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DISCUSSION PAPER SERIES

IZA DP No. 16468

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ABSTRACT

A Bad Break-up? Assessing the Effects of the 2016 Brexit Referendum on Migration

By voting to leave the European Union (EU) in 2016, the United Kingdom (UK) set off a long period of uncertainty and signalled its support for the Leave campaigns, which centred around restricting migration. This paper researches how this decision affected EU-UK migration patterns. We exploit the Brexit referendum as a natural experiment and employ a (synthetic) difference-in-differences estimator to compare EU migration (treated) to non-EU migration (untreated) in the UK. We find a significant decrease in the inflow of EU migrants, although the reduction seems too small to have any impact on the migrant stock. We further find a significant persistent rise in British citizenship applications and grants. Our results reveal that the referendum made the UK a less attractive destination and that the EU migrants already in the UK were encouraged to obtain British citizenship. The Brexit-induced policy uncertainty was the key driver affecting migrants' decision-making.

JEL Classification: F22, J61, J48

Keywords: Brexit referendum, international migration, European Union, uncertainty, anti-immigration

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1 Introduction

In 2019, it was estimated that there were around 270 million migrants. This number increased by just under 20% since 2010 (International Organization for Migration, 2021). While some people migrate to escape conflict or persecution, others move for economic or family reasons. Therefore, the decision to move and live in another country is one that many people have taken. Understanding people's motivations behind this action is of utmost importance. To obtain further insights into the decision to migrate, this paper provides empirical evidence on the causal impact of the Brexit referendum on migration patterns between the European Union (EU) and the United Kingdom (UK), and explores the mechanisms behind those patterns.

'Take back control.' With this campaign slogan, the UK unilaterally voted to leave the EU in the 2016 Brexit referendum. As expected, this vote had repercussions in many different areas (Born et al., 2019; Breinlich et al., 2020; Hassan et al., 2020; Oberhofer & Pfaffermayr, 2021), including migration. By voting to exit the EU, the UK set off a long period of uncertainty and signalled its support for the Leave campaign, which centred around restricting migration. As such, the country became less attractive as a host country and reduced its ability to attract EU migrants that meet the economy's needs.

To study to what extent and how the Brexit vote disrupted migration patterns, we exploit the Brexit referendum as a natural experiment and consider the vote as an exogenous source of variation in migrants' exposure to uncertainty and migrant's awareness of anti-immigration attitudes. The result of the vote was a shock that affected people in the entire EU independent of where they lived in Europe and whether or not they supported Brexit. Using a dynamic two-way fixed effects (TWFE) estimator and synthetic Difference-in-Difference (DD) estimator, we evaluate how migration indicators changed post-referendum. We compare the change in EU migration to the change in non-EU migration in the UK, as these migrants were seemingly unaffected by the event. As the result of the vote was unexpected (see Section 2), any anticipatory effect and the possibility of reverse causality are excluded. Given the worldwide media attention, we credibly assume that all of Europe was aware of the ongoing events. With data from the UK Labour Force Survey (LFS) and the Home Office, we evaluate the referendum's impact on the stock of migrants in the UK, the inflow of migrants as measured through new National Insurance number (NINo) registrations, and the number of British citizenship applications and citizenship grants, while also differentiating between several socio-demographic and local characteristics.

Our paper relates to the extensive body of literature on the determinants of migration. Previous studies consider the decision to move as the result of a comparison of the origin and destination country in terms of costs and benefits. The benefits of migrating are often caused by labour market differences, such as higher wages in the host country. The costs of migrating include transportation costs as well as costs due to psychological distress, cultural distance, legal barriers, or insecurity (Borjas, 1994; Dustmann, 1997; Mayda, 2010). A large, unexpected event, such as the Brexit vote, can significantly affect the costs of migrating through multiple channels. The unexpected choice to leave the EU resulted in a period of uncertainty on how future migration flows between the UK and the EU would be regulated. It was unclear what additional legal and administrative barriers would be introduced once the UK left the EU. The referendum results also illustrated that many British citizens were opposed to freedom of movement (Lutz, 2021; Vasilopoulou, 2016). This could have been interpreted as a reflection of negative attitudes towards EU migrants. Such anti-immigration attitudes, often associated with discrimination, can represent a barrier for immigrants' success in the destination country (Constant et al., 2009; Gorinas & Pytliková, 2017). The vote may not be a direct measure of anti-immigration attitudes, but it signalled existing negative sentiments to the outside and made them visible for all migrants. In this respect, the referendum added a cost for EU immigrants in the UK and reduced the likelihood that a potential migrant perceived the benefits of migrating to the UK as greater than the costs. As such, the referendum may have deterred prospective migrants and may have motivated migrants already in the UK to leave or, to the contrary, to secure their position in the UK.

How policy uncertainty and hostility can influence migration flows has been researched in the past. Evidence on the role of uncertainty is mainly captured in theoretical models. O'Connell (1997) shows that uncertainty about the future conditions in host or origin countries can deter relocation. Czaika (2012) concludes that changes in expectation-based utility can lead to the cancellation or procrastination of migration plans. Evidence on the role of anti-immigration attitudes is mainly empirical. The study by Gorinas and Pytliková (2017) identifies a negative relationship between observed migration trends and anti-immigration sentiments, captured by survey respondents' tendency to discriminate against immigrants on the labour market. Furthermore, Bracco et al. (2018) and Brox and Krieger (2021) show that municipalities with far-right protests or leaders attract fewer immigrants, providing further indication of a relationship between anti-immigration attitudes and migration.

Specifically on the Brexit referendum, several authors have looked into its repercussions on migration. Various studies rely on in-depth interviews with immigrants (Benson & Lewis, 2019; Klimavičiūtė et al., 2020; Lulle et al., 2019; Sredanović, 2021). According to Duda-Mikulin (2023), Polish respondents mentioned that the emotional and material insecurities as well as the feeling of betrayal were affecting their decision-making regarding long-term settlement in the UK. Similar negative responses are found among Italian, Irish and Romanian young adults in London, by Lulle et al. (2018). Respondents stated that the Brexit vote exposed the national and ethnic hierarchies among migrants, where Western Europeans are more welcome than Eastern Europeans. Auer and Tetlow (2020) find that the uncertain implications of the referendum were the driving force behind British citizens who migrated to Germany post-2016, while personal motivations dominated prior. Finally, Godin and Sigona (2022) illustrate how the referendum influenced the decision to apply for British naturalisation. Becoming British was perceived as the only way to partially preserve their status threatened by Brexit. For others, naturalisation was motivated by the desire to avoid the negative stigma believed to be associated with the label 'immigrant'.

Alongside these qualitative studies, a number of empirical papers evaluate and quantify the impact of the Brexit referendum on EU migration. Portes (2021, 2022) shows that net EU migration fell after reaching peak levels in 2015 and early 2016, while non-EU net migration continued to gradually increase for several years after the referendum. The Brexit process moved slowly and economic conditions remained relatively favourable, making the author conclude that the psychological impact of Brexit was considerable. Auer and Tetlow (2020) find a substantial increase in migration flows and naturalisation numbers of UK citizens migrating to the remaining EU countries. The authors employed fixed effects regressions and used intra-EU migration patterns as a control group. Falkingham et al. (2021) examine how the triggering of Article 50, a year after Brexit, affected students' mobility intentions. Using a DD approach and propensity score matching, they find that immediately after the triggering, EU students were significantly more likely than non-EU students to plan on leaving the UK upon graduation. Pickard et al. (2022) research the repercussions of the referendum on internal migration within the UK. After the vote, individuals were less inclined to move when their preferences were aligned with the Brexit preferences of their district.

Finally, Di Iasio and Wahba (2023) follow a similar identification strategy as ours. Using a DD estimator and data from the UK-LFS or Home Office, they compare migration in the UK, before and after the referendum. They compare migrants in the UK from four EU regions (treated units) to migrants from the remaining ten non-EU regions (control units). Immigration from the EU to the UK decreased by approximately 30%, driven by migrants moving for work-related reasons and originating from new EU member states that joined after 2004. Emigration of EU citizens out of the UK doubled and in general, net migration flows from EU countries to the UK fell. The authors additionally find that the stock of EU immigrants in the UK increased. They show that the increase in the post-referendum period was much smaller during the pre-referendum period. The authors further show that the referendum did not have any spillover effects on other EU countries and did not change their relative attractiveness. We will further benchmark our results to theirs in the results section.

This paper contributes to the existing literature, and specifically to the similar research of Di Iasio and Wahba (2023), in several ways. First, by using the specific origin of migrants instead of broad sub-regions as our unit of analysis, we are able to more precisely estimate the impact of the Brexit referendum on EU migration. By using only a selected number of comparable non-EU countries (high- and upper-middle-income countries) as control units, we compare similar types of migrants, control for changes in the origin countries of migrants, and exclude other possible confounders (e.g. the political chaos that ensued after the referendum and socio-economic conditions in the UK or origin countries of migrants). Second, we consider a new outcome of migration, British citizenship applications and grants, and offer insights into the decision-making of migrants already settled in the UK. Third, by complementing our analysis with the synthetic DD, we weaken the reliance on the parallel trend assumption, which further strengthens our identification strategy. Finally, we provide indicative evidence on the mechanisms behind the observed changes in migration and illustrate that uncertainty is the main driving force.

Our findings provide insights into the referendum's impact on migration patterns. We find a decrease of around 22% in the inflow of migrants , illustrating that the referendum result reduced the UK's attractiveness. The impact is driven by young migrants aged 25 to 44, located in London and Remain areas, or originating from Southern and Eastern Europe. The reduction is, however, too small to have any significant effect on the stock of UK migrants originating from the EU. Only when allowing for a linear extrapolation of the pre-referendum differences in trends, we find some indication that the migrant stock declined. We find a large persistent increase (+200%) in British citizenship applications and granted requests by EU migrants, indicating that Brexit-related policy uncertainty induced migrants to secure their status in the UK. The largest increases are found for middle-aged migrants (30 to 50), those from Southern and Western Europe, and those applying based on marriage, but only for countries allowing for dual citizenship. Our results are robust to a variety of checks. We explore various mechanisms and, similar to Auer and Tetlow (2020), suggest that uncertainty about future regulations is the key mechanism behind the Brexit-induced changes in migration.

The remainder of the paper is organised as follows. Section 2 describes the background and implementation of the Brexit referendum. Section 3 presents the empirical strategy. Section 4 describes the data and provides descriptive statistics. Sections 5 and 6 report the econometric results and robustness checks, and Section 7 ends with a brief discussion and conclusion.

2 The 2016 Brexit referendum

In June 2016, the UK unilaterally voted to leave the EU in a close-call referendum. In previous years, there had been increasing interest for such a referendum. After the Conservative Party's victory in May 2015, the first plans for the Brexit vote were set out. One of the issues that heavily dominated the debates was the EU's immigration and border policy. The Leave campaign, led by Boris Johnson, highlighted that as long as the UK was a member of the EU, it could not take control of its own migration policies and was obliged to respect the free movement of persons within the EU (Cap, 2017). Slogans such as 'Vote Leave, Take Control' summarised well the entire Leave campaign and were difficult to counter by opponents (Portes, 2016a). Even though the polls were volatile and struggled with tracking voters' intentions, it was expected that the Remain side would gain the majority of the votes. On the day of the referendum, opinion polls indicated Remain would win by a small margin (48% Remain vs 46% Leave). This was supported by bookmakers and betting odds (Begg, 2016; FT Research, 2016). It was, therefore, quite a shock to the public when on June 23, nearly 52% of voters elected to leave the EU when posed the question: 'Should the United Kingdom remain a member of the European Union or leave the European Union?' (Walker, 2021). Figure 1a illustrates the election results by UK regions, and indicates that Wales and the majority of England voted Leave. Scotland, Northern Ireland, and London voted to remain in the EU, although the difference was very narrow everywhere. The election results by constituency in Figure 1b show further differences within regions.

The vote started a long period of uncertainty about the rights of EU citizens in the UK. It was unclear how restrictive the post-Brexit migration system would be. The UK could preserve access to the EU single market by becoming a member of the European Economic Area or could try to retain benefits by negotiating bilateral agreements. On the other hand, the UK could also remove all preferential treatment towards EU migrants. After triggering Article 50 in March 2017, which gave formal notification of the UK's intention to leave the EU, the Brexit process officially began. A long period of negotiations started and, slowly, the UK clarified its intentions regarding EU migration. In mid-2018, the EU Settlement Scheme was rolled out. The scheme aimed to provide EU citizens residing in the UK with settled status, though it was a very rigid and unsettling process. Near the end of 2018, the UK published a White Paper indicating the country would move towards a skills-based immigration system. Yet, legal and administrative uncertainty remained up until the UK entered the transition period in January 2020. The country officially exited the EU on December 31, 2020. A points-based immigration system, similar to the one in place for non-European migrants, was introduced (Portes, 2016b; Walker, 2021). The Brexit timeline is summarised in Appendix A. British migration policies and regulations throughout this period are summarised in Appendix B.

In addition to triggering a long period of uncertainty, the Brexit referendum also signalled the UK's public opinion. Limiting free movement within the EU and controlling borders were central during the referendum campaigns (Joppke, 2020). Immigration was the most prominent referendum issue in UK newspapers, and coverage of the topic more than tripled over the course of the campaign, in an overwhelmingly negative manner (Moore & Ramsay, 2017). After the vote, research indicated that holding negative attitudes towards foreigners was correlated with voting Leave (Arnorsson & Zoega, 2018). As a result, the outcome of the vote could have been understood as a reflection of Britain's negative perception of immigration. Those negative attitudes towards migrants may have been present before the vote as well, but not all potential migrants were aware of them. The referendum results revealed the prevailing public sentiment and exposed these attitudes to a broader audience, through widespread media attention both within the UK and internationally. To illustrate that the referendum was heavily discussed in the media, Figure 2 shows the headlines of British newspapers the day of the referendum. This highlights the disagreement across newspapers and the uncertainty surrounding the vote. Figure 3 summarises how newspapers in the UK and Europe reacted to the referendum result.

3 Empirical strategy

To evaluate the causal impact of the Brexit referendum on migration, we employ a TWFE estimator, using EU migration in the UK as treated units and non-EU migration as control units. The unit of analysis is the origin country of a migrant. All EU origin countries enter treatment at the same time (non-staggered treatment setup) and remain treated for the entire post-referendum period. We consider several outcome variables: the stock of foreign-born residents in the UK, NINo registrations of incoming overseas nationals, the number of UK citizenship applications, and the number of granted UK citizenship requests. We restrict the sample to the four years before and three years after the referendum, using quarterly data (2012Q3 to 2019Q2). All EU origin countries are considered as treated. European countries belonging to the Schengen area or the European Free Trade Association (EFTA), as well as countries holding bilateral agreements with the EU facilitating border crossing, are excluded from the main analysis. These countries were differently affected by the referendum and are somewhere between treated and untreated. We consider 27 treated origin countries in total.[1] The control units are restricted to high- and upper-middle-income countries, in order to compare similar types of migrants. This results in 72 control units.[2] Due to data limitations,

[1]Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden.

[2]American Samoa, Antigua and Barbuda, Argentina, Australia, Azerbaijan, the Bahamas, Bahrain, Barbados, Belarus, Belize, Bermuda, Botswana, Brazil, British Virgin Islands, Brunei, Canada, Cayman Islands,

the period will be shortened or the number of origin countries will be restricted for certain outcome variables, as explained in the next section. More information on the choice of control origin countries can be found in Appendix C.

