon_t'\}_{t=0}^\infty$. Let $\hat{y}_{t+1} \equiv y_{t+1}/y_t$ denote the relative time change of a variable, and let $\hat{y}'_{t+1} \equiv y'_{t+1}/y_{t+1}$ denote the relative time difference of the variable under a sequence of policies $\{\Upsilon_t'\}_{t=0}^\infty$ relative to the sequence of policies $\{\Upsilon_t\}_{t=0}^\infty$.

For instance, if y_{t+1} are prices, \hat{y}_{t+1} is the relative change in prices as a consequence of the change in policy. Given this notation we can write the equilibrium conditions of the model for

a given change in the sequence of policies. Importantly, the next proposition shows that, given data on the allocations of the economy, we can study the effects of a change in policy without information on the sequence of fundamentals. To simplify notation let $\hat{mpol}_{n,t}^{i,j} \equiv \exp(mpol_{n,t+1}^{i,j} - mpol_{n,t}^{i,j}) / \exp(mpol_{n,t+1}^{i,j} - mpol_{n,t}^{i,j})$, and $\hat{u}_{n,s,t}^{il} \equiv \exp(V_{n,s,t+1}^{il} - V_{n,s,t}^{il}) / \exp(V_{n,s,t+1}^{il} - V_{n,s,t}^{il})$.

Proposition 1. *Given a baseline economy $\{L_t, \mu_t, \pi_t, X_t\}_{t=0}^{\infty}$, elasticities $(\nu, \theta, \beta, \rho)$, and a sequence of counterfactual changes in policy $\{\hat{Y}_t\}_{t=0}^{\infty}$, solving the model does not require $\{\Theta_t\}_{t=0}^{\infty}$, and solves*

$$\hat{u}_{n,s,t}^{il} = \hat{C}_{s,t}^{il} \left(\sum_{j=1}^N \sum_{o=e,ne} \mu_{n,s,t-1}^{il,jo} \dot{\mu}_{n,s,t}^{il,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo} \right)^{\beta/\nu} \right)^{\nu}, \quad (12)$$

$$\mu_{n,s,t}^{il,jo} = \frac{\mu_{n,s,t-1}^{il,jo} \dot{\mu}_{n,s,t}^{il,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo} \right)^{\beta/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \mu_{n,s,t-1}^{il,ka} \dot{\mu}_{n,s,t}^{il,ka} \left(\hat{mpol}_{n,t}^{i,k} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{ka} \right)^{\beta/\nu}}, \quad (13)$$

$$L'_{n,s,t+1}{}^{io} = \sum_{j=1}^N \sum_{\ell=e,ne} \mu_{n,s,t}^{j\ell,io} L'_{n,s,t}{}^{j\ell}, \quad (14)$$

for all ℓ, n , and s , where $\dot{\mu}_{n,s,t}^{il,jo}$ is the time evolution of migration flows in the baseline economy, $\hat{C}_{s,t}^{i,ne} = 1$, and $\hat{C}_{s,t}^{ie} = \hat{\omega}_{s,t}^i(\hat{L}_t, \hat{Y}_t)$ is obtained from solving the static trade equilibrium conditions.²⁷

The result in Proposition 1 follows from CDP, and shows how we can use data and estimated elasticities to study the effects of a change in policy without needing to estimate fundamentals. Relative to CDP we show how to apply their method in the context of a model that has heterogeneous agents (skills and nationalities), and agglomeration effects. We apply the result of Proposition 1 as follows. We first construct a baseline economy. The baseline economy is a sequence of observed allocations (data) that contains information of the actual fundamentals and the policies in place at each time, including the policy changes due to the EU enlargement. In order to construct the baseline economy we assume that all fundamentals and policy variables remain permanently unchanged following our data period and that the economy converges to a steady state for an arbitrarily large period T . We denote the baseline economy as the economy under policies and fundamentals $\{\Upsilon_t, \Theta_t\}_{t=0}^{\infty}$. Therefore, all “hat” variables are relative to the baseline economy, and the evolution of migration flows in the baseline economy is denoted by $\dot{\mu}_{n,s,t}^{il,jo}$ in Proposition 1.

To isolate the effect of the EU enlargement, we solve for a counterfactual sequence of allocations that reflects the evolution of the economies in the absence of the EU enlargement. For the case of the EU enlargement, the counterfactual sequence of policies is to leave tariffs and migration policy unchanged; i.e., at the pre-enlargement level. To compute counterfactuals, we assume that agents

²⁷Appendix G derives the equilibrium conditions of the temporary equilibrium in relative time differences.

at $t = 0$ are not anticipating the change in the path of policies (namely, they expected the EU enlargement to happen) and that at $t = 1$ agents learn about the new entire future counterfactual sequence of policies. Therefore, the solution to the equilibrium conditions in relative time differences presented in Proposition 1 answers the following question: “How would the economy look like if everything would have happened as in the data (changes in fundamentals, other policies, etc.) except for the EU enlargement?”

To compute this counterfactual economy under a new sequence of policies, $\hat{\mathcal{Y}}_t$, relative to the baseline economy using Proposition 1, first note that all ‘dot’ variables are taken as given from the baseline economy. We start with an initial guess where all ‘hat’ variables will be permanently equal to unity. We assume that after period T (long enough) all policy variables remain permanently unchanged and then the system converges to a steady state. We use our initial guess of $\hat{u}_{n,s,t}^{il}$ to solve for the sequence of $\mu_{n,s,t}^{il,jo}$ using equation (13) and use this solution into equation (14) to solve for the sequence of $L_{n,s,t+1}^{io}$. Given the new path of $L_{n,s,t+1}^{io}$ we solve for the sequence of $\hat{C}_{s,t}^{ie} = \hat{\omega}_{s,t}^i(\hat{L}_t, \hat{\mathcal{Y}}_t)$ by solving the trade equilibrium at each time t . With this new sequence of $\hat{C}_{s,t}^{ie}$ we use equation (12) to update our path of $\hat{u}_{n,s,t}^{il}$. We repeat this steps, using the equations in Proposition 1 to update the time paths, iterating in this way until we arrive at a fixed point. Appendix H presents the details of the algorithm we implement to solve for the baseline economy and counterfactual equilibrium.

The methodology developed in CDP has two main attractive properties to quantify the effects of the EU enlargement. First, we only need to identify the change in policy and therefore, we do not need to identify the evolution of the whole set of unobservable parameters (fundamentals) during the period of analysis. Second, we solve for the counterfactual economy relative to an economy that is calibrated using time series, and therefore, when feeding into the model the actual changes in policy, it will match exactly the observed gross migration flows, trade flows, and all the rest of observed labor market allocations. We can apply the result in Proposition 1 to study any other counterfactual change in policy and/or to study changes in fundamentals. Of course, this requires the use of time series data on labor allocations, migration and trade flows, and expenditures, as well as estimates of the elasticities.²⁸ Implementing this methodology requires a measure of the changes in policies that we want to study. While the magnitude of changes in tariffs can be calculated directly from the data, measuring the change in migration costs associated with the EU enlargement is more challenging.

In the next section, we describe how we construct the data to compute the model, we present the estimation strategy used to measure the changes in policy-related migration costs, and we estimate all the relevant elasticities.

²⁸In practice, there is no infinite sequence of data. To overcome this, we follow CDP and use the maximum possible data available and then use the model to solve forward for the economy under a constant set of fundamentals and policies. In our application this would mean to use data from the years 2002 to 2014 and then solve forward with the level of fundamentals and policies implied by the data of the year 2014.

4 Data and Estimation

To implement the DHA described in the previous section, we need data on bilateral migration shares by nationality, skill and labor force status $\mu_{n,s,t}^{i\ell,j\theta}$, bilateral trade shares $\pi_t^{i,j}$, total expenditure by country X_t^i , and the distribution of labor by nationality, skill, and labor force status across countries $L_{n,s,t}^{i\ell}$. In addition, we need to compute the share of labor payments in value added $(1 - \gamma^i)$ and the share of labor by skill $\xi_{s,t}^i$. We collect the data needed for the quantitative analysis for the period 2002-2014, being 2014 the last year with available migration, trade, and production data. We also need estimates of the migration cost elasticity $1/\nu$, an estimate of the elasticity of substitution between low- and high-skilled workers ρ , a value for the trade cost elasticity θ , and for the discount factor β . In our quantitative analysis we use the value $\theta = 4.5$ from Caliendo and Parro (2015), whose methodology is consistent with the gravity-trade equation of our model.²⁹ Finally, we impose a yearly discount factor $\beta = 0.97$. To evaluate the change in trade and migration policy we also need bilateral ad-valorem tariffs $\tau_t^{i,j}$, and the changes in migration costs associated to the policy for each country pair. In this section we describe the data construction, and estimation strategies to obtain the elasticities and changes in migration costs associated to the EU enlargement. Appendix B, C, D, and E present a more extensive description of the data and the estimation methodologies.

4.1 Data

We now briefly describe the production and trade data needed to compute the model. Section 2.3 described the construction of gross migration flows across European countries by nationality, skill and labor force status $\mu_{n,s,t}^{i\ell,j\theta}$. Appendix B presents further details.

We construct the bilateral trade shares $\pi_t^{i,j}$ for the 17 countries in our sample and a constructed rest of the world using trade flows from the World Input-Output Database (WIOD), and we also compute total expenditure by country X_t^i from WIOD. The stock of households $L_{n,s,t}^{i\ell}$ is computed using information by country, nationality, skills, labor force status and year from the EU-LFS. The share of labor payments in value added $(1 - \gamma^i)$ is computed with information on labor compensation retrieved from the socio-economic accounts of the WIOD. The share of labor by skill $\xi_{s,t}^i$ in total labor payment is obtained using labor compensation data by skill from the socio-economic account of the WIOD data set.

4.2 Identifying Policy-Related Changes in Migration and Trade Costs

In this section we present our strategy to measure the changes in migration costs due to the EU enlargement. As we described in Section 2.1, the elimination of migration restrictions was implemented at different points in time for different sets of countries. We separate the set of countries in two “waves”, according to the timing (first wave of countries opened earlier than second wave of countries) and according to the particular methodology we use to estimate the

²⁹The methodology in Caliendo and Parro (2015) is consistent with models that deliver a multiplicative gravity equation, like the model in this paper.

changes in migration policy. We proceed first to present our strategy to identify the migration policy changes associated with the opening of the U.K. in 2004, followed by Greece, Italy, Spain, and Portugal in 2006; what we refer to as the first wave. We then present the methodology and estimates of the policy changes for the second wave, when France (in the year 2008), Belgium (in the year 2009), Denmark (in the year 2009), Austria (in the year 2011) and Germany (in the year 2011) eliminate migration restrictions.

4.2.1 Estimation Strategy for the First Wave: U.K., Greece, Italy, Spain, and Portugal opening to NMS countries

To illustrate our methodology to estimate the cost changes associated to migration policy for the first wave of countries, consider three countries, A , B , and C , and households that are only heterogeneous regarding to their nationality n . Suppose that country B implements changes to its migration policy that affect nationals from country A but not from C . Recall that we assume that migration costs between countries are given by

$$m_{n,t}^{i,j} = \bar{m}_{n,t}^i + \bar{m}_{n,t}^j + \bar{m}_{n,t}^{i,j} + mpol_{n,t}^{i,j},$$

for $i, j = \{A, B, C\}$, where $\bar{m}_{n,t}^{i,i} = 0$ and $mpol_{n,t}^{i,j}$ is the migration policy component of the migration cost.³⁰ The equilibrium flows of households in A that migrates to B is given by

$$\mu_{n,t}^{A,B} = \frac{\exp(\beta V_{n,t+1}^B - m_{n,t}^{A,B})^{1/\nu}}{\sum_{k=A,B,C} \exp(\beta V_{n,t+1}^k - m_{n,t}^{A,k})^{1/\nu}}.$$

Similarly, for stayers

$$\mu_{n,t}^{A,A} = \frac{\exp(\beta V_{n,t+1}^A - m_{n,t}^{A,A})^{1/\nu}}{\sum_{k=A,B,C} \exp(\beta V_{n,t+1}^k - m_{n,t}^{A,k})^{1/\nu}}.$$

Taking the ratio of both expressions we obtain

$$\frac{\mu_{n,t}^{A,B}}{\mu_{n,t}^{A,A}} = \frac{\exp(\beta V_{n,t+1}^B - m_{n,t}^{A,B})^{1/\nu}}{\exp(\beta V_{n,t+1}^A - m_{n,t}^{A,A})^{1/\nu}},$$

and after taking logs from both sides we get

$$y_{n,t}^{A,B} - y_{n,t}^{A,A} = -\frac{1}{\nu} \left(\bar{m}_{n,t}^A + \bar{m}_{n,t}^B + \bar{m}_{n,t}^{A,B} + mpol_{n,t}^{A,B} - m_{n,t}^{A,A} \right) + \frac{\beta}{\nu} V_{n,t+1}^B - \frac{\beta}{\nu} V_{n,t+1}^A,$$

where $y_{n,t}^{A,B} \equiv \log(\mu_{n,t}^{A,B})$. As we can see from this equation, for the term $y_{n,t}^{A,B} - y_{n,t}^{A,A}$ to identify the change in migration policy between A and B , we need to control for the value functions, $V_{n,t+1}^A$

³⁰ Assuming that $\bar{m}_{n,t}^{i,i} = 0$ does not imply $m_{n,t}^{i,i} = 0$. In what follows, all the derivations go through even if we assume that $\bar{m}_{n,t}^{i,i} \neq 0$ provided it is constant over time.

and, $V_{n,t+1}^B$, and for all the non-policy components of migration costs between A and B , namely, $\bar{m}_{n,t}^A + \bar{m}_{n,t}^B + \bar{m}_{n,t}^{A,B} - m_{n,t}^{A,A}$. To do so, we use the information contained in the equilibrium migration flows of the third country, C , which did not change migration policy with countries A and B . To see this, the equilibrium flows of migrants relative to stayers from A to C and from C to B are given by

$$y_{n,t}^{A,C} - y_{n,t}^{A,A} = -\frac{1}{\nu} \left(\bar{m}_{n,t}^A + \bar{m}_{n,t}^C + \bar{m}_{n,t}^{A,C} + mpol_{n,t}^{A,C} - m_{n,t}^{A,A} \right) + \frac{\beta}{\nu} V_{n,t+1}^C - \frac{\beta}{\nu} V_{n,t+1}^A,$$

and

$$y_{n,t}^{C,B} - y_{n,t}^{C,C} = -\frac{1}{\nu} \left(\bar{m}_{n,t}^C + \bar{m}_{n,t}^B + \bar{m}_{n,t}^{C,B} + mpol_{n,t}^{C,B} - m_{n,t}^{C,C} \right) + \frac{\beta}{\nu} V_{n,t+1}^B - \frac{\beta}{\nu} V_{n,t+1}^C.$$

Note that $y_{n,t}^{A,C} - y_{n,t}^{A,A}$ has the same origin-specific components as in $y_{n,t}^{A,B} - y_{n,t}^{A,A}$, while $y_{n,t}^{C,B} - y_{n,t}^{C,C}$ has the same destination-specific components as in $y_{n,t}^{A,B} - y_{n,t}^{A,A}$. Therefore, by using the cross-sectional variation in flows between the three countries, and their time variation (before, *pre*, and after, *post*, the policy change), we can identify the changes in migration policy between A and B ; namely $mpol_{n,post}^{A,B} - mpol_{n,pre}^{A,B}$. To do so, we impose the following identification restrictions: (1) there is no change in policy between A and C ,

$$mpol_{n,post}^{A,C} - mpol_{n,pre}^{A,C} = 0, \quad (15)$$

and no change in policy for migrants in C moving to B

$$mpol_{n,post}^{C,B} = mpol_{n,pre}^{C,B},$$

and (2) that the difference between the non-policy migration costs between countries that change and do not change policy remains constant over time, namely

$$\bar{m}_{n,post}^{A,B} - \left(\bar{m}_{n,post}^{A,C} + \bar{m}_{n,post}^{C,B} \right) = \bar{m}_{n,pre}^{A,B} - \left(\bar{m}_{n,pre}^{A,C} + \bar{m}_{n,pre}^{C,B} \right). \quad (16)$$

Let $Y_{n,t}^{A,B,C}$ be the difference in flows between: migration flows from A to B relative to stayers in A , migration flows from A to C relative to stayers in A , and migration flows from C to B relative to stayers in C . Namely

$$Y_{n,t}^{A,B,C} \equiv \left(y_{n,t}^{A,B} - y_{n,t}^{A,A} \right) - \left(y_{n,t}^{A,C} - y_{n,t}^{A,A} \right) - \left(y_{n,t}^{C,B} - y_{n,t}^{C,C} \right).$$

Applying this triple differentiation before and after the change in policy, and imposing our identification restrictions, we obtain

$$Y_{n,post}^{A,B,C} - Y_{n,pre}^{A,B,C} = -\frac{1}{\nu} \left(mpol_{n,post}^{A,B} - mpol_{n,pre}^{A,B} \right). \quad (17)$$

Note that equation (17), which is derived from equilibrium conditions of the model, tells us that

triple differentiating migration flows before and after an event among countries that satisfy our identification restrictions identifies the migration policy change (scaled by the migration elasticity). This triple differentiation is a key feature of our method, which is guided by our general equilibrium model and the sequential nature of the EU enlargement policy. Note that this method allows us to identify migration policy changes, and not the level of the policy or non-policy component of migration costs. Crucially, as described in Section 3.5, our solution method to compute the effects of the EU enlargement only requires information on the migration policy changes, but not on the levels of migration costs. This connection between our estimation strategy of policy changes and the DHA is an important feature of our methodological contribution in this paper.

We now describe in more detail the estimating equation that we use to implement this method in order to estimate the change in migration costs due to the EU enlargement.

Empirical Specification for the First Wave

We start by describing the estimating equation of the policy-related change in the cost of migrating from NMS to the U.K. We then follow the same empirical strategy for the rest of countries in the first wave, namely Greece, Italy, Spain, and Portugal.

Following our estimation strategy described above, in the case of the U.K. we consider three sets of gross migration flows for NMS nationals: from NMS countries to the U.K.; from NMS countries to Austria, Belgium, Denmark, France, and Germany (henceforth EU-5), and from EU-5 to the U.K. We exploit the fact that (1) EU-5 countries did not open their labor markets to NMS countries until 2008 (which justifies choosing EU-5 as the third-country group up to 2007), and (2) those NMS nationals residing in EU-5 before the EU enlargement did not experience changes in migration costs to the U.K. associated to the EU enlargement.³¹ We use a set of destination and origin fixed-effects and bilateral dummies to control for the different origin-specific and destination-specific components, as well as the non-policy migration costs. Therefore, our empirical specification resulting from our structural model is given by

$$\begin{aligned}
y_{s,t}^{ij} - y_{s,t}^{ii} &= \sum_{s,t} \lambda_{s,t}^{UK} \mathbb{I}(j = UK; s; t) + \sum_{s,t} \sum_{origin \in NMS} \alpha_{s,t}^{origin} \mathbb{I}(i = origin \in NMS; s; t) \\
&+ \sum_s \sum_{origin \in NMS} \beta_s^{origin, UK} \mathbb{I}(i = origin \in NMS; j = UK; s) \\
&+ \beta_{post}^{NMS, UK} \mathbb{I}(i = origin \in NMS; j = UK; t \in post) + \varepsilon_{s,t}^{ij},
\end{aligned} \tag{18}$$

where $\mathbb{I}(condition)$ is an indicator function that takes the value of one when the given condition is satisfied. For example $\mathbb{I}(j = UK, s, t)$ takes the value of one when the destination country j is the U.K. for each skill s and time t . The first term in (18) is the destination-time-skill fixed effect $\lambda_{s,t}^{UK}$ that represents the coefficients of a set of time-skill dummies for when the destination is the U.K. This term absorbs at each t all the U.K. specific factors relative to the EU-5, such

³¹Appendix D.1 provides support for the common trend assumption underlying our identification restrictions for the countries in the first wave.

as, $\frac{\beta}{\nu} \left(V_{NMS,s,t+1}^{UK} - V_{NMS,s,t+1}^{EU5} \right)$, and $\bar{m}_{NMS,s,t}^{UK} - \bar{m}_{NMS,s,t}^{EU5}$. The second term is the origin-time-skill fixed-effect $\alpha_{s,t}^{origin}$ that represents the coefficients of a set of country-year-skill dummies when the origin country is a NMS country. This term absorbs at each t all the NMS country specific factors relative to the EU-5 group for all $i = NMS$ such as, $\frac{\beta}{\nu} \left(V_{NMS,s,t+1}^i - V_{NMS,s,t+1}^{EU5} \right)$, and $\bar{m}_{NMS,s,t}^i - \bar{m}_{NMS,s,t}^{EU5}$. The third term $\beta_s^{origin,UK}$, is a coefficient of a bilateral dummy by skill and country of origin, for when the origin is a NMS country and the destination is the U.K. This term captures the bilateral migration cost between countries that changed policy relative to those that do not.

The term $\beta_{post}^{NMS,UK}$ is the coefficient of a dummy that takes the value of one after the change in policy for when the origin is an NMS country and the destination is the U.K. This is our coefficient of interest, since it estimates the change in migration policy before and after the EU enlargement, normalized by $-1/\nu$, namely,

$$\beta_{post}^{NMS,UK} \equiv -\frac{1}{\nu} \left(mpol_{NMS,post-enlarg.}^{NMS,UK} - mpol_{NMS,pre-enlarg.}^{NMS,UK} \right). \quad (19)$$

Given that the migration policy due to the EU enlargement is non-discriminatory, our specification estimates the change in policy that is non-discriminatory across skills and across NMS nationalities, that is, it is common to all NMS countries. Finally, $\varepsilon_{s,t}^{ij}$ is a random disturbance of relative migration costs and it is assumed to be orthogonal to changes in migration policy.³²

Table 2: Estimates of Changes in Migration Policy, NMS nationals

NMS nationals ($n = NMS$)					
Destination $j \rightarrow$	<i>U.K. (2004)</i>	<i>GR (2006)</i>	<i>IT (2006)</i>	<i>ES (2006)</i>	<i>PT (2006)</i>
$\beta_{post}^{NMS,j}$	3.29*** (0.67)	1.50*** (0.52)	0.76** (0.30)	0.21 (0.34)	0.83*** (0.29)
R^2	0.98	0.99	0.99	0.99	0.99
Obs.	564	564	564	564	564

Note: The table reports the estimates, from separate regressions, of the change in migration cost from NMS countries to either the U.K., Greece (GR), Italy (IT), Spain (ES), or Portugal (PT) for NMS nationals. Recall, from equation (19), that a positive estimate implies a reduction in migration costs. The post periods are 2004-2007 for the U.K., and 2006-2007 for the other countries. Parentheses include robust standard errors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Similar significance is obtained if instead we use two-way clustering at the origin-destination-country level.

Table 2 presents our estimates of the policy-related changes in migration costs for the case of NMS nationals moving from NMS countries to the U.K, Greece, Italy, Spain, and Portugal. As we can see, all estimates are positive and significant (except for Spain), pointing to a reduction

³²We pool the flows of low and high-skilled households for the bilateral dummies to capture the fact that changes in migration policy were non-discriminatory across skills and nationalities, and aggregate across labor force status. In Appendix I we show that after aggregating our model across labor force status we obtain the equilibrium equations that map into our estimating equation (18).

in the cost of migrating from NMS to Europe for NMS nationals both in 2004 and 2006.³³ These coefficients are hard to interpret since they reflect the change in the migration cost scaled by the migration elasticity and measured in units of utility. To understand the magnitude, in terms of consumption, real wages, etc., of these changes we need to use these estimates as inputs in our quantitative model.³⁴

4.2.2 Estimation Strategy for the Second Wave: France, Belgium, Denmark, Austria, and Germany opening to NMS countries

We now consider the other main changes in migration policy, which include France opening in 2008, Belgium and Denmark in 2009, and Austria and Germany in 2011. These countries were the last ones to eliminate the migration restrictions to the NMS countries, and therefore we cannot implement the estimation strategy that we used in the first wave since one of our identification restrictions does not apply to this set of countries.³⁵ As a consequence, we proceed with an alternative approach that exploits a different aspect of the policy changes due to the EU enlargement for this set of countries.

To illustrate our identification strategy, consider two countries A and B, and a policy change applied by B to nationals from country A. Taking the product between the ratio of migrants to stayers in one direction and in the opposite direction—considering only nationals from country A—we can differentiate out the value functions, and the resulting ratio will only contain information on migration costs.³⁶ Defining $y_{n,t}^{A,B} \equiv \log(\mu_{n,t}^{A,B})$, we have that

$$\left(y_{n,t}^{A,B} - y_{n,t}^{A,A}\right) + \left(y_{n,t}^{B,A} - y_{n,t}^{B,B}\right) = -\frac{1}{\nu} \left(\bar{m}_{n,t}^{A,B} + mpol_{n,t}^{A,B} + \bar{m}_{n,t}^{B,A} + mpol_{n,t}^{B,A}\right)$$

As we can see, in order to identify the change in policy applied by country B to country A using the cross-sectional variation in flows between the two countries, and their time variation (before, *pre*, and after, *post*, the policy change), we need to impose some structure on how the non-policy bilateral migration costs change over time. In particular, we impose the following identification restrictions (1) country B’s migration policy change does not affect the cost of migrating back to A for country A nationals, namely

$$mpol_{n,post}^{B,A} = mpol_{n,pre}^{B,A}.$$

³³Recall, from equation (19), that a positive estimate implies a reduction in migration costs.

³⁴In Appendix D.2 we present a placebo-type experiment exercise to support our identification strategy. In particular, we run our empirical specification using a set of nationalities for which there was no change in policy. The intuition is that we expect the costs of migrating from NMS countries to the U.K., Greece, Italy, Spain, and Portugal not to have changed for EU-15 nationals as a consequence of the EU enlargement. We show that our methodology applied to this case estimates no change in policy.

³⁵In particular, we do not have, for the second wave of countries, a group of countries like country C in the example before, or EU5 in the estimation of the first wave, and therefore we cannot impose restriction (1), equation (15).

³⁶This cross-multiplication idea was developed by Head and Ries (2001) and has been applied in the international trade literature extensively to identify trade costs.

and, (2) the bilateral non-policy component of migration costs did not change after the policy change, namely

$$\bar{m}_{n,post}^{A,B} = \bar{m}_{n,pre}^{A,B} \text{ and } \bar{m}_{n,post}^{B,A} = \bar{m}_{n,pre}^{B,A}.$$

Note that these conditions are similar but not identical to the ones we use in the methodology developed for the first wave of countries. The first identification restriction is similar but not the same as the identification restriction (15). However, the second condition is more restrictive than condition (16) that we imposed in the first-wave estimation.³⁷

Let $Y_{n,t}^{A,B} \equiv \left(y_{n,t}^{A,B} - y_{n,t}^{A,A} \right) + \left(y_{n,t}^{B,A} - y_{n,t}^{B,B} \right)$. Taking the difference $Y_{n,post}^{A,B} - Y_{n,pre}^{A,B}$, and applying our identification restrictions, we obtain that

$$Y_{n,post}^{A,B} - Y_{n,pre}^{A,B} = -\frac{1}{\nu} \left(mpol_{n,post}^{A,B} - mpol_{n,pre}^{A,B} \right). \quad (20)$$

As we can see, equation (20), derived from the equilibrium conditions of the model, reflects that one can use cross-country migration flows before and after the change in policy to identify $mpol_{n,post}^{A,B} - mpol_{n,pre}^{A,B}$. We now describe in more detail the estimating equation that we take to the data for the second wave of countries in the EU enlargement.

Empirical Specification for the Second Wave

We describe the empirical specification using as an example the change in policy by Germany to NMS countries. We then apply the same empirical strategy for the rest of countries in the second wave, namely Austria, Belgium, Denmark, and France.

Let's consider the change in migration policy that affected the access of NMS nationals to Germany. Following the identification strategy described in the previous section, in the case of Germany we consider two sets of migration flows conditioning on NMS nationals: from NMS countries to Germany and from Germany to NMS countries, relative to the stayers in NMS countries and in Germany. Notice that the policy did not change the access of NMS nationals going from Germany to NMS countries, thus we have that $mpol_{n,post}^{B,A} = mpol_{n,pre}^{B,A}$ when A is NMS and B is Germany.

Our empirical specification is given by

$$\left(y_{s,t}^{i,GER} - y_{s,t}^{ii} \right) + \left(y_{s,t}^{GER,i} - y_{s,t}^{GER,GER} \right) = \alpha_s^{i,GER} + \beta_{post}^{NMS,GER} \mathbb{I}(t \in post) + \varepsilon_{s,t}^i,$$

where i belongs to the set of NMS countries, and $\mathbb{I}(condition)$ is the indicator function. The term $\alpha_s^{i,GER}$ represents a set of origin-skill fixed effects. These coefficients capture the bilateral components of the mobility costs between NMS countries and Germany in the pre-enlargement period. The term $\beta_{post}^{NMS,GER}$ is the coefficient of a dummy after the policy change. This coefficient

³⁷Yet, similar to the case of bilateral trade costs, one could argue that the bilateral non-policy components of migration costs are usually related to factors that are persistent over time such as distance or language differences. If this is the case, the second condition is very likely to hold.

Table 3: Changes in Migration Policy, Additional EU Countries

		NMS nationals				
Destination $j \rightarrow$	<i>FR (2008)</i>	<i>BE (2009)</i>	<i>DK (2009)</i>	<i>AU (2011)</i>	<i>DE (2011)</i>	
$\beta_{post}^{NMS,j}$	0.62 (0.54)	2.36*** (0.48)	1.27** (0.51)	1.60*** (0.40)	3.10*** (0.41)	
R^2	0.98	0.98	0.98	0.99	0.98	
Obs.	140	140	140	140	140	

Note: The table reports the estimates, from separate regressions, of the change in migration cost from NMS countries to either France (FR), Belgium (BE), Denmark (DK), Germany (DE), or Austria (AT) for NMS nationals. Recall, from equation (21), that a positive estimate implies a reduction in migration costs. The post period is five years after the policy change for each country. Parentheses include robust standard errors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

captures the change in migration policy normalized by $-1/\nu$, namely,

$$\beta_{post}^{NMS,GER} \equiv -\frac{1}{\nu} \left(mpol_{NMS,post}^{NMS,GER} - mpol_{NMS,pre}^{NMS,GER} \right). \quad (21)$$

Analogously, we follow the same approach and identify the change in the policy component of the cost of moving from NMS to France, or Belgium, or Denmark, or Austria.

Table 3 reports the results, and shows the change in the cost of migrating from NMS to the EU member states that opened their borders after 2007 that we attribute to the EU enlargement. As we can see, they are all positive, as expected from (21). Similar to before, in order to understand their economic importance, we use these estimates as inputs in our quantitative model to evaluate the effects of the changes in migration policy.

4.2.3 Change in Trade Policy

Finally, we obtain bilateral tariffs $\tau_t^{i,j}$ between each pair of countries and the rest of the world, using information from the World Integrated Trade Solution (WITS) data set, to capture changes in trade costs due to the EU enlargement. We use effectively applied rates and we combine information from two different data sets, the TRAINS data set and the WTO data set, to have a complete and consistent information on tariffs over time.³⁸

Armed with this set of estimates of the changes in trade and migration costs associated with the EU enlargement, we now proceed to estimate the necessary elasticities for our quantitative analysis.³⁹

³⁸In Appendix B.3.1 we explain in detail how we construct the bilateral tariff data for each country pair.

³⁹We also used the same strategy as for the second wave of countries in order to identify the changes in costs of migrating to NMS for EU nationals. For this case we used the flows of EU nationals from the EU to NMS before and after the change in policy. Given that there are not many flows over our sample period and no significant variation in the flows we ended up obtaining not economically significant estimates for this case. Therefore, in the quantitative analysis we will feed into the model the estimated statistically significant changes in migration policy between NMS countries and EU15 countries for NMS nationals, described in this section.

4.3 International Migration Elasticity

The migration elasticity is needed to evaluate the welfare effects associated to changes in the barriers to migrate: welfare effects depend on the magnitude of the change in barriers, and on how sensitive the decision to migrate is to the barriers themselves. Artuç et al. (2010) and CDP, provide estimates of the elasticities for internal migration flows, while we model international migration flows. We therefore adapt the methodology of Artuç and McLaren (2015) to the structure of our model, and apply it to the flows of EU nationals within the EU, to provide a value for the international migration elasticity.⁴⁰

The first stage of the methodology is a fixed-effect estimation that uses the migration share equation (3) and bilateral gross migration flows data to estimate value differences and the migration cost function normalized by ν . The second stage of the methodology relies on the Bellman equation. We insert the estimated value differences from the first stage into the Bellman equation, and construct a linear regression to retrieve the international migration elasticity by exploiting the variation in real wages. We estimate the second stage model as an IV regression, using two-period lagged values of real wages as instruments, and clustering standard errors at the country level.