The quarterly impact of the vote is estimated by the following dynamic TWFE model:

$$y_{it} = \sum_{t=-\tau}^{+T} \beta_t EU * period_t + X_t' + \delta_i + \alpha_{1t} + \alpha_{2t} + \varepsilon_{it} \tag{1}$$

where y_{it} is an indicator of migration originating from a country i at a time period t. The categorical variable $period_t$ indicates the year and the quarter. The Brexit referendum occurred in June 2016 and therefore, the second quarter of that year (2016Q2) is used as the baseline period. The binary variable EU indicates the treated units who were affected by the referendum. The referendum effect is captured by the coefficients β_t of the interaction term $EU * period_t$. δ_i are unit fixed effects to account for time-constant unobserved heterogeneity between different origin countries and α_{1t} is a vector of time dummy variables (year-quarter). We include quarterly fixed effects (α_{2t}) to allow for seasonality in migration, although these are omitted in certain specifications due to perfect collinearity. The control variables are captured by the vector X_t'. We control for origin country's yearly GDP, population level and unemployment rate. Across all specifications, we implement origin country clustered standard errors to take into account any within-country correlation in the error term.[3]

To weaken the reliance on the parallel trends assumption, we implement a synthetic difference-in-differences estimator. Similar to the standard synthetic control method, this approach re-weights units to match pre-treatment trends. Similar to a standard DD estimator, the method is invariant to additive unit-level shifts and allows for inference with multiple treated units. The

Chile, China, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, French Polynesia, Gabon, Grenada, Guyana, Hong Kong, Jamaica, Japan, Kazakhstan, Kuwait, Lebanon, Libya, Malaysia, Maldives, Mauritius, Mexico, Namibia, New Caledonia, New Zealand, Oman, Panama, Paraguay, Peru, Puerto Rico, Qatar, Russia, Saudi Arabia, Seychelles, Singapore, South Africa, South Korea, St. Kitts and Nevis, St. Lucia, St. Vincent and The Grenadines, Suriname, Taiwan, Thailand, Tonga, Trinidad and Tobago, Turkmenistan, Turks and Caicos Islands, Tuvalu, United Arab Emirates, United States, Uruguay, US Virgin Islands.

[3]When estimating a linear fixed effects (within) regression model with the error term modelled as an AR(1) process, the generalised Durbin-Watson statistic by Bhargava et al. (1982) (test value ranging from 0.26 to 0.68) and the Baltagi-Wu test (test value ranging from 0.42 to 0.79) indicate that positive first-order serial correlation is present in the error term for all four migration outcomes. Autocorrelation in the error term leads to smaller standard errors and incorrect inference. By clustering the standard errors, we relax the assumption that the error terms are independently distributed. We allow for arbitrary correlation in the error within each cluster, in this case, allowing the error term of each origin country to be correlated over time.

synthetic DD approach optimally constructs two types of weights. Unit weights are designed to align pre-treatment trends and make the average outcome for treated units approximately parallel to the weighted average outcome for control units. Time weights are designed to balance pre-treatment periods with post-treatment periods. More specifically, weights are created so that the average post-treatment outcome for each selected control unit differs by a constant from the weighted average of the pre-treatment outcomes for the same units. These weights are then used in a TWFE regression to estimate the average treatment effect. The variance is estimated using a block bootstrap with 200 replications, which is suitable as the number of treated units is large enough. The baseline estimates are not conditioned on any covariates. In further robustness checks, we include control variables. Contrary to the standard synthetic control method, weights are not chosen to ensure that covariates are as closely matched as possible but are used in a pre-processing task. We follow the 'optimised' procedure where the synthetic DD estimator is applied to the residuals of all units after regressing the outcome variable on the re-standardised covariates. Essentially, this removes the impact of changes in covariates from the migration outcomes before calculating the synthetic control (Arkhangelsky et al., 2021).

Overall, our identification strategy is based on the assumption that the Brexit referendum only affected EU migration and had no bearing on immigrants from outside the EU (stable unit treatment value assumption). Despite some relevant concerns, this is a credible assumption. First, as the UK did not belong to the Schengen area, the rights and immigration laws for non-EU immigrants were always handled separately from the rest of the EU. There was thus no policy uncertainty affecting them. During our period of analysis, there were also no relevant changes in either EU or non-EU immigration regulations (see Appendix B). Any possible confounding policy changes are discussed in the robustness section.[4] Second, if the referendum affected EU migration towards the UK and as such caused shortages in certain sectors and occupations, non-European migration might move in the opposite direction in the long run, reflecting labour market pressures. However, our results will focus on the short-run period, for which such a substitution has not been documented. Different data sources (Migration Observatory, 2022; Office for National Statistics, 2020) consistently show an increasing trend

[4] The most noticeable policy change is a relaxation of the Tier 2 cap for doctors and nurses in July 2018.

of non-EU migration in the UK, which began in the mid-2010s and seems uninterrupted by the referendum. In addition, our descriptive figures show no indication of any increase for our non-EU sample. In Appendix D, we show that there is no increase in NINo registrations and visa applications from outside the EU. In a further robustness check, we limit the period of analysis to focus even more on the short-run period after the vote. A final concern may be that non-EU migrants were discouraged to move to the UK due to the anti-immigration attitudes during the Brexit campaigns. If this is the case, we would underestimate the impact on EU migration and results should be interpreted as a lower bound. However, we perform several robustness checks to confirm that our control units are stable.

A second condition that must be satisfied is the assumption of parallel trends. This requires that in the absence of treatment, the difference between the treated and control group is constant over time. In other words, had the Brexit referendum not occurred, EU and non-EU migration to the UK would have continued to follow the same parallel trends. The TWFE strategy discussed above allows us to test whether the two groups followed similar trends before the referendum and gives an indication of the plausibility of the assumption. Sensitivity tests (Section 6.1) and other robustness checks (Section 6.2) probe this assumption further.

4 Data and descriptive statistics

4.1 Data

Data on migrant stocks are obtained from the UK Labour Force Survey (LFS), a quarterly survey conducted on private households residing in Great Britain. It is a rotating panel where each household is interviewed for five successive waves before exiting the sample. Each quarter, one-fifth of the sample is thus replaced. Individuals must be UK residents to be sampled, meaning they must intend to stay in the country for one year or more. This results in a lack of data on short-term (temporary) migration (Eurostat, 2019).[5] The LFS is intended to be representative of the entire UK population. However, its focus is on providing accurate data

[5]A substantial share of movements towards the UK is for a short period. It is estimated that between mid-2014 and mid-2018, non-UK citizens made an annual average of 1.02 million short-term trips (less than a year) to the UK. This is double the estimated inflow of long-term migrants. Roughly 290,000 of these short-term trips were at least three months long (Migration Observatory, 2020). More precise data on short-term migration does not exist, though we do not expect the referendum to have had a major impact on this.

about the labor market, rather than estimating the size of migrant populations. Therefore, even long-term migration may be underrepresented. Despite these drawbacks, the LFS remains the best data source for estimating migrant populations. We use the publicly available data of the LFS, which is only available up until one year after the referendum (2017Q2). We calculate the stock of migrants in the survey for each quarter and create panel data that follows the migrant stock from different origin countries over time. Migrants are defined as residents with a foreign country of birth. We also consider an alternative definition in the robustness checks, by using residents holding foreign citizenship. Sampling (calibration) weights based on sex, age, and residence are used. Given that the LFS is a survey, we need sufficient observations from each origin country for a given stock to be reliable. In the main analysis, we only consider origin countries for which the pre-referendum migrant stock (using both definitions) was larger than 10,000.[6] This means that around 10 to 20 survey respondents from a given origin country were included in that quarterly survey. In the robustness checks, we make this threshold more stringent. More details on the data and data cleaning can be found in Appendix E.

NINo registrations for overseas migrants entering the UK are used as a measure of the inflow of migrants into the UK, primarily for employment. This quarterly administrative data is obtained from the Home Office. The NINo is mandatory for everyone who lives in the UK in order to work or claim benefits/tax credits, including the self-employed and students working part-time. This is regardless of the length of stay, thus including both short-term and long-term migrants. The data includes foreign nationals who have already been in the country but did not previously require a NINo. The data does not include foreign nationals who re-enter the UK but had previously already acquired a NINo (e.g. seasonal workers) and, therefore, likely underestimates the total inflow. The statistics are based on the recorded registration date, i.e. after the NINo application process has been completed. This may be several weeks or months after arriving in the UK. However, it generally takes up to only four weeks to obtain the number (Home Office, 2023). We will only use the data starting in the last quarter of 2014 as due to changes in the operational process of recording NINo allocations, the recorded

[6] Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Costa Rica, Cyprus, Czech Republic, Denmark, Estonia, France, Gabon, Germany, Greece, Hong Kong, Hungary, Ireland, Italy, Jamaica, Japan, Latvia, Libya, Lithuania, Malaysia, Maldives, Mexico, Netherlands, New Caledonia, New Zealand, Panama, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, Slovakia, South Africa, South Korea, Spain, Sweden, Thailand, Tonga, Turks and Caicos Islands, United States, Uruguay.

volume is lower in 2014Q2 and higher in 2014Q3 than would otherwise have been the case (Home Office, 2015).

Finally, data on citizenship applications and grants is obtained from the Home Office immigration statistics, from 2012Q2 to 2019Q2. These national statistics are published quarterly. The data are derived from administrative counts of the Home Office's casework processes and recorded under detailed categories. The dataset does not require a sampling process for analysis and hence has no sampling errors (Home Office, 2022). These outcomes capture migrants that have been in the UK for some time, as individuals must have lived in the UK for a minimum of three to five years to be eligible. It usually takes about six months for applications to be granted or rejected. Eligible migrants generally have an incentive to apply. Having British citizenship gives them permanently settled status, full civic rights (among others the right to vote in elections), no restrictions on the right to work, free NHS medical care, etc. It is, however, also a costly process. Individuals must prove their English language proficiency, pay a high application fee, and pass the 'life in the UK' test. In addition, although the UK allows dual citizenship, some origin countries may not.

The origin country's control variables (GDP in current US dollars, unemployment rate as a percentage of the labour force, and population levels) were gathered from the World Bank (2023). Quarterly control variables for the origin countries and the UK are used as a robustness check. They were obtained from the OECD (2023) and therefore restrict the sample to member countries only.

4.2 Descriptive statistics

Figures 4 and 5 plot the outcome variables in our sample over time. We observe that, before the referendum, the total stock of EU migrants was increasing at a stable rate, while the non-EU migrant stock remained relatively constant over time. After the referendum, the stock of EU migrants stabilises, while non-EU migration continues its previous path. This is mainly driven by the slowed-down increase in the number of migrants from Central and Eastern Europe, but also from Southern or Western Europe. Next, we observe that the number of quarterly NINo registrations is much larger for EU migrants than for non-EU migrants, making them difficult to compare. For this reason, we contrast NINo registrations from migrants of various EU regions with those from all non-EU regions combined. This highlights the initial similar trend over time and illustrates the slight decrease in NINo registrations of EU migrants following the referendum. Finally, the number of British citizenship applications and grants is very volatile for both EU and non-EU migrants. They follow almost identical trends up until the referendum. After the vote, the trends diverge and the numbers increase for EU migrants. This increase is driven by applications and grants from Central, Eastern, Southern and Western Europe.

Table 1 presents summary statistics of our four indicators of migration in the UK while distinguishing by origin region. Over the period of analysis, we find a quarterly mean stock of 1,259,400 foreign-born residents from Central and Eastern Europe, making this the most common origin region. The smallest migrant stock originates from EFTA/Schengen regions and other Europe and Central Asia. These regions consist of a few, generally smaller, countries. In our sample, 67% of the migrant stock originates from EU countries and was thus affected by the referendum. Similar to the migrant stock, the NINo registrations are on average highest for migrants from Central and Eastern Europe, with more than 77,000 migrants entering the UK per quarter. This is in sharp contrast with the most common non-EU origin region, Asia, for which only 6,203.8 migrants enter the UK in an average quarter. In the sample, 86% of migrants entering the UK are from the EU. For the UK citizenship data, most requests originate from Central and Eastern Europe (3,345 applications, 3,084 grants), followed by Asia (1,830 applications, 1,801 grants). On average, 31% of citizenship applications and 42% of citizenship grants originate from EU countries, who were impacted by the referendum.

Table 2 examines the sample composition of the migrant stock in the UK, one year before and one year after the referendum. Before the referendum, there were on average 3,437,300 EU migrants and 1,409,600 non-EU migrants. The stock of EU migrants slightly increased after the referendum, by approximately 124,400. Changes in this stock and most of its separate categories are insignificant. The stock of non-EU migrants in the UK experienced a similar increase to that of EU migrants, despite lower initial levels. This significant increase seems driven by certain categories, such as males, those aged 40 to 64, those holding a postgraduate degree, or those living in London and the rest of England. We find that, both before and after the referendum, the majority of EU migrants are between 20 and 39 years old, while the majority of non-EU migrants are between 20 and 64 years old. Most migrants are highly educated, especially those from outside the EU. Both groups of migrants consist of slightly more women and mainly couples with children. The majority are employed in the service sector, are located in London or the rest of England, and are located in areas that voted Leave. Figure 6 confirms this and additionally shows migrants were concentrated in Greater London and South East England, in absolute numbers as well as relative to the total population.

Table 3 summarises the NINo registrations to overseas nationals. On average, 157,712 EU migrants entered the UK each quarter before the referendum. This decreased by around 14,000 in the year after the vote. The inflow of non-EU nationals from high- and upper-middle-income countries also decreased after the referendum, from around 19,298 to 18,658. This is a smaller decrease compared to EU migrants both in absolute and relative terms. We observe that the majority of incoming migrants are male in the EU category and female in the non-EU category. In general, most migrants are between 18 and 34 years old and are located in England and areas that voted Remain. These are also the categories in which we observe the largest decreases. Figure 7 visualises the location of incoming migrants across the UK.

Finally, Table 4 provides descriptive statistics for British citizenship applications and grants. Before the referendum, we observe an average of almost 4,000 applications and grants per quarter for EU migrants. After the referendum, the mean applications per quarter increased to more than 7,159. Mean quarterly grants only increased by 711. The number of applications and grants for non-EU migrants in our sample is much larger, with a pre-referendum average of 7,397 and 7,556, respectively. These numbers decreased after the referendum. About one-third of all applications are applications based on registration. These are applications from migrants that are automatically British by birth (child of British parents, born in an overseas territory, etc.) but must still register. The majority of migrants are, however, not automatically British and must apply for citizenship through the process of naturalisation. More detailed information is available for the number of grants. The majority of grants arise from naturalisation applications based on residence and most requests are granted to females and migrants aged 30 to 49.

5 Results

5.1 TWFE estimator

Table 5 presents the baseline estimates of the TWFE estimator. Figure 8 shows the estimated treatment effects graphically. Our results indicate that in the year before and after the referendum, there were no significant differences between EU and non-EU migrant stocks in the UK. Although the estimates are insignificant, the plotted coefficients show a steady pre-treatment difference in trends. This illustrates that EU migrant stocks were increasing faster than non-EU stocks prior to the referendum. The difference seems to stabilise after the referendum. This may indicate a negative effect on the EU migrant stock, although we cannot state this with certainty. The second column reveals that the vote was associated with a decrease in the inflow of EU nationals into the UK. This decrease begins around the triggering of Article 50, intensifies over time, and is the largest two years after the referendum. We then find a reduction in the inflow of migrants of almost 1,600. Relative to the EU-mean in the quarter before the referendum, this is a about a 31% decrease. Despite this significant magnitude, it seems the decrease was too small to affect the stock of migrants in such a short period.

For the number of British citizenship applications, we find evidence that the parallel trends assumption is violated. This may reflect some anticipation effect in the two quarters before the referendum. It is possible that migrants who were planning to apply advanced their decision and applied sooner than they would have without the referendum. In addition, the pre-trend differences are relatively small compared to the large positive coefficients after the referendum. This allows us to conclude that the vote was associated with a sharp rise in citizenship applications. Finally, we observe that EU and non-EU citizenship grants followed similar paths before the referendum. In the post-period, we find significant positive coefficients, indicating an increase in the number of granted citizenship requests to EU migrants. The effect increases over time, not necessarily driven by specific Brexit-related events. The effect is largest in the first quarter of 2018 (over 1.5 years after the referendum), with 407 more granted citizenship requests due to the referendum. This increase is more than three times the size of the pre-referendum mean of citizenship grants to EU migrants.

5.2 Synthetic DD

Table 6 shows the referendum's average treatment effect on the treated (ATT) as estimated by the synthetic DD estimator and confirms previous results. We find no significant impact on the stock of foreign-born residents and observe a significant decrease in NINo registrations of almost 1,200. This is equivalent to a 22% reduction in the inflow of EU migrants compared to the quarter before the referendum. Despite this evidence that the vote decreased the attractiveness of the UK as a host country, we also find evidence that the referendum motivated migrants already in the UK to strengthen their position. We observe a significant positive effect of the referendum on British citizenship applications and grants, with an increase of 267 (+214%) and 265 (+213%), respectively. Control units and time periods receiving the most weight for each outcome are summarised in Appendix F.

Figure 9 visualises how the outcomes differ between the treated and weighted control units and shows how the treatment effect dynamically evolves over time. Despite the re-weighting, there still seems to be a small difference in trends between EU and non-EU migrant stocks. However, all pre- and post-referendum coefficients are insignificant and we conclude that the referendum had no impact on the stock of EU migrants in the UK. Our concerns about parallel trends between the inflow of EU and non-EU migrants are resolved using the synthetic DD. This allows us to conclude with certainty that the referendum negatively affected NINo registrations. The decline grew gradually after the referendum and peaked in the second quarter of 2018. Finally, we find that the sharp increase in citizenship applications and grants is now even more pronounced.

5.3 Heterogeneous effects

To understand the uncovered impact better, we break the outcomes of interest down by migrant characteristics. Table 7 summarises the heterogeneous treatment estimates for the stock of foreign-born residents, calculated using the synthetic DD. The coefficients of almost all categories are insignificant. The few significantly positive treatment effects are mainly a result from larger pre-referendum differences in the trends between EU and non-EU migrant stocks. They thus reflect violations of the parallel trends assumption, rather than positive treatment effects. In addition, the sample size is too small to be reliable when estimating the migrant stock for separate categories.

The heterogeneity analysis for NINo registrations, as shown in Table 8, indicates that the reduced inflow is mainly driven by a smaller inflow of male migrants and migrants aged 25 to 44. This may be explained by the traditional gender divide in the most common reasons to migrate, with men being more driven by work-related motivations and women primarily motivated by family-related reasons (Strey et al., 2018). Compared to family-driven migrants, who often travel to countries where their relatives have already settled, migrant workers tend to be more flexible in their choice of destination country. There does not seem to be a difference in impact between the inflow to boroughs (predominantly urban) and county constituencies (predominantly rural). The effect is largest for those located in the Greater London area, followed by the rest of England. We find no significant impact on the inflow of migrants into Wales, Scotland and Northern Ireland. This likely reflects the fact that very few migrants were moving there in the first place, and those who were, were likely motivated by specific reasons. We find that the effect is largest for migrants moving to areas where the majority of people voted Remain during the referendum. This result still holds when excluding London from the analysis. Overall, EU migrants seem to have changed their decision to move to the UK altogether; we do not find any evidence that potential migrants changed their destination within the UK. Although noisily estimated, we find that the effect is largest for the inflow of migrants from Central and Eastern Europe, followed by Southern European migrants. The reason for this may be that immigration from Eastern European countries was often centred in UK media and was often subject to prejudice after the enlargement of the EU. These migrants further became the centre of the anti-immigration discourse in the wake of the referendum and were sometimes specifically targeted by pro-Brexit politicians (Martins, 2021; Moore & Ramsay, 2017).

The heterogeneous treatment effects for the number of British citizenship applications and grants are shown in Tables 9 and 10. The data on citizenship applications include less details and we, therefore, focus our discussion on the heterogeneous differences in the citizenship grants. We find no difference when differentiating by migrants' sex and we find significant effects for all age categories below 70, although the relative impact is largest for those between 30 and 69 years old. We find the largest increase in applications based on marriage (a more than 500% increase), followed by applications based on residence. The increase in granted requests is significant for all EU migrants, although we find the largest impact on migrants from Southern Europe, followed by Western Europe. Applying for citizenship is expensive and bureaucratically demanding. Therefore, these significant categories likely reflect not only the group of migrants who were eligible to apply, but also those who were able to afford so. We only observe a significant increase in grants from origin countries that do not have any restrictions on dual citizenship.[7] This indicates that, even though immigrants were reacting strongly to the increased policy uncertainty, they were not yet willing to give up their original nationality.

5.4 Mechanisms

In this next section, we address the potential mechanisms that could be driving our results. Namely, we examine any changes in the value of currency, uncertainty, and the negative sentiment surrounding immigration.

5.4.1 Exchange rates

First, we explore the exchange rate fluctuations associated with the Brexit referendum. After the vote, a sharp depreciation of the British pound (GBP) was observed (Nasir & Morgan, 2018). If these changes are more pronounced for EU citizens, they may adapt their behaviour. Given that we find an increase in citizenship applications, i.e. that those who are in the UK and are eligible to become citizens do so, it seems unlikely that the patterns we find are driven by short-term currency fluctuations. However, to be certain, we measure the GBP in the origin country's currency and include its quarterly percentage change in our analysis. We interact the exchange rate change with the treatment interaction in a DD regression.

Table 11 show the baseline DD results (panel A) and the DD results including the exchange rate fluctuations (panel B). We find that currency changes positively affect the inflow of migrants in general. As the GBP appreciates, it becomes more beneficial to be in the UK as the competitiveness improves, economic expectations are favourable, and remittances have a higher real value. Currency changes, however, do not impact the treatment effect of the referendum

[7] Dual citizenship prohibited or only allowed under certain strict conditions: Austria, Bulgaria, Estonia, Germany, Lithuania, Netherlands, Slovakia.

on NINo registrations, indicating that potential EU migrants were affected by the referendum independently of the associated depreciation of the pound. Interestingly, for citizenship applications and grants, currency changes have no impact on their own while they do significantly affect the treatment effect. These results show that exchange rate fluctuations reinforce the treatment effect. Positive changes in the exchange rate are associated with a more positive referendum effect. Especially for migrants sending home remittances, any appreciation of the pound may be an extra motivation to remain in the UK. Negative changes in the exchange rate are associated with a more negative referendum effect. Any currency depreciation, which is what was observed after the referendum, thus weakens the treatment effect. The main estimated treatment coefficients do not change in magnitude. We find coefficients with a similar sign and significance level when including lagged instead of current exchange rate changes.

5.4.2 Uncertainty indices

To illustrate the role of uncertainty, panel C of Table 11 includes several news-based indicators of uncertainty in our analysis. Dai and Elliott (2022) offer Brexit-related uncertainty measures. The aggregate Brexit Uncertainty index (BUI) is a monthly index based on the frequency of relevant news articles in 11 leading UK newspapers. Using techniques from computational linguistics, articles that contain the words 'Brexit', 'uncertainty' and 'UK', or similar related words are selected. The index is normalized to a maximum value of 100. Using machine learning algorithms, the authors identify different aspects of Brexit coverage and create topic-specific indices, including an immigration-specific BUI. The authors also construct a similar index using the frequency of Twitter tweets instead of newspaper articles, based on the same methodology. For the Twitter BUI, tweet counts are scaled by the total number of tweets containing 'today' and 'UK' in the same period. These three indices capture how the uncertainty caused by the referendum varied dynamically over time. We aggregate the monthly indicators by averaging them and then include the quarterly indices as a continuous measure of treatment intensity in three separate DD regressions. For all three uncertainty indices, we find no significant impact on the migrant stock, a significant negative impact on NINo registrations, and a significant positive impact on citizenship applications and grants. As all indices are scaled differently, the coefficients vary a lot in magnitude. The standardized coefficients are more in line with each other and show that the largest impact is captured by the aggregate BUI index. Although these indices are not perfect measures of the uncertainty over time, they clearly show how Brexit-caused uncertainty affected migrants' behaviour.

The last row of panel C uses the Economic Policy Uncertainty (EPU) index from Baker et al. (2016) as a treatment intensity indicator in one final regression. This index utilizes the number of news articles containing the terms 'uncertain'/'uncertainty', 'economic'/'economy', and a policy-relevant term (e.g. policy, tax, spending, etc.). The count of articles is then scaled by the smoothed total number of articles and normalized to a mean of 100 before 2011. The index aims to capture policy-related economic uncertainty in the UK and is thus not restricted to Brexit or migration. This type of uncertainty should affect migrants from all origin countries. As a result, we do not find a significant treatment effect.

5.4.3 Google and (social) media

Finally, we explore how involved various countries were in the Brexit process. First, we examine the extent of newspaper coverage. Media outlets across the EU reported heavily on Brexit. Qualitative case studies indicate that, in the run-up to the referendum, the majority of media texts were in explicit opposition to Brexit. Migration was one of the many key issues that prominently appeared in the headlines (Müller, 2018). After the vote, however, European media reporting seemed more fact-based. Only 18% of the analysed news items conveyed a clear opinion on the referendum. Apart from Ireland, European news items reflected on the UK situation without much concern about the implications for the EU (Borchardt et al., 2018). To consider the importance of news-based information, we divide EU countries by their extent of news reporting on the Brexit process. Using the LexisNexis database, we obtain the count of news articles containing the keyword 'Brexit' for a given country in the year after the referendum (2016Q3-2017Q2). To account for differences in the coverage and size of countries, we scale the count by the number of articles containing the keyword 'today'. Only news articles in the native language and published within the country are included. Countries without sufficient coverage in the database were excluded and as a result, we create the measure of newspaper reporting for 19 of the treated EU countries. We compare the impact of the referendum between countries with a large number and a small number of Brexit news articles.[8]

Panel A of Table 12 provides an overview of the results. We find a much larger reduction in NINo registrations for countries with a high number of Brexit news articles, although this is noisily estimated. We find larger increases in citizenship grants and applications for countries with fewer articles on Brexit. Overall, it seems that migrants originating from countries with much Brexit-related news coverage, who were thus more informed and aware of Brexit, were the most discouraged from migrating to the UK and were less motivated to secure their position in the country. Those with fewer available news articles were less discouraged from moving to the UK and more motivated to stay permanently.

Next, we separate EU countries depending on how much the keyword 'Brexit' was googled in the year after the referendum (2016Q3-2017Q2).[9] Google searches are assigned to particular countries based on location, not based on the origin country of the user and search terms are made relative to the total number of Google searches performed at that time in the specific location. Panel B shows the synthetic DD results for EU countries with a low and high number of Google searches on Brexit. The reduction in the inflow of migrants is bigger for countries with fewer searches. It thus seems that the individuals still motivated to migrate to the UK, were those seeking most for information. These migrants may also be compensating for the low number of newspaper articles on the Brexit process by further obtaining their information from Google and informing themselves before migrating to the UK. We also find the largest increase in citizenship applications and grants for countries with many searches. We do not know, however, whether migrants already in the UK had similar search patterns as people in their origin country. Using searches in a different period (e.g. in the quarter before the referendum) or of different keywords (e.g. 'Brexit' + 'migration') does not substantially change the classification of countries. These findings highlight the role of information and uncertainty in the decision to migrate.

[8] Low number of newspaper articles: Belgium, Bulgaria, Czech Republic, Denmark, France, Italy, Malta, Portugal, Spain. High number of newspaper articles: Austria, Cyprus, Finland, Germany, Greece, Ireland, Luxembourg, Netherlands, Poland, Sweden. Croatia, Estonia, Hungary, Latvia, Lithuania, Romania, Slovakia, and Slovenia are excluded as they do not have sufficient coverage in the LexisNexis database (less than five newspapers).

[9] Low number of Google searches: Bulgaria, Croatia, Czech Republic, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden. High number of Google searches: Austria, Belgium, Cyprus, Denmark, France, Germany, Ireland, Italy, Luxembourg, Malta, the Netherlands, Spain.

Third, we separate origin countries depending on their Brexit-related Twitter activity. Chen et al. (2022) gather all migration-related tweets from several European countries and capture public attitudes towards migration using advanced topic modelling techniques and textual sentiment analysis. They create a knowledge base of yearly tweets annotated with entities, sentiments, hashtags, and topics. Using this migration knowledge base, we gather tweets from 2016 to 2019 that include the hashtag #Brexit and hold a negative sentiment. The knowledge base only includes English tweets for which the location is known. Although the included tweets are highly selective, they may indicate the overall sentiment of Twitter conversations in the origin countries. To partly account for differences in the use and popularity of Twitter in various countries, we use the share of negative tweets compared to the total (negative, neutral, and positive) tweets on Brexit. This allows us to divide the eight available EU countries into those with a high and a low share of negative #Brexit tweets.[10]

Panel C summarises the results. We find no significant effect on the migrant stock for both groups and a larger reduction in NINo registrations for EU migrants from countries with a low proportion of negative tweets. We find a larger increase in citizenship applications and grants for those with the highest share of negative tweets. If the negative attitudes towards migrants during the referendum were an important mechanism in the observed changes, we would expect that the countries more exposed to Brexit-related anti-immigration attitudes have the largest reduced inflows. Our findings thus do not support this hypothesis. These results are, however, sensitive to the exclusion of specific countries or the chosen period.

6 Robustness checks

6.1 Credible approach to parallel trends

The validity of our empirical strategy relies on the parallel trends assumption. Inspecting whether trends are similar before the referendum, gives an indication of the plausibility of this assumption. However, we can only noisily estimate the true pre-treatment differences and the TWFE estimator has low power to detect statistically significant pre-trend differences.

[10]Low share of negative tweets: Austria, Italy, Poland, Spain. High share of negative tweets: France, Germany, the Netherlands, Sweden. Hungary is excluded as it does not have sufficient tweets in the knowledge base.

Pre-trend differences, therefore, do not offer decisive evidence on whether the assumption is violated or not. To be cautious, we perform a sensitivity analysis following Rambachan and Roth's (2023) credible approach to parallel trends. The intuition is that the pre-treatment differences in our data are informative about the counterfactual post-treatment differences. The authors formalise this by imposing the restriction that the counterfactual difference in trends cannot be 'too different' than the pre-trend difference. This allows us to determine confidence bounds for the treatment effect under scenarios with different violations of parallel trends, instead of assuming a common trend. Different types of restrictions could be placed on the relationship between the pre-trend and post-trend differences.

First, we can allow for smoothly evolving secular trends that differently affect treated and control units. We impose that the differential trends evolve smoothly over time and bound how far post-treatment differences can deviate from a linear extrapolation of the pre-trend. These so-called smoothness restrictions, $\Delta^{SD}(M)$, impose that the slope of the underlying trend cannot change by more than M across consecutive periods. The restriction $M = 0$ corresponds with allowing only for linear violations of parallel trends, and larger values of M allow for larger deviations from linearity. We employ these smoothness restrictions in the analysis of the migrant stock, as previous sections showed that EU migrant stocks in the UK had been increasing faster than non-EU stocks in the years before the referendum. Figure 10 shows the robust confidence intervals for different values of M. Panel (a) shows the average impact in the first year after the referendum. This average treatment effect is negative when allowing for a linear extrapolation of pre-trend differences $M = 0$. The breakdown value for a significant effect is $M \simeq 0.3$. This means we can reject a null effect unless we are willing to allow for the linear extrapolation across consecutive periods to be off by more than 0.3. Panel (b) shows the treatment effect of the second quarter, the quarter which seemed most affected. We find a significant negative effect for this quarter's treatment effect when allowing for linear trend differences ($M = 0$) and changes in the slope up to almost 0.6 per period. Despite the pre-treatment differences between EU and non-EU stocks, we are able to give some indication of a change in the EU migrant stock due to the referendum.