In our preferred specification with $\beta = 0.97$ we obtain an elasticity of 0.50—significant at 1 percent—which implies a value of ν of 2. This is the value that we use in our quantitative analysis.

4.4 Elasticity of Substitution Between Low- and High-Skilled Workers

In this section, we provide the estimate of the elasticity of substitution between low- and high-skilled workers. From the first-order conditions of the firm’s cost minimization problem we have that⁴¹

$$\ln \frac{w_{h,t}^i}{w_{l,t}^i} = -\frac{1}{\rho} \ln \frac{L_{h,t}^{ie}}{L_{l,t}^{ie}} + \frac{1}{\rho} \ln \frac{\delta_{h,t}^i}{\delta_{l,t}^i}.$$

Denote by $\varrho_t^i = \frac{1}{\rho} \ln \frac{\delta_{h,t}^i}{\delta_{l,t}^i}$ the country factor demand shifters in log units. Following Katz and Murphy (1992) and Acemoglu and Autor (2011), one can model ϱ_t^i with a time-invariant component that captures the skill intensity in the production function in each country, and a country-specific linear trend that reflects factor-augmenting technology changes, namely $\varrho_t^i = \alpha^i + \varphi_t^i$.

Therefore, our empirical specification to estimate the elasticity of substitution between high-skilled and low-skilled workers is given by

$$\ln \frac{w_{h,t}^i}{w_{l,t}^i} = -\frac{1}{\rho} \ln \frac{L_{h,t}^{ie}}{L_{l,t}^{ie}} + \alpha^i + \varphi_t^i + \varepsilon_t^i, \quad (22)$$

where the error term captures the residual relative wages due to unobservable skills.⁴² We use data

⁴⁰In Appendix E we describe in detail the implementation of the methodology and report the results, both for the benchmark case and for the extension with public good described later.

⁴¹Using the labor market clearing $L_{s,t}^{ie} = \int_0^\infty L_{s,t}^{ie}(z^i) \phi^i(z) dz$ to aggregate factor demands, it follows that the first-order conditions of the firm are also satisfied at the aggregate level.

⁴²See e.g. Juhn et al. (1993).

Table 4: Elasticity of substitution between high- and low-skilled workers

	(1)	(2)	(3)	(4)
Specification with:	$\alpha^i + \varphi_t^i$	$\alpha + \varphi_t^i$	$\alpha^i + \varphi_t$	$\alpha + \varphi_t$
$-1/\rho$	-0.246*** (0.083)	-0.250*** (0.027)	-0.038 (0.032)	-0.221*** (0.031)
R-squared	0.95	0.84	0.95	0.27
Obs.	130	130	130	130

Note: This table presents the estimates of the elasticity of substitution between high-skilled and low-skilled labor. Specification in Column (1) includes a country-specific time-invariant component and a country-specific linear trend, specification in Column (2) includes a common constant and a country-specific linear trend, specification in Column (3) includes a country-specific time-invariant component and a common linear trend, and specification in Column (4) includes a constant and a common linear trend. Parentheses include robust standard errors, *** $p < 0.01$.

on wages by skill using the WIOD Socio-Economic Accounts, and the stock of employed workers by skill we obtained from the EU-LFS for the EU-15 countries and the period 2002-2014, as explained in Section 2.3 and Appendix B.

Table (4) presents our estimates of ρ . Column (1) shows the estimated coefficient $-1/\rho$ in equation (22), which corresponds to a value of ρ around 4. This is our preferred estimate that we use in the quantitative analysis later on. The other columns in the table provide estimates under alternative specifications for the factor demand shifter, and we also obtain values for ρ around 4, except for one specification that results in a non-significant coefficient. Our estimate of $\rho = 4$ is somewhat above the estimates in Katz and Murphy (1992), Johnson (1997), Krusell et al. (2000), Ottaviano and Peri (2012), Ciccone and Peri (2005), and Acemoglu and Autor (2011) which range between 1.4 and 2.9 for the U.S., and somewhat lower than the elasticity of substitution of 5 between low- and medium-skilled workers estimated in Dustmann et al. (2009) for Germany. Estimates in the literature differ, in part, due to differences in the measurement of skills; for instance, as described before, and in Appendix B.2.4, high-skilled workers in our sample includes all individuals with some college education while Katz and Murphy (1992) assign a fraction of workers with some college education to the low-skilled group.⁴³

5 Economic Effects of the 2004 EU Enlargement

In this section, we use the estimated policy-related changes in migration costs, and the observed changes in tariffs, to quantify the migration and welfare effects of the EU enlargement. We first compute the migration effects from the actual changes to migration and trade policies over the period 2002-2014, and we then quantify the welfare effects. We also use our model to study the

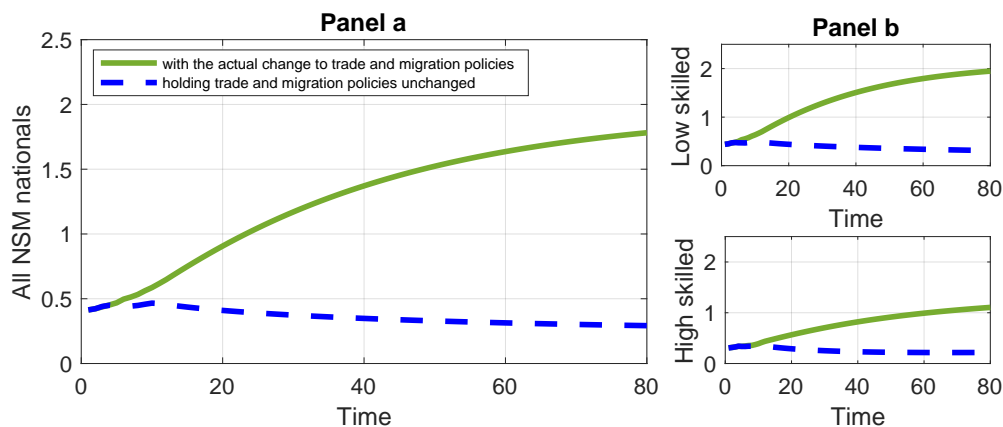
⁴³In Appendix F, we provide an alternative estimate of the elasticity of substitution between high-skilled and low-skilled workers that builds on the same approach but exploits the cross-regional and cross-sectoral variation in the matched employer-employee Portuguese data (universe of workers), and we find a similar value. For completeness, and as a sensitivity analysis, in Section 5.3.2 we also compute the effects of the EU enlargement using $\rho = 1.41$ estimated by Katz and Murphy (1992).

interaction between trade openness and migration policy, and to study the role of the different mechanisms of the model in shaping the migration and welfare effects.

5.1 Migration Effects

We start by quantifying the migration effects from the EU enlargement. In particular, with our structural model we want to answer questions such as: How did the stock of new member states (NMS) migrants in EU-15 countries respond to the EU enlargement? Was NMS migration gradual or a once and for all process? What was the change in the stock of NMS migrants in EU-15 countries across skill groups, and in the short and long-run? What would have been the migration effects in the absence of changes to trade policy?

Figure 4: Evolution of the stock of NMS migrants in EU15 countries (population share, percent)



Note: This figure presents the evolution of the share of NMS migrants in EU-15 countries (in percentage). The solid lines show the evolution of this share with actual changes to trade and migration policies. The dashed lines show the evolution holding trade and migration policies unchanged. Panel (a) presents the results for all migrants (employed and non-employed), and panel (b) presents the results for high and low skilled households (as a share of high and low skilled populations, respectively). Time is expressed in years.

To compute the migration effects, we solve for the counterfactual economy with no change in policy by feeding into our structural model the inverse of the estimated changes in migration costs and the inverse of observed changes in tariffs over 2002-2014, and compute the change in migration effects of this counterfactual economy relative to the baseline economy where migration and trade policies were the observed ones. Figure 4 displays the evolution of the stock of NMS nationals in EU-15 countries (for all migrants and by skill as the population share). The solid line shows the evolution of the stock in the baseline economy with the actual changes to migration and trade policies between 2002-2014. The dashed line shows the evolution of the stock of NMS nationals in the counterfactual economy, where we hold migration costs and tariffs constant at the levels before the EU enlargement. Therefore, the difference between the two lines is the migration effects from the EU enlargement. From the figure, panel (a), we can see that the increase in the stock of NMS migrants in EU-15 countries is realized very gradually over time. In Table 5, Column (1),

Table 5: Migration effects: Change in the stock of NMS nationals in EU-15 (percentage points)

	All NMS		Low-Skill		High-Skill	
	EU	no changes to	EU	no changes to	EU	no changes to
	enlargement	trade policy	enlargement	trade policy	enlargement	trade policy
	(1)	(2)	(3)	(4)	(5)	(6)
2002	0	0	0	0	0	0
2007	0.054	0.055	0.065	0.065	0.010	0.013
2015	0.274	0.277	0.307	0.308	0.142	0.149
Steady state	1.654	1.671	1.797	1.810	1.075	1.106

Note: This table shows the percentage point change in the share of low-skilled and high-skilled NMS nationals in EU-15 countries due to the 2004 EU enlargement, displayed in Columns (1), (3), and (4). Columns (2), (4), and (6) report the effects in the absence of trade policy changes.

we compute the effects of the EU enlargement on the stock of NMS nationals in EU-15 countries for different time horizons. In particular, three years after the EU enlargement (that is, in 2007) the stock of NMS nationals in EU-15 countries increases by 0.05 percentage points, while ten years after the implementation, the stock raises by 0.27 percentage points, which represents an increase of about 1 million between 2004-2015 (or about 1.5 percent of the population of the NMS countries in 2004). We find that in steady state, the stock of NMS nationals in EU-15 countries increases by 1.65 percentage points. Across individual countries, we find that the U.K. is the country that experienced the largest increase in the stock of NMS nationals, followed by Germany, and Austria.

We now turn to compute the change in the stock of migrants across different skills, and after doing so, we discuss the interaction between migration and trade policies. Figure 4, panel (b), presents the evolution of the stock of low and high-skill NMS migrants in EU15 countries. In Table 5, Columns (3) and (5), we also decompose the stock of NMS nationals in EU-15 countries by skill. We find that the EU enlargement primarily increases the migration of low-skilled NMS households to EU-15 countries, and to a lesser extent the migration of high-skilled workers. For instance, as we can see from the table, the stock of NMS high-skilled households in EU-15 countries increases by 0.01 percentage points by 2007, by 0.14 percentage points by 2015, and by 1.07 percentage points in the long run. We find that the change in the stock of NMS low-skilled households is larger. Specifically, the stock of low-skilled NMS nationals in EU-15 countries increases by 0.07 percentage points by 2007, by 0.31 percentage points by 2015, and by 1.80 percentage points in the steady state.

We can also use the model to compute what the migration effects would have been in the absence of changes to trade policy. In Columns (2), (4), and (6) of Table 5, we compute the change in the stock of NMS nationals in EU-15 countries holding trade policy constant. We find that migration would have been larger in the absence of changes to trade policy. Overall, the stock of NMS nationals in EU15 countries would have been about 0.02 percentage points higher in steady state. The effect of trade policy on migration is heterogenous across countries, and much larger than the aggregate effect in some countries, in particular for high-skilled households. For instance, in the absence of changes to trade policy, the stock of high-skilled households would have increased by

Table 6: Effects of the EU enlargement on non-employment shares (percentage points)

	All Households		Low-Skill		High-Skill	
	EU-15	NMS	EU-15	NMS	EU-15	NMS
	(1)	(2)	(3)	(4)	(5)	(6)
2002	0	0	0	0	0	0
2007	-0.058	-0.328	-0.065	-0.350	-0.038	-0.107
2015	-0.096	-0.730	-0.114	-0.801	-0.046	-0.147
Steady state	-0.098	-1.881	-0.143	-2.117	-0.038	-0.283

Notes: This table shows the percentage-point change in the share of non-employed households due to the EU enlargement.

about 0.5 percentage points in Austria, 0.1 percentage in Denmark, and 0.04 percentage points in Spain, Italy, and the U.K. The gains from trade associated with the entry of NMS countries into the European Custom Union and the common commercial policy seemed to have moderated a bit the incentive to emigrate towards the EU-15 member states. Intuitively, with trade integration, a net inflow of workers puts downward pressure on wages in the receiving (EU-15) countries, worsening their terms of trade and reducing the incentives to migrate to EU-15 member states.⁴⁴

We finish this section by quantifying the effect of the EU enlargement on non-employment. As discussed above, the transitions rates between employment and non-employment are endogenous in our model, and therefore can be impacted by the changes in trade and migration policies. In particular, as shown in equation (3), they are heterogeneous for migrants and stayers across countries, and depend on the mobility costs and the expected value of changing labor force status across locations. Table 6 shows the change in the share of non-employed households by skill group in the EU-15 and NMS countries as a consequence of the EU enlargement. Columns (1), (3), and (5) present the non-employment effects in EU-15 countries for all households, low-skilled, and high skilled, respectively. Columns (2), (4), and (6) present the same figures for NMS households. We find that the EU enlargement leads to a decline in the non-employment share. In particular, NMS countries experience a larger decline in non-employment, and the decline is larger for low-skilled households. For instance, in steady state the share of non-employed households declines by 1.88 percentage points, and across skills, the decline is 2.11 percentage points for low-skilled households and 0.28 percentage points for high-skilled households. Non-employment in EU-15 decreases slightly, by about 0.1 percentage point in steady state. Across individual countries, Poland experiences the largest drop in the non-employment share, about 3.5 percentage points. We also find that the share of non-employment increases in some NMS and EU-15 countries, namely Austria, Germany, Spain and Hungary. Among these countries, Germany has the largest increases the non-employment share, with a 0.2 percentage point increase. The increase in non-employment in these countries is mostly driven by low-skilled households. In fact, we find that non-employment of high-skilled households stayed almost constant in Germany, and it declines in Spain and Hungary.

⁴⁴This intuition is in line with the mechanism emphasized in Galiani and Torrens (2015).

5.2 Welfare Effects

We now turn to the welfare analysis. We start by describing the welfare effects of the EU enlargement, and we then study the interaction between trade and changes to migration policy. We also study the importance of the timing of the changes to migration policy.

Table 7, Column (1), presents the welfare effect of the EU enlargement. Similar to the previous section, to compute these welfare effects, we feed into our structural model the estimated policy-related changes in migration costs and the observed changes in tariffs over 2002-2014, and compute the change in welfare, measured in terms of consumption equivalent, compared with an economy where migration and trade policies stayed unchanged. We do so across skills and nationalities (NMS nationals and EU nationals), and to facilitate the analysis we aggregate individual countries into NMS and EU-15 countries using population as weights.⁴⁵ Before turning to the results, it is important to clarify the interpretation of the welfare numbers from the table. In particular, the welfare effect for a given country and skill group, say NMS low-skilled households, corresponds to the change in welfare, measured in consumption equivalent, of a representative low-skilled household living in NMS countries previous to the EU enlargement. In other words, this welfare number takes into account both leavers and stayers.

Table 7: Welfare effects of trade and migration policies (percent)

		EU enlargement (1)	Only changes to trade policy (2)	Only changes to migration policy (3)
EU-15	High-skill	0.136	0.146	-0.014
	Low-skill	0.020	0.094	-0.076
	Aggregate	0.043	0.105	-0.064
NMS	High-skill	1.701	0.552	1.079
	Low-skill	1.099	0.328	0.755
	Aggregate	1.170	0.354	0.793
Europe	Aggregate	0.233	0.147	0.081

Notes: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) presents the welfare effects due to changes in migration and trade policies, Column (2) presents the welfare effects from only changes to trade policies, and Column (3) shows the welfare effects due to only changes to migration policy. Aggregate effects are calculated as the population weighted average of the high and low-skilled households.

Turning to the results in Table 7, we find that Europe as whole is better off with the EU enlargement. In particular, welfare in Europe increases by 0.23 percent. The largest winners are the NMS countries that experience a welfare increase of 1.17 percent compared to a increase of 0.04 percent in the EU-15 countries. In terms of skill groups, we find that the welfare gains are heterogenous across skills. In NMS countries, welfare of high-skilled households increases by 1.70

⁴⁵We aggregate welfare in individual countries using the population shares at the initial year. In other words, we use a utilitarian approach to aggregate welfare of households with different labor force status.

percent, while in EU-15 countries it increases by 0.14 percent. We find that low-skilled households are also better off with the EU enlargement. Welfare of low-skilled households in NMS countries increases by 1.1 percent, and it increases by 0.02 percent in EU-15 countries. In EU-15 countries, households benefit from the EU enlargement due exclusively to the access to cheaper goods as result of the reduction in tariffs. In fact, in Column (2) we compute the effects of only changes in trade policy, that is, holding migration policy constant at the initial level, and find welfare increases across all skill groups. However, this welfare gains from only changes in trade policy is partially offset by welfare losses from changes in migration policy. Specifically, in Column (3) we compute the effects of only changes in migration policy, that is, holding tariffs constant at the initial level. We find that both high skilled and low skilled households in EU-15 countries are worse off with the actual changes in migration policy, but especially low-skilled households that face bigger competition from a larger increase in the supply of low-skilled households due to the migration of NMS nationals into EU-15 countries. In NMS countries, low-skilled and high-skilled households benefit from both trade and migration policies. High-skilled households experience a relatively larger welfare gain in part because they tend to have a larger labor market participation than low-skilled households, benefiting more from the access to labor markets in EU-15 countries. Overall, we find that in NMS countries trade policy contributes to about 30 percent of the overall gains from the EU enlargement, while migration policy contributed to about 68 percent (with the residual explained by their interaction).

In Table 8 we study further the interaction between trade and migration policies. In particular, we compute the welfare effects of the changes to migration policy under three different levels of goods market integration. Column (1) replicates the third column in the previous table, and therefore it shows the welfare effects of the actual changes to migration policy under the actual level of trade integration at the time of the EU enlargement. In Column (2) we compute the welfare effects of the actual changes to migration policy if Europe would have been under trade autarky at the time of the enlargement. To do so, we first compute the equilibrium allocations when trade costs are set to infinite, and we then feed into the model the changes to migration policies. In Column (3), we study the welfare effects of the actual changes to migration policy if Europe would have been a free trade area at the time of the enlargement. To do so, we first compute the equilibrium allocations when tariffs are eliminated, and we then feed into the model the changes to migration policies.

We can see from the table how the level of trade openness impacts the welfare effects of migration policy. In particular, for the case of NMS countries, the computed welfare effects of migration policy would have been lower under trade autarky compared to free trade. Intuitively, in an open economy the net outflow of workers puts upward pressure to domestic factor prices in the NMS countries, and downward pressure in wages in the EU-15 countries. As a result, terms of trade move in favor of NMS countries and against the EU-15 countries, an effect that is absent under trade autarky. The opposite happens in EU-15 countries that experience a net inflow of households. We can see from the table that EU-15 countries would have had smaller welfare losses from the changes to migration policy under trade autarky, although this effect is small. Also, notice that high-skilled households

Table 8: Trade openness and welfare effects of migration policy (percent)

		Only changes to migration policy	Changes to migration policy under trade autarky	Changes to migration policy under free trade
		(1)	(2)	(3)
EU-15	High skill	-0.014	0.008	-0.015
	Low skill	-0.076	-0.063	-0.077
	Aggregate	-0.064	-0.049	-0.065
NMS	High skill	1.079	1.009	1.086
	Low skill	0.755	0.718	0.758
	Aggregate	0.793	0.752	0.797
Europe	Aggregate	0.081	0.087	0.081

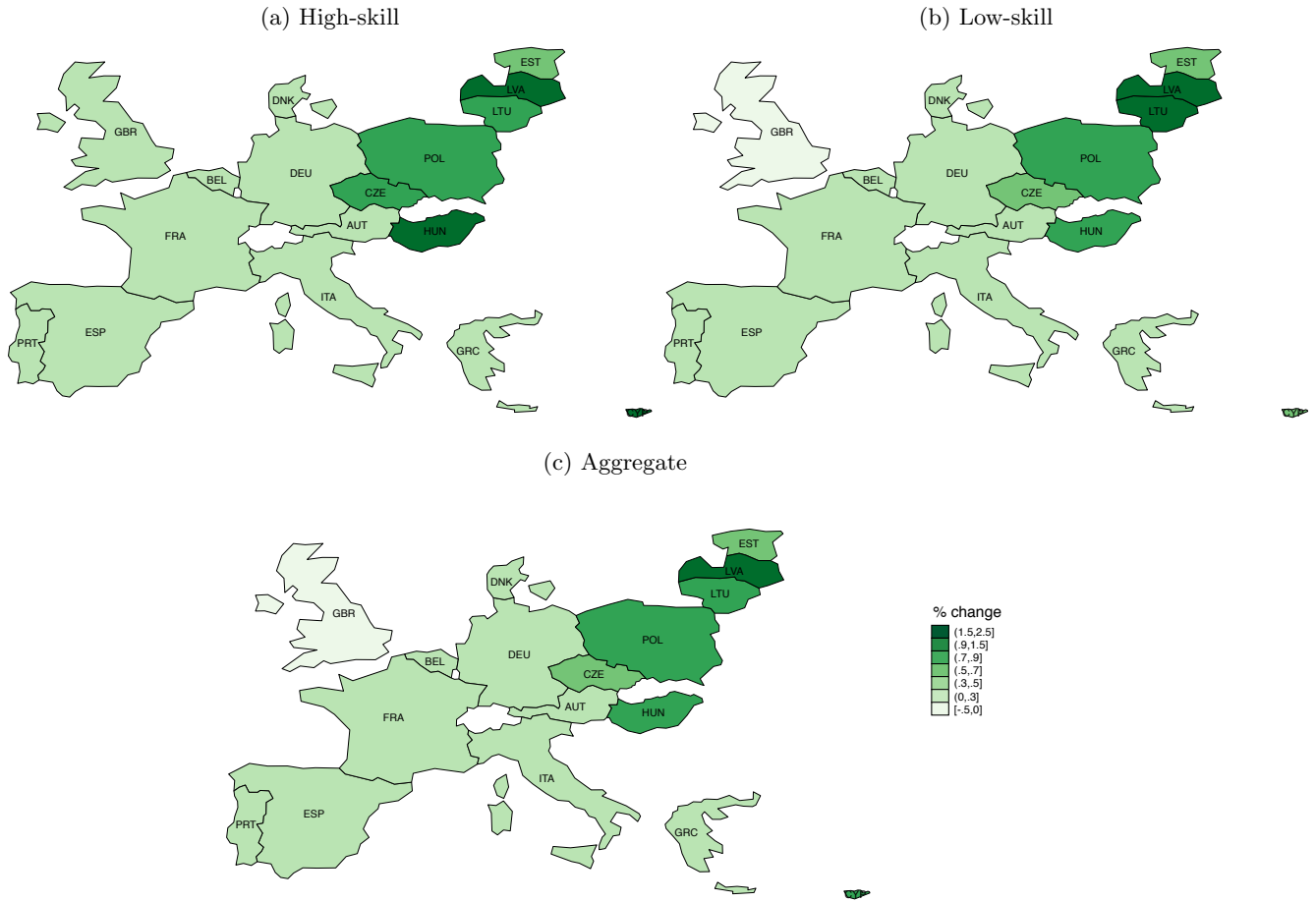
Notes: This table shows the percentage change in welfare, measured as consumption equivalent, due to the actual change to migration policy. Column (1) presents the welfare effects under the actual level of trade openness, Column (2) shows the welfare effects under trade autarky, and Column (3) shows the welfare effects under free trade.

in EU-15 countries would have been slightly better off with the change in migration policy under trade autarky, compared with the welfare losses under free trade. The differential welfare effects of migration policy with the level of trade openness are more striking for some individual countries; for instance, U.K. welfare under autarky would have declined by 0.14 percent, and the welfare losses would have been 0.19 percent under free trade, a one-third larger drop. The take away is that trade impacts the quantitative welfare evaluation of migration policy.

Figure 5 presents the welfare effects of the EU enlargement across different countries. We can see from the figure that although NMS countries are the largest winners, there is heterogeneity in the welfare effects across countries. We find that the only country that experiences welfare losses is the U.K., and specifically low-skilled households whose welfare declines 0.14 percent as a consequences of the EU enlargement. As mentioned above, we find that low-skilled households in EU-15 countries lose from only changes in migration policy because of the large increase in the supply of low-skilled households. In the case of the U.K., these losses are larger than the gains from the reduction in tariffs.

For completeness, we also report the welfare effects of the rentiers in NMS and EU-15 countries. We assume that rentiers have the same preferences as households and, as explained before, their income is given by the share on the global portfolio. We find that welfare of the rentiers in NMS countries decreases by 0.29 percent as a consequence of the EU enlargement while welfare of the rentiers in EU-15 countries increases by 0.68 percent. As we did before, we also evaluate the welfare effects from trade and migration policy separately. We find that rentiers gain from trade in NMS and EU-15 countries, as their real income increases. In particular, as a consequence of the trade policy, welfare of NMS rentiers increases by 0.04 percent and welfare of EU-15 rentiers increases by 0.52 percent. Migration policy generates more heterogeneous effects due to its effect on factor prices across countries. In particular, the welfare of the rentiers in NMS countries decreases by

Figure 5: Welfare effects, percent



Notes: These figures present the welfare effects of the EU enlargement across different countries and skill groups.

0.30 percent and the welfare of the EU-15 rentiers increases by 0.14 percent as a consequence of migration policy. These results show that the EU-enlargement has distributional consequences, not only across skill groups but also across owners of different factors of production.

Finally, the government is another agent in our model, and therefore we are also interested in computing their welfare effects as a consequence of the EU enlargement. We assume that the government in each country has linear utility over their real income that is given by tariff revenues divided by the local price index. We define the welfare of the government as the change in consumption equivalent, analogous to our welfare measures for households and rentiers.⁴⁶ We find that as a consequence of the EU enlargement, the governments in NMS countries experience an average decline in consumption equivalent of about 3.1 billion US 2002 dollars, or about 1.7 percent of real GDP. In EU-15 countries, the governments experience an average decline in consumption equivalent of about 11.9 billion US 2002 dollars, equivalent to 0.47 percent of real GDP. In Europe

⁴⁶Different from households and rentiers, we assume linear utility for the government in order for the measures of consumption equivalent to be directly comparable to changes in national income. As a result, the change in welfare of the government is the same as the change in real income.

as a whole, the decline in consumption equivalent is about 11.5 billion US 2002 dollars, or about 0.53 percent of real GDP. In Appendix I, we present the derivation of the welfare measures for households, rentiers, and the government.

5.2.1 Distributional Effects of the Timing of Migration Policy

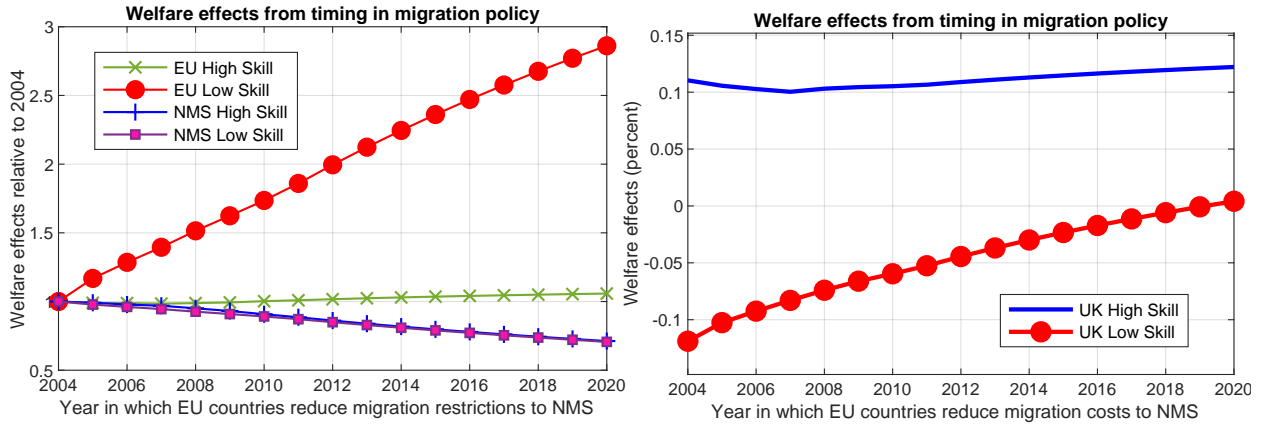
What would have been the welfare effects if countries had changed migration restrictions with a different timing? In this subsection we study the importance of the timing of changes to migration policy. To do so, Figure 6 panel (a), shows the welfare effects for EU-15 and NMS countries assuming that instead of changing policy as they did, countries would have changed policy in different years. That is, we study the effects from a bilateral reduction in migration restrictions between the U.K., Greece, Italy, Spain, Portugal, France, Belgium, Denmark, Austria, Germany, and NMS all happening in the year 2004, or 2005, 2006, 2007, and so on. The left panel in the figure presents the welfare effects for each skill group and nationality from a policy in which all these countries open in the years 2005, 2006, etc., relative to all countries opening in 2004. The results show that delaying the opening in migration would have resulted in lower welfare gains for NMS countries. For instance, if all countries had changed migration policy in 2012, welfare gains for NMS low-skilled households would have been about 10 percent lower than opening in 2004. On the other hand, we find that low-skilled households in EU-15 countries would have been better off by delaying changes to migration policy (see left panel). For instance, the welfare of EU-15 low-skilled households would have been three times larger from all countries opening in 2020 relative to all countries opening in 2004, namely an increase from 0.02 percent to 0.06 percent. The result is explained by the fact that EU-15 low-skilled households gained from changes to trade policy but lost from changes to migration policy, and therefore, delaying the changes to migration policy increases the relative impact of trade policy in their welfare. EU-15 high-skilled households would have been slightly better off by delaying the opening in migration for the same reason.

In part, the previous result is driven by the U.K. that is the only country that experiences welfare losses for low-skilled households. Given that, in the right panel we investigate the welfare effects on the U.K. of delaying the change in migration policy. The figure plots the welfare effects under different opening years, and we find that delaying changes to migration policy would have benefited low-skilled households in the U.K., reducing the gap with the welfare changes of high-skilled households.

5.3 Additional Results

In this section we extend our model to account for additional congestion effects coming from publicly-provided consumption services. In addition, we present a series of extensions and robustness exercises under different assumptions on the modeling of the scale effects, ownership structure of the fixed factor, and elasticity of substitution between high-skilled and low-skilled workers. In what follows we discuss our main findings, and relegate to Appendix J all tables and figures.

Figure 6: Welfare effect of changes in the timing of migration policy



Notes: The left panel of this figure shows the welfare effects for EU-15 and NMS countries assuming that instead of changing policy as they did, countries would have changed policy in different years. The right panel shows the welfare effects for high and low-skill U.K. households from different timings in migration policy changes.

5.3.1 Accounting for Publicly-Provided Consumption Services

This extension is motivated by recent studies that argue that migrants are net beneficiaries of the welfare system across countries, and therefore are more likely to use social benefits and benefit from publicly-provided consumption services than natives.⁴⁷ To capture this additional congestion effect due to immigration, we assume that households derive some utility from the per capita provision of publicly-provided consumption services in the economy. Specifically, the indirect utility of an employed household with skill s in country i is given by

$$C_{s,t}^{i,e} = \left(\frac{G^i}{L_t^i} \right)^{\alpha_i} \left((1 - \tau_L^i) \frac{w_{s,t}^i}{P_t^i} \right)^{1-\alpha_i}, \quad (23)$$

where P_t^i is the local price index, and α_i is the utility weight of publicly-provided consumption services in households utility.⁴⁸ Similarly, the indirect utility of a non-employed household is given by $C_{s,t}^{i,ne} = (G^i/L_t^i)^{\alpha_i} (b^i)^{1-\alpha_i}$. The supply of publicly-provided consumption services, G^i , is fixed over time. In order to supply G^i the government purchases final goods and finances its spending from three sources: tariff revenues, labor taxes (τ_L^i), and lump sum transfers from the owners of fixed factors in each country. As a result, the government budget constraint is given by

$$P_t^i G^i = T_t^i + \sum_{n=1}^N \sum_{s=h,t} \tau_L^i w_{s,t}^i L_{n,s,t}^{ie} + R_t^i \text{ for all } i, \quad (24)$$

where the double summation term on the right-hand side represents labor tax revenues, and R_t^i are lump-sum taxes.

⁴⁷See Kerr and Kerr (2011) for a survey.

⁴⁸Similar specifications for preferences of public goods have been used recently in quantitative studies, see Fajgelbaum et al. (2018).

The total expenditure on goods by country i is now given by government purchases, by net labor income of workers of all skill levels and nationalities residing in country i , and by local rentiers. Namely, the goods market clearing is given by

$$X_t^i = P_t^i G^i + \sum_{n=1}^N \sum_{s=h,t} (1 - \tau_L^i) w_{s,t}^i L_{n,s,t}^{ie} + \iota^i \chi_t - R_t^i, \text{ for all } i, \quad (25)$$

with $\chi_t = \sum_{i=1}^N r_t^i H^i$. As we can see, the net income of rentiers is given by the share of the global portfolio minus lump-sum taxes, $(\iota^i \chi_t - R_t^i)$.

The equilibrium of this economy is the same as that described in Section 3.4, but with the indirect utility given by (23), and the market clearing conditions given by (24) and (25). Given this, the CDP solution method described in Section (3.5) also applies in this economy with publicly-provided consumption services. To compute the model, we need to re-estimate the migration cost elasticity $1/\nu$ consistent with the utility function (23). In Appendix E.1 we show how to adapt the estimation methodology to the model with publicly-provided consumption services. We estimate a value of $\nu = 1.6$ that we feed into the model to quantify the migration and welfare effects of the EU enlargement. We also need a value for the importance of publicly-provided consumption services in preferences, α^i . We calibrate this parameter using data on final government consumption over total final consumption by country using data from the WIOD.⁴⁹ Finally, we resort to data on labor income taxes from the OECD Tax Database.

We now turn to quantify the migration and welfare effects of the EU enlargement in the model with publicly-provided consumption services. Starting with the migration effects, we still find a gradual increase in the stock of NMS nationals in EU-15 countries as a consequence of the enlargement. In terms of the magnitudes, we find somewhat lower migration effects in the model with publicly-provided consumption services. Specifically, three years after the EU enlargement (that is, in 2007) the stock of NMS nationals in EU countries increases by 0.04 percentage points, while ten years after the implementation, the stock raises by 0.25 percentage points. In steady state, the stock of NMS nationals in EU-15 countries increases by 1.25 percentage points as a result of the EU enlargement. Publicly-provided consumption services introduce an additional source of congestion. As a consequence, the households' utility and incentives to migrate are reduced compared to the economy without publicly-provided consumption services. Across skills, we find that most of the migration, as a consequence of the enlargement, is low-skilled, similarly to our finding in Section 5.1. In the long run, the stock of NMS high-skilled households in EU-15 countries increases by 0.83 percentage points, while the stock of NMS low-skilled households increases by 1.35 percentage points.

We now turn to the analysis of the welfare effects of the EU enlargement in the presence of

⁴⁹The values of α^i across countries range from 0.16 to 0.31, with a mean value of 0.21. Given our assumption on how public services are provided, it is not necessarily the case that government final consumption shares identify precisely α_i . Yet, we think that this is a good proxy provided the government is deciding how much to supply of public services taking into account consumer preferences. Direct estimates of preferences over public-good services are, in general, difficult to obtain. Other studies in the literature that use similar quantitative models with public goods use as a proxy for α_i the share of total government revenue over GDP, see Fajgelbaum et al. (2018).

publicly-provided consumption services. Overall, we find larger welfare gains for NMS countries, and smaller welfare gains for EU-15 countries, compared with the results in Section 5.2. This result is explained by the fact that EU-15 countries experience a net inflow of households, which congests publicly-provided consumption services and has a negative impact on welfare compared with a model without publicly-provided consumption services. On the other hand, the net outflow of households in NMS countries contributes to decongesting publicly-provided consumption services, which has a positive effect on welfare. In particular, welfare of NMS households increases by 1.44 percent, and welfare of high-skilled and low-skilled households increase by 1.85 percent and 1.38 percent, respectively. Welfare of EU-15 households decline by 0.08 percent, and welfare of high-skilled and low-skilled households decline by 0.02 percent and 0.09 percent, respectively in the EU-15 countries. In the presence of publicly-provided consumption services, migration of NMS nationals leads to stronger congestion effects that affect negatively high-skilled and low-skilled households, more than offsetting the welfare gains from trade policy in EU-15 countries.

Finally, in Appendix J.1, we perform two additional exercises. First, we compute the migration and welfare effects of the EU enlargement using a common value for the share of publicly-provided consumption services in the utility function of $\alpha_i = 0.23$ for all i countries, which corresponds to the value calibrated by Fajgelbaum et al. (2018). We find that overall, with this value, the results are similar to our benchmark results. Second, we compute the effects of the EU enlargement in a model that has a different notion of public goods. Specifically, we assume that public goods are non-rival, thus they do not create additional congestion effects in the model. In this context, the indirect utility of a household with skill s in country i is given by $C_{s,t}^{i,e} = (G^i)^{\alpha_i} ((1 - \tau_L^i)w_{s,t}^i/P_t^i)^{1-\alpha_i}$. Given that we compute the model in changes, it is straightforward to see that this version of the model is similar to one presented in Section 3, with the only difference that the change in real wages is scaled to the power $1 - \alpha_i$ in the utility function. Accordingly, we find somewhat smaller welfare effects and similar migration effects compared to our benchmark results.

5.3.2 The Role of Scale Effects, Ownership Structure, and Skill Substitution

We first start by computing the welfare effects in a closed economy version of the model with no scale effects (agglomeration and congestion forces). By doing so, we study how important quantitatively is to account for all of these mechanisms together; or saying it in a different way, how far we would have gotten in quantifying the effects of the EU enlargement by using a more stylized model where most of the mechanisms in our model are absent. We find that welfare effects are substantially different in this version of the model: welfare gains for NMS are reduced by half, and for the EU-15 welfare losses for low-skilled households are smaller and high-skilled households now gain with the migration policy changes due to the EU enlargement (see Table J.5 in Appendix J). As a consequence, this exercise shows that accounting for relevant mechanisms such as trade openness, agglomeration and congestion forces matters quantitatively for the evaluation of migration policy. We now turn to study in more detail the role of the different margins each at a time.

An aspect of our model that we revisit is the importance of the strength of the scale effects,

namely agglomeration and congestion forces. While the importance of the agglomeration force in our model follows directly from using the Eaton and Kortum (Ricardian) trade model, one might still be concerned that our model has strong agglomeration forces and, as a result, large scale effects and too much migration.⁵⁰ We evaluate the role of the scale effects for the quantitative implications of the EU enlargement by using alternative estimates of agglomeration elasticities from the literature. We use an agglomeration elasticity of 0.2, estimated by Kline and Moretti (2014), corresponding to a value within a wide range of estimates cited in a meta-analysis in Melo et al. (2009).⁵¹ In particular, we assume that the elasticity of technology to labor is 0.2 (i.e., we assume the following functional form for technology $A_t^i = \phi_t^i(L_t^i)^{0.2}$). In addition, given that Kline and Moretti (2014) estimate the elasticity of the change in productivity with respect to a change in labor relative to land size (that is, controlling for density or the size of the local fixed factor in the context of our model), we also compute the migration effects in a model where we assume that technology takes the following functional form $A_t^i = \phi_t^i(L_t^i/H^i)^{0.2}$, and the fixed factor is no longer a market input in production.

As expected, we find that the model with larger scale effects (agglomeration elasticity of 0.2 and no fixed factors) delivers somewhat larger migration effects relative to our benchmark model (results presented in Section 5.1) and relative to the model with smaller scale effects (agglomeration elasticity of 0.2 and with fixed factors). For instance, in the model with smaller scale effects we find that the stock of NMS nationals in EU-15 countries increases by 1.44 percentage points in steady state (0.21 percentage points lower than in Section 5.1). Across skills, the steady state change in stocks of low-skilled and high-skilled households are 0.22 percentage points and 0.16 percentage points smaller, respectively, than in our benchmark results. However, the model with smaller agglomeration forces and no fixed factor delivers larger migration effects than in our benchmark results. In particular, the stock of NMS nationals in EU-15 countries increases by 2.02 percentage points in steady state (0.37 percentage points higher than in Section 5.1). The steady state change in stocks of low-skilled and high-skilled households are 0.40 percentage points and 0.26 percentage points larger, respectively, than in our benchmark results. The migration effects computed in our benchmark model are therefore in between these alternative formulations of the scale effects.⁵²

Regarding the welfare effects, following the logic described for the case of publicly-provided consumption services, a smaller agglomeration elasticity redistribute some of the welfare gains from EU-15 countries that experience new inflows of migrants and benefit less from agglomeration

⁵⁰Following Eaton and Kortum (2001), Ramondo et al. (2016) show that the properties of the Fréchet distribution imply that technology scales with country size. Similar agglomeration elasticities arise in other gravity trade models with heterogeneous firms as in Melitz (2003) with a Pareto technology as in Chaney (2008), and with homogeneous firms as in Krugman (1980).

⁵¹The range of values for the agglomeration elasticity estimated in the literature is quite wide, in part due to the fact that models, data, and time periods used in the studies are vastly different. As reported in Melo et al. (2009), for example, estimates for France in Combes et al. (2012) and Combes et al. (2010) imply agglomeration elasticities of 0.029 and 0.032, respectively. At the other extreme, Greenstone et al. (2010)'s estimates imply an elasticity in the range 1.25–3.1.

⁵²Figure J.5 in Appendix J.2 presents the migration effects over time under different scale effects, and shows that the differences across these alternative formulations are very small at shorter time horizons.

forces, to NMS countries that experience net outflows of migrants. In fact, we find that the aggregate welfare gains for Europe are 0.21 percent in the model with smaller scale effects, very similar to the aggregate gains 0.23 percent in the model with a unitary agglomeration elasticity (our benchmark model). When we shut down the fixed factor from the model, as expected, welfare gains in NMS countries are reduced since there is no benefit from the decongestion caused by the outflow of households, and for the opposite reason, welfare gains for EU-15 countries are increased. Overall, welfare effects computed in Section 5.2 are of the same order of magnitude (in between) as the ones computed with these alternative assumptions on the scale effects.⁵³

Overall we find that the distributional consequences of the EU enlargement are not very significantly affected by the strength of the scale effects. Part of this is due to the fact that our model is meant to capture the distributional effects and the transitional dynamics of the agreement and not its growth effects. In a model with long run growth effects, scale effects might play a more prominent role.

We also study the role of our assumption on the ownership structure of the fixed factor in shaping our results.⁵⁴ To do so, we compute the migration and welfare effects of the EU enlargement in a model with an alternative ownership structure. In particular, we assume that revenues from the fixed factors are kept locally, thus there is no global portfolio, and trade imbalances are exogenous at the initial year level. We find that the ownership structure is playing a very small role in shaping our computed effects of the EU enlargement; the results are very similar to our framework with endogenous trade imbalances. For instance, we find that welfare in NMS countries increases by 1.16 percent (compared to 1.17 percent in our benchmark results), and welfare in EU-15 countries increases by 0.05 percent (compared to 0.04 percent in our benchmark results). On migration effects we find that the stock of NMS nationals in EU-15 countries increases by 1.69 percent in steady state, compared with an increase of 1.65 percent in our benchmark model.

Finally, we also revisit our results by using a different elasticity of substitution between high-skilled and low-skilled households. In particular, we compute the migration and welfare effects using the value of $\rho = 1.41$, which corresponds to the estimate in Katz and Murphy (1992) for the United States. Migration effects are slightly smaller than in our benchmark results. For instance, the stock of NMS nationals in EU-15 countries increases by 1.61 percentage points in steady state, compared with an increase of 1.65 percentage points in our benchmark model. Across skills, the stock of low-skilled and high-skilled NMS nationals in EU-15 countries increases by 1.75 percentage points and 1 percentage point in steady state, respectively, while the same figures in our benchmark

⁵³In Appendix J.2, we also study the implications of assuming that productivity is scaled by employment instead of country size. We find that the migration effects are slightly smaller; for instance, the stock of NMS nationals in EU15 countries increased by 1.58 percent in steady state compared with 1.65 percent in our baseline model. We find somewhat bigger welfare gains for both NMS countries and EU-15 countries than in our benchmark model.

⁵⁴As discussed in Section 3, revenues from the fixed factors are sent to a global portfolio, and each country has a share of the global revenues that matches the observed trade imbalances in the data. This modeling choice allows us to deal in a relatively simple way with endogenous trade imbalances. Still, the ownership structure assumed in our model might not be innocuous. Even when it does not directly affects migration decisions since revenues from the global portfolio are spent in local goods by the rentier, it might affect household decisions through general equilibrium effects (e.g. expenditures and prices).

model are 1.80 percentage points and 1.11 percentage points, respectively. Aggregate welfare effects for NMS and EU15 countries are slightly smaller than in our benchmark model, but the elasticity of substitutions has some distributional effects across skills. In particular, welfare for NMS households increases by 1.15 percent compared to 1.17 percent in our benchmark results, and welfare in EU-15 countries increases by 0.04 percent, almost the same as in our benchmark results. Across skills, we find that welfare of high-skilled households is higher and welfare of low-skilled households is lower than in our benchmark model. Intuitively, a lower elasticity of substitution between high-skilled and low-skilled workers make both factors less substitutable, which magnifies differences in the wage effects of policy changes. Overall, the elasticity of substitution has some effect on how the welfare effects of the EU enlargement are distributed across factors, but it does not play a significant role in the aggregate. In fact, welfare in Europe as a whole increases by 0.22 percent, compared with an increase of 0.23 percent in our benchmark results.

6 The General Equilibrium Effects of Brexit

One of the biggest events concerning the European Union in recent years is the decision of the U.K. to leave the economic block, the so-called Brexit. This resolution was voted in the U.K. on June 23rd 2016, initiating an ongoing process of debate on how migration and trade policies will shape after Brexit.

In this section, we apply the quantitative framework developed in this paper to quantify the general equilibrium effects of Brexit. To perform the quantitative analysis of Brexit we take our model to the year 2014, our last available data point, and compute the effects of increasing migration and trade restrictions applied between the U.K. and the other members of the EU. By doing so, our quantification of the effects of Brexit takes into account that the structure of economic activity, namely production, level of trade openness, stock of migrants, fundamentals, etc. is different from the one when the EU enlargement was signed. We first compute a baseline economy with constant fundamentals. We then solve for a counterfactual economy that makes migration and trade between the U.K. and the other EU countries more restrictive assuming that agents at $t=0$ are not anticipating Brexit.

Since there is no complete clarity on the exact form of a post-Brexit deal between the U.K. and the European Union, we use our framework to study several counterfactual scenarios. First, Brexit might involve an increase in both tariffs and tariff-equivalent non-tariff barriers; thus, in the first counterfactual, we compute the effects of making trade and migration between the U.K. and the EU more prohibitive. In particular, we assume that migration between the U.K. and the EU is prohibitive, tariffs applied between the U.K. and the EU are raised to the MFN level, and there is also an increase in tariff-equivalent NTBs. We model a change in NTBs in the model as a change in iceberg trade costs so that they do not generate revenues, and we feed an increase of 8.31 percent, which corresponds to the value estimated by Dhingra et al. (2017) in their pessimistic

Brexit scenario.⁵⁵ Since leaving the EU would also involve to resign the existing FTAs signed with other countries, we also assume that the U.K. applies the MFN tariff to the rest of the world and NTBs are also increased. In a second, less disruptive, counterfactual scenario, we assume that migration between the U.K. and the EU is prohibitive, the tariffs applied between the U.K., and the EU and the rest of the world are raised to the MFN level. We assume an increase in NTBs of 2.77 percent, which corresponds to the value estimated by Dhingra et al. (2017) in their optimistic Brexit scenario. Finally, we also compute the effects of only changes to migration restrictions, namely the U.K. is able to keep trade policy unchanged, and also the effects of only changes to trade restrictions with no change to migration policy. We now briefly summarize the different counterfactual scenarios:

1. Prohibitive migration costs between the U.K. and the EU. MFN tariffs between the U.K. and the EU, and between the U.K. and the rest of the world. A 8.31 percent increase in NTBs applied between the U.K. and the EU, and between the U.K. and the rest of the world.
2. Prohibitive migration costs between the U.K. and the EU. MFN tariffs between the U.K. and the EU, and between the U.K. and the rest of the world. A 2.77 percent increase in NTBs applied between the U.K. and the EU, and between the U.K. and the rest of the world.
3. Unchanged migration policy between the U.K. and the EU. MFN tariffs between the U.K. and the EU, and between the U.K. and the rest of the world. A 8.31 percent increase in NTBs applied between the U.K. and the EU, and between the U.K. and the rest of the world.
4. Unchanged migration policy between the U.K. and the EU. MFN tariffs between the U.K. and the EU, and between the U.K. and the rest of the world. A 2.77 percent increase in NTBs applied between the U.K. and the EU, and between the U.K. and the rest of the world.
5. Prohibitive migration costs between the U.K. and the EU. Unchanged trade policy.

Table 9 shows the welfare effects in NMS countries and EU-15 countries of Brexit under our different counterfactual scenarios. The first two columns present the effects of increased migration and trade restrictions between the U.K. and the other EU members (Counterfactuals 1 and 2). We find that Brexit would lead to a decline in welfare in the old members states excluding the U.K. that we label as EU-14 countries, and a larger decline in NMS countries. The welfare losses for EU-14 countries are 0.12 percent and 0.10 percent for scenarios 1 and 2, respectively. The welfare losses for NMS countries are also similar across both scenarios, 0.38 percent and 0.36 percent, respectively. These welfare losses are generalized across skills in both group of countries, but losses are smaller for low-skilled households. Columns (3), (4) and (5) display the welfare effects of increasing trade restrictions only and migration restrictions only, respectively (Counterfactual 3, 4, and 5). We find that both migration and trade restrictions result in welfare losses for high-skilled and low-skilled

⁵⁵We downloaded MFN tariffs from WITS, and obtain an average MFN tariff value of 4.1% for the U.K. and the European Union. In our counterfactual scenarios we assume that migration restrictions for NMS nationals leaving the U.K. is unchanged.

Table 9: Welfare effects of Brexit (percent)

		Brexit counterfactual scenarios				
		(1)	(2)	(3)	(4)	(5)
EU-14	High-skill	-0.244	-0.206	-0.109	-0.060	-0.150
	Low-skill	-0.089	-0.073	-0.046	-0.027	-0.046
	Aggregate	-0.118	-0.098	-0.058	-0.033	-0.065
NMS	High-skill	-0.630	-0.602	-0.104	-0.058	-0.557
	Low-skill	-0.342	-0.324	-0.061	-0.035	-0.297
	Aggregate	-0.376	-0.357	-0.066	-0.038	-0.328
U.K.	High-skill	-0.730	-0.354	-0.704	-0.372	0.079
	Low-skill	-0.381	-0.084	-0.590	-0.309	0.259
	Aggregate	-0.468	-0.151	-0.618	-0.325	0.215
Europe	Aggregate	-0.211	-0.149	-0.139	-0.076	-0.069

Note: This table shows the percentage change in welfare, measured as consumption equivalent, due to Brexit. EU-14 refers to the EU-15 countries excluding U.K., and Europe includes EU-15 and NMS countries. Each column presents the results of a different counterfactual scenario. Columns (1) to (5) show the effects of counterfactual scenarios 1 to 5, respectively. Please refer to the main text for a description of change in trade and migration costs in each counterfactual scenario.

households in EU-14 and NMS countries. We also find that EU-14 countries, and in particular NMS countries, lose more from increased migration restrictions than from trade restrictions.

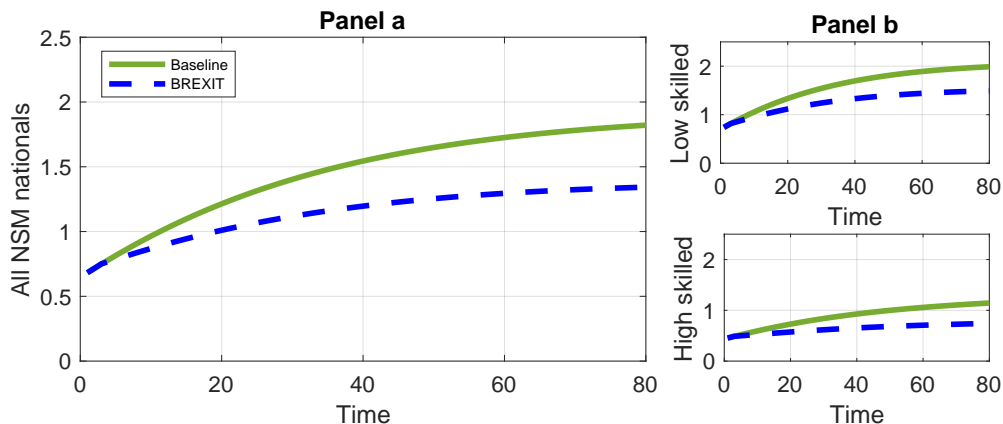
In Table 9, we also present the effects of Brexit on the U.K. economy. We find that the U.K. loses from trade restrictions but gains from migration restrictions. For high-skilled and low-skilled households, the welfare gains from migration restrictions do not offset the losses from trade restrictions, thus they are worse off in all counterfactual scenarios. The welfare losses for the U.K. range between 0.47 percent in with more restrictive policies, and 0.15 percent with less restrictive policies. Appendix K reports the welfare effects of Brexit across countries under our five counterfactual scenarios.⁵⁶ For Europe as a whole, we find that Brexit results in welfare losses between 0.21 percent and 0.15 percent, which are a bit smaller than our computed gains from the EU enlargement.

Since the U.K. experiences one of the largest inflow of migrants as a consequence of the EU enlargement, we finish this section by quantifying how much of the overall migration effects due to the EU enlargement computed in Section 5.1 would be reversed with Brexit. As an illustration, Figure 7 presents the evolution of the stock of NMS households in EU-15 countries in the baseline economy and Counterfactual scenario 1, with prohibitive trade and migration restrictions between the U.K. and the EU.

Table 10 presents the migration effects of Brexit for different time horizons. We find that, on

⁵⁶Our computed welfare losses from trade policy for the U.K. are in line, but on the lower side of those computed in Dhingra et al. (2017). Our analysis complements the results in Dhingra et al. (2017), who use a static trade framework with multiple industries. Although we abstract from multiple sectors, we bring to the analysis a framework that takes into account migration policy, dynamic migration decisions, and skill heterogeneity, as well as congestion and agglomeration forces.

Figure 7: Evolution of the stock of NMS migrants in EU15 countries with Brexit (population share, percent)



Note: This figure presents the evolution of the share of NMS migrants in EU-15 countries. The solid lines show the evolution of this stock in a baseline economy with constant fundamentals. The dashed lines show the evolution with Brexit. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively). The figure shows the effects of counterfactual scenario 1: prohibitive migration costs, MFN tariffs and an increase by 8.31 percent in NTB between the UK and the EU. MFN tariffs and an increase by 8.31 percent in NTB between the UK and the rest of the world.

average, Brexit would reduce the stock of NMS nationals in EU-15 countries by about 0.56 percentage points for low-skilled households and by 0.50 percentage points for high-skilled households in steady state. Overall, the stock of NMS nationals in EU-15 declines by about 0.55 percentage points in steady state, namely, Brexit would undo about one-third of the total migration effects of the EU enlargement. In line with the discussion in previous sections, migration effects are somehow larger with more restricted trade policy (Counterfactual scenario 1 versus Counterfactual scenario 2 in the table).

Table 10: Migration effects of Brexit: change in stock of NMS nationals in EU-15 (percentage points)

	Counterfactual scenario 1			Counterfactual scenario 2		
	All NMS nationals	High-skill	Low-skill	All NMS nationals	High-skill	Low-skill
2002	0	0	0	0	0	0
2007	-0.043	-0.031	-0.045	-0.041	-0.030	-0.043
2015	-0.143	-0.107	-0.151	-0.139	-0.105	-0.147
Steady state	-0.549	-0.500	-0.561	-0.534	-0.490	-0.545

Note: This table shows the percentage point change in the share of low-skilled and high-skilled NMS nationals in EU-15 countries due to Brexit. Columns 1, 2 and 3, present the results of counterfactual scenario 1, and Columns 4, 5 and 6, present the results of counterfactual scenarios 2.

7 Conclusion

Migration and trade are two themes that, historically and nowadays, are central in Europe as well as in other regions of the world. The freedom of movement of people and of goods are considered as two of the four fundamental freedoms guaranteed by EU law. At the same time, immigration into Europe during the enlargement process, as well as the influx of refugees from war-torn countries, are recent major shocks whose economic effects are hard to evaluate, since they interact with heterogeneous production structures, free intra-Community trade, and the European Union Customs Union. In this context, the international economics literature has made considerable advances on the quantification and understanding of the gains from economic integration, but most of the focus has been on the goods market, and less attention has been devoted to the factors market and to migration policy. In this paper we aim at making progress in this area.

We quantify the general equilibrium effects of trade and labor market integration. We show that in order to evaluate the economic effects of labor market integration it is crucial to take in to account the process of integration in the goods market. We find that the EU enlargement primarily fostered the migration of low-skilled households and that trade policy helped to moderate migration flows and mitigate congestion effects. While all Europe gained from the EU enlargement, the largest winners were the new member states, and we find heterogeneous welfare effects across skill groups. Importantly, we find that in the absence of changes to trade policy, the EU-15 would have been worse off after the enlargement. Motivated by the recent events concerning the European Union, we quantify the general equilibrium effects of Brexit and find generalized welfare losses across skill groups for EU-15 and NMS countries, although the U.K. households, in particular low-skilled households, would be better off with increased migration restrictions. We find that Brexit would undo about one-third of the migration effects of the EU enlargement.

Our paper incorporates different but complementary elements in the analysis. We use reduced-form analysis that exploits migration policy changes to identify changes in migration costs and key elasticities. We build a rich dynamic general equilibrium model that includes important mechanisms considered in the literature to quantify the migration and welfare effects of actual changes to trade and migration policies. Among other things, we show quantitatively how the effects of labor market integration are affected by the extent to which countries are open to trade. Future work might aim at studying the distributional effects across sectors of the economy. Sectoral linkages are important for trade policy quantitative analysis and they might well be also for migration policy evaluation.

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Appendix

A EU Accession and the Freedom of Movement of Workers

In this Appendix we describe in detail the process that resulted in the entry of ten new countries into the European Union in 2004, i.e. the EU membership process.

The process of joining the EU broadly consists of 4 stages. It is in essence based on the prospective member's ability of satisfying the accession criteria—also called the “Copenhagen criteria” after the European Council in Copenhagen in 1993 which defined them. The accession criteria have a political (stability of institutions guaranteeing democracy, the rule of law, human rights, and respect for and protection of minorities), economic (a functioning market economy and the capacity to cope with competition and market forces) and administrative/institutional (capacity to effectively implement EU law, and ability to take on the obligations of membership) component. The four stages that characterize the membership process are the following.

1. *Official candidate for membership.* A country wishing to join the EU submits a membership application to the Council of the European Union, which asks the European Commission to assess the applicant's ability to meet the Copenhagen criteria. If the Commission's opinion is positive, membership negotiations cannot start until all EU governments agree, in the form of a unanimous decision by the EU Council. Negotiations take place between ministers and ambassadors of the EU governments and the candidate country in what is called an intergovernmental conference.
2. *Negotiations.* The negotiation process includes three stages: screening, definition of counterparties' negotiation positions, and closing of the negotiations. In the screening phase, the European Commission, together with the candidate country, prepares a detailed report of how well the candidate country is prepared in each of the 36 Chapters of the EU Law, spanning all major economic, social, and institutional aspects (e.g the free movement of goods, justice, and defense policy). If the results of the screening are satisfactory the Commission makes a recommendation to open negotiations. The candidate country then has to submit its position on every chapter of EU Law, and the EU must adopt a common position. Negotiations then continue until the candidate's progress is considered satisfactory in any field.
3. *Accession Treaty.* Once negotiations are successfully concluded, the Accession Treaty (containing the detailed terms and conditions of membership, all transitional arrangements and deadlines, as well as details of financial arrangements and any safeguard clauses) is prepared.
4. *Support and Ratification.* The Accession Treaty becomes binding once (i) it wins the support of the EU Council, the Commission, and the European Parliament; (ii) it is signed by the candidate country and representatives of all existing EU countries; and (iii) it is ratified by the candidate country and every individual EU country, according to their constitutional rules.

Table A.1: NMS Countries Characteristics

	Date of Application	Accession Date	2004 Population
Cyprus	July 3rd, 1990	May 1st, 2004	1.01
Estonia	November 24th, 1995	May 1st, 2004	1.36
Hungary	March 31st, 1994	May 1st, 2004	10.11
Latvia	October 13th, 1995	May 1st, 2004	2.26
Lithuania	December 8th, 1995	May 1st, 2004	3.34
Malta	July 3rd, 1990	May 1st, 2004	0.40
Poland	April 5th, 1994	May 1st, 2004	38.18
Czech Republic	January 17th, 1996	May 1st, 2004	10.20
Slovakia	June 27th, 1995	May 1st, 2004	5.37
Slovenia	June 10th, 1996	May 1st, 2004	2.00

Notes: 2004 population (in millions) from the World Bank World Development Indicators. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.

Table A.1 shows the date of application, the accession date, as well as population for each NMS country.

A.1 Migration Policies

The new members states had to comply with the fundamental principles of the European Union. Article 6 of the Treaty on the European Union states that “The Union is founded on the principles of liberty, democracy, respect for human rights and fundamental freedoms, and the rule of law, principles which are common to the member states.” The freedom of movement of workers is considered as one of the four fundamental freedoms guaranteed by EU law (*acquis communautaire*), along with the free movement of goods, services, and capital.⁵⁷ EU law effectively establishes the right of EU nationals to freely move to another member state, to take up employment, and reside, as well as protects against any possible discrimination in employment-related matters, on the basis of nationality, skill and labor forces status.

The Accession Treaty of 2003 (European Union (2003)) allowed the “old” member states to temporarily restrict—for a maximum of 7 years—the access to their labor markets to citizens from the accessing countries, with the exception of Malta and Cyprus.⁵⁸ These temporary restrictions were organized in three phases according to a 2+3+2 formula: During an initial period of 2 years (May 1st, 2004 to April 30th, 2006), member states, through national laws, could regulate the

⁵⁷As effectively and concisely defined by Article 45 (ex Article 39 of the Treaty Establishing the European Community) of the Treaty on the Functioning of the European Union, the freedom of movement of workers entails “the abolition of any discrimination based on nationality between workers of the member states as regards employment, remuneration and other conditions of work and employment”, Council of the European Union (2012).

⁵⁸These restrictions could only be applied to workers but not to the self-employed. They only applied to obtaining access to the labor market in a particular member state, not to the freedom of movement across member states. Once a worker has been admitted to the labor market of a particular member state, Community law on equal treatment as regards remuneration, social security, other employment-related measures, and access to social and tax advantages is valid.

access of workers from all new member states, except Malta and Cyprus; member states could then extend their national measures for an additional 3 years (until April 30th, 2009), upon notification to the European Commission; an additional extension for other 2 years was possible in case the member state notified the European Commission of a serious disturbance in its labor market or threat thereof.⁵⁹ The transitional arrangements were scheduled to end irrevocably seven years after accession—i.e. on April 30th, 2011.

Figure A.1 shows the set of bilateral arrangements before the 2004 enlargement (panel (a)), and during each of the three phases (panels (b), (c), and (d)). A blue cell means that there are no restrictions in place in flowing from the origin to the destination country, i.e. EU law on free movement of workers apply. A yellow (mixed blue-yellow) cell means that some restrictions are in place during (part of) the phase.

Before 2004. Panel (a) shows that, before the 2004 enlargement, workers could flow freely within the EU-15 member states but not between EU-15 and NMS as well as between NMS countries.

Phase 1. On May 1st, 2004, the U.K. (together with Ireland and Sweden) opens its borders to NMS countries, which reciprocate by opening their borders to British citizens. All the other EU-15 countries keep applying restrictions to NMS countries, except to Cyprus and Malta. All NMS countries decide to open their border to EU-15 member states, except for Hungary, Poland, and Slovenia which apply reciprocal measures. Finally, NMS countries lift all restrictions among each others.