Second, we can allow for differential economic shocks. We assume that shocks after the referendum are not too different in magnitude than those before the referendum. In particular, we bound the possible violations of parallel trends between consecutive post-treatment periods by $\overline{M}$ times the maximum pre-treatment violation. These are bounds on relative magnitudes, denoted by $\Delta^{RM}(\overline{M})$. Restrictions on relative magnitude will be implemented on the NINo registrations, citizenship applications and citizenship grants, as they all experience similar paths before the referendum with occasional deviations from parallel trends. As treatment effects increased over time, we implement the approach on the average effect of the second year and on the largest treatment effect observed. Figure 11 shows robust confidence intervals for different values of $\overline{M}$ for the referendum's effect on NINo registrations. We find cut-off values for $\overline{M} \simeq$ below 0.2 for each treatment effect, indicating our results are quite sensitive to the assumption of parallel trend. Even with very small violations of the assumption, we are unable to reject a null effect anymore. Figure 12 uses the same approach on British citizenship applications. The average treatment effect in the second year after the referendum has a breakdown value of $\overline{M} \simeq 0.8$. The largest effect was found 11 quarters after the vote. We find that this effect is significant up to a violation of parallel trends of almost 2.5 times the magnitude of the maximum pre-treatment violation. For the British citizenship grants, shown in Figure 13, we find a breakdown value of $\overline{M} \simeq 1$ for the average treatment effect in the second year after the referendum. The largest positive effect was found seven quarters after the vote. This effect is significant up to a violation of twice the largest pre-treatment violation.

Overall, the credible approach to parallel trends illustrates that our results on the NINo registrations are relatively sensitive to the assumption. This is not necessarily an issue. It simply highlights the importance of the assumption and, to a certain extent, justifies the use of the synthetic DD estimator which helps us select the most similar control units. However, note that the synthetic DD approach does not circumvent or solve the existing issues with building analyses based on observed pre-trend differences as mentioned above. Our results on the citizenship applications and grants are insensitive to violations in parallel trends, reassuring the robustness of our findings.

6.2 Other robustness checks

6.2.1 Alternative specifications

The robustness checks summarised in Table 13 explore a set of alternative specifications. First, the two quarters before the referendum are excluded in order to compare migration from 2012Q3 to 2015Q4, the period before the official Brexit campaigns, with the period after the referendum. In our identification strategy, we assume that individuals are not allowed to strategically change their behaviour before the treatment occurs. Since the results of the Brexit referendum came as such a surprise, we do not expect migrants to have adapted their migration decisions before the results were known. Panel A confirms this and shows how excluding any possible anticipation period does not change our conclusions.

Panel B summarises the treatment effect for a hypothetical placebo event one year before the referendum (2015Q3), when the referendum was announced. We find no significant effect on NINo registrations and British citizenship grants. The marginally significant coefficient for the migrant stock was expected, as this is the result of the nonparallel trends of the EU and non-EU outcome before the referendum. The small but significant increase in British citizenship applications likely reflects some slight anticipation in the months before the referendum, as discussed in the main results. Migrants seem to have accelerated their plans to apply for citizenship, driven by the announcement. The magnitude of this coefficient is very small, however, and as formally discussed in Section 6.1, our main results are unlikely to be a consequence of a violation in parallel trends.

Panels C and D include yearly and quarterly control variables (GDP, unemployment rate, population) in our baseline synthetic DD specification. Quarterly control variables are only available for OECD countries and limit the sample to 22 EU and 10 non-EU origin countries. Our results are robust to the inclusion of both types of control variables. Panel E includes control variables on the British economy in the synthetic DD. We control for quarterly GDP, unemployment rate, population, and the number of vacancies in the country. These measures of the UK economy are the same for all migrants, regardless of their origin country, and are thus in principle already controlled for by our control units. As expected, the estimates do not change.

Next, we restrict the post-period to 1.5 years after the referendum. Even though we do not observe any changes in non-EU migration for our sample, there may still be concerns that these migrants were affected by the referendum through labour market pressures. The substitution of EU workers by non-EU workers was facilitated in late 2018, with the cap on Tier 2 visas for non-EU migrants being relaxed for healthcare workers (Home Office, 2018). In principle, this should not affect our estimates. It has been shown that during this period, the UK's health sector simply became more reliant on its traditional pre-existing sources of nurses in Asia, such as India and the Philippines. These low-middle income countries are not included in our sample and therefore, we do not expect this policy change to undermine our identification strategy. Panel F addresses any remaining concerns and shows that even when focusing on the more immediate period after the referendum, we still observe a significant negative impact on the inflow of EU migrants and a significant positive impact on British citizenship applications and grants. The magnitudes are smaller, however, because the referendum effect is increasing over time and.

Finally, panel G uses the logarithmic outcome variables. Significance levels do not change and we find similar relative treatment effects as in the main analysis. The log transformation, however, reduces the credibility of the parallel trends assumption, hence this is not our preferred model.

6.2.2 Varying control group

A second set of robustness checks, listed in Table 14, explores the suitability of our control units. First, we examine the group of migrants originating from non-EU countries in the Schengen area and EFTA or countries holding bilateral agreements (Stabilisation and Association Agreement or Customs Union arrangement) with the EU. These agreements are typically concluded with countries that have expressed a wish to join the EU, and facilitate border crossing, with a focus on trade and short-term mobility. These origin countries were initially excluded from the analysis as they were not directly targeted by the referendum but may have been impacted by the same policy uncertainty as other EU countries. We test whether this group of origin countries is a suitable control group. By comparing migrants from these countries to remaining non-EU migrants, we conclude that, in fact, their migration outcomes were not affected by the referendum(see panel G). As these countries lie close to the EU, they may form more comparable and optimal control units. Therefore, panel H compares treated EU migrants in the UK with untreated migrants originating from the Schengen area, EFTA, or countries holding bilateral agreements with the EU. We find very similar estimates as previously.

Second, we restrict the control group to fewer but more common origin countries. We only consider the 20 most common origin countries (in the quarter before the referendum) for a given outcome variable. Migration from these countries may be more comparable to EU migration, as we observe stocks of migrants and numbers of citizenship requests that are of similar magnitude as those originating from the EU. Panel I shows that our results do not change when restricting our control units. Finally, panel J excludes Middle Eastern and African origin countries in our sample. Before the referendum, the campaigns were either directed towards EU migrants or refugees (Moore & Ramsay, 2017). Although refugee-origin countries were not included in our analysis (only high- and upper-middle-income economies), we exclude migrants from origin countries that are often perceived the same as refugees. Finally, panel K excludes Commonwealth countries from the sample. Prominent Leave campaigners sometimes claimed that the EU was favouring EU migrants over those from the Indian subcontinent. Brexit was seen as an opportunity to 'level out' this unfairness and reconnect with the rest of the world, starting with the Commonwealth (Dilley, 2016; Ehsan, 2017). Our results are robust to the exclusion of these groups. The decline in NINo registrations and the rise in citizenship applications and grants remain significant and of similar magnitude.

6.2.3 Sensitivity of the LFS

The final set of robustness checks inspects the sensitivity of our LFS results and is shown in Table 15. The first panel shows results for the baseline stock of migrants. The second panel considers an alternative definition, where we use individuals holding foreign citizenship rather than foreign-born individuals. These two definitions are relatively similar measures for the migrant stock, and results do not differ for these outcomes. In the different columns, the threshold for which the migrant stock is considered unreliable is varied. Column (1) shows the baseline restriction that excludes origin countries for which either the stock of foreign-born residents or the stock of foreign citizens was below 10,000 in the quarter before the referendum. In further restrictions, we remove any migrant stocks from the analysis that is below a stricter threshold. The stricter the threshold, the less origin countries and observations are included. The estimates remain insignificant and our conclusion does not change.

7 Discussion and conclusion

This paper examines whether the uncertainty and anti-immigration attitudes associated with the Brexit referendum affected migrants and their decision to move. To do so, we research the impact of the vote on several migration outcomes: the stock of migrants (foreign-born residents), NINo registrations from overseas nationals, British citizenship applications and British citizenship grants. Using a DD approach, we compare the change in EU migration to the change in non-EU migration. We hypothesised that the Brexit referendum reduced the flow of EU migrants into the UK, and increased the number of British citizenship applications and grants EU citizens already in the UK.

We do not find any significant impact on the stock of foreign-born residents. This is not a surprising result, as it can be expected that changes in the stock of migrants would move slowly and only become visible in the longer run. Only when allowing for a linear extrapolation of the pre-referendum differences in trends (and thus taking into account that EU stocks were increasing faster), we are able to provide some demonstration that the stock of EU migrants was reduced. This is in line with Di Iasio and Wahba (2023), who find that the increase in migrant stocks after the referendum was smaller than the pre-referendum increase. We find a significant decrease of around 22% in the inflow of EU migrants, as measured through NINo registrations. This is slightly smaller than estimates provided by previous studies. The reduction is driven by males and those of working age. The effect is largest for those located in London, followed by the rest of England, and for those originating from Central and Eastern Europe. This likely points to a group of migrants driven by work-related motivations that are relatively flexible to change destinations. We find a large positive impact (+200%) on citizenship applications and grants, increasing in magnitude over time. These novel results indicate that migrants already in the UK tried to secure their position and renew the sense of safety and security that had been compromised by the referendum. This overall increase could have been even larger, considering the number of EU nationals with the potential to apply. This confirms the bureaucratic complexity and high cost associated with applying. We only find an effect on migrants originating from EU countries allowing for dual citizenship, indicating that migrants were not willing to give up their original nationality to mitigate insecurity.

What exactly is driving our findings? On the one hand, the increase in British citizenship applications and grants indicates that migrants were focused on securing their position in the UK, illustrating the importance of policy uncertainty. On the other hand, the decline in EU immigrants highlights that the UK's attractiveness was reduced, which may be the result of multiple causes. To provide further insights, this study explores various potential channels. We find that the main mechanism behind the observed changes is Brexit-induced uncertainty, which is confirmed by various media-based indicators. We also find that the reduction in immigrant flows is most pronounced for origin countries with more Brexit-related newspaper articles and fewer Google searches on Brexit. This may point to a group of migrants that is aware of the range of possible consequences and uncertain implications due to the referendum. As a result, they may be discouraged from moving and are seeking less information on their own. The importance of uncertainty in the referendum impact is in line with other qualitative work (Auer & Tetlow, 2020; Duda-Mikulin, 2023; Godin & Sigona, 2022). In addition, we find that although the income effect through exchange rate fluctuations plays a significant role in the decision to migrate, it cannot explain much of the uncovered impact. We find no suggestive evidence that countries more exposed to Brexit-related anti-immigration tweets experienced larger changes. Overall, our analyses indicate that the uncertainty about future regulations is the key mechanism behind the Brexit-induced changes in migration.

Our results provide a causal estimate on the impact of the Brexit referendum and show that such a large unexpected event can impact international migration even before leading to any actual policy changes. When initiating uncertainty (due to a referendum or other event), policymakers must foresee these changes in migration and take into account that the country's attractiveness as a destination may be reduced. For economies relying on migrant workers, it may be beneficial to consider implementing policies aimed at attracting migrants and native workers to certain shortage occupations. In addition, policymakers must anticipate the increased number of citizenship applicants. We recommend that public authorities are prepared and suggest to mitigate these effects by offering immediate clarity on future policy regulations.

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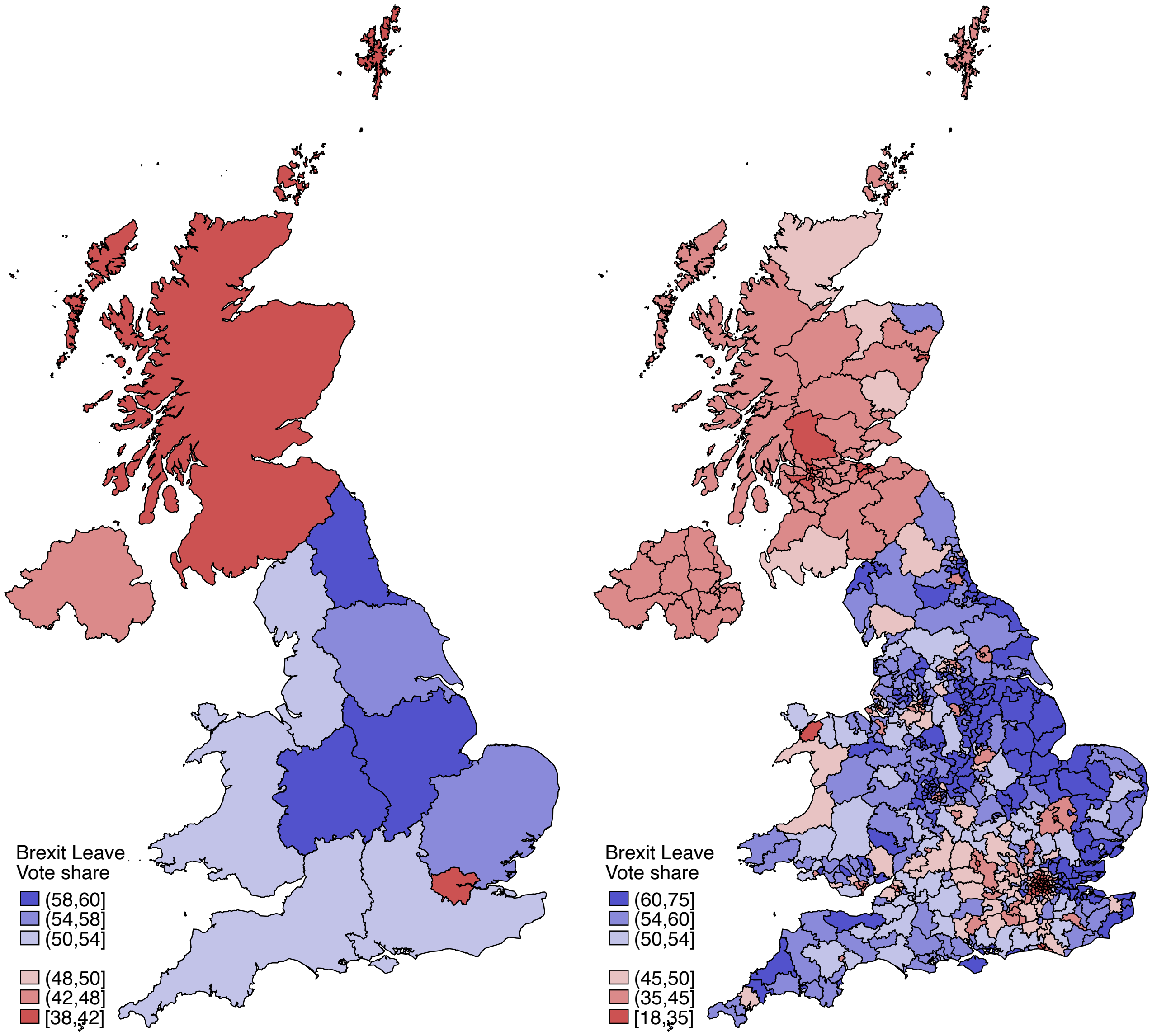
Figures

Figure 1: Percentage of population (valid votes) voting Leave



(a) UK regions **(b)** UK constituencies

Note: Regional Brexit referendum results (left) from the Electoral Commission: https://www.electoralcommission.org.uk/. Brexit referendum results by constituency (right), as estimated by Hanretty (2017) and obtained from https://www.pippanorris.com/data.

Figure 2: National newspapers' headlines, 23/06/2016

Note: Newspaper headlines obtained from Moore and Ramsay (2017), https://www.kcl.ac.uk/policy-institute/assets/cmcp/uk-media-coverage-of-the-2016-eu-referendum-campaign.pdf.