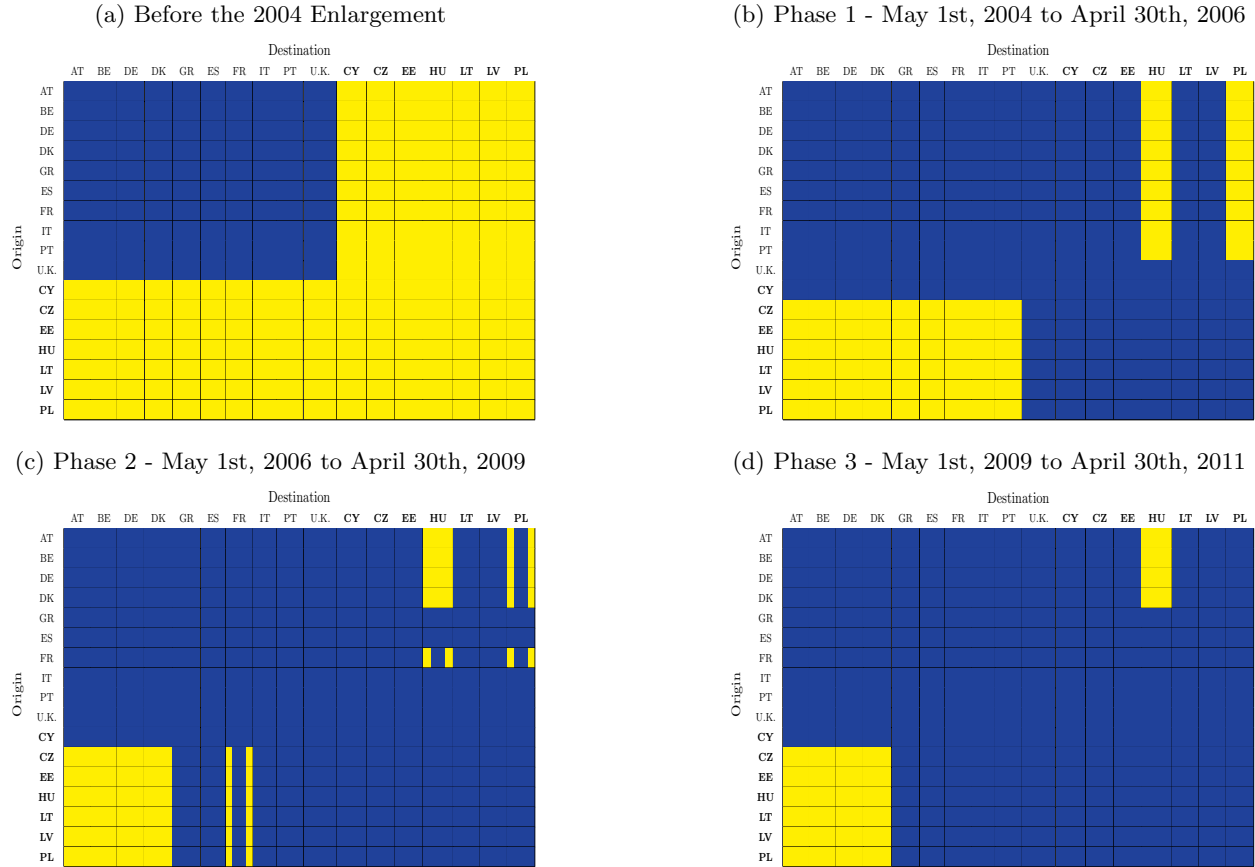
Phase 2. On May 1st, 2006, Greece, Portugal, and Spain, followed by Italy on July 27th, lift restrictions on workers from EU-8 countries. As a consequence, Hungary and Poland drop their reciprocal measures towards these four member states. Slovenia lifts its reciprocal measures on May 25th, 2006, Poland on January 17th, 2007, while Hungary simplifies its reciprocal measures on January 1st, 2008. During phase 2, The Netherlands (on May 1st, 2007), Luxembourg (on November 1st, 2007), and France (on July 1st, 2008) also lift restrictions on workers from EU-8 countries.

Phase 3. Belgium, Denmark, Germany and Austria keep restricting access to their labor markets under national law. Hungary applies (simplified) reciprocal measures, limiting access to its labor market for workers from EU-15 member states that restrict the access of Hungarian workers.

Belgium and Denmark opened their labor market to NMS countries on May 2009, while Austria and Germany opened their labor markets at the end of the transitional period, on May 2011.

⁵⁹The EU-25 member states that decide to lift restrictions can, throughout the remainder of the transitional period, be able to reintroduce them, using the safe-guard procedure set out in the 2003 Accession Treaty, should they undergo or foresee disturbances on their labor markets. Notwithstanding the restrictions, a member state must always give preference to EU-2 (Malta and Cyprus) and EU-8 workers over those who are nationals of a non-EU country with regard to access to the labor market.

Figure A.1: Migration restrictions: transitional arrangements between EU-15 and NMS



Note: Origin countries on the rows, destination countries on the columns. EU-15 member states (AT, BE, DE, DK, GR, FR, IT, PT, U.K.) followed by NMS countries (CY, CZ, EE, HU, LT, LV, PL) in bold. A blue cell means that there are no migration restrictions in place in flowing from the origin to the destination country, i.e. EU law on free movement of workers apply. A yellow (mixed blue-yellow) cell means that some migration restrictions are in place during (part of) the phase.

A.2 Trade Policies

New member states became part of the European Union Customs Union, and of the European common commercial policy.⁶⁰ The customs union implies that members apply the same tariffs to goods imported from the rest of the world, and apply no tariffs internally among members.⁶¹ The common commercial policy covers trade in goods and services, intellectual property rights,

⁶⁰The customs union initiated with the Treaty of Rome in 1957, kick-started on July 1st 1968, and it is regulated by the Treaty on the Functioning of the European Union. The common commercial policy is also set down in the Treaty on the Functioning of the European Union.

⁶¹Once the goods have cleared customs, they can circulate freely or be sold anywhere within the EU customs territory. Import duties collected by customs remain an important source of income for the EU. In 2013, they represented nearly 11 percent of the EU budget, which amounts to €15.3 billion. Besides common tariffs, an important aspect of the customs union is the implementation of common and streamlined procedures across the union regardless of where in the EU the goods are declared. Reduced time, homogeneity of rules, and lower uncertainty can be significant factors in boosting trade relationships (Hummels et al. (2007); Hummels and Schaur (2013); Martinus et al. (2015); Handley and Limao (2015)).

and foreign direct investment. As a consequence of the EU enlargement process, the new member states automatically entered into international trade agreements to which the EU is a party, and forwent their own existing agreements.⁶²

B Data

B.1 List of Countries

The sample includes 17 European countries and a constructed rest of the world (RoW). Of our 17 countries, 10 are pre-2004 EU members and 7 countries joined the EU in 2004. The list of pre-2004 EU members includes Austria, Belgium, Germany, Denmark, Spain, France, Greece, Italy, Portugal, and the U.K. while the new members are Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia and Poland. Overall, these 17 countries cover about 91 percent of the population of the 25 members of the European Union in 2004.

We assign Ireland, The Netherlands, Malta, Sweden and Slovenia to the RoW aggregate because their EU-LFS country surveys do not contain sufficient information regarding the country of residence 12 months before the worker was interviewed. Specifically, Ireland does not provide information on the country of origin for any year in the survey, making it impossible to construct migration flows from any country in the sample to Ireland. The country surveys for the Netherlands and Malta are available from 2006 and 2009 onward respectively, hence after the enlargement of the European Union. The case of Sweden presents two different problems: first, data before 2005 contain information on the country of residence 12 months before only if this is Sweden itself. Moreover, in 2005 and 2006 there is no information on the country of origin in the Swedish survey. Finally, in the Slovenian survey information on the country of origin is available from 2008 on only.

We also assign Bulgaria, Slovakia, Luxembourg, Romania and Finland to the RoW due to missing information on the nationality of the households. More specifically, Romania has information on nationality only from 2004 onward, Bulgaria has no information on nationality before 2008, Slovakia has no information before 2003 while Finland does not distinguish the nationality of the countries involved in the 2004 enlargement from the nationality of Bulgaria and Romania, which entered the European Union in 2007.

B.2 Construction of the Gross Migration Flows

Data on gross migration flows by country of origin, destination, nationality, skill, labor force status, and year are constructed from the micro data of the European Labour Force Survey (EU-LFS). For each individual surveyed, the questionnaire reports the country in which the individual resided 12 months before—besides reporting the current country of residence, the year and week in which

⁶²The entry of the new member states into the EU common commercial policy also had an impact in terms of bargaining power. While all the ten new EU member states were already part of the WTO before 2004, from 2004 on they participate to the WTO's activities through the European Commission. EU trade policy is in fact carried on by the European Commission, on behalf of the European Union, working closely with the member states and keeping informed the European Parliament.

the individual was interviewed, and a sampling weight that makes the survey representative at the national level. We refer to the country in which the survey was carried out as “destination”, and to the country in which the interviewed individual was living 12 months before as “origin”. The questionnaire also reports information regarding the age, education, labor force status and nationality of the household. We focus on individuals between 15 and 65 years old, and use the information reported to infer if the individual is a migrant—in case the country where she resides today is different from the one she was residing one year before—as well as the origin country, and the year of migration.

We import the raw micro data into Stata using the `Setup_EULFS_1983-2016.y.do` and `Labels_EULFS_1983-2016.do` Stata dofiles made available by the German Microdata Lab of GESIS - Leibniz Institute for the Social Sciences (<http://www.gesis.org/en/gml/>). We restrict the imported dataset to the following set of variables:

- country* - Current country of residence (ISO country classification)
- countr1y* - Country of residence one year before survey (ISO country classification)
- refyear* - Year of survey
- coeff* - Yearly weighting factor (Numbers in thousands)
- refweek* - Reference week
- age* - Age of interviewed person (in 5-year age bands, 0-4, 5-9,...)
- national* - Nationality
- hat97lev* - Highest educational attainment level (ISCED 1997 classification, till 2013)
- hat11lev* - Highest educational attainment level (ISCED 2011 classification, from 2014)
- ilostat* - ILO Work status
- wstat1y* - Situation with regard to activity one year before survey

B.2.1 Frequency, Completeness, and Date of Migration

From 1983 to 1997, the European Labour Force Survey was conducted only in spring (quarter 1 or 2 depending on the country). Since 1998, the transition to a quarterly continuous survey (with reference weeks spread uniformly throughout the year) has been gradually conducted by member states. Some countries first introduced a continuous annual survey (meaning the reference weeks were uniformly distributed throughout the spring quarter) and then switched to a quarterly collection, whereas others moved directly to a quarterly continuous survey. For simplicity, we make every survey continuous quarterly. We emphasize that the reason for doing this is just practical. The procedure outlined below does not affect our results in any way since our analysis is carried on at the destination-origin-nationality-skill-year level and the procedure operates instead at the intra-annual level.

1. For each survey we count the number of weeks in which interviews were carried on.
2. We multiply the sampling weight associated to each interview by the number of weeks covered in the survey and divide by 52.
3. We compute a representative week by averaging out the sampling weight associated to each interview, by destination, origin, and year.
4. We assign the representative week to any week not originally covered by the survey, thereby ending up with 52 weeks for each country of destination and year.

We make three further corrections to the EU-LFS survey. First, in a minority of instances in some surveys—about 1.8 percent of the individuals, once accounting for sampling weights—interviewed individuals could, instead of indicating the specific country of origin, refer to a broad group.⁶³ When the broad group is “European Union (EU-15)” we re-assign individuals to each individual EU-15 country proportionally, by destination and year, on the basis of all the other observations in which information on the specific country of origin is available. When the broad group is either “Other European Economic Area”, “Other Central and Eastern Europe”, or “Other Europe” we re-assign individuals to each individual NMS country proportionally, by destination and year, on the basis of all the other observations in which information on the specific country of origin is available. When the broad group is “Other or stateless” we re-assign, by destination and year, individuals to the RoW. When the country of origin is missing we re-assign individuals to all other countries proportionally, by destination and year, on the basis of all the other observations in which information on the specific country of origin is available.

Second, for a few destination-origin-year-months the information is not complete. In those cases, we use a standard interpolation procedure when the missing information is between two years in which we have data, or backward projection if the missing year is at the beginning of the series.⁶⁴ Since the analysis carried on in the paper refers to the 2002-2014 period and some of the destination-origin-year-months with incomplete observations refer to countries that we drop from the analysis, the potential impact of the interpolations and projections on the results is even smaller.

Third, the survey does not report the exact date of migration but only the country in which the interviewed individual was living 12 months before. In other words, an individual that is interviewed in April of 2006 in the U.K. and declares that 12 months before she was living in Poland could have migrated out of Poland any time in the previous 12 months. Therefore, we spread the sampling weight associated to this individual to the previous 12 months.

⁶³This can also happen because of confidentiality concerns, which may differ on a country-by-country basis due to national legislation, especially before the country joins the European Union.

⁶⁴Interpolation is performed for the U.K. in 2008, and France in 2003, 2004 and 2005. Backward projection is used for Latvia in 2001, 2002 and 2003, Czech Republic in 2001, Italy in 2001, 2002, 2003, and 2004, Slovakia in 2001 and 2002.

Table B.1: Nationality mapping - before 2004

<i>Before 2004</i>			
Code	Label	EU-15 survey	NMS8 survey
0	Nationals	EU-15	NMS8
111	EU-15	EU-15	EU-15
911	Non EU-15	NMS8 or other **	NMS8 or other **
800	Non-National/Non-Native *	EU-15, NMS8 or other **	EU-15, NMS8 or other **
<i>After 2004</i>			
0	Nationals	EU-15	NMS8
1	EU-15	EU-15	EU-15
2	NMS10	NMS8	NMS8
Multiple codes	Other categories	Other	Other

B.2.2 Nationality

The EU-LFS contains information on the nationality of the interviewed individuals. However, mainly because of country-specific privacy regulations, the variable “nationality” has different categories before and after 2004. Specifically, before 2004 the variable “nationality” takes only four values: “Nationals” (code 0), “EU-15” (code 111), “Non EU-15” (code 911), and “Non-National/Non-Native” (code 800) in case the distinction EU-15/Non-EU-15 is not available. After 2004, the category “Non EU-15” has been expanded to distinguish between “New member states NMS10” (code 2) and other countries or groups of countries we will refer to as “other categories”. Our goal is to create the following three nationality categories: “EU-15”, “NMS10” and “Other”. In order to do so we have to redistribute individuals from the “Non EU-15” category before 2004 into “NMS10” and “Other”, as well as redistribute individuals from the “Non-National/Non-Native” category before 2004 into “EU-15”, “NMS10” and “Other”.⁶⁵

In order to construct the nationality we need to deal with the *number* of people with nationality “Other” (different from EU-15 and NMS nationals). We assume that the accession of NMS countries does not affect the flow of “other” nationals within the EU28. For every destination and origin country pair, and for every year, we compute the number of “other” nationals for the period 2004 onward. We then take the simple average—at the destination-origin level—over the period 2004-2008 and we subtract it to the codes 800 and 911 before 2004.⁶⁶ In practice, for the 800 group we split it in EU-15 and non EU-15 nationals using the average 2004-2008 shares of non-EU-15 within non-natives. Then for the 800 and 911 groups, we split them between NMS and other nationals by computing the average number of “Other” post 2004 divided by the sum of the weights of the 911 and 800-turned-non-EU-15 observations for a given destination-origin-year-week. In sum, we

⁶⁵After 2004, the surveys for Latvia report the category NMS13 instead of distinguishing between NMS10 and NMS3. When creating nationalities described below, we use NMS13 in place of NMS10 for Latvia.

⁶⁶For destination-origin pairs that appear before 2004 but not after, we assign, for each destination, the average share across all origins. Note that in more than 99 percent of the cases this happens when country of origin is missing.

define 3 nationalities, “EU-15”, “NMS” and “Other” based on Table B.1.

The Case of Poland The variable nationality for Poland is available only since 2004 and it only includes three codes: 0 “National / Native of own Country”, 5 “EU28”, and 8 “Europe outside EU28”. In order to separate EU-15 from NMS10 nationals, we construct an alternative nationality variable for Poland applying the origin-year-specific shares of EU-15, NMS10, and Other nationals computed for Hungary to the survey for Poland. We choose Hungary as a reference because, just like Poland and unlike other NMS countries, it applies reciprocal measures to EU-15 nationals. Poland lifted the reciprocal measures on January 1st, 2007, while Hungary simplified the reciprocal measures on January 1st, 2008.

B.2.3 Labor Force Status

We measure the labor force status in the destination (i.e. in the survey country) using the variable *ilostat*, which measures the labor force status following the guidelines of the International Labour Organization (ILO). We consider two labor force status: employment and non-employment, the latter pooling together unemployed, inactive, and compulsory military service. The labor force status in the origin country (i.e. one year before the survey) is measured through the variable *wstat1y*, which measures the situation with regard to activity one year before survey. Here as well, we consider two aggregate labor force status: employed and not employed. Employed corresponds to “Carries out a job or profession, including unpaid work for a family business or holding, including an apprenticeship or paid traineeship, etc,” while not employed pools together unemployed, and a number of inactive statuses including “Pupil, student, further training, unpaid work experience”, “In retirement or early retirement or has given up business”, “Permanently disabled”, “In compulsory military service”, “Fulfilling domestic tasks”, and “Other inactive person”.⁶⁷

Table B.2 shows the share of employed individuals, from 15 to 65 years old, by country, before and after 2004 based on our final data set. The correlation between our computed non-employment shares by country and the official Eurostat data is 99 percent for the year 2002, 98 percent for the year 2004, and 96 percent for the year 2015.

B.2.4 Education

The EU-LFS contains information on the education level of the interviewed individuals. Each individual is assigned an education level according to the International Standard Classification of Education (ISCED). The raw data follows ISCED 1997 until the survey year 2013 and ISCED 2011 from the survey year 2014. We use the ISCED classification to split individuals into two education

⁶⁷An alternative way to measure the labor force status in the survey country is to use the variable *mainstat*, which is constructed in a way that is more similar to the *wstat1y* variable. The issue with *mainstat* is that it is missing for some countries—for example, *mainstat* is always missing for Germany and the UK, and it is missing for France and Spain for selected years—while *ilostat* is never missing. Moreover, since we aggregate the labor force status to two broad categories like employed and not employed, the correlation between *mainstat* and *ilostat*, for the observations in which they are both available, is higher than 95 percent.

Table B.2: Share of Employed - Before and After 2004

	2002-2003	2004-2015		2002-2003	2004-2015
Austria	0.67	0.69	Cyprus	0.67	0.66
Belgium	0.59	0.62	Czech Republic	0.64	0.66
Denmark	0.74	0.74	Estonia	0.61	0.64
France	0.62	0.63	Hungary	0.56	0.57
Germany	0.64	0.69	Latvia	0.57	0.63
Greece	0.58	0.57	Lithuania	0.61	0.61
Italy	0.55	0.59	Poland	0.52	0.57
Portugal	0.68	0.66			
Spain	0.59	0.60			
UK	0.70	0.70			
Average	0.62	0.65	Average	0.55	0.59

Note: The table shows the share of employed population from 15 to 64 years. Averages, across years and countries, are population weighted.

levels, defining as high-skilled all the individuals with at least some tertiary education. We assign to the low-skilled group the residual workers with education up to post secondary non-tertiary education. The main reason why we separate categories this way in order to obtain skill groups that are comparable across countries and over time.⁶⁸ When information on education is missing (about 3 percent of the interviewed), we proceed as follows: if in a destination-origin-year-week we only observe individuals with either high-skill (low-skill) or missing education, we assume all the individuals with missing education to be low-skilled (high-skilled). If in a destination-origin-year-week we observe individuals with high-skill, low-skill and missing education, we proportionally split the missings to high and low skill. Finally, if for a destination-origin-year-week we do not have any information on education, we proportionally assign education using the average annual shares of high and low-skill migrants for that same destination-origin-year or destination-origin. The correlation between our computed aggregate share of high-skilled and low-skilled individuals by country and the official Eurostat data is 99 percent for the year 2002, 97 percent for the year 2004, and almost 89 percent for the year 2015.

B.2.5 Stocks and Flows Algorithm

Our goal is to construct a data set of migration flows that is internally consistent. Let's consider a given nationality-skill pair. For each country-labor force status-year cell (i, v, t) we potentially have two separate measures of the stock of individuals: the first measure comes directly from the EU-LFS (i, t) survey; the second measure can be constructed from the set of EU-LFS $\{(i, t + 1)\}_i$ surveys for the following year. For example, the Polish survey of 2006 provides a measure of the number of low-skill NMS nationals with labor force status v in Poland in 2006. However, another

⁶⁸For the correspondence between ISCED 1997 and ISCED 2011, see the Eurostat ISCED correspondence document, available at https://ec.europa.eu/eurostat/documents/1978984/6037342/Comparability_ISCED_2011_ISCED_1997.pdf.

measure can be constructed using the surveys for all countries in 2007—including the survey for Poland—reporting immigrants with labor force status v in Poland the year before. Let's define the first measure as $S_{06}^{PL,v}$ and the second measure as $\tilde{S}_{06}^{PL,v}$. If $S_{06}^{PL,v} > \tilde{S}_{06}^{PL,v}$ we can conjecture that the difference $(S_{06}^{PL,v} - \tilde{S}_{06}^{PL,v})$ captures migrants from Poland to the RoW (for which there is no survey available). To the contrary, if $S_{06}^{PL,v} < \tilde{S}_{06}^{PL,v}$ we can replace $S_{06}^{PL,v}$ with $\tilde{S}_{06}^{PL,v}$, and adjust the migration flows between $t - 1$ and t accordingly. The following algorithm captures this idea.

1. Consider a given nationality, skill level, time interval $t \in [0, \dots, T]$, and set of countries $i \in \{EU, NMS, ROW\}$ where EU is the set of our 10 EU countries, NMS is the set of our 7 NMS countries, and ROW is a residual set of countries (that must be commonly defined in each survey).
2. Let $S_t^{i,v}$ be the stock of people in country i -labor force status v -year t according to country i survey in year t . Let $F_{t-1,t}^{ijuv}$ be the flow of migrants from labor force status u in country i to labor force status v in country j between $t - 1$ and t according to country j survey in year t .
3. Consider $t = T$.
 - (a) For each country and labor force status iu in $t = T - 1$, it must be the case that either
 - i. $S_{T-1}^{iu} > \sum_j \sum_v F_{T-1,T}^{ijuv}$ (the stock is higher than the sum of the outflows) or
 - ii. $S_{T-1}^{iu} < \sum_j \sum_v F_{T-1,T}^{ijuv}$ (the stock is lower than the sum of the outflows).
 - (b) In the first case, we assume that the difference between the stock and the flows represents migration from i to ROW . In order to determine the labor force status in the destination we use the average matrix for all other destinations, i.e.

$$\tilde{F}_{T-1,T}^{iROWuv} = \left(S_{T-1}^{iu} - \sum_j \sum_v F_{T-1,T}^{ijuv} \right) \sum_{j \neq ROW} \left[\left(F_{T-1,T}^{ijuv} / \sum_v F_{T-1,T}^{ijuv} \right) \right] / 17$$

for all v . Housekeeping: We also set $\tilde{F}_{T-1,T}^{ijuv} = F_{T-1,T}^{ijuv}$ for all $j \neq ROW$, and $\tilde{S}_{T-1}^{iu} = S_{T-1}^{iu}$.

- (c) In the second case:
 - i. We trust the flows and update the stock in $T - 1$, i.e. we set $\tilde{S}_{T-1}^{iu} = S_{T-1}^{iu} + \left[\left(\sum_j \sum_v F_{T-1,T}^{ijuv} \right) - S_{T-1}^{iu} \right]$;
 - ii. We also update the inflows, between $T - 2$ and $T - 1$ to be consistent with the new stock \tilde{S}_{T-1}^{jv} . We do so by assigning the difference between \tilde{S}_{T-1}^{jv} and S_{T-1}^{jv} to inflows from ROW . In order to determine the labor force status in the origin we use the average matrix for all other countries of origin, i.e.

$$\tilde{F}_{T-1,T}^{ROWjvw} = \left(\tilde{S}_{T-1}^{jv} - S_{T-1}^{jv} \right) \sum_{i \neq ROW} \left[\left(F_{T-1,T}^{ijvw} / \sum_u F_{T-1,T}^{ijvw} \right) \right] / 17$$

for all u . Housekeeping: We also set $\tilde{F}_{T-1,T}^{ijuv} = F_{T-1,T}^{ijuv}$ for all $j \neq ROW$, and $\tilde{F}_{T-1,T}^{iROWuv} = 0$ for all uv .

(d) Housekeeping: we set $\tilde{S}_T^{iv} = S_T^{iv}$ for all $i \neq ROW$.

4. Consider now $t = T - 1$ and loop back to point 3.

In order to perform the algorithm described above, we need information on the stock of people in the RoW, as well as their distribution across nationalities and labor force status. We use information on population levels and on the share of population between 15 and 64 years old from the World Bank World Development Indicators database to construct the stock of people in the rest of world in 2002.⁶⁹ We further use the average year-nationality-skill-labor force status shares from our 17 countries (EU members plus NMS countries) and apply them to the RoW population to split people in the relevant groups for our analysis. Specifically, we apply the average year-nationality-skill-labor force status shares from our 17 countries to a share of the population of the RoW that equals the aggregate population of our 17 countries. The remaining part of the population of the RoW is assigned to the “Other” nationality, with a split between employed and not employed that reflects that average share of employed among “Other” nationals in the 17 EU countries.

Some destination-origin-nationality-skill-year flows have missing values that we interpret as measurement errors in the surveys. We perform the following procedure to, essentially, replace them with tiny positive values. We start from the stock of individuals in 2002, which includes three instances of missings: high-skill, employed and not employed, EU nationals in Estonia and Latvia, and low-skill, employed and not employed, EU nationals in Lithuania. We compute the average ratio of low to high-skill EU nationals across NMS countries and apply the (inverse) ratio to the stock of high (low) skill to these cases. Then we consider the migration shares that are missings and set them to be equal to the minimum positive migration share in the data, conditional on all the relevant information that affects migration decisions in our model. In particular, in our baseline specification we compute the minimum migration share conditional on nationality, skill, labor force status in $t - 1$, labor force status in t and year, exploiting the variation across origin and destination countries. We also explore alternative ways to compute these minima by conditioning on a subset of variables by dropping, one at the time, either nationality, or skill, or labor force status in $t - 1$, or labor force status in t or year. These alternative ways of conditioning the data have an insignificant impact on the flows, the correlations among all of them are near one. We also compare the final dataset and the raw data along three key dimensions: population, skill composition, and employment composition. Specifically, we find that the correlation between the raw and final data in terms of (i) the share of each country population relative to the aggregate population in the sample, (ii) the share of low-skilled in each country, and (iii) the share of employed in each country is about 99.8 percent, 99.7 percent, and 94 percent, respectively, in 2002. The same correlations are 99.2 percent, 96.2 percent, and 89.9 percent, respectively, in 2007, and 99.3 percent, 88.5 percent,

⁶⁹Total population is based on the *de facto* definition of population, which counts all residents regardless of legal status or citizenship. The values used are midyear estimates.

and 90.6 percent, respectively, in 2015. Finally, the find that the magnitude of the estimates of the migration policy changes are also very similar over the different ways to compute these minima.

B.2.6 Migration Data Checks

We provide some external validation for our constructed gross migration data. We compare the migration data with migration information coming from alternative data sources: Statistics Denmark and the UK Office for National Statistics. As mentioned above, it is not easy to find accessible and comparable migration data. The U.K. is of particular interest given the role it played in the 2004 EU enlargement, while Denmark is particularly well known for collecting precise statistical information. We find that the correlation between the immigration shares into Denmark, by year and country of origin, based on Statistics Denmark information and based on our data is 0.79 for the 2003-2007 period. The correlation between the UK Office for National Statistics aggregate inflow of migrants from NMS and the inflow based on our data is 0.93 for the 2003-2007 period.⁷⁰

Finally, we use our migration data set to investigate a number of specific migration patterns that have either been documented in the literature, or that have been prominently featured in the press and are part of the public awareness. We focus on three migration routes: (i) from Poland to Germany/UK, (ii) Portugal to France, and (iii) Italy to Germany/France/UK. The 2011 German Census reports that about 2.7 million people whose country of birth is Poland live in Germany.⁷¹ While Germany has been, for several reasons throughout history, the main European destination for Polish emigrants, Dustmann et al. (2015) notes that "Whereas Germany was the main destination in 1997, absorbing about 27 percent of the Polish emigrant population, the largest destination country in 2007 was the UK (with 31 percent of all emigrants)."⁷² Figure 3 in the main text, using our data on migration flows, clearly shows the leapfrogging of Germany by the UK in terms of main European destination for emigration, both for low-skilled and high-skilled NMS nationals. Just like for Poland, a large fraction of the Portuguese population lives abroad, and France has traditionally been the main European destination for Portuguese migrants.⁷³ The 2011 French Census reports

⁷⁰Denmark: Statistics Denmark series on immigration by sex, age, citizenship, country of last residence and time are published in the StatBank, INDVAN time series. These data include persons who took up residence in Denmark and who had resided abroad before. The data come from the CPR, the central population register. We select people between 15 and 64 years, aggregate the data by year and country of origin, and build immigration shares by dividing by the corresponding Denmark population from the World Bank World Development Indicators database. UK: We use the UK Office for National Statistics "Revised Net Long-Term International Migration" time series. These data include long-term migrants, i.e. those that change their usual country of residence. The primary data source is the International Passenger Survey (IPS), a continuous voluntary survey conducted at all principal air and sea routes and the channel tunnel. Slovenia and Slovakia are included in the UK Office for National Statistics sample but not in our data, while Cyprus is included in our data but not in the UK Office for National Statistics sample.

⁷¹The 2011 Population and Housing Census marks a milestone in census exercises in Europe. For the first time, European legislation defined in detail a set of harmonized high-quality data from the population and housing censuses conducted in the EU Member States.

⁷²The figures mentioned in Dustmann et al. (2015)'s quote come from the Polish Labour Force Survey, a rotating quarterly panel conducted in Poland by the Polish Central Statistical Office. The survey registers the country of present residence for individuals who are part of the household but who have been residing abroad for more than 3 months.

⁷³The New York Times article "Pictures Tell the Story of Portuguese in France" captures the importance of the Portuguese presence in France in the 1960s.

that about 6 percent of the Portuguese population lives in France. After France, the other top four countries in terms of Portuguese-born people in 2011 are Spain, Luxembourg, Germany, and Belgium. Our data set on gross flows of migrants period confirms this ranking. The third case we consider features another country which has experienced throughout history large outflows of population is Italy. According to the 2011 Italian Census, the top four countries in terms of stock of Italian-born population are France, Germany, Switzerland, and the U.K.. Once again, with the exclusion of Switzerland our data is entirely consistent with the information coming from the census.

B.3 Bilateral Trade

The bilateral trade flows between each country in the sample are computed using information from the WIOD database (Timmer et al. (2015a)). We keep the set of countries consistent with the migration data and we pool all the remaining countries in the rest of the world. Values are in US dollars at current prices.

Table B.3 shows the share of NMS, EU-15, and Rest of the World, into either NMS or EU-15 imports or exports. The table points to three patterns. First, the larger trade integration among NMS countries, whose average weight into imports or exports increases by 73 and 63 percent, respectively within 5 years. Second, the larger weight of NMS in EU-15's imports or exports which increases by 44 and 35 percent, respectively within 5 years, and by 72 and 47 percent after 11 years. Third, both EU-15 and NMS countries tend to trade more with the Rest of the World, and less with EU-15 countries themselves. All patterns are consistent with the reductions in tariffs, between EU-15 and NMS, among NMS countries, and between EU and the Rest of the World discussed in Section 2.2.

B.3.1 Tariffs

The bilateral tariff data are constructed using the information in the WITS database. We use effectively applied tariff rates from the TRAIN dataset, which is defined as the lowest available tariff.⁷⁴

The procedure followed to construct the tariff dataset we use in the paper is the following. We start from the aggregate effectively applied tariffs rate from the TRAINS data set and we proceed as follows to make the series complete:⁷⁵

We download the tariff data from WITS-Trains. We use the (effective applied rates) AHS data and trade weighted average. In the download query we select as reporters: Cyprus, Czech Republic, Estonia, EU25 --- EU25 members, Hungary, Latvia, Lithuania, Poland and World. As partners: Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy,

⁷⁴WITS uses the concept of effectively applied tariff which is defined as the lowest available tariff. If a preferential tariff exists, it will be used as the effectively applied tariff. Otherwise, the MFN applied tariff will be used.

⁷⁵The raw data we use is aggregated by the WITS website at the level of importer-exporter-year.

Table B.3: Imports and exports shares, EU-15 and NMS

Imports shares						
	<i>NMS importing from:</i>			<i>EU-15 importing from:</i>		
	Other NMS	EU-15	RoW	NMS	Other EU-15	RoW
2002	5.6	51.2	43.2	3.6	47.1	49.4
2007	9.7	48.1	42.2	5.2	43.3	51.5
2014	10.7	45.7	43.6	6.2	38.9	54.9
Change (2002-2007)	+4.1	-3.1	-1.0	+1.6	-3.8	+2.1
Change (2002-2014)	+5.1	-5.5	+0.4	+2.6	-8.2	+5.5

Exports shares						
	<i>NMS exporting to:</i>			<i>EU-15 exporting to:</i>		
	Other NMS	EU-15	RoW	NMS	Other EU-15	RoW
2002	6.0	52.5	41.5	3.4	43.3	53.3
2007	9.8	51.0	39.2	4.6	40.9	54.5
2014	9.8	47.3	42.9	5.0	35.3	59.7
Change (2002-2007)	+3.8	-1.5	-2.3	+1.2	-2.4	+1.2
Change (2002-2014)	+3.8	-5.2	+1.4	+1.6	-8.0	+6.4

Notes: This table shows the weighted average imports and exports shares for NMS and EU-15 countries. Averages have been constructed using the same set of EU-15 countries and NMS countries as in our data set on gross migration flows. The remaining countries are aggregated into the Rest of the World (RoW).

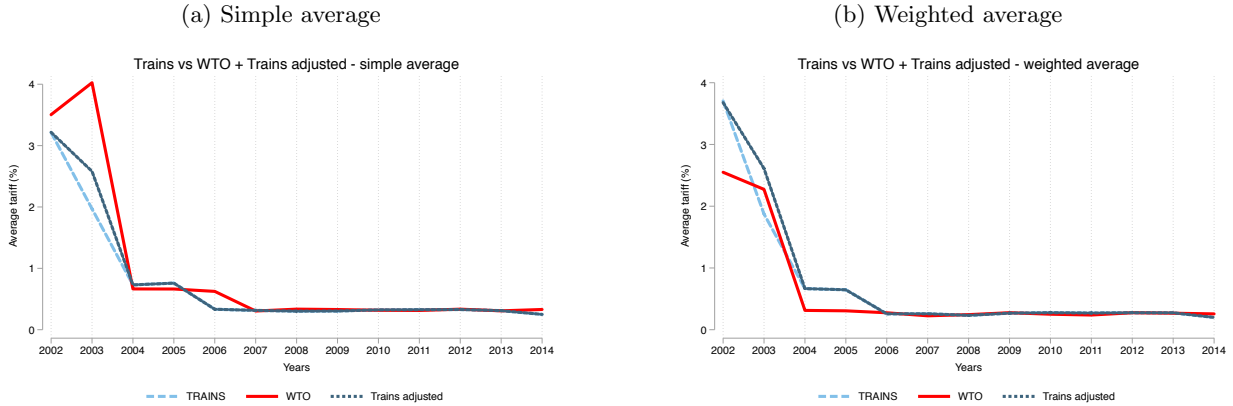
Latvia, Lithuania, Poland, Portugal, Spain, U.K., EU25 --- EU25 members, World. We use data for the years 2002 and 2003. Tariffs in the year 2003 were missing for the following countries: Cyprus, Hungary, Latvia. We used tariffs for the year 2002 for the case of Cyprus and Hungary and for the year 2001 for the case of Latvia.

For completeness, Figure B.1 reports the comparison among the simple and weighted average TRAIN tariff, the WTO tariff, and the tariff we construct using the methodology described above. The values in figure B.1 are average tariffs applied by NMS, EU15 and RoW to each other. For each year, the graph shows the average tariff among the tariffs applied by EU15-NMS, NMS-EU15, EU15-RoW, RoW-EU15, NMS-RoW, RoW-NMS.

B.4 Real Wages and the Share of Labor Compensation in Value Added

We compute the share of labor compensation in value added by skill at the national level using data on value added and labor payment from the Socio Economic Accounts in the WIOD database and the EUKLEMS database. To construct a complete series of employment level by skill, we combine

Figure B.1: Tariffs data



the information from WIOD for the years 2000 to 2008 with the information from EUKLEMS for the years 2009 to 2014.⁷⁶

To construct the series of real wages we use the information on labor compensation from the Socio Economic Accounts in the WIOD database and the information on the price levels of the countries in our sample from the Penn World Tables version 9.0 (www.ggd.net/pwt). We use the variable "Price level of CCON, equal to the PPP (ratio of nominal CON to CCON) divided by the nominal exchange rate (National currency per USD)" which in other words is just the ratio of expenditure at local prices to that at reference prices measured in the currency of the base country—in our case the US.

Because the PPP is in units of the currency of country j per unit of the currency of the base country, it is common to divide it by the nominal exchange rate to obtain what is called the "price level" of country j (see Feenstra et al. (2015)). Moreover, the WIOD database provides also information on the employment level of each country over time, which constitutes the denominator of the formula for real wages.

C Employment and Non-Employment Transitions

In this appendix, we provide further description of the transition rates between employment and non-employment. We first describe the transition rates in NMS and EU-15 countries, and we then focus on the transition rates of NMS nationals, distinguishing between migrants and stayers, and across skills.

⁷⁶We validate the consistency of the constructed labor shares by skills across the two datasets using the information available for the overlapping years (2008 and 2009).

Transition rates in EU-15 and NMS countries

We first compare the transition rates between employment and non-employment in EU-15 and NMS countries for all households living in this group of countries. When aggregating all nationalities in each country, the transition rates from non-employment to employment are similar in EU-15 and NMS countries between 2002 and 2015. On average, about 15 percent of non-employed becomes employed the year after, and transition rates from employment to employment are similar, about 92 percent, in EU-15 and NMS countries.

We also compare the transition rates between employment and non-employment for NMS nationals and EU-15 nationals in EU-15 countries. The transition rates from non-employment to employment are generally lower and more stable for EU-15 nationals than for NMS nationals. Also, we observe a drop in the transition rate from non-employment to employment of NMS nationals around the period of the global financial crisis.

Transition rates of NMS nationals for stayers and migrants across skills

We also compare the transition rates for NMS nationals, and across skills, for stayers and migrants. Table C.1 provides a summary of these transition rates for NMS nationals. Panel (a) shows the transition rates for all NMS nationals, Panel (b) displays the transition rates for low-skilled households, and Panel (c) presents the transition rates for high-skilled households. For NMS nationals that do not migrate (stay from one year to the other in the same country), employment and non-employment are persistent states, especially for low-skilled households. In particular, about 90 percent of the non-employed low-skilled NMS nationals remain non-employed after a year, and about 73 percent for the case of high-skilled households. For the case of employed households, about 93 percent of the employed low-skilled households, and 96 percent of the high-skilled households remain employed after a year. The transition from non-employment to employment is higher for NMS migrants than for non-migrants (stayers). We observe that 49 percent of the low-skilled and 46 percent of the high-skilled NMS migrants transition from non-employment in the NMS countries into employment in the EU-15 countries. The transition from employment to employment is even higher for NMS migrants; 82 percent of the low-skilled and 76 percent of the high-skilled NMS nationals remain employed after migrating to the EU-15.

D Change in Migration Costs: Trends and Placebo Exercise

In Section 4.2, we described the methodology used to identify changes in migration costs: the U.K. opening to NMS countries in 2004, followed by Greece, Italy, Spain, and Portugal in 2006. In this appendix we provide additional support for our identification strategy by showing, in sub-appendix D.1, a series of plots that allow to evaluate the common trend assumption. In sub-appendix D.2, we develop a placebo exercise to support our identification strategy.

Table C.1: Transition Rates between Empl. and Non-Empl. for NMS nationals (percent)

status at $t - 1$ /status at t	Panel (a): All NMS households			
	Stayers		Migrants to EU-15 countries	
	Non-employment	Employment	Non-employment	Employment
Non-employment	89	11	51	49
Employment	6	94	19	81
	Panel (b): Low-skilled NMS households			
	Stayers		Migrants to EU-15 countries	
	Non-employment	Employment	Non-employment	Employment
Non-employment	90	10	51	49
Employment	7	93	18	82
	Panel (c): High-skilled NMS households			
	Stayers		Migrants to EU-15 countries	
	Non-employment	Employment	Non-employment	Employment
Non-employment	73	27	54	46
Employment	4	96	24	76

Note: This table shows the transition rates between employment and non-employment for NMS national stayers and migrants into EU-15 countries. Panel (a) presents the transition rates for all NMS nationals, Panel (b) shows the transition rates for low-skilled households, and Panel (c) presents the transition rates for high-skilled households.

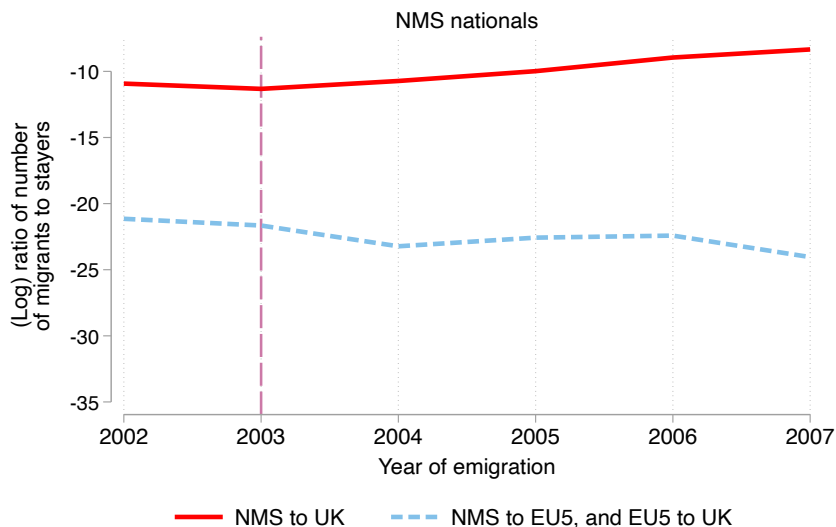
D.1 Common Trend Assumption

Figure D.1 shows the evolution over time of the (log) odds of migrating vs. staying for the flows between NMS countries and U.K. and the flows between the EU-5 group and the U.K. and from NMS to the EU-5 group. Similarly, Figure D.2 shows the same information as in Figure D.1 but for the case of Greece, Italy, Spain and Portugal. Overall, the evolution of the flows between NMS and the set of EU-15 countries that change policy does not show a break in the relative trends before the policy changes, consistent with our identification restriction in Section 4.2.

D.2 Placebo Exercise

We now present an exercise to support our identification strategy. In particular, we run a placebo-type experiment where we look at a set of nationalities for which there was no change in policy. The intuition is that we expect the costs of migrating from NMS countries to the U.K., Greece, Italy, Spain, and Portugal not to have changed for EU-15 nationals as a consequence of the EU enlargement and, as a result, if we run our specification we should not identify any change in policy. Figure D.3 reports the average evolution of the (log) odds for the migration flows between this group of countries and Table D.1 reports the estimates from our empirical specification (18) for EU-15 nationals, which reassuringly shows no change in the policy due to the enlargement from NMS to EU-15 for those that already were European citizens.

Figure D.1: Migration to the U.K. for NMS nationals, 2002-2007



Note: NMS to U.K. in solid, NMS to EU5 and EU5 to U.K. flows are dashed. The vertical dashed line marks the change in policy period.

E International Migration Elasticity

In this appendix we describe in detail the estimation method used to find the international migration elasticity in Section 4.3. We estimate the international migration elasticity, $1/\nu$, by adapting the method presented in Artuç and McLaren (2015) to our theory and data. The method has two stages: first the Poisson regression stage where we estimate value differences and the migration cost function, normalized by ν , for every time period. Second, the Bellman equation stage, where we insert the estimated value differences into a Bellman equation and construct a linear regression to retrieve the international migration elasticity, $1/\nu$.

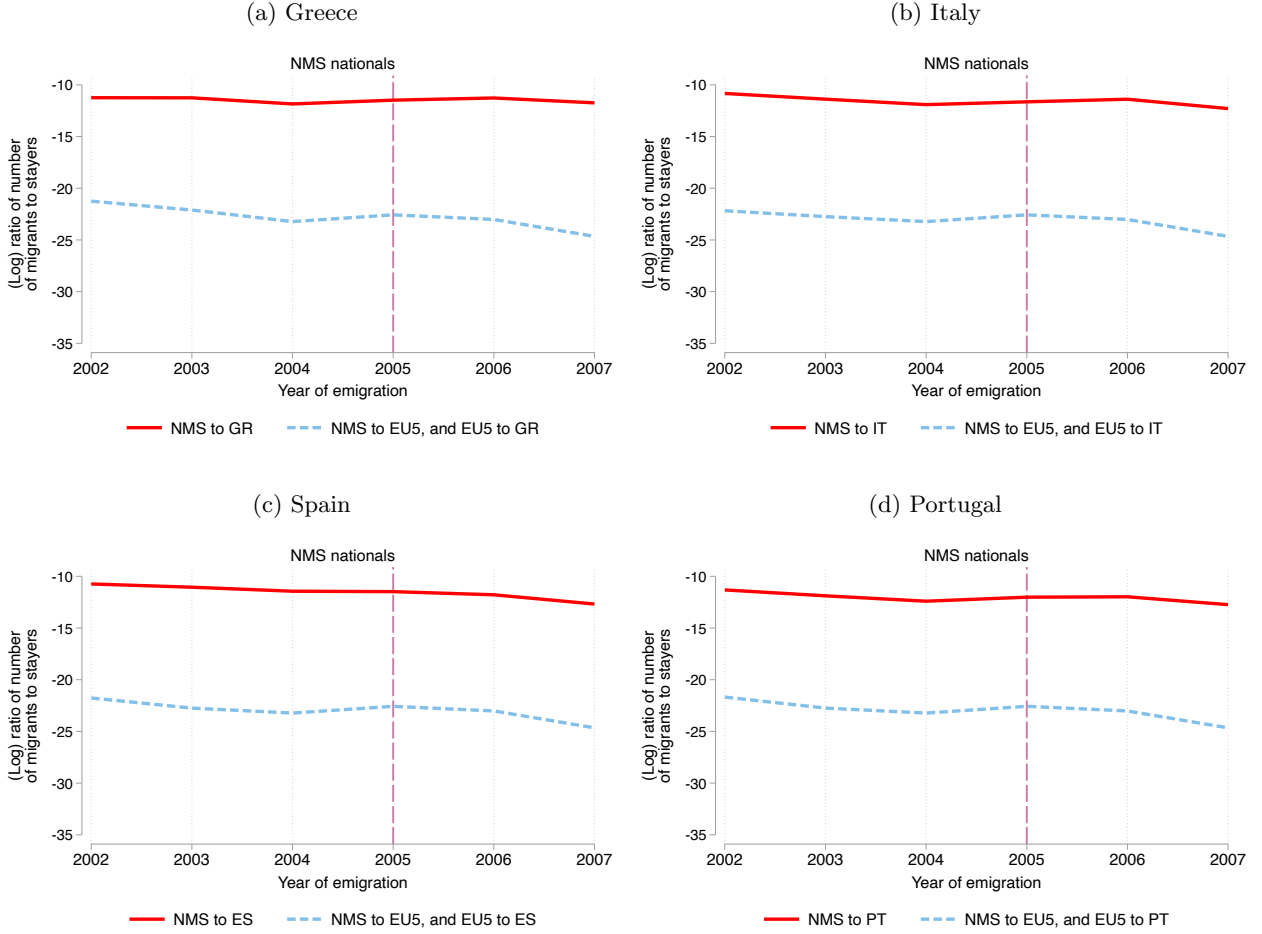
Since, in the baseline, we estimate the migration elasticity using only flows of EU nationals, that are employed in the country of origin, within the EU-15, we drop the n and ℓ subscripts from the model.⁷⁷ The estimation method relies on the following two equilibrium conditions from the model: the migration share equation

$$\mu_{s,t}^{ij} = \frac{\left(\exp\left(\beta V_{s,t+1}^j - m_{s,t}^{i,j}\right)\right)^{1/\nu}}{\sum_{k=1}^N \left(\exp\left(\beta V_{s,t+1}^k - m_{s,t}^{i,k}\right)\right)^{1/\nu}}, \quad (26)$$

and the Bellman equation

⁷⁷To estimate the migration elasticity we condition on employment since, as explained below, the second-stage estimation relies on cross-country variation in real wages. As a robustness, later on, we also estimate the migration elasticity including employed and non-employed households and obtain similar values.

Figure D.2: Migration to Greece/Italy/Spain/Portugal, 2002-2007



Note: The solid lines show the flows (log odds) from NMS countries to the EU-15 countries that changes policy to NMS nationals, the dashed lines show the third-country flows. The vertical dashed line marks the beginning of the change in policy period.

$$\begin{aligned}
 V_{s,t}^i &= \log(C_{s,t}^i) + \nu \log \left(\sum_{k=1}^N \left(\exp(\beta V_{s,t+1}^k - m_{s,t}^{i,k}) \right)^{1/\nu} \right) = \\
 &= \log(w_{s,t}^i/P_t^i) + \beta E_t V_{s,t+1}^i - m_{s,t}^{i,i} + \Omega_{s,t}^i,
 \end{aligned} \tag{27}$$

where

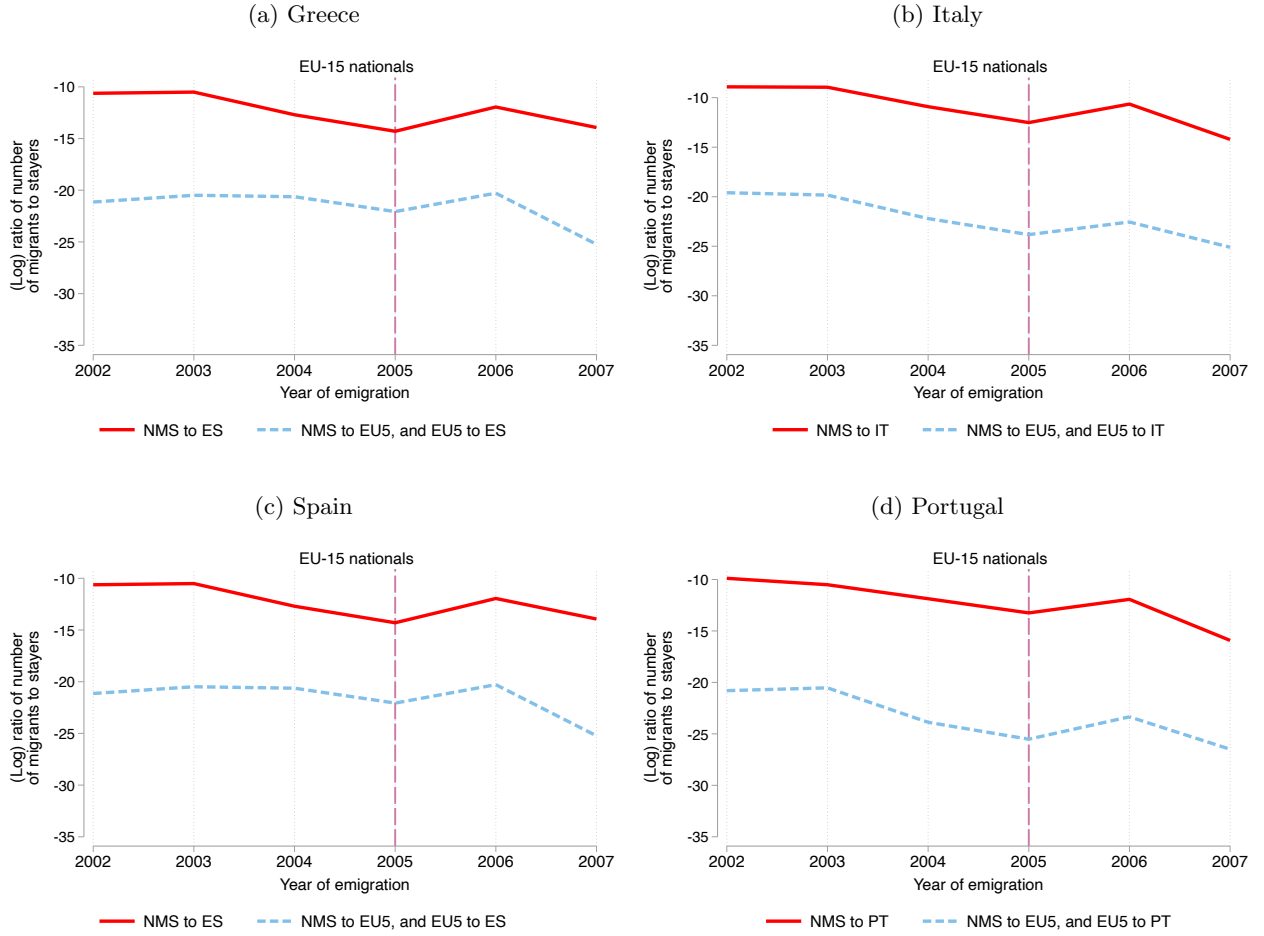
$$C_{s,t}^i = w_{s,t}^i/P_t^i$$

is the consumption aggregator, and

$$\Omega_{s,t}^i = \nu \log \sum_{k=1}^N \left(\exp(\beta (V_{s,t+1}^k - V_{s,t+1}^i) - (m_{s,t}^{i,k} - m_{s,t}^{i,i})) \right)^{1/\nu}$$

is the option value of migration.

Figure D.3: Migration for EU nationals, from NMS to Greece/Italy/Spain/Portugal, 2002-2007



Note: The solid lines show the flows from NMS countries to the EU-15 that changes policy to NMS nationals, the dashed lines show the third-country flows. The vertical dashed line marks the beginning of the change in policy period

First stage: Poisson regression The first stage is a fixed-effect estimation—based on the migration share equation and bilateral gross migration flows data—to estimate value differences and the migration cost function normalized by ν .

The estimating equation can be derived as follows. In the migration share equation (26), multiply both numerator and denominator on the right hand side by $\left[\exp \left(-\beta V_{s,t+1}^i + m_{s,t}^{i,i} \right) \right]^{1/\nu}$,

$$\mu_{s,t}^{i,j} = \frac{\left(\exp \left(\beta \left(V_{s,t+1}^j - V_{s,t+1}^i \right) - \left(m_{s,t}^{i,j} - m_{s,t}^{i,i} \right) \right) \right)^{1/\nu}}{\sum_{k=1}^N \left(\exp \left(\beta \left(V_{s,t+1}^k - V_{s,t+1}^i \right) - \left(m_{s,t}^{i,k} - m_{s,t}^{i,i} \right) \right) \right)^{1/\nu}}.$$

Then multiply both sides by the mass of agents $L_{s,t}^i$,

Table D.1: Placebo Estimates of Changes in Migration Policy, EU nationals

EU nationals ($n = EU15$)					
Destination $j \rightarrow$	<i>U.K. (2004)</i>	<i>GR (2006)</i>	<i>IT (2006)</i>	<i>ES (2006)</i>	<i>PT (2006)</i>
$\beta_{post}^{NMS,j}$	0.62 (0.93)	0.84 (0.97)	0.35 (0.96)	0.77 (0.97)	-0.31 (1.03)
R^2	0.91	0.92	0.92	0.92	0.92
Obs.	564	564	564	564	564

Note: The table reports estimates, from separate regressions, of the change in migration cost from NMS countries to either the United Kingdom (U.K.), Greece (GR), Italy (IT), Spain (ES), or Portugal (PT) for EU-15 nationals. The results correspond to a placebo exercise since no migration policy changes occurred for EU-15 nationals. The post period is 2004-2007 for the U.K., and 2006-2007 for the other destinations. Parentheses includes robust standard errors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Similar significance is obtained if instead we use two-way clustering at the origin-destination-country level.

$$L_{s,t}^i \mu_{s,t}^{i,j} = \frac{\left(\exp \left(\beta \left(V_{s,t+1}^j - V_{s,t+1}^i \right) - \left(m_{s,t}^{i,j} - m_{s,t}^{i,i} \right) \right) \right)^{1/\nu}}{\sum_{k=1}^N \left(\exp \left(\beta \left(V_{s,t+1}^k - V_{s,t+1}^i \right) - \left(m_{s,t}^{i,k} - m_{s,t}^{i,i} \right) \right) \right)^{1/\nu}} L_{s,t}^i,$$

and rewrite as

$$L_{s,t}^i \mu_{s,t}^{i,j} = \exp \left(\frac{\beta}{\nu} V_{t+1,s}^j - \frac{\beta}{\nu} V_{t+1,s}^i - \frac{1}{\nu} \left(m_{t,s}^{i,j} - m_{s,t}^{i,i} \right) + \log L_{t,s}^i - \frac{1}{\nu} \Omega_{t,s}^i \right). \quad (28)$$

Use the migration cost specification

$$m_{s,t}^{i,j} - m_{s,t}^{i,i} = \bar{m}_{s,t}^j - \bar{m}_{s,t}^i + \bar{m}_{s,t}^{i,j} + mpol_t^{i,j},$$

and given that for the case of EU 15 countries, we have that $mpol_t^{i,j} = 0$, we obtain that

$$L_{s,t}^i \mu_{s,t}^{i,j} = \exp \left(\frac{\beta}{\nu} V_{s,t+1}^j - \frac{\beta}{\nu} V_{s,t+1}^i + \frac{1}{\nu} \bar{m}_{s,t}^i - \frac{1}{\nu} \bar{m}_{s,t}^j - \frac{1}{\nu} \bar{m}_{s,t}^{i,j} + \log L_{s,t}^i - \frac{1}{\nu} \Omega_{s,t}^i \right)$$

We interpret the equation above as Poisson pseudo-maximum likelihood. The first stage regression is then

$$Z_{s,t}^{i,j} = \exp \left(\Lambda_{s,t}^j + \Gamma_{s,t}^i - \frac{1}{\nu} \bar{m}_{s,t}^{i,j} \right) + \varepsilon_{s,t}^{i,j}, \quad (29)$$

where $Z_{s,t}^{i,j} = L_{s,t}^i \mu_{s,t}^{i,j}$ is the mass of agents with skill s moving from i to j in t , $\Lambda_{s,t}^j$ is a destination-skill-time fixed effect, $\Gamma_{s,t}^i$ is an origin-skill-time fixed effect.

The $\Lambda_{s,t}^j$ and $\Gamma_{s,t}^i$ terms are not separately identified, so without loss of generality we set $\Lambda_{s,t}^1 = 0$ (or equivalently choose cell $\Lambda_{s,t}^1$ as the omitted category for the fixed effects). Overall, this is equivalent to defining the destination-skill-time fixed effects as

$$\Lambda_{s,t}^j = \frac{\beta}{\nu} \left(E_t V_{s,t+1}^j - E_t V_{s,t+1}^1 \right) - \frac{1}{\nu} \bar{m}_{s,t}^j + \frac{1}{\nu} \bar{m}_{s,t}^{j=1}, \quad (30)$$

and the origin-skill-time fixed effects as

$$\Gamma_{s,t}^i = -\frac{\beta}{\nu} \left(E_t V_{s,t+1}^i - E_t V_{s,t+1}^1 \right) + \log L_{s,t}^i - \frac{1}{\nu} \Omega_{s,t}^i + \frac{1}{\nu} \bar{m}_{s,t}^i - \frac{1}{\nu} \bar{m}_{s,t}^{j=1}$$

Note that the migration option value for an agent with skill s living in country i in year t can be written as

$$\frac{1}{\nu} \Omega_{s,t}^i = -\Lambda_{s,t}^i - \Gamma_{s,t}^i + \log L_{s,t}^i. \quad (31)$$

Analogously to Silva and Tenreyro (2006), we use Poisson Pseudo Maximum Likelihood (PPML) to estimate equation (29). This implies that, if we write the estimating equation (29) in the form $W_{s,t}^{ij} = \exp \left(\mathbb{I}_{s,t}^{ij} \mathbb{Q}_{t,s} \right) + \varepsilon_{s,t}^{ij}$, where $\mathbb{I}_{s,t}^{ij}$ is a vector of dummy variables and $\mathbb{Q}_{t,s}$ is the vector of parameters to be estimated, then we choose the parameters to solve the first-order condition

$$\sum_t \sum_{ij} \left(W_{s,t}^{ij} - \exp \left(\mathbb{I}_{s,t}^{ij} \mathbb{Q}_{t,s} \right) \right) \mathbb{I}_{s,t}^{ij} = 0.$$

Second stage: Bellman equation In stage 1 we have estimated the destination-skill-time and origin-skill-time fixed effects $\Lambda_{t,s}^j$ and $\Gamma_{t,s}^i$. The second stage rewrites the Bellman equation (27) as an estimating equation using the estimated values from the first stage.

Using (27), we can write

$$\frac{\beta}{\nu} E_t V_{s,t+1}^i = \frac{\beta}{\nu} \left(\log \left(\frac{w_{s,t+1}^i}{P_{t+1}^i} \right) + \beta E_t V_{s,t+2}^i - m_{s,t+1}^{i,i} + \Omega_{s,t+1}^i \right).$$

Using (31) to substitute out the continuation value $\Omega_{s,t+1}^i$, and using the expression for the destination-skill-time fixed effects (30), we get

$$\begin{aligned} \Lambda_{s,t}^i + \beta \Gamma_{s,t+1}^i - \beta \log L_{s,t+1}^i &= \frac{\beta}{\nu} \log \left(\frac{w_{s,t+1}^i}{P_{t+1}^i} \right) \\ + \frac{\beta^2}{\nu} E_t V_{s,t+2}^1 - \frac{\beta}{\nu} E_t V_{s,t+1}^1 - \frac{\beta}{\nu} \bar{m}_{s,t+1}^i - \frac{\beta}{\nu} \bar{m}_{s,t+1}^{j=1} - \left(\frac{1}{\nu} \bar{m}_{s,t}^i - \frac{1}{\nu} \bar{m}_{s,t}^{j=1} \right). \end{aligned} \quad (32)$$

Define

$$B_{s,t}^i = \Lambda_{s,t}^i + \beta \Gamma_{s,t+1}^i - \beta \log L_{s,t+1}^i, \quad (33)$$

and

$$\mathfrak{C}_{s,t} = \frac{\beta^2}{\nu} E_t V_{s,t+2}^1 - \frac{\beta}{\nu} E_t V_{s,t+1}^1,$$

and rewrite (32) as

$$B_{s,t}^i = \mathfrak{C}_{s,t} + \kappa_{s,t}^i + \frac{\beta}{\nu} \log \left(\frac{w_{s,t+1}^i}{P_{t+1}^i} \right) + \epsilon_{s,t}^i, \quad (34)$$

where $B_{s,t}^i$ is the dependent variable constructed from Stage 1 estimates using (33), $\mathfrak{C}_{t,s}$ is a time-

Table E.1: International Migration Elasticity, Second Stage Estimates

	Baseline	With public good
$1/\nu$	0.50*** (0.17)	0.62*** (0.19)
Obs.	100	100

Notes: Standard errors clustered at the country-level in parentheses. *** $p < 0.01$.

skill dummy, $\kappa_{s,t}^i = -\left(\frac{\beta}{\nu}\bar{m}_{s,t+1}^{j=1} - \frac{1}{\nu}\bar{m}_{s,t}^{j=1}\right) - \frac{\beta}{\nu}\bar{m}_{s,t+1}^i - \frac{1}{\nu}\bar{m}_{s,t}^i$, and $\epsilon_{s,t}^i$ is the regression residual. Note that in order to identify $\kappa_{s,t}^i$, and therefore the migration elasticity, we need to impose that it does not vary by skill, and/or it does not vary over time. In our baseline specification, we estimate this parameter as a country fixed effect, and as a robustness we estimate it as a country-time fixed effects. The remaining right hand-side variables are all taken from the data: $\log(w_{s,t+1}^i/P_{t+1}^i)$ is the (log) real wage; $\log(L_{t+1}^i)$ is the lead of the (log) population in country i . We estimate (34) as an IV regression, using two-period lagged values of real wages as instruments similar to Artuç et al. (2010), and clustering standard errors at the country level.

We build wages, for each country i and year $t \in [2002 - 2009]$, as the ratio of the economy-wide “Labour compensation” (in millions of national currency) and “Number of persons engaged” (in thousands) from the WIOD Socio-Economic Accounts (SEA) data set (Timmer et al. (2015b)). Then, we use the purchasing-power-parity adjusted real exchange rate from version 9.0 of the Penn World Tables to compare wages across countries and time (Feenstra et al. (2015)). To compute wages by skill level we resort once again to the WIOD Socio-Economic Accounts: the high-skilled wage is computed using the high-skilled share of labor compensation and the high-skilled share of total hours; we convert hours into persons by assuming that the number of hours per person does not vary with skills.⁷⁸

Table (E.1) reports the second stage IV estimates for $1/\nu$ for $\beta = 0.97$ for the baseline case and for the extension with public good described below. The estimates for alternative values of $\beta = \{0.90, 0.95\}$ are the same up to the second decimal digit.⁷⁹

⁷⁸See Appendix B.4 for more details.

⁷⁹We obtain a value $1/\nu = 0.6$ when estimating the second stage with country-time fixed effects. The difference in the estimated migration elasticity has a minor effect in the computed migration and welfare effects of the EU enlargement. For instance, with $1/\nu = 0.5$ we find that the welfare gains for high-skilled and low-skilled households in NMS countries is 1.70 percent and 1.10 percent, respectively. The welfare change for high-skilled and low-skilled households in EU-15 countries is 0.14 percent and 0.02 percent, respectively. With $1/\nu = 0.6$ the same figures in NMS countries are 1.70 and 1.09, respectively, while the welfare change in EU-15 countries are the same at the second decimal. In terms of migration effects, with $1/\nu = 0.5$ the stock of high-skilled and low-skilled households in EU-15 countries in steady state increases by 1.08 percentage points and 1.80 percentage points, respectively, while with $1/\nu = 0.6$ the same figures are 1.06 percentage points and 1.76 percentage points, respectively. As an additional robustness, we also estimated the migration elasticity including employed and non-employed households and obtain similar values, $1/\nu = 0.5$ and $1/\nu = 0.61$ when estimating the second stage with country fixed effects, and country-time fixed effects, respectively.