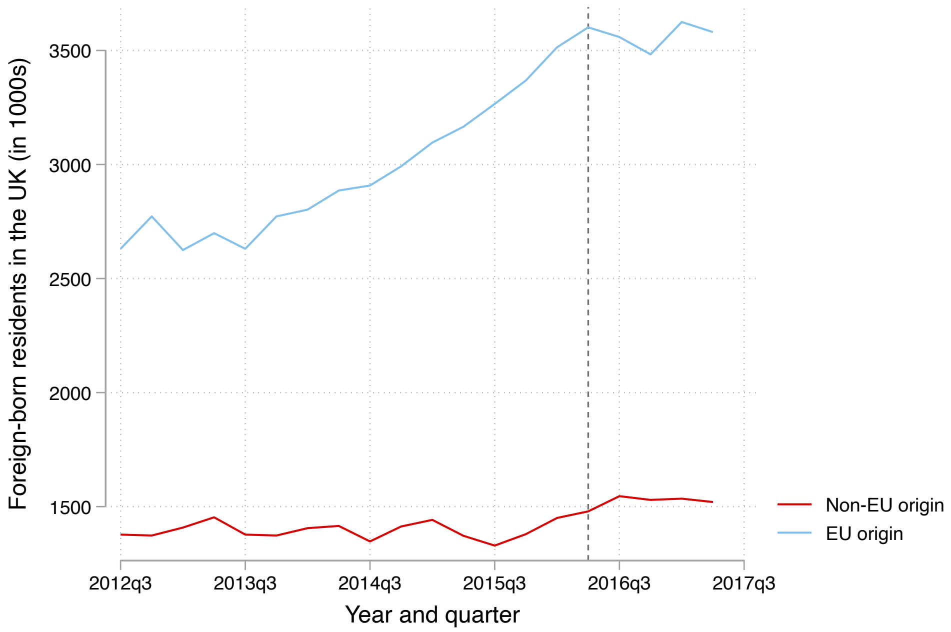
Figure 3: National and international newspapers' headlines, 24/06/2016

(a) British newspapers' headlines

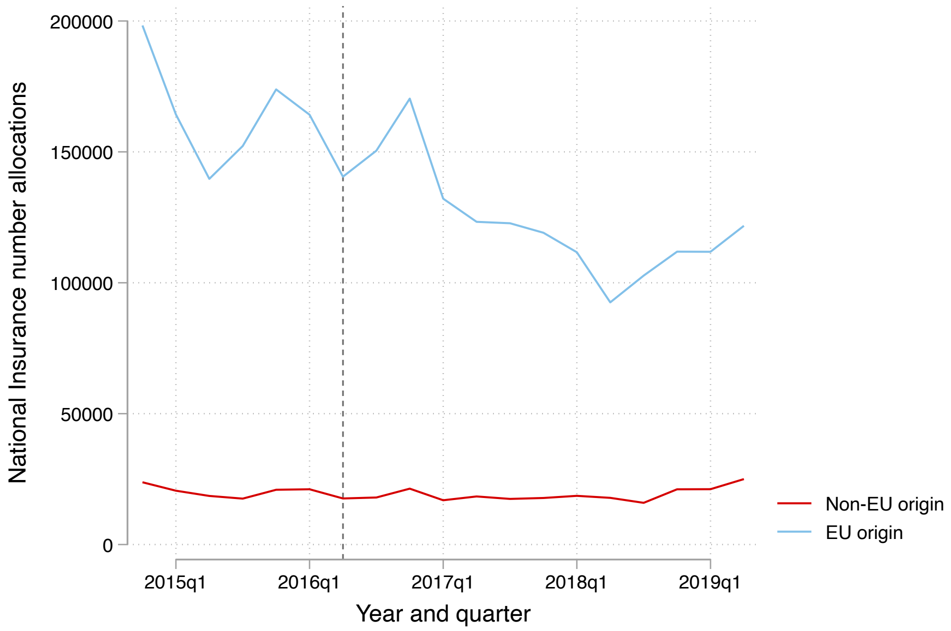
(b) European newspapers' headlines

Note: Newspaper headlines obtained from *The Guardian, 2016*, https://www.theguardian.com/media/gallery/2016/jun/25/brexit-front-pages-in-pictures.

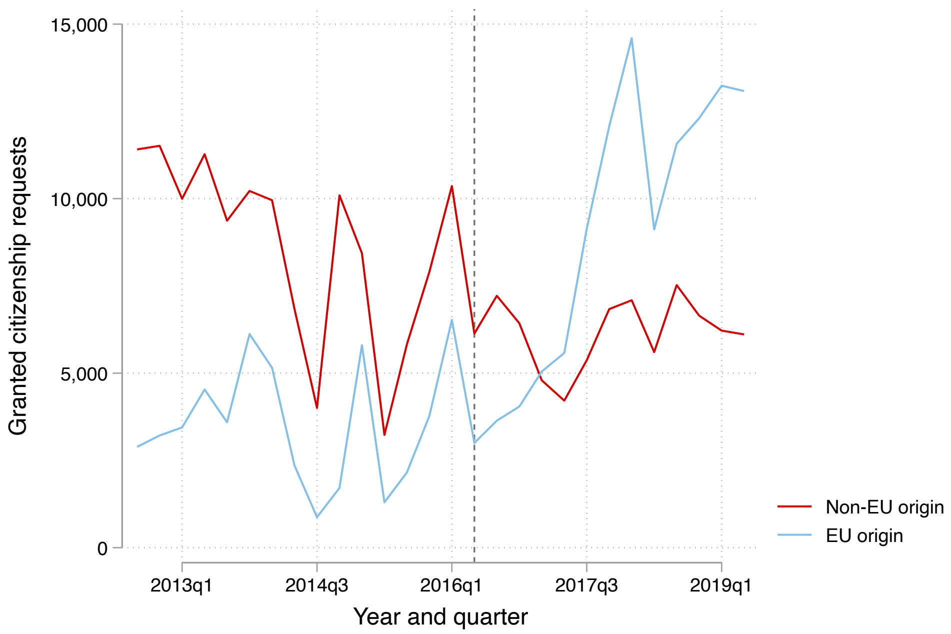
Figure 4: EU and non-EU migration in the UK



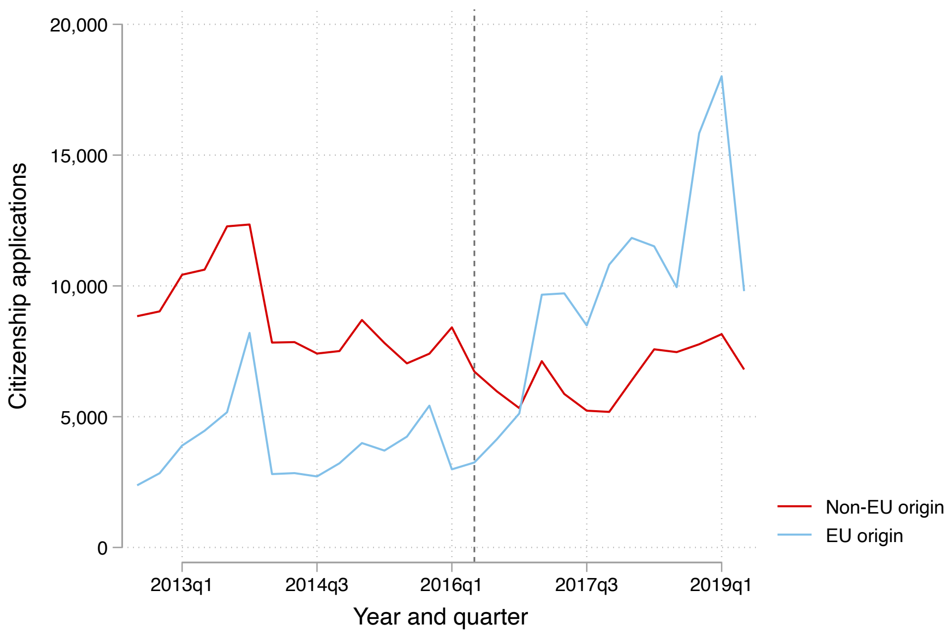
(a) Stock of foreign-born residents



(b) NINo registrations



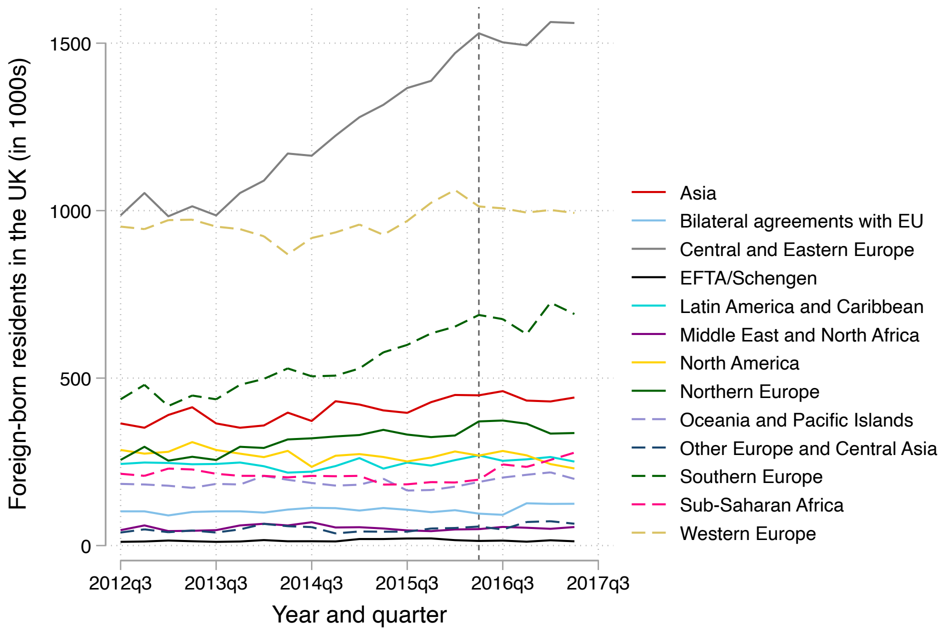
(c) British citizenship applications



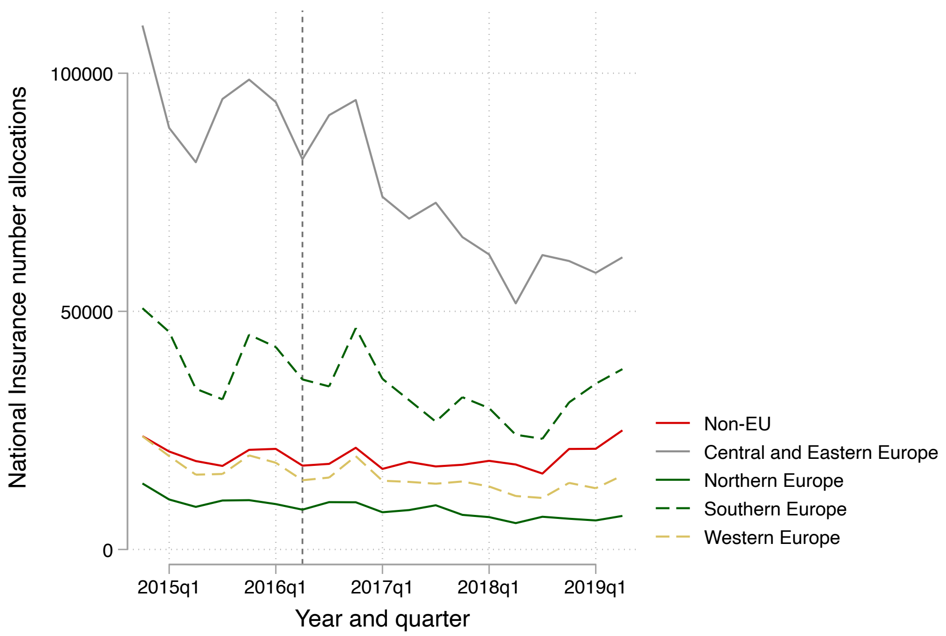
(d) British citizenship grants

Note: Authors' estimations based on the UK LFS and the Home Office's NINo registrations and citizenship data. Migrant stocks are expressed in 1,000. The dotted line indicates the quarter in which the referendum took place.

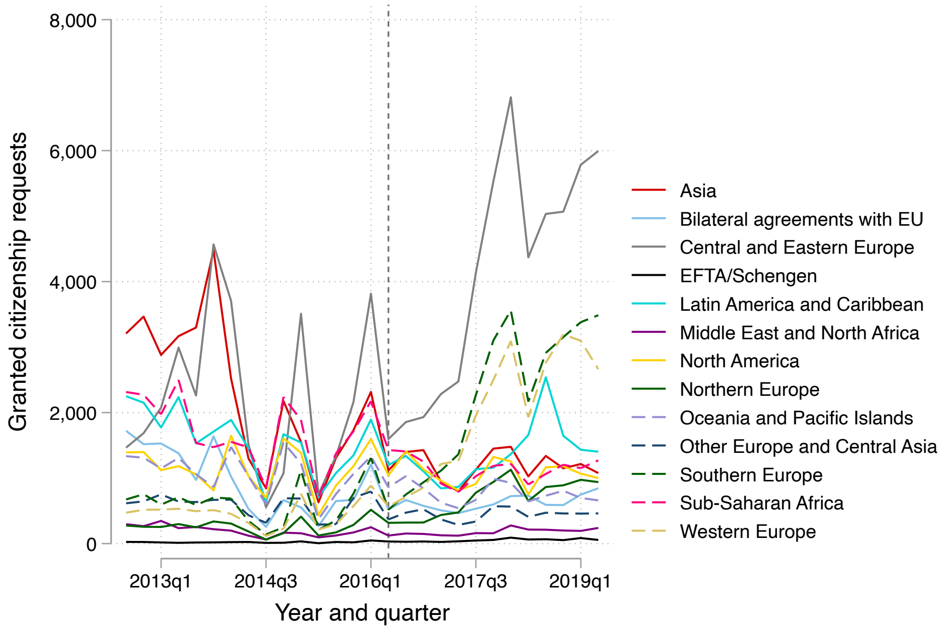
Figure 5: Migration in the UK by region of origin