E.1 Estimation with Publicly-provided Consumption Services

In section 5.3.1 of the main text we extended our model to account for additional congestion effects coming from publicly-provided consumption services. It turns out that this extension only slightly modifies the methodology for the estimation of the international migration elasticity outlined above. The first stage, based on the migration share equation, is unchanged. The second stage relies on a modified Bellman equation that includes the per capita public provision of consumption services (G^i/L_{t+1}^i), weighted by the fraction of those services in total consumption (α_i), as well as wages net of labor income taxes,

$$\frac{\beta}{\nu} E_t V_{s,t+1}^i = \frac{\beta}{\nu} \left\{ \begin{aligned} &\alpha_i \log(G^i/L_{t+1}^i) + (1 - \alpha_i) \log\left(\left(1 - \tau_{t+1}^i\right) \frac{w_{s,t+1}^i}{P_{t+1}^i}\right) \\ &+ \beta E_t V_{s,t+2}^i - m_{s,t+1}^{i,i} + \Omega_{s,t+1}^i \end{aligned} \right\}.$$

Following the same steps outlined above for the case without publicly-provided consumption services, it is easy to obtain the estimating equation

$$B_{s,t}^i = \epsilon_{s,t} + \kappa_{s,t}^i + \frac{\beta}{\nu} \left\{ -\alpha_i \log L_{t+1}^i + (1 - \alpha_i) \log\left(\left(1 - \tau_{t+1}^i\right) \frac{w_{s,t+1}^i}{P_{t+1}^i}\right) \right\} + \epsilon_{s,t}^i, \quad (35)$$

where the country fixed effect is now defined as $\kappa_{s,t}^i = (\beta/\nu) \alpha_i \log G^i - \left(\frac{\beta}{\nu} \bar{m}_{s,t+1}^{j=1} - \frac{1}{\nu} \bar{m}_{s,t}^{j=1}\right) - \frac{\beta}{\nu} \bar{m}_{s,t+1}^i - \frac{1}{\nu} \bar{m}_{s,t}^i$. In terms of data, we need to compute the fraction of publicly-provided consumption services in total consumption α_i , which we construct using the WIOD World Input-Output Database, and we need information on labor income taxes. In order to compute net real wages we resort to the OECD Tax Database, which provides data on combined central and sub-central government income tax plus employee social security contribution, as a percentage of gross wage earnings, for people whose income is 100 percent of the average wage (OECD (2016)). In the OECD Tax Database the average wage is defined as the average annual gross wage earnings of adult, full-time, manual and non-manual workers. Data are available for each year for 14 countries in our sample, all except Lithuania, Latvia and Cyprus. For these three countries we compute the tax rate as the average of the tax rate for all the other NMS countries, by year. The second column in Table (E.1) reports the second stage IV estimates for $1/\nu$ with publicly-provided consumption services.

F Alternative Methodology to Estimate the Elasticity of Substitution Between Low- and High-Skilled Workers

In this appendix we provide an alternative estimate of the elasticity of substitution between low and high-skilled workers.

We estimate the elasticity of substitution using detailed information on workers' wages and hours, as well as firms' location and industry, from the Portuguese matched employer-employee

data (*Quadros de Pessoal*) for the period 1991-2005.⁸⁰ Similar to our methodology in Section 4.4, our estimation strategy builds on the first-order conditions of the firm’s cost minimization problem. In this alternative methodology, we compute the first-order conditions of firms’ cost minimization problem for firms located in a given industry and region in Portugal. Following Katz and Murphy (1992) and Acemoglu and Autor (2011)), we model the demand shifter of firms located in industry v and region r , ϱ_t^{vr} , with a time-invariant component that captures the skill intensity in the production function, and a location-sector specific linear trend, namely $\varrho_t^{vr} = \alpha^{vr} + \varphi_t^{vr}$. Therefore, our empirical specification is given by

$$\ln \frac{w_{h,t}^{vr}}{w_{l,t}^{vr}} = -\frac{1}{\rho} \ln \frac{L_{h,t}^{vr}}{L_{l,t}^{vr}} + \alpha^{vr} + \varphi_t^{vr} + \epsilon_t^{vr}, \quad (36)$$

where $\left(w_{h,t}^{vr}/w_{l,t}^{vr}\right)$ is the ratio of high- and low-skilled workers’ wages in industry v and region r , $\left(L_{h,t}^{vr}/L_{l,t}^{vr}\right)$ is the corresponding relative supply, and ρ is the elasticity of substitution between low and high-skilled workers. Finally, ϵ_t^{vr} is an error term due to unobservables that affect relative wages. We tackle potential endogeneity issues in this region-industry regression by using instrumental variable estimation.⁸¹ Our instrument for $\left(L_{h,t}^{vr}/L_{l,t}^{vr}\right)$ is constructed using information on the local availability of low and high-skilled workers that change firm because of displacement, and in particular because of firm closure.⁸² A firm closure can be considered as an exogenous shock to a worker’s career, since it results in a separation of all plant’s workers and it is not related to the worker’s own job performance (Dustmann and Meghir (2005)). Moreover, when instrumenting the relative labor supply of a given industry, we consider only closures of firms that belong to other industries, so that their closure is hardly related to the market of the industry under consideration. Finally, as workers tend to search and accept more easily new jobs in the same local labor market of the past job, we consider closures of firms that belong to the same region of the industry under consideration. Overall, the local availability of displaced workers can then be considered as an exogenous labor supply shock for local firms. Figure F.1 shows the correlation between the

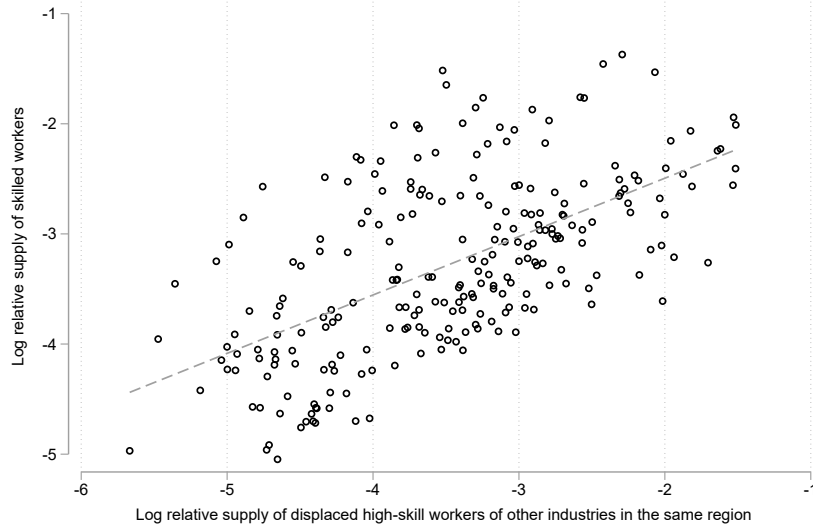
⁸⁰We resort to *Quadros de Pessoal* for a number of reasons. First, *Quadros de Pessoal*’s provides an exhaustive coverage of firms and their workers over a long time-span. Second, we can estimate an elasticity of substitution between low and high-skill workers that is consistent with the skills definitions from the EU-LFS. Third, we can estimate an elasticity of substitution using data from an European country, and we can compare our findings to other estimates available in the literature for other countries. Last but not least, we can exploit the richness of the data to implement an instrumental variable strategy, described below, that facilitates the identification of the elasticity of substitution.

⁸¹In general, papers estimating the elasticity of substitution between low- and high-skilled workers do not consider endogeneity issues. Two important exceptions are Angrist (1995) and Ciccone and Peri (2005). Angrist (1995) estimate the relationship between the return to schooling and the supply of more educated workers among Palestinians in the West Bank and the Gaza Strip during the 1980s, exploiting the fact that the increase in the supply of more educated workers was mainly driven by the creation of new local institutions of higher education. Ciccone and Peri (2005) estimate the long-run elasticity of substitution between low- and high-skilled workers at the U.S. state level using data from five 1950-1990 decennial censuses. They exploit time- and state-specific child labor and compulsory school attendance laws as instruments.

⁸²Displacement is usually defined as the permanent and involuntary separation of workers from their jobs without cause (i.e. for economic reasons). Displacement occurs when a firm shuts down or substantially downsizes.

instrumented variable and the instrument.⁸³

Figure F.1: Relative supply of high-skilled workers and displaced high-skilled workers, by industry and region, 1991-2005



Note: Own elaboration using the matched employer-employee data set *Quadros de Pessoal* described below in this appendix. Low-skill includes all workers with a high-school degree or less, and high-skill are workers with some college education and college graduates. Each circle in the plot corresponds to an industry-region-year. We split the data on continental Portugal into five regions (Norte, Algarve, Alentejo, Centro and Lisbon Metropolitan area) that approximately follow the NUTS II classification, industries at NACE 1-digit, and 17 years. The population in each region is: Norte, 3.6 million; Algarve, 451 thousand; Alentejo, 711.9 thousand; Centro, 2.4 million; and Lisbon Metropolitan area, 2.8 million.

The data used in the estimation considers all industries in the economy except for agriculture and fishing, international organizations, and government and justice. We aggregate industries to the following level: “Agriculture, Fishing, and Mining”, Manufacturing, Construction, “Wholesale, and Retail Trade”, “Services and Other”. We consider all single-job workers between 18 and 65 years old, working no more than 480 hours per month, earning at least the minimum wage, excluding apprentices and workers for which no information on education is available. We trim the top and bottom 1 percent of workers according to the distribution of hourly wages in each year. We end up with about 18 millions observations that we aggregate into skill-year groups to construct hours. To construct the average wage in each cell we use a more selective sample that includes only employees with a permanent contract, working at least 35 hours per week. The average weekly wage in a skill-year cell is constructed by using only the base wage, and then taking the weighted average over workers where the weights are the regular hours worked by the individual. Wages are deflated to 2005 using Statistics Portugal monthly consumer price index by special aggregates that we convert to annual. In order to classify workers as “displaced” we partly follow Carneiro

⁸³The first stage of the estimation shows a coefficient of 0.6 with a t-stat of 18.89 (P-value = 0.000), the Kleibergen-Paap rk LM statistic of the underidentification test is 91.7 (Chi-sq(1) P-val = 0.0000), and the Kleibergen-Paap rk Wald F statistic for the weak identification test with non i.i.d. errors is 356.8 showing that weak identification is not an issue (as Figure F.1 shows).

Table F.1: Elasticity of substitution between low- and high-skill workers, Portuguese matched employer-employee data

	Industry-region-level			Country-level			Country-level (composition-adjusted)		
	Elasticity	R^2	Obs.	Elasticity	R^2	Obs.	Elasticity	R^2	Obs.
IV	4.0	0.80	240						
Linear trend	5.0	0.94	280	4.2	0.97	14	3.6	0.97	14
Spline	4.2	0.93	280	3.1	0.98	14	3.0	0.99	14

Note: All estimates are significant at 1 percent. All industry-region-level estimates include industry-region fixed effects. Industry-region-level OLS estimates include industry-region-specific trends.

and Portugal (2006) and define a firm as shutting down after year t when the firm is observed in the *Quadros de Pessoal* data in year t but is not observed in the dataset in any of the three subsequent years. If a firm is last active in t we record the total regular hours worked by its low- and high-skilled workers in t and use these hours to construct the instrument for $t + 1$.⁸⁴

Table F.1 reports the estimates, which are all significant at 1 percent. Employing the IV methodology and data outlined above, we obtain an elasticity of 4, which is similar to the number we obtain with the method we employ in the main text. The estimate of the elasticity of substitution turns out to be pretty robust to alternative different specifications, methodologies, and levels of data aggregation. Table F.1 reports an alternative set of estimates using OLS with linear or spline (with break in 1993) trends, at the industry-region and country-level. It also reports a set of estimates based on an alternative way to construct the data series for hours and wages based on Autor et al. (2008). In this case we construct a fix-weighted ratio of high-skill to low-skill wages for a composition-constant set of sex-education-experience groups. To do that, we regress monthly deflated wages, for each sex and year, on five education categories (3 years or less, between 4 and 6 years, between 7 and 9 years, between 10 and 12 years, and 13 years and above), a quartic in experience (defined as age minus 6 minus the number of education years), and all the interactions between the education dummies and the quartic in experience. The predicted wages for each sex-education-experience-year group are then aggregated at the skill-year level with a constant set of weights based on the aggregate hours shares of each group. The series for hours is constructed by aggregating at the skill-year level the series for total regular hours worked by sex, five education groups and experience. The aggregation employs a series of weights to turn hours into efficiency units. Weights are constructed by normalizing the predicted wages described above by the top wage across cells. Estimates for the elasticity of substitution, using different types of trends turn out to be slightly smaller, but overall pretty similar to all the others.

⁸⁴We construct the lead because the information reported in *Quadros de Pessoal* is collected in October of every year from 1994 on (before that it was collected in March).

Further Details on the Portuguese Matched Employer-Employee Data Set

In this section of the appendix, we provide further details on the Portuguese matched employer-employee data used for the estimation of the elasticity of substitution between high-skilled and low-skilled workers described in the previous section. Employer-employee data come from *Quadros de Pessoal*, a longitudinal data set matching virtually all firms and workers based in Portugal.⁸⁵ Reported data cover the firm itself, as well as each of its workers. Each firm and each worker entering the database are assigned a unique, time-invariant identifying number which can be used to follow firms and workers over time.

Each year, every firm with wage earners is legally obliged to fill in a standardized questionnaire. Reported data cover the firm itself, each of its plants, and each of its workers. The worker-level data cover information on all personnel working for the reporting firms in a reference week. They include information on gender, age, occupation, schooling, hiring date, earnings, hours worked (normal and overtime), etc. The information on earnings includes the base wage (gross pay for normal hours of work), seniority-indexed components of pay, other regularly paid components, overtime work, and irregularly paid components.⁸⁶ It does not include employer’s contributions to social security.

The administrative nature of the data and their public availability at the workplace—as required by the law—imply a high degree of coverage and reliability. The public availability requirement facilitates the work of the services of the Ministry of Employment that monitor the compliance of firms with the law (e.g., illegal work).

G Temporary Equilibrium in Changes

In this appendix, we describe the equilibrium conditions of the production and trade static problem of the firm in relative time differences (counterfactual economy relative to the baseline economy). As in the main text, let $\dot{y}_{t+1} \equiv y_{t+1}/y_t$ denote the relative time change of a variable and $\hat{y}_{t+1} \equiv \dot{y}'_{t+1}/\dot{y}_{t+1}$ denote the relative time difference of the variable under a sequence of policies $\{\mathcal{Y}'_t\}_{t=0}^\infty$ relative to the sequence of policies $\{\mathcal{Y}_t\}_{t=0}^\infty$ and where $\{\dot{\Theta}'_t\}_{t=1}^\infty = \{\dot{\Theta}_t\}_{t=1}^\infty$; namely fundamentals in the counterfactual economy change in the same way as in the baseline economy.

Let’s define

$$\varpi_{s,t}^i \equiv w_{s,t}^i (r_t^i)^{\gamma^i / (1-\gamma^i)}. \quad (37)$$

⁸⁵Public administration and non-market services are excluded. *Quadros de Pessoal* has been used by, among others, Cabral and Mata (2003) to study the evolution of the firm size distribution; by Blanchard and Portugal (2001) to compare the U.S. and Portuguese labor markets in terms of unemployment duration and worker flows; by Cardoso and Portugal (2005) to study the determinants of both the contractual wage and the wage cushion (difference between contractual and actual wages); by Carneiro et al. (2012) who, in a related study, analyze how wages of newly hired workers and of existing employees react differently to the business cycle; by Martins (2009) to study the effect of employment protection on worker flows and firm performance. See these papers also for a description of the peculiar features of the Portuguese labor market.

⁸⁶It is well known that employer-reported wage information is subject to less measurement error than worker-reported data. Furthermore, the *Quadros de Pessoal* registry is routinely used by the inspectors of the Ministry of Employment to monitor whether the firm wage policy complies with the law.

Using this definition, the cost of a bundle of inputs is given by

$$x_t^i = \zeta^i \left(\delta_{h,t}^i (\varpi_{h,t}^i)^{1-\rho} + \delta_{l,t}^i (\varpi_{l,t}^i)^{1-\rho} \right)^{\frac{1-\gamma^i}{1-\rho}}.$$

Dividing this equation by x_{t-1}^i , multiplying and dividing by $\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}$, and writing the expression in time differences, we have that

$$\dot{x}_t^i = \left(\sum_{s=h,l} \frac{\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}} \dot{\delta}_{s,t}^i (\dot{\varpi}_{s,t}^i)^{1-\rho} \right)^{\frac{1-\gamma^i}{1-\rho}}. \quad (38)$$

From the first order conditions of the firm's cost minimization problem we have that

$$\xi_{s,t-1}^i = \frac{\delta_{s,t-1}^i (w_{s,t-1}^i)^{1-\rho}}{\delta_{h,t-1}^i (w_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (w_{l,t-1}^i)^{1-\rho}}, \quad (39)$$

and after multiplying and dividing each wage term in (39) by $(r_t^i)^{\gamma^i/(1-\gamma^i)}$, and using the definition of $\varpi_{s,t}^i$ in (37) we obtain

$$\xi_{s,t-1}^i = \frac{\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}}, \quad (40)$$

which we can use into (38) to obtain

$$\dot{x}_t^i = \left[\xi_{h,t-1}^i \dot{\delta}_{h,t}^i (\dot{\varpi}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \dot{\delta}_{l,t}^i (\dot{\varpi}_{l,t}^i)^{1-\rho} \right]^{\frac{1-\gamma^i}{1-\rho}}. \quad (41)$$

In addition, note that in time differences, (40) can be written as

$$\dot{\xi}_{s,t}^i = \frac{\xi_{s,t}^i}{\xi_{s,t-1}^i} = \frac{\frac{\delta_{s,t}^i (\varpi_{s,t}^i)^{1-\rho}}{\delta_{h,t}^i (\varpi_{h,t}^i)^{1-\rho} + \delta_{l,t}^i (\varpi_{l,t}^i)^{1-\rho}}}{\frac{\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}}}$$

or

$$\dot{\xi}_{s,t}^i = \frac{\frac{\delta_{s,t}^i (\varpi_{s,t}^i)^{1-\rho}}{\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}}}{\frac{\delta_{h,t}^i (\varpi_{h,t}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}} + \frac{\delta_{l,t}^i (\varpi_{l,t}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}}},$$

and using the “dot” notation we obtain

$$\dot{\xi}_{s,t}^i = \frac{\dot{\delta}_{s,t}^i (\dot{\varpi}_{s,t}^i)^{1-\rho}}{\frac{\delta_{h,t}^i (\varpi_{h,t}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}} + \frac{\delta_{l,t}^i (\varpi_{l,t}^i)^{1-\rho}}{\delta_{h,t-1}^i (\varpi_{h,t-1}^i)^{1-\rho} + \delta_{l,t-1}^i (\varpi_{l,t-1}^i)^{1-\rho}}}$$

and multiplying and dividing each term in the denominator by $\delta_{s,t-1}^i (\varpi_{s,t-1}^i)^{1-\rho}$ and using (40)

in each term in the denominator we obtain that

$$\hat{\xi}_{s,t}^i = \frac{\xi_{s,t}^i}{\xi_{s,t-1}^i} = \frac{\delta_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho}}{\xi_{h,t-1}^i \delta_{h,t}^i (\hat{\omega}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \delta_{l,t}^i (\hat{\omega}_{l,t}^i)^{1-\rho}}. \quad (42)$$

Note that the denominator can be rewritten using (41) to obtain

$$\xi_{s,t}^i = \xi_{s,t-1}^i \frac{\delta_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho}}{(\hat{x}_t^i)^{\frac{1-\rho}{1-\gamma^i}}}. \quad (43)$$

Taking the ratio between \hat{x}_t^i in the counterfactual economy relative to the baseline economy, namely $\hat{x}_t^i = \hat{x}_t^{i'} / \hat{x}_t^i$, we obtain

$$\hat{x}_t^i = \left(\frac{\xi_{h,t-1}^{i'} \delta_{h,t}^{i'} (\hat{\omega}_{h,t}^{i'})^{1-\rho} + \xi_{l,t-1}^{i'} \delta_{l,t}^{i'} (\hat{\omega}_{l,t}^{i'})^{1-\rho}}{\xi_{h,t-1}^i \delta_{h,t}^i (\hat{\omega}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \delta_{l,t}^i (\hat{\omega}_{l,t}^i)^{1-\rho}} \right)^{\frac{(1-\gamma^i)}{1-\rho}},$$

now note that if we multiply and divide the numerator by $\xi_{s,t-1}^i \delta_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho}$ we obtain that

$$\frac{\xi_{s,t-1}^{i'} \delta_{s,t}^{i'} (\hat{\omega}_{s,t}^{i'})^{1-\rho}}{\xi_{h,t-1}^i \delta_{h,t}^i (\hat{\omega}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \delta_{l,t}^i (\hat{\omega}_{l,t}^i)^{1-\rho}} = \frac{\xi_{s,t-1}^i \delta_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho} \frac{\xi_{s,t-1}^{i'}}{\xi_{s,t-1}^i} \delta_{s,t}^{i'} (\hat{\omega}_{s,t}^{i'})^{1-\rho}}{\xi_{h,t-1}^i \delta_{h,t}^i (\hat{\omega}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \delta_{l,t}^i (\hat{\omega}_{l,t}^i)^{1-\rho}}$$

and since $\hat{\delta}_{s,t}^i = 1$, then

$$\hat{x}_t^i = \left[\sum_{s=h,l} \frac{\xi_{s,t-1}^i \delta_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho}}{\xi_{h,t-1}^i \delta_{h,t}^i (\hat{\omega}_{h,t}^i)^{1-\rho} + \xi_{l,t-1}^i \delta_{l,t}^i (\hat{\omega}_{l,t}^i)^{1-\rho}} \frac{\xi_{s,t-1}^{i'}}{\xi_{s,t-1}^i} (\hat{\omega}_{s,t}^{i'})^{1-\rho} \right]^{\frac{(1-\gamma^i)}{1-\rho}},$$

and using (42) from the main text, we get

$$\hat{x}_t^i = \left(\sum_{s=h,l} \xi_{s,t}^i \frac{\xi_{s,t-1}^{i'}}{\xi_{s,t-1}^i} (\hat{\omega}_{s,t}^{i'})^{1-\rho} \right)^{\frac{(1-\gamma^i)}{1-\rho}}.$$

Inverting this equation, we have that

$$\xi_{s,t}^{i'} = \xi_{s,t-1}^{i'} \xi_{s,t}^i (\hat{\omega}_{s,t}^i)^{1-\rho} (\hat{x}_t^i)^{\frac{\rho-1}{(1-\gamma^i)}}.$$

The price index (7) in time differences is given by

$$\dot{P}_t^i = \left(\frac{\sum_{j=1}^N A_t^j \left(\kappa_t^{i,j} x_t^j \right)^{-\theta}}{\sum_{j=1}^N A_{t-1}^j \left(\kappa_{t-1}^{i,j} x_{t-1}^j \right)^{-\theta}} \right)^{-\frac{1}{\theta}}.$$

Multiplying and dividing each term of the numerator by $A_{t-1}^j \left(\kappa_{t-1}^{i,j} x_{t-1}^j \right)^{-\theta}$ we get

$$\dot{P}_t^i = \left(\frac{\sum_{j=1}^N \frac{A_t^j \left(\kappa_t^{i,j} x_t^j \right)^{-\theta}}{A_{t-1}^j \left(\kappa_{t-1}^{i,j} x_{t-1}^j \right)^{-\theta}}}{\sum_{j=1}^N \frac{A_t^j \left(\kappa_t^{i,j} x_t^j \right)^{-\theta}}{A_{t-1}^j \left(\kappa_{t-1}^{i,j} x_{t-1}^j \right)^{-\theta}}} \right)^{-\frac{1}{\theta}},$$

and using (6) we obtain

$$\dot{P}_t^i = \left(\sum_{j=1}^N \pi_{t-1}^{i,j} \hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}.$$

Similarly, the change in the price index in the counterfactual economy is given by

$$\dot{P}_t^{\prime i} = \left(\sum_{j=1}^N \pi_{t-1}^{\prime i,j} \hat{A}_t^{\prime j} \left(\hat{\kappa}_t^{\prime i,j} \hat{x}_t^{\prime j} \right)^{-\theta} \right)^{-\frac{1}{\theta}},$$

and taking the ratio between the change in the price index in the counterfactual economy and the baseline economy we obtain

$$\hat{P}_t^i = \left(\frac{\sum_{j=1}^N \pi_{t-1}^{\prime i,j} \hat{A}_t^{\prime j} \left(\hat{\kappa}_t^{\prime i,j} \hat{x}_t^{\prime j} \right)^{-\theta}}{\sum_{j=1}^N \pi_{t-1}^{i,j} \hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}} \right)^{-\frac{1}{\theta}}.$$

Multiplying and dividing each term in the numerator by $\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}$ we get

$$\hat{P}_t^i = \left(\frac{\sum_{j=1}^N \pi_{t-1}^{\prime i,j} \frac{\hat{A}_t^{\prime j} \left(\hat{\kappa}_t^{\prime i,j} \hat{x}_t^{\prime j} \right)^{-\theta}}{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}}{\sum_{j=1}^N \pi_{t-1}^{i,j} \frac{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}} \right)^{-\frac{1}{\theta}}$$

and using (44), which is derived below we obtain

$$\hat{P}_t^i = \left(\sum_{j=1}^N \pi_{t-1}^{\prime i,j} \hat{\pi}_t^{i,j} \hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}},$$

Finally, using $\hat{A}_t^j = 1$, we get

$$\hat{P}_t^i = \left(\sum_{j=1}^N \pi_{t-1}^{\prime i,j} \hat{\pi}_t^{i,j} \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}.$$

The bilateral trade shares (6) expressed in time differences are given by

$$\dot{\pi}_t^{i,j} = \frac{\dot{A}_t^j \left(\dot{\kappa}_t^{i,j} \dot{x}_t^j \right)^{-\theta}}{\sum_{k=1}^N \dot{A}_{t-1}^k \left(\dot{\kappa}_{t-1}^{i,k} \dot{x}_{t-1}^k \right)^{-\theta} \dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}},$$

dividing and multiplying each term in the denominator by $\sum_{m=1}^N \dot{A}_{t-1}^m \left[\dot{\kappa}_{t-1}^{i,m} \dot{x}_{t-1}^m \right]^{-\theta}$ we get

$$\dot{\pi}_t^{i,j} = \frac{\dot{A}_t^j \left(\dot{\kappa}_t^{i,j} \dot{x}_t^j \right)^{-\theta}}{\sum_{k=1}^N \frac{\dot{A}_{t-1}^k \left(\dot{\kappa}_{t-1}^{i,k} \dot{x}_{t-1}^k \right)^{-\theta}}{\sum_{m=1}^N \dot{A}_{t-1}^m \left(\dot{\kappa}_{t-1}^{i,m} \dot{x}_{t-1}^m \right)^{-\theta}} \dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}},$$

and using (6) we obtain

$$\dot{\pi}_t^{i,j} = \frac{\dot{A}_t^j \left(\dot{\kappa}_t^{i,j} \dot{x}_t^j \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{i,k} \dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}}. \quad (44)$$

Similarly in the counterfactual economy we have

$$\dot{\pi}_t^{\prime i,j} = \frac{\dot{A}_t^{\prime j} \left(\dot{\kappa}_t^{\prime i,j} \dot{x}_t^{\prime j} \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{\prime i,k} \dot{A}_t^{\prime k} \left(\dot{\kappa}_t^{\prime i,k} \dot{x}_t^{\prime k} \right)^{-\theta}}.$$

Taking the ratio between the bilateral trade shares in the counterfactual economy and the baseline economy we get

$$\hat{\pi}_t^{i,j} = \frac{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}{\frac{\sum_{k=1}^N \pi_{t-1}^{\prime i,k} \hat{A}_t^{\prime k} \left(\hat{\kappa}_t^{\prime i,k} \hat{x}_t^{\prime k} \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{i,k} \dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}}}$$

Multiplying and dividing each term of the denominator by $\dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}$ we obtain,

$$\hat{\pi}_t^{i,j} = \frac{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}{\frac{\sum_{k=1}^N \pi_{t-1}^{\prime i,k} \hat{A}_t^{\prime k} \left(\hat{\kappa}_t^{\prime i,k} \hat{x}_t^{\prime k} \right)^{-\theta} \hat{A}_t^k \left(\hat{\kappa}_t^{i,k} \hat{x}_t^k \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{i,k} \dot{A}_t^k \left(\dot{\kappa}_t^{i,k} \dot{x}_t^k \right)^{-\theta}}},$$

and using (44) we obtain

$$\hat{\pi}_t^{i,j} = \frac{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{\prime i,k} \pi_{t-1}^{i,k} \hat{A}_t^k \left(\hat{\kappa}_t^{i,k} \hat{x}_t^k \right)^{-\theta}}.$$

Finally, using the fact that $\hat{A}_t^j = 1$, we get

$$\hat{\pi}_t^{i,j} = \frac{\left(\hat{\kappa}_t^{i,j} \hat{x}_t^j\right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{\prime i,k} \hat{\pi}_t^{i,k} \left(\hat{\kappa}_t^{i,k} \hat{x}_t^k\right)^{-\theta}}.$$

Total expenditure (9) in the counterfactual economy can be expressed as

$$X_t^{i'} = \sum_{n=1}^N \sum_{s=h,l} w_{s,t}^{\prime i} L_{n,s,t}^{\prime ie} + \iota^i \chi_t^i + T_t^i, \text{ for all } i, \quad (45)$$

where $\chi_t^i = \sum_{i=1}^N r_t^{\prime i} H^i$ and $T_t^i = \sum_{j=1}^N \tau_t^{\prime i,j} \frac{\pi_t^{\prime i,j}}{(1+\tau_t^{\prime i,j})} X_t^i$ are tariff revenues. We can rewrite this expression as

$$X_t^i = \frac{\sum_{n=1}^N \sum_{s=h,l} w_{s,t}^{\prime i} L_{n,s,t}^{\prime ie} + \iota^i \chi_t^i}{1 - \sum_{j=1}^N \frac{\tau_t^{\prime i,j}}{1+\tau_t^{\prime i,j}} \hat{\pi}_t^{\prime i,j} \pi_{t-1}^{\prime i,j}}.$$

Using the following relationships

$$\dot{w}_{s,t}^{\prime i} = \left(\dot{\varpi}_{s,t}^{\prime i}\right)^{(1-\gamma^i)} \left(\dot{\xi}_{s,t}^{\prime i}\right)^{\gamma^i} \left(\dot{L}_{s,t}^{\prime ie}\right)^{-\gamma^i},$$

and

$$\begin{aligned} \chi_t^i &= \sum_i r_t^{\prime i} H^i = \sum_i \hat{r}_t^{\prime i} r_{t-1}^{\prime i} H^i \\ &= \sum_{i=1}^N \left(\dot{\varpi}_{h,t}^{\prime i}\right) \left(\frac{\dot{L}_{h,t}^{\prime ie}}{\dot{\xi}_{h,t}^{\prime i}}\right)^{1-\gamma^i} r_{t-1}^{\prime i} H^i, \end{aligned}$$

which are derived from using the equilibrium demand for labor and structures

$$\frac{r_t^i H^i}{\gamma^i} = \frac{1}{1-\gamma^i} \frac{w_{h,t}^i L_{h,t}^{ie}}{\xi_{h,t}^i}$$

and in time differences in the counterfactual economy we obtain

$$\hat{r}_t^{\prime i} = \frac{\dot{w}_{h,t}^{\prime i} \dot{L}_{h,t}^{\prime ie}}{\dot{\xi}_{h,t}^{\prime i}},$$

and using the definition of $\dot{\varpi}_{h,t}^{\prime i}$

$$\dot{w}_{s,t}^{\prime i} = \frac{\dot{\varpi}_{s,t}^{\prime i}}{\left(\hat{r}_t^{\prime i}\right)^{\gamma^i/(1-\gamma^i)}} \quad (46)$$

we obtain

$$\hat{r}_t^{\prime i} = \left(\dot{\varpi}_{h,t}^{\prime i} \frac{\dot{L}_{h,t}^{\prime ie}}{\dot{\xi}_{h,t}^{\prime i}}\right)^{(1-\gamma^i)}. \quad (47)$$

Replacing these expressions in the total expenditure equation, we obtain

$$\begin{aligned} X_t^i &= \frac{\sum_{n=1}^N \sum_{s=h,l} \dot{w}_{s,t}^i \dot{L}_{n,s,t}^{ie} w_{s,t-1}^i L_{n,s,t-1}^{ie} + \iota^i \chi_t^i}{1 - \sum_{j=1}^N \frac{\tau_t^{i,j}}{1+\tau_t^{i,j}} \dot{\pi}_t^{i,j} \dot{\pi}_{t-1}^{i,j}} \\ &= \frac{\sum_{s=h,l} \left(\dot{\omega}_{s,t}^i \right)^{(1-\gamma^i)} \left(\dot{\xi}_{s,t}^i \right)^{\gamma^i} \left(\dot{L}_{s,t}^{ie} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^{ie} + \iota^i \chi_t^i}{1 - \sum_{j=1}^N \frac{\tau_t^{i,j}}{1+\tau_t^{i,j}} \dot{\pi}_t^{i,j} \dot{\pi}_{t-1}^{i,j}}. \end{aligned}$$

with $\chi_t^i = \sum_{i=1}^N \left(\dot{\omega}_{h,t}^i \right) \left(\frac{\dot{L}_{h,t}^{ie}}{\dot{\xi}_{h,t}^i} \right)^{1-\gamma} r_{t-1}^i H^i$, and we also use that $L_{s,t}^{ie} = \sum_n L_{n,s,t}^{ie}$

Finally, the labor market clearing (10) in the counterfactual equilibrium is given by

$$\dot{w}_{s,t}^i \dot{L}_{s,t}^{ie} w_{s,t-1}^i L_{s,t-1}^{ie} = \xi_{s,t}^i (1 - \gamma^i) \sum_{j=1}^N \frac{\pi_t^{j,i}}{(1 + \tau_t^{j,i})} X_t^j, \text{ for all } i, s,$$

and using (46) and (47) we get

$$\left(\dot{\omega}_{s,t}^i \right)^{(1-\gamma^i)} = \frac{(1 - \gamma^i) \xi_{s,t}^i}{\left(\dot{\xi}_{s,t}^i \right)^{\gamma^i} \left(\dot{L}_{s,t}^{ie} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^{ie}} \sum_{j=1}^N \frac{\pi_{t-1}^{j,i}}{1 + \tau_t^{j,i}} \dot{\pi}_t^{j,i} X_t^j X_t^j.$$

H Solution Algorithm

Part I: Solving for the Baseline Economy

We first show how we solve for the baseline economy given an initial allocation of the economy, $(L_0, \pi_0, X_0, \mu_{-1})$, and given an anticipated sequence of changes in fundamentals, $\{\dot{\Theta}_t\}_{t=1}^\infty$, and policies $\{\dot{\Upsilon}_t\}_{t=1}^\infty$. Our “dot” notation refers to the time difference of a variable, namely $\dot{y}_{t+1} \equiv y_{t+1}/y_t$.

We take as the initial allocation, $t = 0$, the last year in our sample (namely, the year 2014) and assume that $\dot{\Theta}_t = \dot{\Upsilon}_t = 1$, constant fundamentals after 2014.

The baseline economy from 2002 to 2014 is the data. We use the following equilibrium conditions to solve for the baseline economy after 2014

$$\mu_{n,s,t+1}^{il,jo} = \frac{\mu_{n,s,t}^{il,jo} \left(\dot{u}_{n,s,t+2}^{jo} \right)^{\beta/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \mu_{n,s,t}^{il,ka} \left(\dot{u}_{n,s,t+2}^{ka} \right)^{\beta/\nu}}, \quad (48)$$

$$\dot{u}_{n,s,t+1}^{il} = \dot{C}_{s,t}^{il} \left(\sum_{j=1}^N \sum_{o=e,ne} \mu_{n,s,t}^{il,jo} \left(\dot{u}_{n,s,t+2}^{jo} \right)^{\beta/\nu} \right)^\nu, \quad (49)$$

$$L_{n,s,t+1}^{io} = \sum_{j=1}^N \sum_{\ell=e,ne} \mu_{n,s,t}^{j\ell,io} L_{n,s,t}^{j\ell}, \quad (50)$$

for all ℓ, o, i, j, n , and s at each t , where $\hat{C}_{s,t}^{ine} = 1$, and $\hat{C}_{s,t}^{rie} = \hat{\omega}_{s,t}^i(\hat{L}_t)$ is the solution to the temporary equilibrium in time differences given the sequence of labor $\{\hat{L}_t\}_{t=1}^\infty$ and no change in policies and fundamentals.

We now describe the equilibrium conditions we use to solve for the temporary equilibrium in time differences. Define

$$\varpi_{s,t}^i \equiv w_{s,t}^i (r_t^i)^{\gamma^i / (1-\gamma^i)},$$

then given the allocation at $t-1$, $\left\{ \xi_{s,t-1}^i, w_{s,t-1}^i L_{n,s,t-1}^{ie}, \pi_{t-1}^{i,j}, r_{t-1}^i H^i \right\}_{i=1, j=1, s=h,l}^{N,N}$ a change in employment $\left\{ \hat{L}_{n,s,t}^{ie} \right\}_{i=1, j=1, s=h,l}^{N,N}$, and a new set of fundamental and policy changes, $\left\{ \delta_{s,t}^i, \hat{\kappa}_t^{i,j}, \hat{A}_t^j \right\}_{i=1, j=1, s=h,l}^{N,N}$, which in the case of the baseline after the year 2014 we use $\delta_{s,t}^i = 1$, $\hat{\kappa}_t^{i,j} = 1$, and $\hat{A}_t^j = 1$ for all i, j, s and t , $\left\{ \hat{\omega}_{s,t}^i \right\}_{i=1, s=h,l}^N$ solves equilibrium conditions

$$\left(\hat{\omega}_{s,t}^i \right)^{(1-\gamma^i)} = \frac{(1-\gamma^i) \xi_{s,t}^i}{\left(\hat{\xi}_{s,t}^i \right)^{\gamma^i} \left(\hat{L}_{s,t}^{i,e} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^{i,e}} \sum_{j=1}^N \frac{\pi_{t-1}^{j,i}}{1 + \tau_t^{j,i}} \hat{\pi}_t^{j,i} X_t^j \text{ for all } i, s \quad (51)$$

where

$$\xi_{s,t}^i = \xi_{s,t-1}^i \left(\hat{\omega}_{s,t}^i \right)^{1-\rho} \left(\hat{x}_t^i \right)^{\frac{\rho-1}{1-\gamma^i}},$$

the input cost in time differences is given by

$$\hat{x}_t^i \equiv \left(\sum_{s=h,l} \xi_{s,t-1}^i \delta_{s,t}^i \left(\hat{\omega}_{s,t}^i \right)^{1-\rho} \right)^{\frac{1-\gamma^i}{1-\rho}}, \quad (52)$$

the price index in time differences is

$$\hat{P}_t^i = \left(\sum_{j=1}^N \pi_{t-1}^{i,j} \hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}, \quad (53)$$

the bilateral expenditure shares in time differences are

$$\hat{\pi}_t^{i,j} = \frac{\hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta}}{\sum_{k=1}^N \pi_{t-1}^{i,k} \hat{A}_t^k \left(\hat{\kappa}_t^{i,k} \hat{x}_t^k \right)^{-\theta}}. \quad (54)$$

Finally, the goods market clearing condition in relative time changes can be written as

$$X_t^i = \frac{\sum_{s=h,l} \left(\hat{\omega}_{s,t}^i \right)^{(1-\gamma^i)} \left(\hat{\xi}_{s,t}^i \right)^{\gamma^i} \left(\hat{L}_{s,t}^{ie} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^{ie} + \iota^i \chi_t}{1 - \sum_{j=1}^N \frac{\tau_t^{i,j}}{1+\tau_t^{i,j}} \hat{\pi}_t^{i,j} \pi_{t-1}^{i,j}}, \quad (55)$$

where we used that $L_{s,t}^{ie} = \sum_n L_{n,s,t}^{ie}$ and that

$$\dot{w}_{s,t}^i = (\varpi_{s,t}^i)^{(1-\gamma^i)} (\xi_{s,t}^i)^{\gamma^i} (\dot{L}_{s,t}^{ie})^{-\gamma^i},$$

and

$$\begin{aligned} \chi_t &= \sum_i r_t^i H^i = \sum_i \dot{r}_t^i r_{t-1}^i H^i \\ &= \sum_i \left(\frac{\dot{\varpi}_{h,t}^i \dot{L}_{h,t}^{ie}}{\dot{\xi}_{h,t}^i} \right)^{(1-\gamma^i)} r_{t-1}^i H^i, \end{aligned}$$

which follows from using the equilibrium demand for labor and structures

$$\frac{r_t^i H^i}{\gamma^i} = \frac{1}{1-\gamma^i} \frac{w_{h,t}^i L_{h,t}^{ie}}{\xi_{h,t}^i},$$

and in time differences we obtain

$$\dot{r}_t^i = \frac{\dot{w}_{h,t}^i \dot{L}_{h,t}^{ie}}{\dot{\xi}_{h,t}^i},$$

and using the definition of $\varpi_{h,t}^i$

$$\frac{\dot{\varpi}_{s,t}^i}{(\dot{r}_t^i)^{\gamma^i/(1-\gamma^i)}} = \dot{w}_{s,t}^i$$

we obtain

$$\dot{r}_t^i = \left(\frac{\dot{\varpi}_{h,t}^i \dot{L}_{h,t}^{ie}}{\dot{\xi}_{h,t}^i} \right)^{(1-\gamma^i)}.$$

Given the solution to $\{\dot{\varpi}_{s,t}^i\}_{i=1,s=h,l}^N$, we have that

$$\dot{C}_{s,t}^{i,e} = \frac{(\dot{\varpi}_{s,t}^i)^{(1-\gamma^i)} (\dot{\xi}_{s,t}^i)^{\gamma^i} (\dot{L}_{s,t}^{ie})^{-\gamma^i}}{\dot{P}_t^i}.$$

We now proceed to describe the algorithm to solve for the baseline economy.

1. Initiate the algorithm at $t = 0$ with a guess for the path of $\{\dot{u}_{n,s,t+1}^{i\ell(0)}\}_{t=0}^T$, where the superscript (0) indicates that it is a guess. The path should converge to $\dot{u}_{n,s,T+1}^{i\ell(0)} = 1$ for a sufficiently large T . Take as given the set of initial conditions $L_{n,s,0}^{i\ell}$, $\mu_{n,s,-1}^{i\ell,jo}$, $\pi_0^{i,j}$, $w_{s,0}^i L_{s,0}^{ie}$, $r_0^i H_0^i$.
2. For all $t \geq 0$, use $\{\dot{u}_{n,s,t+1}^{i\ell(0)}\}_{t=0}^T$ and $\mu_{n,s,-1}^{i\ell,jo}$ to solve for the path of $\{\mu_{n,s,t}^{i\ell,jo}\}_{t=0}^T$ using equilibrium condition (48).
3. Use the path for $\{\mu_{n,s,t}^{i\ell,jo}\}_{t=0}^T$ and $L_{n,s,0}^{i\ell}$ to compute the new path for $\{L_{n,s,t}^{i\ell}\}_{t=0}^T$ using equation (50).

4. Solving for the trade equilibrium:

- (a) For each $t \geq 0$, given $\dot{L}_{n,s,t}^{il}$, guess a value for $\dot{\omega}_{s,t}^i$.
- (b) Obtain \dot{x}_t^i , \dot{P}_t^i , and $\dot{\pi}_t^{i,j}$ using equations (52), (53), and (54).
- (c) Use $\dot{\pi}_t^{i,j}$, $\dot{\omega}_{s,t}^i$, and $\dot{L}_{n,s,t}^{il}$ to compute X_t^i using equation (55).
- (d) Verify if the labor market clearing conditions (51) hold, and if not, go back to step (a) and adjust the initial guess for $\dot{\omega}_{s,t}^i$ until labor markets clear.

- (e) Repeat steps (a) through (d) for each period t and obtain paths for $\left\{ \dot{C}_{s,t}^{ie} = \frac{(\dot{\omega}_{s,t}^i)^{(1-\gamma^i)} \left(\frac{\xi_{s,t}^i}{\dot{L}_{s,t}^{ie}} \right)^{\gamma^i}}{\dot{P}_t^i} \right\}_{t=0}^T$.

5. For each t , use $\mu_{n,s,t}^{il,jo}$, $\dot{C}_{s,t}^{ie}$, and $\dot{u}_{n,s,t+2}^{il(0)}$ to solve backwards for $\dot{u}_{n,s,t+1}^{il(1)}$ using equation (49). We now obtain a new sequence of $\left\{ \dot{u}_{n,s,t+1}^{il(1)} \right\}_{t=0}^T$, where the superscript 1 indicates the first updated value.

6. Use the new sequence of $\left\{ \dot{u}_{n,s,t+1}^{il(1)} \right\}_{t=0}^T$ as the new set of initial conditions.

7. Verify if $\left\{ \dot{u}_{n,s,t+1}^{il(1)} \right\}_{t=0}^T \simeq \left\{ \dot{u}_{n,s,t+1}^{il(0)} \right\}_{t=0}^T$. If not, return back to step 1 and iterate until convergence.

Part II: Solving for counterfactuals

We now show how we solve for the counterfactual economy given the evolution baseline economy $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=0}^\infty$, a convergent sequence of changes in fundamentals, $\{\Theta_t\}_{t=1}^\infty$, and a counterfactual sequence of policies $\{\hat{\Upsilon}_t\}_{t=1}^\infty$. Our “hat” notation refers to the proportional change between the counterfactual equilibrium, $\dot{y}'_{t+1} \equiv y'_{t+1}/y'_t$, and the baseline economy, $\dot{y}_{t+1} \equiv y_{t+1}/y_t$ across time, namely $\hat{y}_{t+1} \equiv \dot{y}'_{t+1}/\dot{y}_{t+1}$.

To compute counterfactuals we assume that agents at $t = 0$ are not anticipating the change in the path of fundamentals and policies and that at $t = 1$ agents learn about the entire future counterfactual sequence of policies $\{\Upsilon'_t\}_{t=1}^\infty$.

We use the following equilibrium conditions to solve for the counterfactual economy

$$\hat{u}_{n,s,t}^{il} = \hat{C}_{s,t}^{il} \left(\sum_{j=1}^N \sum_{o=e,ne} \mu_{n,s,t-1}^{il,jo} \dot{\mu}_{n,s,t}^{il,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo} \right)^{\beta/\nu} \right)^\nu, \quad (56)$$

$$\mu_{n,s,t}^{il,jo} = \frac{\mu_{n,s,t-1}^{il,jo} \dot{\mu}_{n,s,t}^{il,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo} \right)^{\beta/\nu}}{\sum_{k=1}^N \sum_{a'=e,ne} \mu_{n,s,t-1}^{il,ka'} \dot{\mu}_{n,s,t}^{il,ka'} \left(\hat{mpol}_{n,t}^{i,k} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{ka'} \right)^{\beta/\nu}}, \quad (57)$$

$$L'^{io}_{n,s,t+1} = \sum_{j=1}^N \sum_{\ell=e,ne} \mu'^{j\ell,io} L'^{j\ell}_{n,s,t}, \quad (58)$$

for all ℓ, o, i, j, n , and s at each t , where $\hat{C}_{s,t}^{ine} = 1$, and $\hat{C}_{s,t}^{ie} = \hat{\omega}_{s,t}^i(\hat{L}_t, \hat{Y}_t)$ is the solution to the counterfactual temporary equilibrium in time differences relative to the baseline economy given the sequence of labor $\{\hat{L}_t\}_{t=1}^{\infty}$ and counterfactual changes in fundamentals $\{\hat{Y}_t\}_{t=1}^{\infty}$.

Given the allocation at $t-1$, $\left\{ \xi_{s,t-1}^i, w_{s,t-1}^i L_{n,s,t-1}^{ie}, \pi_{t-1}^{i,j}, r_{t-1}^i H^i \right\}_{i=1, j=1, s=h,l}^{N,N}$ a counterfactual change in employment $\left\{ \hat{L}_{n,s,t}^{ie} \right\}_{i=1, j=1, s=h,l}^{N,N}$, a counterfactual change in fundamentals and policies, given by $\left\{ \hat{\delta}_{s,t}^i, \hat{\kappa}_t^{i,j}, \hat{A}_t^j \right\}_{i=1, j=1, s=h,l}^{N,N}$, which in the case of changes to migration and trade policies we use $\hat{\delta}_{s,t}^i = 1$, $\hat{\kappa}_t^{i,j} = \tilde{\tau}_t^{i,j}$, where $\tilde{\tau}_t^{i,j} = (1 + \tau_t^{i,j})$ and $\hat{A}_t^j = 1$ for all i, j, s and t , $\left\{ \hat{\omega}_{s,t}^i \right\}_{i=1, s=h,l}^N$ solves the equilibrium conditions

$$\left(\hat{\omega}_{s,t}^i \right)^{(1-\gamma^i)} = \frac{(1-\gamma^i) \xi_{s,t}^{i'}}{\left(\xi_{s,t}^{i'} \right)^{\gamma^i} \left(\hat{L}_{s,t}^{i,e} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^i} \sum_{j=1}^N \frac{\pi_{t-1}^{j,i}}{1 + \tau_t^{j,i}} \pi_t^{j,i} X_t^j X_t^j \text{ for all } i, s \quad (59)$$

where

$$\xi_{s,t}^i = \xi_{s,t-1}^i \hat{\omega}_{s,t}^i \left(\hat{x}_t^i \right)^{\frac{\rho-1}{(1-\gamma^i)}},$$

the input cost in the counterfactual economy is given by

$$\hat{x}_t^i = \left(\sum_{s=h,l} \xi_{s,t}^i \frac{\xi_{s,t-1}^i}{\xi_{s,t-1}^i} \left(\hat{\omega}_{s,t}^i \right)^{1-\rho} \right)^{\frac{(1-\gamma^i)}{1-\rho}}, \quad (60)$$

the price index in the counterfactual economy is given by

$$\hat{P}_t^i = \left(\sum_{j=1}^N \pi_{t-1}^{i,j} \pi_t^{i,j} \hat{A}_t^j \left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \right)^{-\frac{1}{\theta}}, \quad (61)$$

and bilateral expenditure shares in the counterfactual economy are

$$\hat{\pi}_t^{i,j} = \frac{\left(\hat{\kappa}_t^{i,j} \hat{x}_t^j \right)^{-\theta} \hat{A}_t^j}{\sum_{k=1}^N \pi_{t-1}^{i,k} \pi_t^{i,k} \hat{A}_t^k \left(\hat{\kappa}_t^{i,k} \hat{x}_t^k \right)^{-\theta}}. \quad (62)$$

Finally, the goods market clearing condition in relative time changes can be written as

$$X_t^i = \frac{\sum_{s=h,l} \left(\hat{\omega}_{s,t}^i \right)^{1-\gamma^i} \left(\xi_{s,t}^{i'} \right)^{\gamma^i} \left(\hat{L}_{s,t}^{i,e} \right)^{1-\gamma^i} w_{s,t-1}^i L_{s,t-1}^{ie} + l^i \chi_t^i}{1 - \sum_{j=1}^N \frac{\tau_t^{i,j}}{1+\tau_t^{i,j}} \pi_t^{i,j} \pi_{t-1}^{i,j}}. \quad (63)$$

Given the solution to $\left\{ \hat{\omega}'_{s,t} \right\}_{i=1,s=h,l}^N$, and the evolution of the baseline economy we have that

$$\hat{C}_{s,t}^{ie} = \frac{(\hat{\omega}_{s,t}^i)^{(1-\gamma^i)} \left(\hat{\xi}_{s,t}^i \right)^{\gamma^i} \left(\hat{L}_{s,t}^{ie} \right)^{-\gamma^i}}{\hat{P}_t^i}.$$

1. Initiate the algorithm at $t = 0$ with a guess for the path of $\left\{ \hat{u}_{n,s,t+1}^{il(0)} \right\}_{t=0}^T$, where the superscript (0) indicates it is a guess. The path should converge to $\hat{u}_{n,s,T+1}^{il(0)} = 1$ for a sufficiently large T . Take as given the initial conditions $L_{n,s,0}^{il}$, $\mu_{n,s,-1}^{il,jo}$, $\pi_0^{i,j}$, $w_{s,0}^i L_{s,0}^{ie}$, $r_0^i H_0^i$, the baseline economy, $\{\hat{L}_t, \hat{\mu}_{t-1}, \hat{\pi}_t, \hat{X}_t\}_{t=0}^\infty$ and the counterfactual sequence of policies $\{\hat{\Upsilon}_t\}_{t=1}^\infty$.
2. For all $t \geq 0$, use $\left\{ \hat{u}_{n,s,t+1}^{il(0)} \right\}_{t=0}^T$ and $\left\{ \mu_{n,s,-1}^{il,jo} \right\}_{t=0}^\infty$ to solve for the path of $\left\{ \mu_{n,s,t}^{il,jo} \right\}_{t=0}^T$ using equilibrium condition (57):

For $t = 0$

$$\begin{aligned} \hat{u}_{n,s,0}^{il(0)} &= 1, \\ \mu_{n,s,0}^{il,jo} &= \mu_{n,s,0}^{il,jo} \\ L_{n,s,1}^{io} &= L_{n,s,1}^{io} = \sum_{j=1}^N \sum_{\ell=e,ne} \mu_{n,s,0}^{j\ell,io} L_{n,s,0}^{il} \end{aligned}$$

For period $t = 1$

$$\mu_{n,s,1}^{il,jo} = \frac{\vartheta_0^{il,jo} \left(\hat{mpol}_{n,1}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,2}^{jo} \right)^{\beta/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \vartheta_0^{il,ka} \left(\hat{mpol}_{n,1}^{i,k} \right)^{-1/\nu} \left(\hat{u}_{n,s,2}^{ka} \right)^{\beta/\nu}}$$

where

$$\vartheta_0^{il,jo(0)} = \mu_1^{il,jo} \left(\hat{u}_1^{jo(0)} \right)^{\beta/\nu}$$

For period $t \geq 1$:

$$\mu_{n,s,t}^{il,jo} = \frac{\mu_{n,s,t-1}^{il,jo} \mu_{n,s,t}^{il,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo} \right)^{\beta/\nu}}{\sum_{k=1}^N \sum_{a'=e,ne} \mu_{n,s,t-1}^{il,ka'} \mu_{n,s,t}^{il,ka} \left(\hat{mpol}_{n,t}^{i,k} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{ka'} \right)^{\beta/\nu}}.$$

3. Use the path for $\left\{ \mu_{n,s,t}^{il,jo} \right\}_{t=0}^T$ and $L_{n,s,0}^{il}$ to compute the new path for $\left\{ L_{n,s,t}^{il} \right\}_{t=0}^T$ using equation (58).
4. Solving for the temporary equilibrium
 - (a) For each $t \geq 0$, given $\hat{L}_{n,s,t}^{il}$ and $\hat{\omega}_{s,t}^i$ guess a value for $\hat{\omega}'_{s,t}^i$.
 - (b) Obtain \hat{x}_t^i , \hat{P}_t^i , and $\hat{\pi}_t^{i,j}$ using equations (60), (61) and (62).

(c) Use $\hat{\pi}_t^{i,j}$, $\hat{\omega}_{s,t}^i$, and $\hat{L}_{n,s,t}^{i\ell}$ to compute X_t^i using equation (63).

(d) Verify if the labor market clearing conditions (59) hold, and if not, go back to step (a) and adjust the initial guess for $\hat{\omega}_{s,t}^i$ until labor markets clear.

(e) Repeat steps (a) through (d) for each period t and obtain paths for $\left\{ \hat{C}_{s,t}^{ie} = \frac{(\hat{\omega}_{s,t}^i)^{(1-\gamma^i)} \left(\frac{\xi_{s,t}^i}{\hat{L}_{s,t}^{ie}} \right)^{\gamma^i}}{\hat{P}_t^i} \right\}_{t=0}^T$.

5. For each t , use $\mu_t^{mj,ik}$, $\hat{\omega}_{t+1}^i$, \hat{P}_{t+1}^i , and $\hat{u}_{t+2}^{i\ell(0)}$ to solve for backwards $\hat{u}_{t+1}^{i\ell(1)}$ using equations:

For periods t where $t \geq 2$

$$\hat{u}_{n,s,t}^{i\ell(1)} = \left(\hat{C}_{s,t}^{i\ell} \right) \left(\sum_{j=1}^N \sum_{o=e,ne} \mu_{n,s,t-1}^{i\ell,jo} \mu_{n,s,t}^{i\ell,jo} \left(\hat{mpol}_{n,t}^{i,j} \right)^{-1/\nu} \left(\hat{u}_{n,s,t+1}^{jo(0)} \right)^{\beta/\nu} \right)^\nu$$

For period 1:

$$\hat{u}_{n,s,1}^{i\ell(1)} = \left(\hat{C}_{s,1}^{i\ell} \right) \left(\sum_{j=1}^N \sum_{o=e,ne} \vartheta_0^{i\ell,jo(0)} \left(\hat{u}_{n,s,2}^{jo} \right)^{\beta/\nu} \right)^\nu$$

This delivers a new path for $\left\{ \hat{u}_{n,s,t+1}^{i\ell(1)} \right\}$, where the superscript 1 indicates an updated value for \hat{u} .

6. Use the new path for $\left\{ \hat{u}_{n,s,t+1}^{i\ell(1)} \right\}$ as the new set of initial conditions.

7. Check if $\left\{ \hat{u}_{n,s,t+1}^{i\ell(1)} \right\} \simeq \left\{ \hat{u}_{n,s,t+1}^{i\ell(0)} \right\}$. If not, go back to step 1 and update the initial guess.

I Welfare Measures and Aggregate Model

This appendix derives the welfare measures of households, rentiers, and government used in the quantitative analysis. We also derive an aggregate version of our model across labor force status that maps into our estimating equations to identify policy changes.

Welfare Measures

In this part of the appendix, we derive the welfare equations for the households, rentiers, and government.

Welfare of Households

The lifetime utility of a worker of nationality n , skill s , labor force status ℓ , in country i is given by

$$V_{n,s,t}^{i\ell} = \log(C_{s,t}^{i\ell}) + \nu \log \left(\sum_{j=1}^N \sum_{o=e,ne} \exp \left(\beta V_{n,s,t+1}^{jo} - m_{n,s,t}^{i\ell,jo} \right)^{1/\nu} \right),$$

which can be rewritten as

$$V_{n,s,t}^{il} = \log(C_{s,t}^{il}) + \beta V_{n,s,t+1}^{il} - m_{n,s,t}^{il,il} + \nu \log \left(\sum_{j=1}^N \sum_{o=e,ne} \exp \left(\beta \left(V_{n,s,t+1}^{jo} - V_{n,s,t+1}^{il} \right) - \left(m_{n,s,t}^{il,jo} - m_{n,s,t}^{il,il} \right) \right)^{1/\nu} \right).$$

The fraction of households of nationality n , and skill s that stays in country i , conditional on labor force status ℓ is given by

$$\mu_{n,s,t}^{il,il} = \frac{\exp \left(\beta V_{n,s,t+1}^{il} - m_{n,s,t}^{il,il} \right)^{1/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \exp \left(\beta V_{n,s,t+1}^{ka} - m_{n,s,t}^{il,ka} \right)^{1/\nu}}.$$

Hence we have

$$\nu \log \left(\sum_{j=1}^N \sum_{o=e,ne} \exp \left(\beta \left(V_{n,s,t+1}^{jo} - V_{n,s,t+1}^{il} \right) - \left(m_{n,s,t}^{il,jo} - m_{n,s,t}^{il,il} \right) \right)^{1/\nu} \right) = -\nu \log \mu_{n,s,t}^{il,il},$$

and therefore

$$V_{n,s,t}^{il} = \log(C_{s,t}^{il}) + \beta V_{n,s,t+1}^{il} - m_{n,s,t}^{il,il} - \nu \log \mu_{n,s,t}^{il,il}.$$

Iterating this equation forward we get

$$V_{n,s,t}^{il} = \sum_{m=t}^{\infty} \beta^{m-t} \log(C_{s,m}^{il}) - \sum_{m=t}^{\infty} m_{n,s,m}^{il,il} - \nu \sum_{m=t}^{\infty} \beta^{m-t} \log \mu_{n,s,m}^{il,il}.$$

The expected lifetime utilities in the counterfactual and in the baseline economy are then given by

$$\begin{aligned} V_{n,s,t}^{\prime il} &= \sum_{m=t}^{\infty} \beta^{m-t} \log(C_{s,m}^{\prime il}) - \sum_{m=t}^{\infty} m_{n,s,m}^{il,il} - \nu \sum_{m=t}^{\infty} \beta^{m-t} \log \mu_{n,s,m}^{\prime il,il}, \\ V_{n,s,t}^{il} &= \sum_{m=t}^{\infty} \beta^{m-t} \log(C_{s,m}^{il}) - \sum_{m=t}^{\infty} m_{n,s,m}^{il,il} - \nu \sum_{m=t}^{\infty} \beta^{m-t} \log \mu_{n,s,m}^{il,il}. \end{aligned}$$

We define the compensating variation in consumption for a household of nationality n and skill s and labor force status ℓ in country i at time $t = 0$ to be the scalar $\bar{c}_{n,s}^{il}$ such that

$$V_{n,s,0}^{\prime il} = V_{n,s,0}^{il} + \sum_{m=0}^{\infty} \beta^m \log(\bar{c}_{n,s}^{il}).$$

Hence,

$$\log(\bar{c}_{n,s}^{il}) = (1 - \beta) \left(V_{n,s,0}^{\prime il} - V_{n,s,0}^{il} \right),$$

and therefore

$$\log(\bar{c}_{n,s}^{il}) = (1 - \beta) \sum_{m=0}^{\infty} \beta^m \log \left(\frac{C_{s,m}^{\prime il} / C_{s,m}^{il}}{\mu_{n,s,m}^{\prime il} / \mu_{n,s,m}^{il}} \right).$$

Welfare of Rentiers

As described in the main text, we assume that the rentiers have the same preferences as households and their nominal income is given by the share on the global portfolio. Hence, the lifetime utility of the rentier in the counterfactual and in the baseline economy are given by

$$V_{R,t}^{\prime i} = \sum_{m=t}^{\infty} \beta^{m-t} \log(\iota^i \chi_m' / P_m^i),$$

$$V_{R,t}^i = \sum_{m=t}^{\infty} \beta^{m-t} \log(\iota^i \chi_m / P_m^i).$$

We define the compensating variation in real income for a rentier in country i at time $t = 0$ to be the scalar \bar{c}_R^i such that

$$V_{R,0}^{\prime i} = V_{R,0}^i + \sum_{m=0}^{\infty} \beta^m \log(\bar{c}_R^i).$$

Hence,

$$\log(\bar{c}_R^i) = (1 - \beta) (V_{R,0}^{\prime i} - V_{R,0}^i),$$

and therefore

$$\log(\bar{c}_R^i) = (1 - \beta) \sum_{m=0}^{\infty} \beta^m \log \left(\frac{\iota^i \chi_m' / P_m^i}{\iota^i \chi_m / P_m^i} \right).$$

Welfare of the Government

We assume that the the government in country i has linear utility, and the nominal income is given by tariff revenues. Hence, the lifetime utility of the government in the counterfactual and in the baseline economy are given by

$$V_{G,t}^{\prime i} = \sum_{m=t}^{\infty} \beta^{m-t} (T_m^i / P_m^i),$$

$$V_{G,t}^i = \sum_{m=t}^{\infty} \beta^{m-t} (T_m^i / P_m^i).$$

where $T_t^i = \sum_{j=1}^N \tau_t^{ij} \frac{\pi_t^{ij}}{(1+\tau_t^{ij})} X_t^i$.

We define the compensating variation in real income for the government in country i at time t

= 0 to be the scalar \bar{c}_G^i such that

$$V'_{G,0}{}^i = V_{G,0}{}^i + \sum_{m=0}^{\infty} \beta^m (\bar{c}_G^i).$$

Hence,

$$\bar{c}_G^i = (1 - \beta) \left(V'_{G,0}{}^i - V_{G,0}{}^i \right),$$

and therefore

$$\bar{c}_G^i = (1 - \beta) \sum_{m=0}^{\infty} \beta^m \left(T'_m{}^i / P'_m{}^i - T_m{}^i / P_m{}^i \right).$$

Aggregate Model Across Labor Force Status

In this part of the appendix, we derive the log odds of migrants relative to stayers described in Section 4.2 by aggregating the model across labor force status.

Start with the gross flow equation $\mu_{n,s,t}^{il,jo} = \frac{\exp(\beta V_{n,s,t+1}^{jo} - m_{n,s,t}^{il,jo})^{1/\nu}}{\sum_{k=1}^N \sum_{a=e,ne} \exp(\beta V_{n,s,t+1}^{ka} - m_{n,s,t}^{il,ka})^{1/\nu}}$. Let define $(u_{n,s,t}^{il} / C_{s,t}^{il})^{1/\nu} = \sum_{j=1}^N \sum_{o=e,ne} \exp(\beta V_{n,s,t+1}^{jo} - m_{n,s,t}^{il,jo})^{1/\nu}$ then $\mu_{n,s,t}^{il,jo} = \left(u_{n,s,t+1}^{jo} \right)^{\beta/\nu} \exp(m_{n,s,t}^{il,jo})^{-1/\nu} \left(u_{n,s,t}^{il} / C_{s,t}^{il} \right)^{-1/\nu}$.