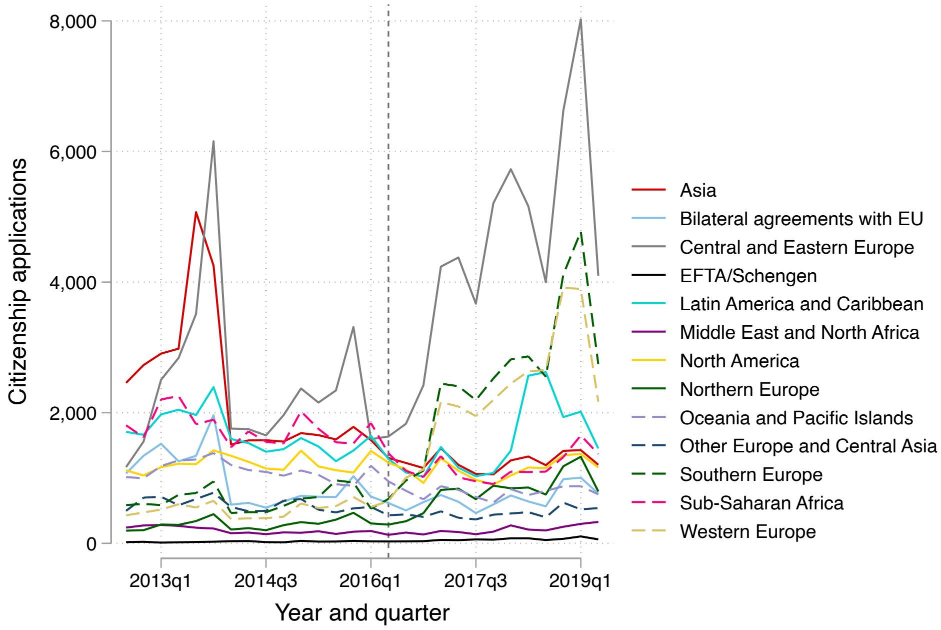
(a) Stock of foreign-born residents



(b) NINo registrations



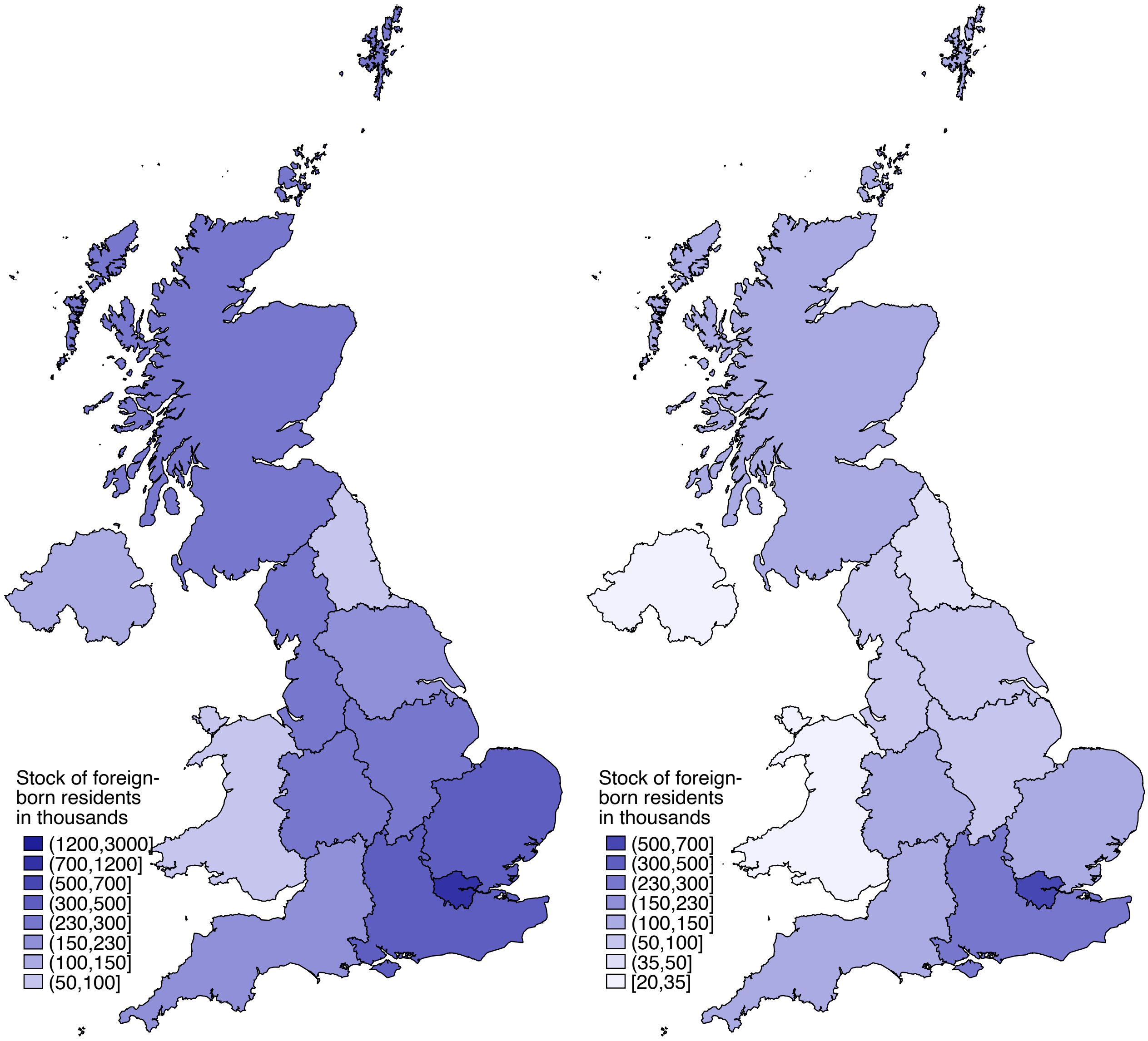
(c) British citizenship applications



(d) British citizenship grants

Note: Authors' estimations based on the UK LFS and the Home Office's NINo registrations and citizenship data. Migrant stocks are expressed in 1,000. The dotted line indicates the quarter in which the referendum took place.

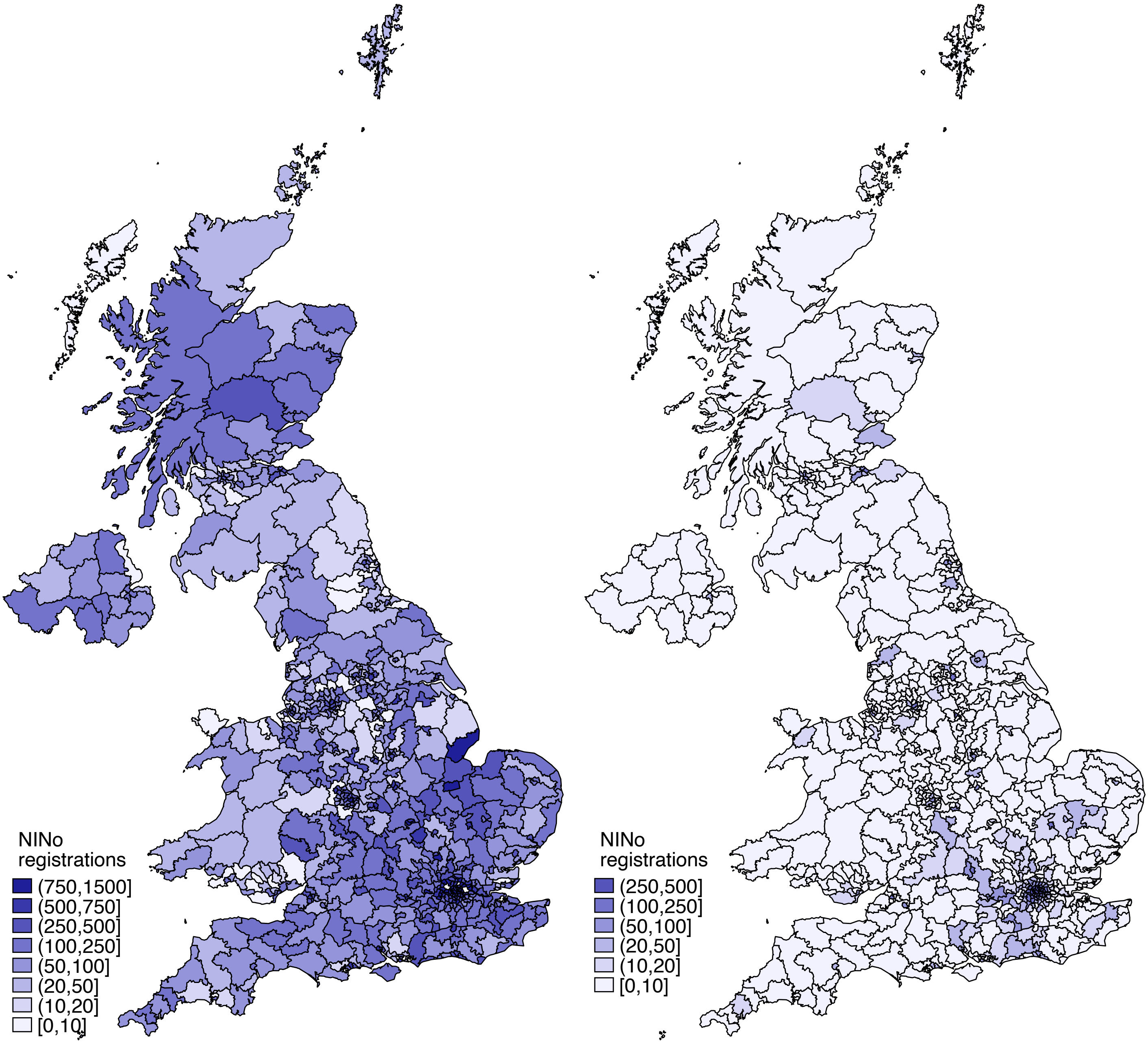
Figure 6: Stock of foreign-born residents across the UK



(a) EU migrant stock **(b)** non-EU migrant stock

Note: Authors' estimations based on UK LFS data in the quarter before the referendum, 2016Q2.

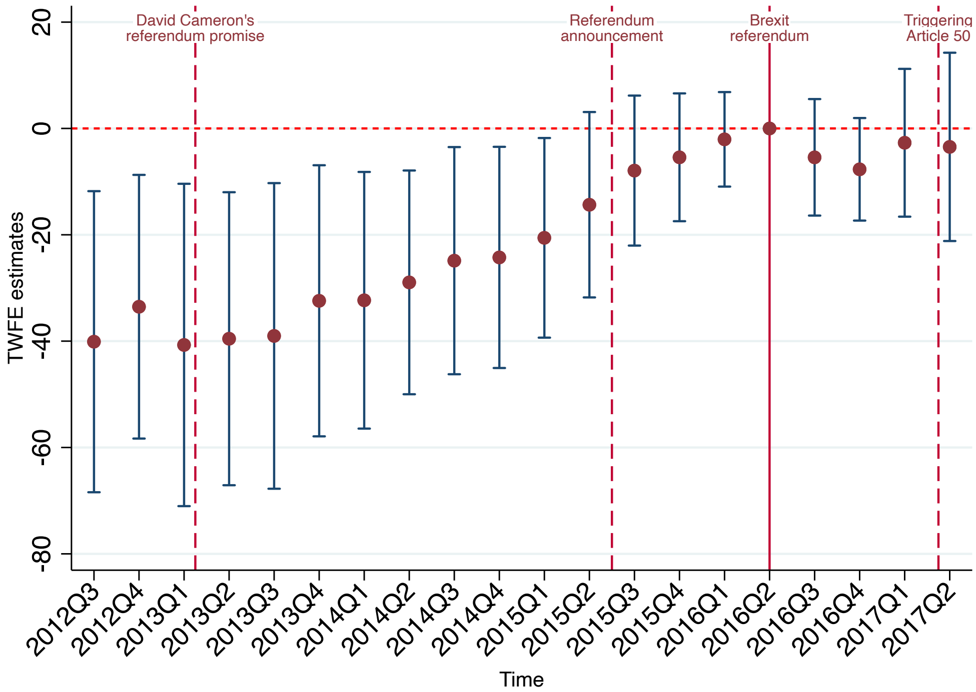
Figure 7: NINo registrations across the UK



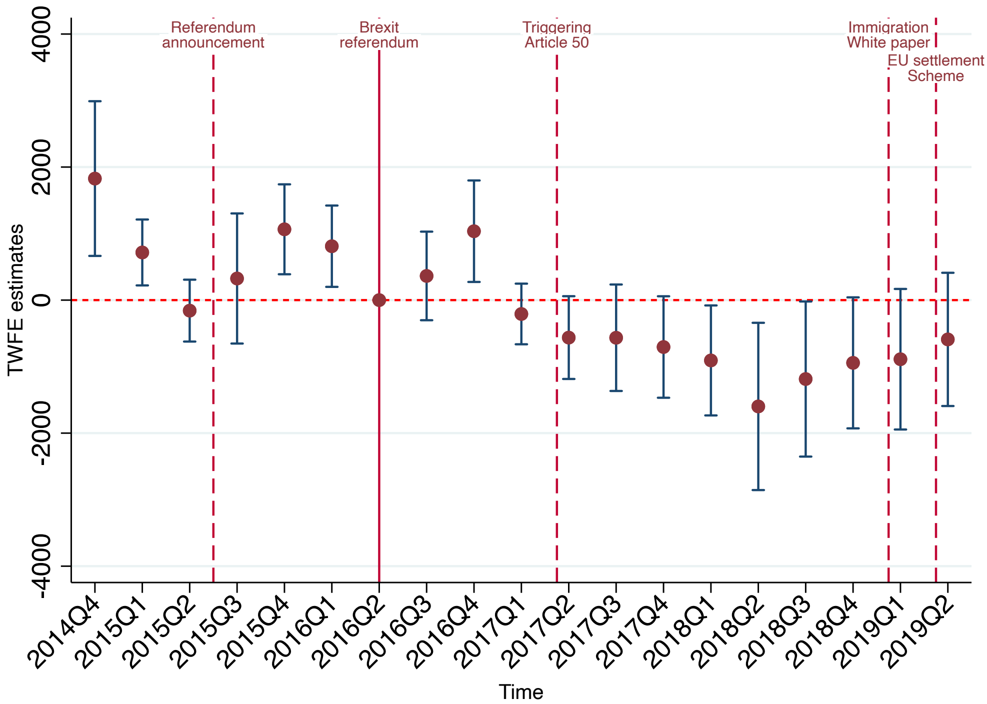
(a) EU inflow **(b)** non-EU inflow

Note: Authors' estimations based on Home Office NINo data in the quarter before the referendum, 2016Q2.