Aggregating across labor force status we get

$$\begin{aligned} \mu_{n,s,t}^{i,j} &= \sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \sum_o \mu_{n,s,t}^{il,jo} \\ &= \sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \sum_o \left(u_{n,s,t+1}^{jo} \right)^{\beta/\nu} \exp(m_{n,s,t}^{il,jo})^{-1/\nu} \left(u_{n,s,t}^{il} / C_{s,t}^{il} \right)^{-1/\nu}. \end{aligned}$$

Imposing $m_{n,s,t}^{il,jo} = m_{n,s,t}^{i,j}$ for all ℓ and o , we have

$$\begin{aligned} \mu_{n,s,t}^{i,j} &= \sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \sum_o \mu_{n,s,t}^{il,jo} \\ &= \exp(m_{n,s,t}^{i,j})^{-1/\nu} \left(\sum_o \left(u_{n,s,t+1}^{jo} \right)^{\beta/\nu} \right) \left(\sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \left(u_{n,s,t}^{il} / C_{s,t}^{il} \right)^{-1/\nu} \right) \\ &= \exp(m_{n,s,t}^{i,j})^{-1/\nu} \left(\sum_o \left(u_{n,s,t+1}^{jo} \right)^{\beta/\nu} \right) \left(\sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \left(u_{n,s,t}^{il} / C_{s,t}^{il} \right)^{-1/\nu} \right). \end{aligned}$$

Analogously,

$$\begin{aligned} \mu_{n,s,t}^{i,i} &= \sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \sum_o \mu_{n,s,t}^{il,jo} \\ &= \exp(m_{n,s,t}^{i,i})^{-1/\nu} \left(\sum_o \left(u_{n,s,t+1}^{io} \right)^{\beta/\nu} \right) \sum_{\ell} \left(L_{n,s,t}^{i\ell} / L_{n,s,t}^i \right) \left(u_{n,s,t}^{il} / C_{s,t}^{il} \right)^{-1/\nu}, \end{aligned}$$

now, let $y_{n,s,t}^{ij} = \log(\mu_{n,s,t}^{ij})$ and after taking log differences we get

$$y_{n,s,t}^{ij} - y_{n,s,t}^{ii} = -\frac{1}{\nu} \left(m_{n,s,t}^{i,j} - m_{n,s,t}^{i,i} \right) + \tilde{V}_{n,s,t+1}^j - \tilde{V}_{n,s,t+1}^i,$$

This equation maps into the equilibrium equation that we differentiate to obtain the estimating equations that identify the policy changes in the main text.

J Additional Results

J.1 Publicly-Provided Consumption Services

In this appendix, we compute the migration and welfare effects of the EU enlargement with a calibrated share of publicly-provided consumption services in the utility function $\alpha_i = 0.23$ common for all countries, a value taken from Fajgelbaum et al. (2018). In doing so, we also re-estimate the migration elasticity taking into account this value of α_i , and found a value $1/\nu = 0.61$. Table J.1 reports the migration effects of EU enlargement, and Table J.2 reports the welfare effects.

Table J.1: Migration effects: Change in the stock of NMS nationals in EU-15 with publicly-provided consumption services (percentage points)

	All NMS nationals	High-skill	Low-Skill
	(1)	(2)	(3)
2002	0	0	0
2007	0.043	0.003	0.053
2015	0.250	0.127	0.280
Steady state	1.210	0.804	1.311

Note: This table shows the percentage point change in the share of low-skilled and high-skilled NMS nationals in EU-15 countries due to the 2004 EU enlargement with publicly-provided consumption services.

Table J.2: Welfare effects of the EU enlargement with publicly-provided consumption services (percent)

	EU15 countries	NMS countries
	(1)	(2)
High-skill	-0.030	1.922
Low-skill	-0.097	1.476
Aggregate	-0.084	1.529

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) reports the welfare effects for EU15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model with publicly-provided consumption services

Non-rival Public Good Provision

We now turn to compute the migration and welfare effects of the EU enlargement in model with a different notion of public goods. In particular, we assume that public goods are non-rival, and

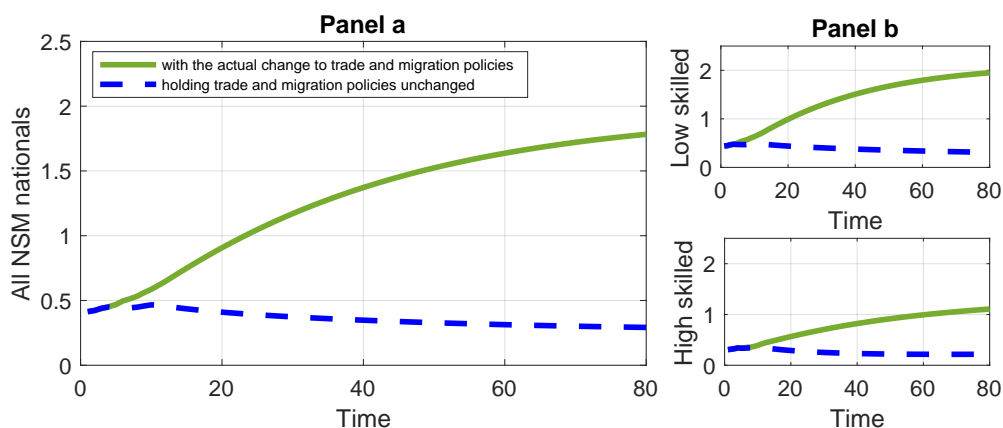
therefore they do not add to additional congestion effects of immigration. In particular, we assume that G^i

the indirect utility of a household with skill s in country i is given by

$$C_{s,t}^{ie} = (G^i)^{\alpha_i} ((1 - \tau_L^i)w_{s,t}^i/P_t^i)^{1-\alpha_i}.$$

The rest of the equilibrium conditions are the same as describe in Section . Figure J.1 displays the evolution of the stock of NMS nationals in EU15 countries (for all households, and by skill). The solid line shows the evolution of the stock in the baseline economy with the actual changes in migration and trade policies between 2002-2014. The dashed line shows the evolution of the stock of NMS nationals in the counterfactual economy, holding migration policy and tariffs constant at the initial level before the EU enlargement. Table J.3 reports the migration effects of the EU enlargement under different time horizons, and Table J.4 presents the welfare effects.

Figure J.1: Evolution of the stock of NMS migrants in EU-15 with non-rival public goods (population share, percent)



Notes: This figure presents the evolution of the share of NMS migrants in EU-15 countries in the model with non-rival public goods. The solid lines show the evolution of this share with actual changes to trade and migration policies. The dashed lines show the evolution holding trade and migration policies unchanged. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively).

J.2 The Role of Scale Effects, Ownership Structure, and Skill Substitution

In this appendix we present more details on the series of extensions and robustness exercises that we discuss in Section 5.3.2.

We start by computing the welfare effects in a closed economy version of the model with no scale effects (agglomeration and congestion effects). As explained in the main text, we want to study how quantitatively important it is to account for all of these mechanisms together; or saying it in a different way, how far we would have gotten in quantifying the effects of the EU enlargement by using a more stylized model where most of the mechanisms in our model are absent. Since there

Table J.3: Migration effects: Change in the stock of NMS nationals in EU-15 with non-rival public goods (percentage points)

	All NMS nationals (1)	High-Skill (2)	Low-Skill (3)
2002	0	0	0
2007	0.054	0.010	0.065
2015	0.274	0.142	0.306
Steady state	1.655	1.079	1.797

Note: This table shows the percentage point change in the share of low-skill and high-skill NMS nationals in EU-15 countries due to the 2004 EU enlargement in a model with non-rival public goods.

Table J.4: Welfare effects of the EU enlargement with non-rival public goods (percent)

	EU15 countries (1)	NMS countries (2)
High-Skill	0.106	1.360
Low-Skill	0.015	0.883
Aggregate	0.033	0.939

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) reports the welfare effects for EU15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model with non-rival public goods.

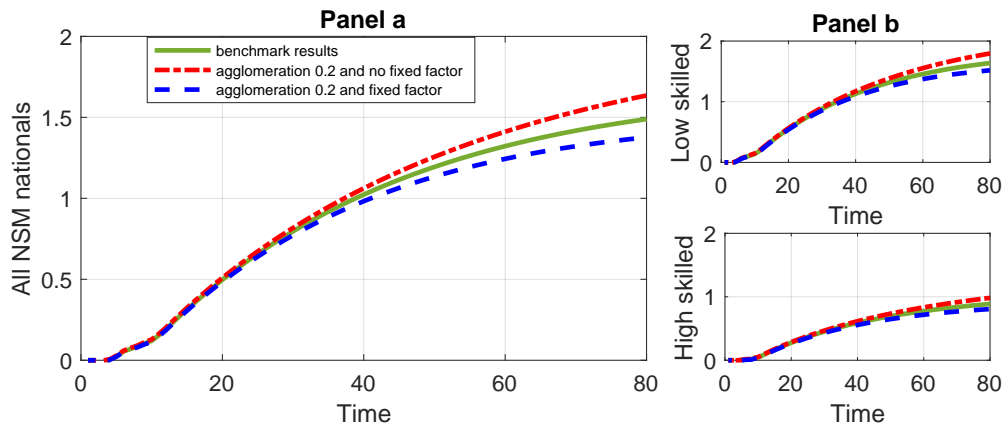
is no trade in this version of the model, we compare the effects of only changes to migration policy. Welfare effects are displayed in Table J.5, where Column (1) shows the welfare effects in EU-15 countries, and Column (2) presents the welfare effects for NMS countries. Compared with the third column in Table 7 welfare effects are substantially different in this version of the model; welfare gains for NMS are reduced by half, and for EU-15 welfare losses for low-skilled households are smaller and high-skilled households now gain. As concluded in the main text, this exercise shows that accounting for relevant mechanisms such as trade openness, agglomeration and congestion forces matter quantitatively for the evaluation of migration policy since without them we would obtain different distributional effects. We now present the detailed results on the role of different margins at a time.

Table J.5: Welfare effects of only changes to migration policy in closed economy and no scale effects (percent)

	EU15 countries (1)	NMS countries (2)
High-Skill	0.067	0.362
Low-Skill	-0.027	0.389
Aggregate	-0.008	0.386

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration policies. Column (1) reports the welfare effects for EU-15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model under autarky, and without congestion and agglomeration forces.

Figure J.2: Migration effects of the EU enlargement with alternative scale effects (population share, percent)



Note: This figure presents the evolution of the share of NMS migrants in EU-15 countries (in percentage). Each line represents, for each model, the difference between the counterfactual and the baseline economy. The solid lines show the migration effects of the EU enlargement in our benchmark model. The dashed-dot lines show the migration effects of the EU enlargement in the model with an agglomeration elasticity of 0.2 and no fixed factor. The dashed line show the migration effects of the EU enlargement in the model with an agglomeration elasticity of 0.2 and with a fixed factor. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively).

The Role of Scale Effects

Another aspect of our model that we revisit in Section 5.3.2 is the importance of the strength of the scale effects, namely agglomeration and congestion forces. As described in in Section 5.3.2, while the importance of the agglomeration force in our model follows directly from using the Eaton and Kortum Ricardian trade model, one might still be concerned that our model has strong agglomeration forces and, as a result, large scale effects and too much migration. We evaluate the role of the scale effects for the quantitative implications of the EU enlargement using estimates of agglomeration elasticities from the literature.

Figure J.2 and Columns (1), (2), and (3) of Table J.6 report the migration effects of the EU enlargement in the case in which we assume that the elasticity of technology to labor is 0.2 (i.e., we assume the following functional form for technology $A_t^i = \phi_t^i(L_t^i)^{0.2}$). In addition, given that Kline and Moretti (2014) estimate the elasticity of the change in productivity with respect to a change in labor relative to land size (that is, controlling for density or the size of the local fixed factor in the context of our model), in Figure J.2 and Table J.6 Columns (4), (5) and (6) we present the migration effects in a model where we assume that technology takes the following form $A_t^i = \phi_t^i(L_t^i/H^i)^{0.2}$, and the fixed factor is no longer a market input in production.

In Figure J.2 we present the migration effects. Each line represents, for each model, the difference between the counterfactual and the baseline economy. For example, the solid lines in the figure present the migration effects from using our benchmark model and they correspond to the difference in the lines displayed in Figure 4. As we can see, the model with larger scale effects

Table J.6: Migration effects: Change in the stock of NMS nationals in EU-15 with alternative scale effects (percentage points)

	Agglomeration elasticity of 0.2			Aggl. elast. of 0.2, no fixed factor		
	All NMS	High-Skill	Low-Skill	All NMS	High-Skill	Low-Skill
	(1)	(2)	(3)	(4)	(5)	(6)
2002	0	0	0	0	0	0
2007	0.051	0.006	0.062	0.058	0.015	0.069
2015	0.267	0.135	0.300	0.284	0.152	0.317
Steady state	1.443	0.916	1.573	2.024	1.333	2.194

Note: This table shows the percentage point change in the share of low skilled and high skilled NMS nationals in EU-15 countries due to the 2004 EU enlargement. Columns (1) to (3) compute the effects in a model with an agglomeration elasticity of 0.2. Columns (4) to (6) present the effects in a model with an agglomeration elasticity of 0.2 and no fixed factor.

(agglomeration elasticity of 0.2 and no fixed factors) delivers larger migration effects relative to our benchmark model (results presented in Section 5.1) and relative to the model with smaller scale effects (agglomeration elasticity of 0.2 and with fixed factors). More interesting, all models have very similar short and medium-run effects, as can be seen from the figure and comparing across columns in the results in Table J.6 for different time horizons.

As expected, the long run effects are affected by the scale effects. For example, note that in the the model with weaker agglomeration forces and with a fixed factor, the migration effects are smaller to those in Section 5.1. For instance, in Table J.6 Column (1) we can see that the stock of NMS nationals in EU-15 countries increases by 1.44 percentage points in steady state (0.21 percentage points lower than in Section 5.1). Across skills, Columns (2) and (3) show that the steady state stock of low-skilled would be 0.22 percentage points and 0.16 percentage points lower than in our baseline results, (compare to Columns (3) and (5) of Table 5). However, the model with smaller agglomeration forces but with no fixed factor delivers larger effects in the long run.

In Table J.7 we present the welfare effects under these alternative scale effects. Columns (1) and (2) show the welfare effects for EU-15 and NMS countries, respectively, in the version of the model with an agglomeration elasticity of 0.2. Columns (3) and (4) report the analogous welfare effects in the model with same agglomeration elasticity and no fixed factor. Following the logic described for the case of publicly-provided consumption services, a smaller agglomeration elasticity redistribute some of the welfare gains from EU-15 countries that experience new inflows of migrants and benefit less from agglomeration forces, to NMS countries that experience net outflows of migrants. In fact, we find that the aggregate welfare gains for Europe are 0.21 percent (not displayed in the table), almost identical to the aggregate gains 0.23 percent in the model with a unitary agglomeration elasticity (our benchmark model). When we shut down the fixed factor from the model, as expected, welfare gains in NMS countries are reduced since there is no benefits from the decongestion caused by the outflow of households, and for the opposite reason, welfare gains for EU-15 countries are increased. Overall, welfare effects computed in Section 5.2 are of the same order of magnitude (in between) as the ones computed with these alternative assumptions on the scale effects.

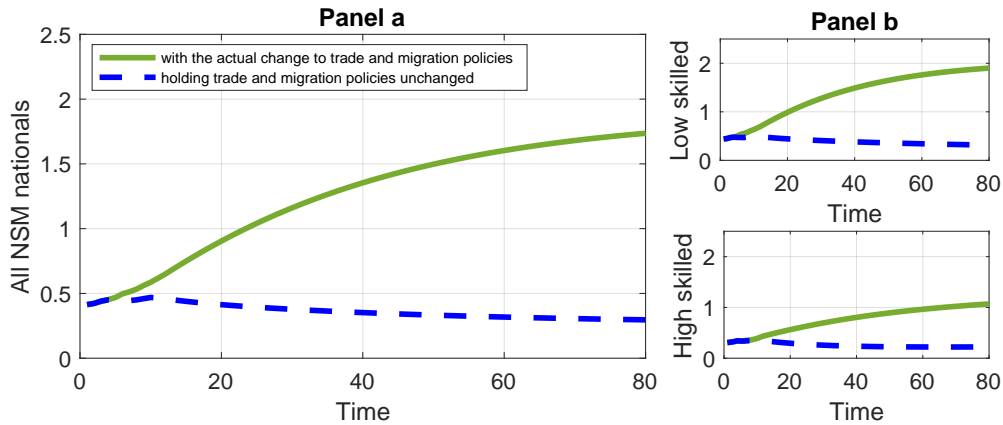
Table J.7: Welfare effects of the EU enlargement with alternative scale effects (percent)

	Agglomeration elasticity of 0.2		Aggl. elast. of 0.2, no fixed factor	
	EU-15 (1)	NMS (2)	EU-15 (3)	NMS (4)
High-Skill	0.047	2.024	0.281	1.268
Low-Skill	-0.034	1.267	0.110	0.907
Aggregate	-0.018	1.356	0.144	0.949

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Columns (1) and (3) report the welfare effects for EU-15 countries, and Columns (2) and (4) report the effects for NMS countries. Welfare effects are computed in in two versions of the model. Columns (1) and (2) report the effects in a model with an agglomeration elasticity of 0.2, and Columns (3) and (4) report the effects in a model with an agglomeration elasticity of 0.2 and no fixed factor.

Finally, we also study the implications of assuming that productivity is scaled by employment instead of country size. We therefore also explore the effects of the EU enlargement under this possibility. Figure J.3 and Table J.8 show the migration effects and Table J.9 presents the welfare effects. In short, we find that the migration effects are slightly smaller; for instance, the stock of NMS nationals in EU15 countries increased by 1.58 percent in steady state compared with 1.65 percent in our baseline model. We find somewhat bigger welfare gains for both NMS countries and EU-15 countries than in our benchmark model.

Figure J.3: Evolution of the stock of NMS migrants in EU15 countries with agglomeration in employment (population share, percent)



Notes: This figure presents the evolution of the share of NMS migrants in EU-15 countries. The green lines show the evolution of this share with actual changes to trade and migration policies. The dashed lines show the evolution holding trade and migration policies unchanged. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively). The effects are computed in a model with scale effects on employment.

Table J.8: Migration effects: Change in the stock of NMS nationals in EU-15 with agglomeration in employment (percentage points)

	All NMS nationals (1)	High-Skill (2)	Low-Skill (3)
2002	0	0	0
2007	0.052	0.008	0.063
2015	0.271	0.139	0.303
Steady state	1.575	1.007	1.715

Note: This table shows the percentage point change in the share of low-skill and high-skill NMS nationals in EU-15 countries due to the 2004 EU enlargement in a model with scale effects on employment.

Overall we find that the strength of the scale effects matter, mostly for the long run allocations, but that the distributional consequences of the EU enlargement are not very significantly affected. Part of this is due to the fact that our model is meant to capture the distributional effects and the transitional dynamics of the agreement and not the growth effects. In a model with long run growth effect, scale effects might play a more prominent role.

Table J.9: Welfare effects of the EU enlargement with agglomeration in employment (percent)

	EU15 countries (1)	NMS countries (2)
High-Skill	0.150	1.936
Low-Skill	0.028	1.239
Aggregate	0.052	1.321

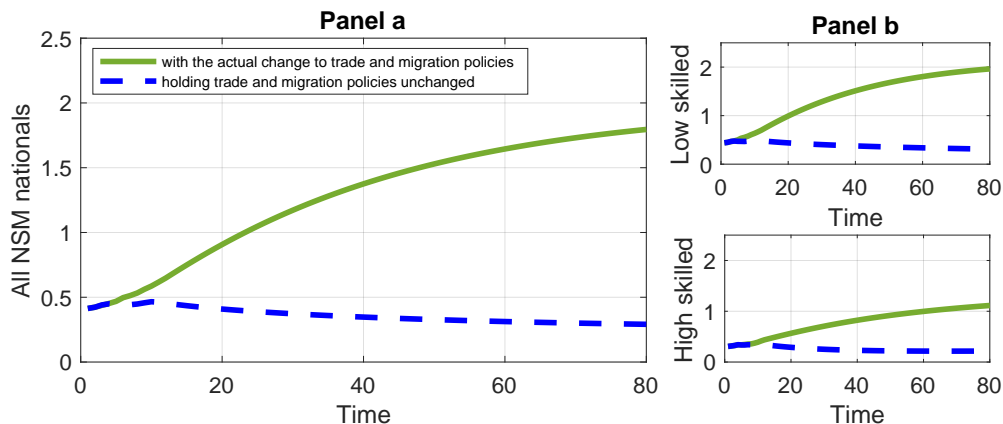
Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) reports the welfare effects for EU15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model with scale effects in employment.

The Role of the Ownership Structure of the Fixed Factors

We also want to study the robustness of our assumption on the ownership structure of the fixed factor. As discussed in Section 3, revenues from the fixed factors are sent to a global portfolio, and each country has a share of the global revenues that matches the observed trade imbalances in the data. This modeling choice allows us to deal in a relatively simple way with endogenous trade imbalances. Still, the ownership structure assumed in our model might not be innocuous. Even when it does not directly affects migration decisions since revenues from the global portfolio are spent in local goods by the rentier, it might affect household decisions through general equilibrium effects (e.g. expenditures and prices). Therefore, we also want to investigate further how important is our ownership structure of the fixed factor in shaping our results. To do so, we compute the migration and welfare effects of the EU enlargement in a model with an alternative ownership structure. In particular, we assume that revenues from the fixed factors are kept locally, thus there is no global portfolio, and trade imbalances are exogenous at the initial year level.

Figure J.4 and Table J.10 report the migration effects, and Table J.11 shows the welfare effects. Comparing the migration and welfare effects with those in our model reported in Sections 5.1 and

Figure J.4: Evolution of the stock of NMS migrants in EU15 countries with exogenous trade imbalances (population share, percent)



Note: This figure presents the evolution of the share of NMS migrants in EU-15 countries. The solid lines show the evolution of this share with actual changes to trade and migration policies. The dashed lines show the evolution holding trade and migration policies unchanged. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively). Migration effects are computed in a model with no global portfolio and exogenous trade imbalances.

Table J.10: Migration effects: Change in the stock of NMS nationals in EU-15 with exogenous trade imbalances (percentage points)

	All NMS nationals	High-Skill	Low-Skill
	(1)	(2)	(3)
2002	0	0	0
2007	0.054	0.010	0.065
2015	0.275	0.143	0.307
Steady state	1.687	1.098	1.832

Note: This table shows the percentage point change in the share of low skill and high skill NMS nationals in EU-15 countries due to the 2004 EU enlargement in a model with no global portfolio and exogenous trade imbalances.

5.2, we can see that the ownership structure is playing a very small role in shaping our computed effects of the EU enlargement; the results are very similar to our framework with endogenous trade imbalances. For instance, we find that welfare in NMS countries increases by 1.16 percent (compared to 1.17 percent in our benchmark results), and welfare in EU-15 countries increases by 0.05 percent (compared to 0.04 percent in our benchmark results). On migration effects we find that the stock of NMS nationals in EU-15 countries increases by 1.69 percent in steady state, compared with an increase of 1.65 percent in our benchmark model.

The Role of the Elasticity of Substitution Between Skills

Finally, we also revisit our results by using a different elasticity of substitution between high-skilled and low-skilled households. In particular, we compute the migration and welfare effects using the value of $\rho = 1.41$, which corresponds to the estimate in Katz and Murphy (1992) for the United

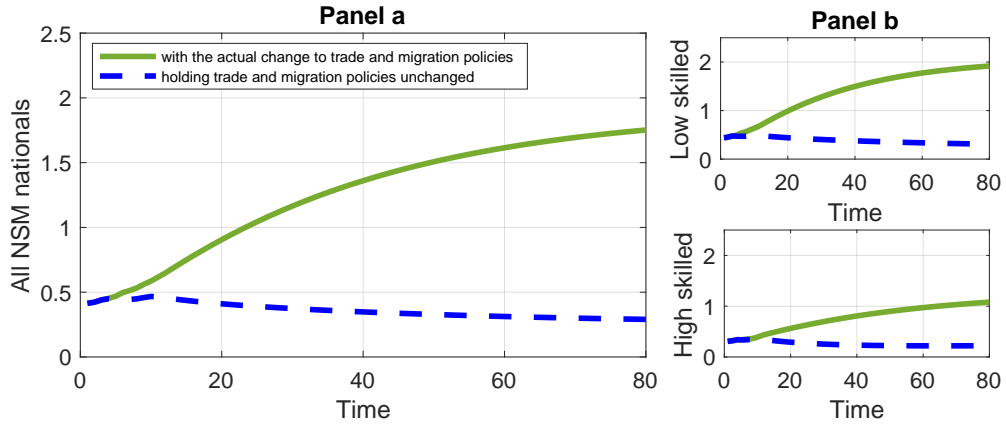
Table J.11: Welfare effects of the EU enlargement with exogenous trade imbalances (percent)

	EU15 countries	NMS countries
	(1)	(2)
High-Skill	0.153	1.677
Low-Skill	0.029	1.086
Aggregate	0.054	1.156

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) reports the welfare effects for EU-15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model with no global portfolio and exogenous trade imbalances

States, higher than our elasticity estimated for Europe. Figure J.5 and Table J.12 report the migration effects, and Table J.13 shows the welfare effects. Migration effects are slightly smaller than in our benchmark results. For instance, the stock of NMS nationals in EU-15 countries increases by 1.61 percentage points in steady state, compared with an increase of 1.65 percentage points in our benchmark model. Across skills, the stock of low-skilled and high-skilled NMS nationals in EU-15 countries increases by 1.75 percentage points and 1 percentage point in steady state, respectively, while the same figures in our benchmark model are 1.80 percentage points and 1.11 percentage points, respectively. Aggregate welfare effects for NMS and EU15 countries are slightly smaller than in our benchmark model, but the elasticity of substitutions has some distributional effects across skills. In particular, welfare for NMS households increases by 1.15 percent compared to 1.17 percent in our benchmark results, and welfare in EU-15 countries increases by 0.04 percent, almost the same as in our benchmark model. Across skills, comparing the welfare effects in Table J.13 with our benchmark results in Table 7, we can see that the EU enlargement has some distributional effects, namely welfare of high-skilled households is higher and welfare of low-skilled households is lower than in our benchmark model. In fact, we now have that low-skilled households in EU-15 countries are slightly worse off. Intuitively, a lower elasticity of substitution between high-skill and low-skill workers make both factors less substitutable, which magnifies differences the wage effects of policy changes. Overall, we find that the elasticity of substitution has some effect on how the welfare effects of the EU enlargement are distributed across factors, but it does not play a significant role in the aggregate. In fact, welfare in Europe as a whole increases by 0.22 percent, compared with an increase of 0.23 percent in our benchmark results.

Figure J.5: Evolution of the stock of NMS migrants in EU15 countries with alternative skill substitution (population share, percent)



Note: This figure presents the evolution of the share of NMS migrants in EU-15 countries. The solid lines show the evolution of this share with actual changes to trade and migration policies. The dashed lines show the evolution holding trade and migration policies unchanged. Panel (a) presents the results for all households, and panel (b) presents the results for high and low-skilled households (as a share of high and low skilled populations, respectively). Migration effects are computed in a model with $\rho = 1.41$.

Table J.12: Migration effects: Change in the stock of NMS nationals in EU-15 with alternative skill substitution (percentage points)

	All NMS nationals	High-Skill	Low-Skill
	(1)	(2)	(3)
2002	0	0	0
2007	0.053	0.010	0.064
2015	0.273	0.142	0.306
Steady state	1.606	1.004	1.754

Note: This table shows the percentage point change in the share of low-skill and high-skill NMS nationals in EU-15 countries due to the 2004 EU enlargement in a model with $\rho=1.41$.

Table J.13: Welfare effects of the EU enlargement with alternative skill substitution (percent)

	EU15 countries	NMS countries
	(1)	(2)
High-Skill	0.242	1.994
Low-Skill	-0.015	1.038
Aggregate	0.036	1.145

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from changes to migration and trade policies. Column (1) reports the welfare effects for EU-15 countries, and Column (2) reports the effects for NMS countries. Welfare effects are computed in a model with $\rho = 1.41$.

K Additional Results: Welfare Effects of Brexit Across Countries

In this Appendix, we present the welfare effects of Brexit, measured as the change in consumption equivalent, across countries, under the five counterfactual scenarios described in Section 6. Table K.1 reports the welfare effects for the counterfactual scenarios 1 and 2, and Table K.2 reports the welfare effects for the counterfactual scenarios 3, 4, and 5.

Table K.1: Welfare effects of Brexit across countries (percent)

	Counterfactual (1)			Counterfactual (2)		
	High-Skill	Low-Skill	Aggregate	High-Skill	Low-Skill	Aggregate
EU-15						
Austria	0.015	-0.030	-0.023	0.047	-0.018	-0.008
Belgium	-0.171	-0.073	-0.097	-0.118	-0.048	-0.065
Germany	-0.139	-0.095	-0.104	-0.101	-0.071	-0.077
Denmark	-0.727	-0.035	-0.208	-0.679	0.000	-0.170
Spain	-0.188	-0.159	-0.166	-0.161	-0.146	-0.150
France	-0.199	-0.055	-0.089	-0.153	-0.040	-0.066
Greece	-0.452	-0.072	-0.130	-0.427	-0.066	-0.121
Italy	-0.543	-0.054	-0.108	-0.517	-0.043	-0.095
Portugal	-0.767	-0.261	-0.303	-0.720	-0.243	-0.283
U.K.	-0.730	-0.381	-0.468	-0.354	-0.084	-0.151
NMS						
Cyprus	0.072	-0.425	-0.293	0.174	-0.397	-0.246
Czech Repub.	-0.318	-0.247	-0.254	-0.295	-0.235	-0.241
Estonia	-0.167	-0.103	-0.118	-0.145	-0.090	-0.103
Hungary	-1.020	-0.237	-0.333	-0.981	-0.220	-0.313
Lithuania	-0.841	-1.027	-0.991	-0.818	-1.000	-0.965
Latvia	-1.474	-1.336	-1.358	-1.448	-1.291	-1.316
Poland	-0.548	-0.291	-0.318	-0.524	-0.274	-0.301

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from Brexit under the five counterfactual scenarios 1 and 2 described in Section 6.

Table K.2: Welfare effects of Brexit across countries (percent)

	Counterfactual (3)			Counterfactual (4)			Counterfactual (5)		
	High Skill	Low Skill	Aggregate	High Skill	Low Skill	Aggregate	High Skill	Low Skill	Aggregate
EU-15									
Austria	-0.087	-0.030	-0.038	-0.047	-0.017	-0.022	0.093	0.001	0.015
Belgium	-0.149	-0.064	-0.085	-0.086	-0.039	-0.051	-0.032	-0.007	-0.013
Germany	-0.105	-0.067	-0.074	-0.059	-0.040	-0.041	-0.041	-0.030	-0.033
Denmark	-0.177	-0.096	-0.116	-0.099	-0.058	-0.068	-0.601	-0.059	-0.106
Spain	-0.087	-0.041	-0.052	-0.046	-0.022	-0.028	-0.121	-0.127	-0.126
France	-0.125	-0.038	-0.058	-0.068	-0.022	-0.033	-0.087	-0.016	-0.033
Greece	-0.080	-0.021	-0.030	-0.041	-0.012	-0.017	-0.392	-0.055	-0.107
Italy	-0.091	-0.026	-0.034	-0.048	-0.015	-0.019	-0.478	-0.027	-0.077
Portugal	-0.178	-0.063	-0.072	-0.093	-0.035	-0.040	-0.654	-0.216	-0.252
U.K.	-0.704	-0.590	-0.618	-0.372	-0.309	-0.325	0.079	0.259	0.215
NMS									
Cyprus	-0.217	-0.074	-0.112	-0.119	-0.042	-0.063	0.306	-0.358	-0.182
Czech Rep.	-0.073	-0.047	-0.050	-0.041	-0.027	-0.028	-0.258	-0.214	-0.218
Estonia	-0.059	-0.039	-0.044	-0.035	-0.023	-0.026	-0.109	-0.067	-0.077
Hungary	-0.148	-0.065	-0.075	-0.082	-0.040	-0.045	-0.921	-0.190	-0.280
Lithuania	-0.112	-0.115	-0.114	-0.063	-0.062	-0.062	-0.778	-0.961	-0.925
Latvia	-0.153	-0.156	-0.156	-0.083	-0.084	-0.084	-1.405	-1.231	-1.259
Poland	-0.093	-0.055	-0.059	-0.051	-0.031	-0.033	-0.483	-0.249	-0.273

Note: This table shows the percentage change in welfare, measured as consumption equivalent, from Brexit under the counterfactual scenarios 3, 4, and 5 described in Section 6.