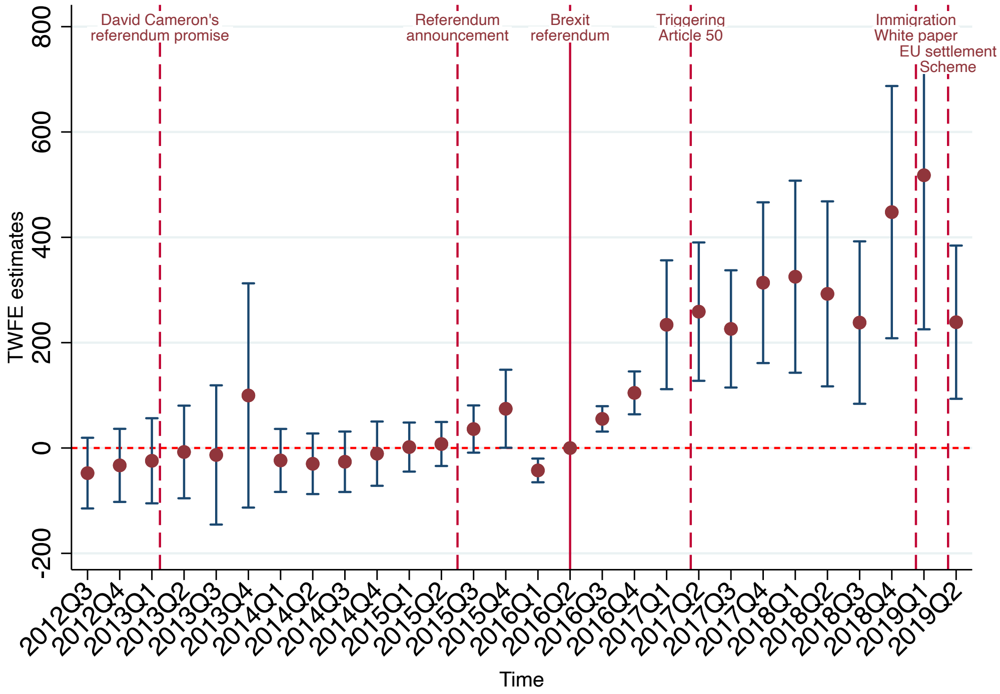
Figure 8: TWFE estimates



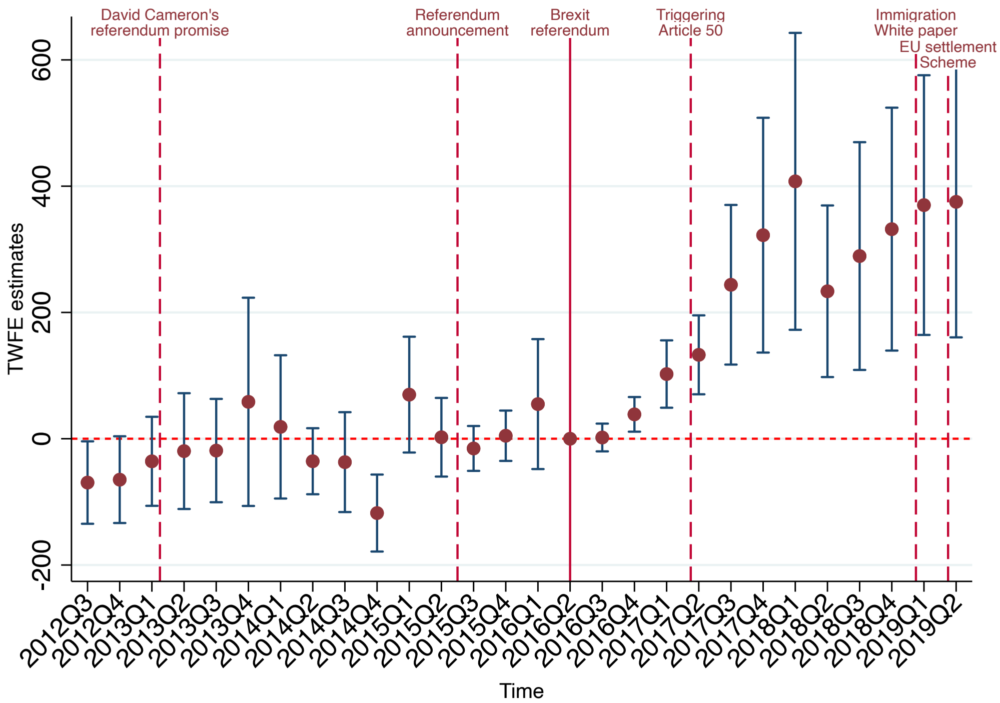
(a) Stock of foreign-born residents



(b) NINo registrations



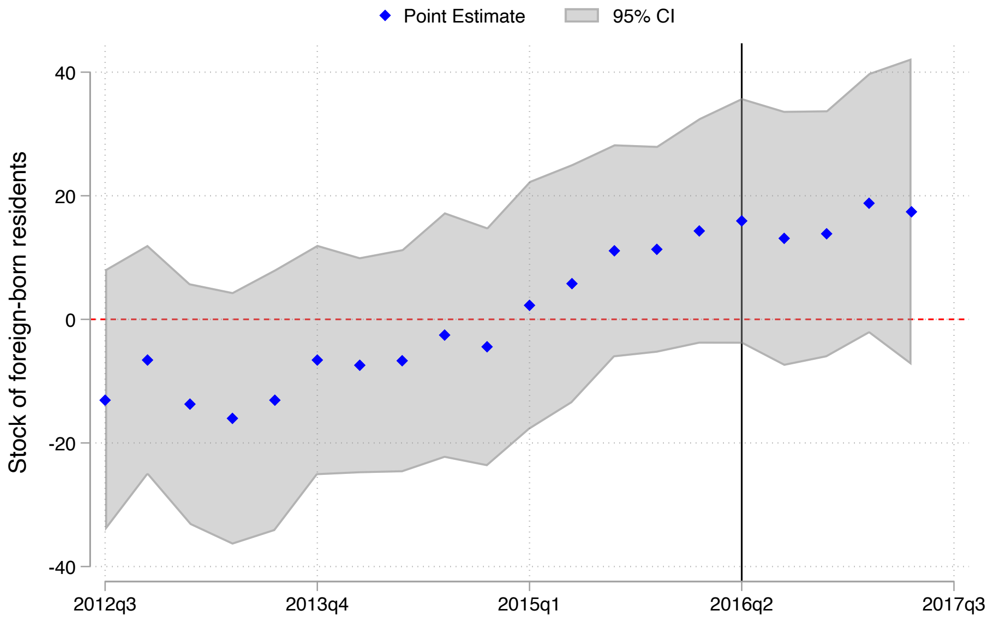
(c) British citizenship grants



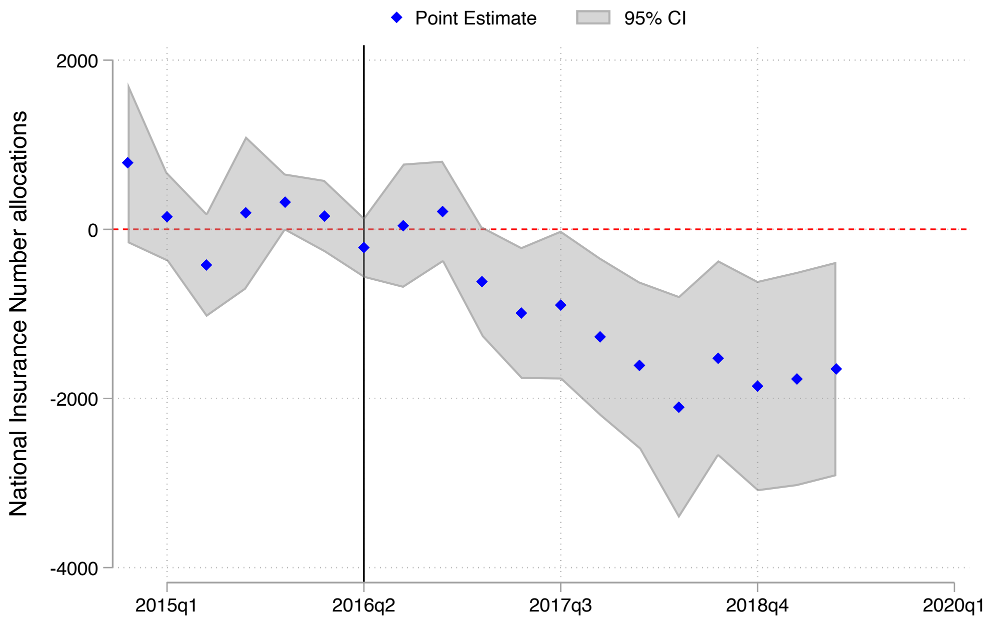
(d) British citizenship applications

Note: Graphical representation of Table 5. Estimates and confidence intervals based on sample from 2012Q3 to 2017Q2 (fig. a), 2014Q4 to 2019Q2 (fig. b), and 2012Q3 to 2019Q2 (fig. c-d). Migrant stocks are reported in 1,000.

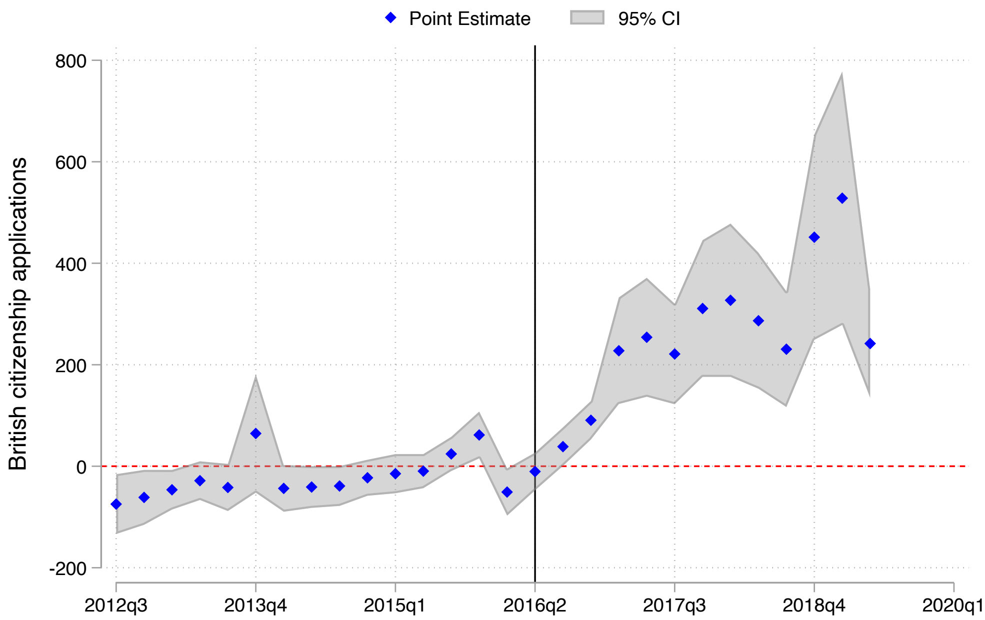
Figure 9: Synthetic DD, main results



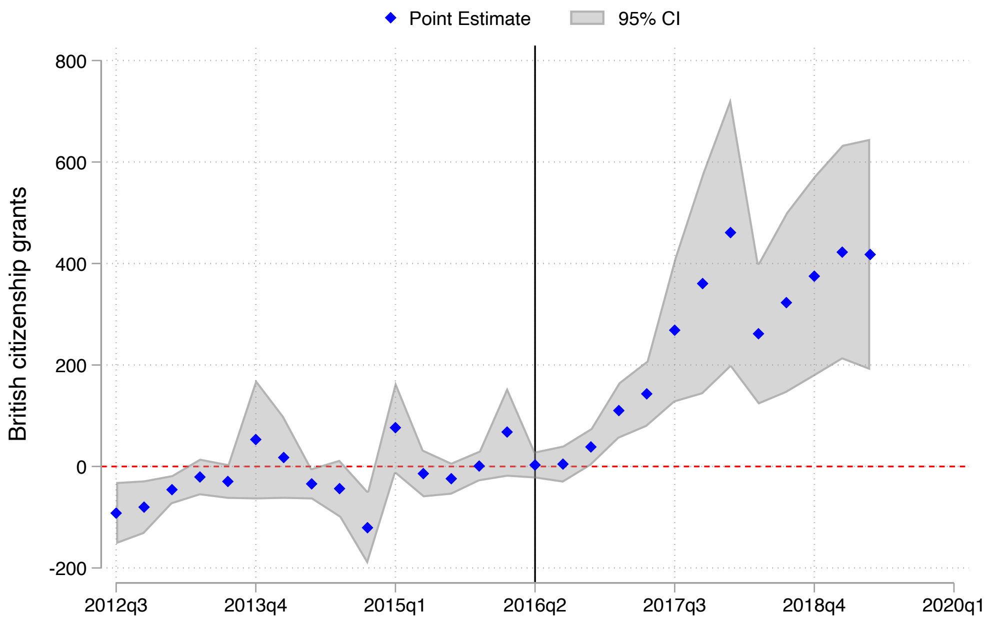
(a) Stock of foreign-born residents



(b) NINo registrations



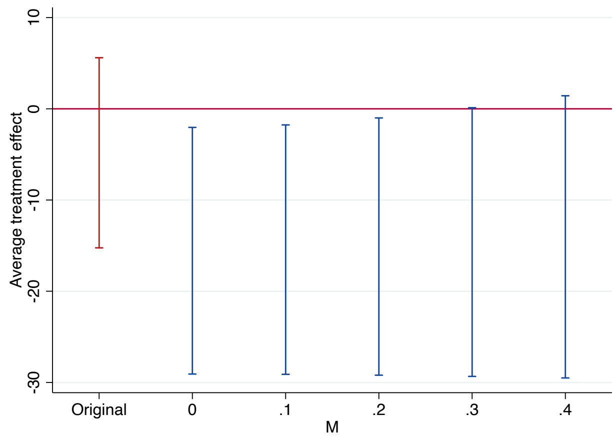
(c) British citizenship applications



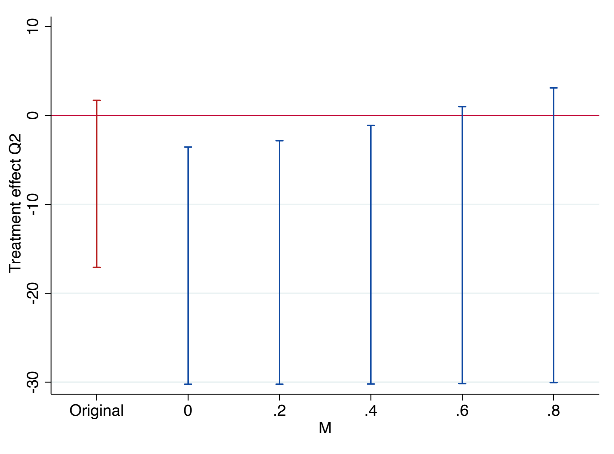
(d) British citizenship grants

Note: Synthetic DD estimates based on sample from 2012Q3 to 2017Q2 (fig. a), 2014Q4 to 2019Q2 (fig. b), and 2012Q3 to 2019Q2 (fig. c-d). Confidence intervals are calculated using 200 bootstrap replications. Migrant stocks are reported in 1,000.

Figure 10: Credible approach to parallel trends, stock of foreign-born residents



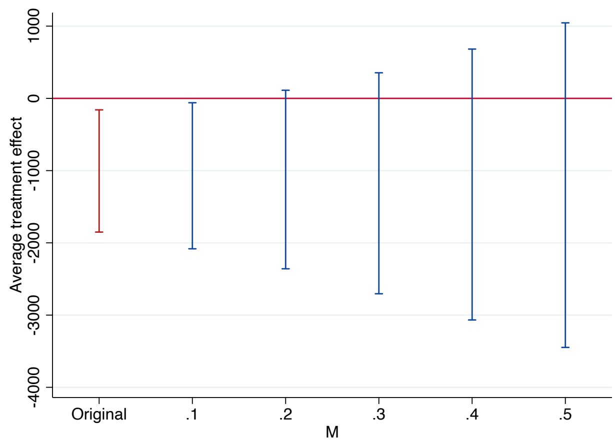
(a) Average treatment effect, first year



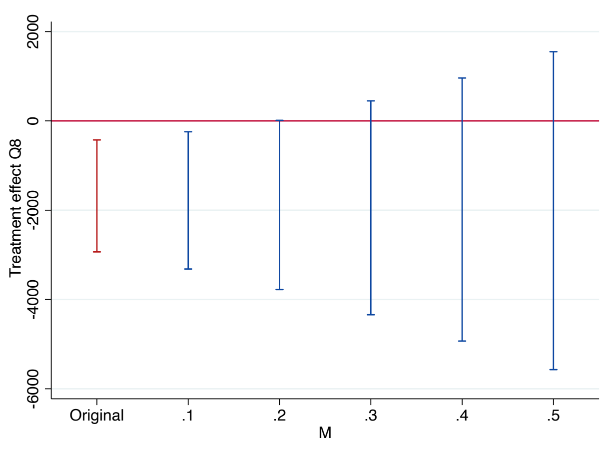
(b) Treatment effect, second quarter

Note: Sensitivity analysis for treatment effect as estimated in Table 5. Confidence bounds based on smoothness restriction: linear extrapolation from linear trend 2015Q1-2016Q2. The x-axis (M) indicates the deviation from linearity.

Figure 11: Credible approach to parallel trends, NINo registrations



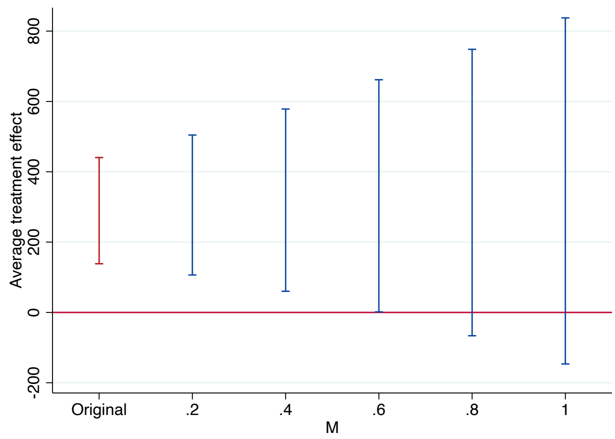
(a) Average treatment effect, second year



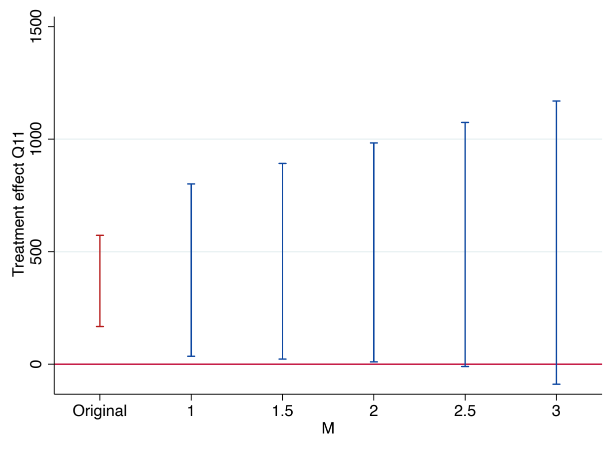
(b) Treatment effect, eighth quarter

Note: Sensitivity analysis for treatment effect as estimated in Table 5. Confidence bounds based on relative magnitude restriction: allowing for max. common trends violation observed in 2015Q1-2016Q2. The x-axis (M) indicates the factor multiplying the max. violation.

Figure 12: British citizenship applications



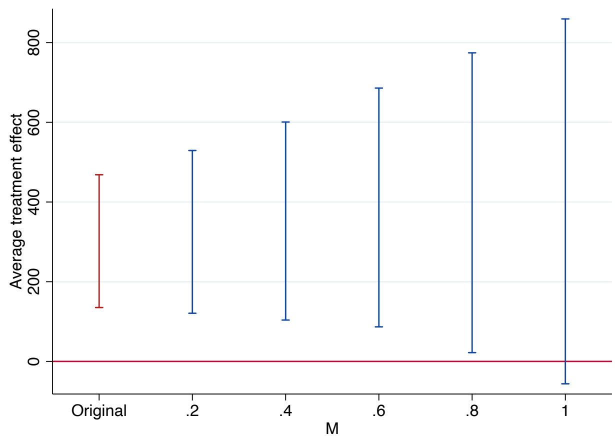
(a) Average treatment effect, second year



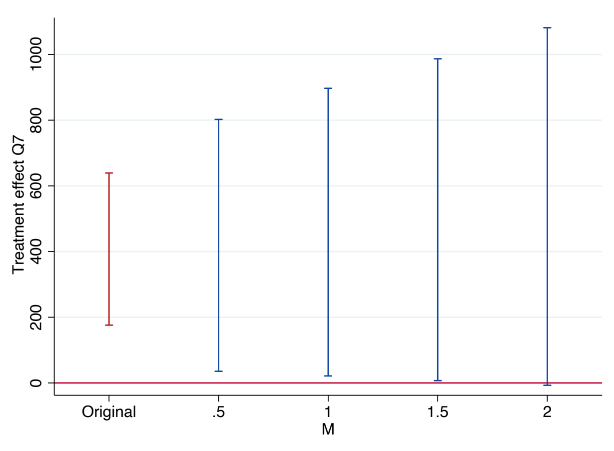
(b) Treatment effect, eleventh quarter

Note: Sensitivity analysis for treatment effect as estimated in Table 5. Confidence bounds based on relative magnitude restriction: allowing for max. common trends violation observed in 2015Q1-2016Q2. The x-axis (M) indicates the factor multiplying the max. violation.

Figure 13: British citizenship grants



(a) Average treatment effect, second year



(b) Treatment effect, seventh quarter

Note: Sensitivity analysis for treatment effect as estimated in Table 5. Confidence bounds based on relative magnitude restriction: allowing for max. common trends violation observed in 2015Q1-2016Q2. The x-axis (M) indicates the factor multiplying the max. violation.

Tables

Table 1: Descriptive statistics of UK migration by region of origin

	Stock foreign born residents		NINo registrations		Citizenship applications		Granted citizenship	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Northern Europe	315.6	37.2	8585.7	2021.1	517.4	317.3	461.8	304.4
Central and Eastern Europe	1259.4	213.3	77465.8	16691.9	3344.7	1797.4	3083.5	1764.8
Southern Europe	557.1	98.2	35378.7	7682.6	1508.5	1200.4	1354.0	1134.3
Western Europe	966.7	43.7	15602.9	3251.7	1309.0	1084.4	1167.7	1019.5
EFTA/Schengen	14.8	3.3	1071.8	180.7	40.4	22.7	35.5	22.1
Bilateral agreements with EU	106.1	10.2	1877.2	684.8	845.2	356.3	809.7	408.6
Other Europe and Central Asia	50.8	11.0	879.3	130.1	531.8	108.3	521.1	153.4
Asia	405.4	35.4	6203.8	1089.8	1829.9	963.1	1801.2	985.9
Oceania and Pacific Islands	188.1	15.0	4223.2	645.8	965.6	200.9	944.2	305.5
North America	269.3	18.6	3946.0	658.2	1180.9	141.8	1123.1	289.2
Latin America and Caribbean	245.7	13.3	2523.6	458.3	1617.2	436.9	1484.2	473.9
Middle East and North Africa	52.7	7.5	596.7	81.1	203.4	55.5	189.0	66.0
Sub-Saharan Africa	214.4	24.4	1081.3	209.6	1496.8	376.1	1458.8	503.6

Note: Quarterly mean and standard deviation of outcome variables. Migrant stocks are denoted in 1,000 and from the UK LFS, 2012Q2-2017Q2. Citizenship applications (2012Q2-2019Q2), citizenship grants (2012Q2-2019Q2), and NINo registrations (2014Q4-2019Q2) data are from the Home Office.

Table 2: Descriptive statistics of the stock of foreign-born residents in the UK, by socio-demographic characteristic, before and after the referendum

	EU migrant stock					non-EU migrant stock				
	(1)		(2)		(2)-(1)	(3)		(4)		(4)-(3)
	Before		After		Diff.	Before		After		Diff.
	mean	sd	mean	sd		mean	sd	mean	sd	
Total migrant stock	3437.3	149.4	3561.7	59.3	124.4	1408.9	68.3	1532.7	10.7	123.8*
Sex										
Male	1627.2	71.2	1706.5	30.4	79.4	628.2	32.3	699.2	24.7	71.0*
Female	1810.1	78.5	1855.2	36.6	45.1	780.7	39.2	833.5	15.7	52.8
Age										
Below 20 years	500.3	37.9	517.5	31.5	17.1	171.8	7.7	180.2	12.2	8.3
20 to 39 years	1704.6	106.1	1802.1	25.2	97.5	542.1	27.7	576.3	12.9	34.3
40 to 64 years	882.4	36.0	923.1	14.9	40.7	534.1	16.4	592.7	15.4	58.6**
Above 65 years	257.8	33.6	239.3	25.7	-18.6	102.3	19.4	120.6	11.2	18.3
Education										
Postgraduate	991.1	75.8	1037.5	28.4	46.4	607.8	36.4	692.2	12.4	84.4*
Graduate	243.0	21.2	256.7	8.0	13.7	112.0	4.4	100.1	4.7	-11.9**
High school	634.3	17.4	663.6	42.2	29.3	240.4	16.7	283.7	23.2	43.3*
Other qualifications	669.7	14.1	700.8	11.3	31.1*	151.7	9.0	149.4	5.0	-2.3
No qualifications	250.6	16.7	249.0	18.4	-1.6	68.8	4.5	60.5	12.6	-8.3
Non-UK Education										
Postgraduate	644.7	61.3	661.9	23.1	17.3	312.9	23.1	350.2	18.4	37.3*
Graduate	160.8	15.4	163.1	3.4	2.3	49.6	5.2	51.5	2.7	1.8
High school	283.1	23.2	294.0	33.8	10.8	62.5	6.0	72.6	7.5	10.1
Other qualifications	230.2	7.9	263.8	18.9	33.6*	40.3	3.8	42.4	7.2	2.1
Family composition										
Single, no child	723.4	33.7	699.2	28.9	-24.2	306.4	27.3	334.2	14.7	27.7
Single, with child	322.8	10.5	320.3	13.6	-2.5	125.0	8.3	110.3	8.2	-14.7*
Couple, no child	896.2	29.4	905.9	28.4	9.8	364.8	27.7	424.5	21.2	59.6*
Couple, with child	1494.9	102.4	1636.2	65.2	141.4	612.6	14.3	663.7	7.7	51.1**
Work status										
Employee	1838.0	78.0	1957.3	17.9	119.3	663.4	31.4	745.1	2.1	81.7*
Self-employed	340.9	27.6	353.2	22.1	12.3	144.4	11.4	167.4	8.4	23.0*
Unemployed	101.5	5.3	103.5	11.1	2.1	43.9	6.4	39.2	4.2	-4.7
Retired	326.5	39.9	305.6	20.9	-20.9	156.5	21.9	168.0	16.3	11.5
Sector										
Agriculture	30.8	3.0	35.2	4.6	4.4	10.5	3.2	13.0	2.3	2.5
Manufacturing	518.4	37.2	567.2	11.8	48.8	90.6	5.7	103.1	2.2	12.4*
Service	1610.4	66.1	1689.4	24.8	79.0	702.6	26.8	791.3	7.4	88.7**
UK region										
England, excl. London	1989.2	73.9	2138.2	37.0	149.0*	791.0	18.6	830.0	23.2	39.0*
London	1044.4	60.2	1015.2	45.0	-29.1	485.4	37.6	559.1	31.6	73.7*
Wales	96.3	6.2	84.2	6.5	-12.1*	27.6	3.0	26.5	7.7	-1.2
Scotland	211.6	13.4	221.5	5.6	9.9	90.1	16.6	97.1	9.0	7.0
Northern Ireland	95.9	9.5	102.6	11.4	6.8	14.8	2.6	20.1	4.1	5.3
Region by voting outcome										
Remain	1390.2	78.4	1372.9	41.3	-17.3	603.9	54.9	696.4	36.6	92.6*
Leave	2047.1	76.1	2188.8	39.0	141.7*	805.0	14.0	836.3	33.0	31.2

Note: Quarterly mean and standard deviation based on UK LFS data, 2015Q3-2017Q2. *** p<0.01, ** p<0.05, * p<0.1. Difference in means tested using t-test for unequal variances. Stocks are denoted in 1,000 and were aggregated by EU and non-EU origin region. Excluding countries from the Schengen Area or EFTA, and countries holding bilateral agreements with the EU.

Table 3: Descriptive statistics of NINo registrations, by socio-demographic characteristic and type, before and after the referendum

	EU origin countries					non-EU origin countries				
	(1)		(2)		(2)-(1)	(3)		(4)		(4)-(3)
	Before		After		Diff.	Before		After		Diff.
	mean	sd	mean	sd		mean	sd	mean	sd	
Total NINo	157712	14471	144056	20866	-13655	19298	1993	18658	1902	-640
Sex										
Male	91139	7758	81740	10522	-9399	7831	706	7526	651	-305
Female	66578	7364	62322	10511	-4256	11460	1323	11132	1315	-328
Age										
Below 18 years	2128	582	2557	711	429	177	24	159	9	-18
18 to 24 years	57582	9185	54424	11869	-3158	6510	1232	6021	1106	-490
25 to 34 years	55818	7322	47415	6846	-8403	8977	596	8730	897	-248
35 to 44 years	25517	1981	22918	2328	-2599	2333	290	2371	150	38
45 to 54 years	12601	1355	12472	1240	-129	895	88	941	22	46
Above 54	4053	672	4255	610	202	308	48	338	13	30
UK region										
England	143719	13583	130620	18817	-13100	17486	1733	16830	1636	-657
Wales	2626	339	2544	401	-82	370	69	340	88	-30
Scotland	8470	1732	8076	1998	-393	1229	234	1254	205	25
Northern Ireland	2247	387	2147	169	-100	134	21	123	22	-11
Region by voting outcome										
Remain	80580	9527	72254	11688	-8326	12204	1427	11351	1361	-852
Leave	66498	4379	61826	8383	-4672	1623	269	1509	125	-114

Note: Quarterly mean and standard deviation based on Home Office data, 2015Q3-2017Q2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Difference in means tested using t-test for unequal variances. NINo registrations were aggregated by EU and non-EU origin region. Excluding countries from the Schengen Area or EFTA and countries holding bilateral agreements with the EU.

Table 4: Descriptive statistics of British citizenship applications and grants, by socio-demographic characteristic and type, before and after the referendum

	EU origin countries					non-EU origin countries				
	(1)		(2)		(2)-(1)	(3)		(4)		(4)-(3)
	Before		After		Diff.	Before		After		Diff.
	mean	sd	mean	sd		mean	sd	mean	sd	
Total applications	3974	1106	7160	2950	3185	7398	734	6073	756	-1325*
Application type										
Naturalisation	2815	1190	4956	2419	2141	5212	453	4137	574	-1075*
Registration	1160	218	2204	574	1044*	2185	290	1936	184	-250
Total grants	3865	1894	4577	892	712	7556	2081	5664	1398	-1893
Application type										
Naturalisation										
Marriage	392	222	582	175	190	1830	563	1090	336	-739
Residence	2438	1435	2331	442	-106	3593	878	2825	837	-768
Registration										
Minor children	876	321	1300	233	424	1390	472	1106	260	-285
Other grounds	160	112	363	97	204*	744	383	643	21	-101
Sex										
Female	2075	1053	2458	486	382	4352	1185	3144	818	-1208
Male	1787	843	2118	408	331	3201	898	2517	577	-684
Age										
Below 18 years	938	378	1500	289	562	1522	520	1226	243	-296
18 to 29 years	374	181	366	59	-9	775	211	622	154	-153
30 to 49 years	2286	1363	2325	507	39	4303	1083	3047	857	-1256
50 to 69 years	251	135	357	82	106	877	299	701	163	-176
Above 70 years	16	4	30	8	14*	80	23	66	15	-14

Note: Quarterly mean and standard deviation based on Home Office data, 2015Q3-2017Q2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Difference in means tested using t-test for unequal variances. Applications and grants were aggregated by EU and non-EU origin region. Excluding countries from the Schengen Area or EFTA and countries holding bilateral agreements with the EU.

Table 5: TWFE estimates

	(1) Stock foreign-born residents	(2) NINo registrations	(3) British citizenship applications	(4) British citizenship grants
2015Q1	-20.57**	715.95***	1.77	69.87
	(9.33)	(249.04)	(23.43)	(46.10)
2015Q2	-14.35	-158.27	7.62	2.33
	(8.66)	(233.79)	(21.02)	(31.31)
2015Q3	-7.93	324.53	35.99	-15.40
	(7.01)	(491.63)	(22.55)	(17.87)
2015Q4	-5.43	1,064.32***	74.53**	4.73
	(5.97)	(339.72)	(37.25)	(20.06)
2016Q1	-2.05	809.94**	-42.57***	54.86
	(4.42)	(307.39)	(11.32)	(51.73)
Brexit referendum				
2016Q3	-5.43	363.12	55.29***	1.99
	(5.45)	(334.80)	(12.13)	(11.05)
2016Q4	-7.69	1,035.57***	104.68***	38.60***
	(4.79)	(383.48)	(20.47)	(13.79)
2017Q1	-2.69	-208.69	234.03***	102.43***
	(6.91)	(229.10)	(61.50)	(26.82)
2017Q2	-3.47	-563.59*	258.91***	132.90***
	(8.80)	(312.76)	(66.05)	(31.43)
2017Q3		-566.31	226.12***	243.85***
		(402.29)	(55.96)	(63.56)
2017Q4		-705.56*	313.87***	322.39***
		(383.46)	(76.73)	(93.49)
2018Q1		-907.15**	325.20***	407.62***
		(415.63)	(91.69)	(118.22)
2018Q2		-1,598.89**	292.67***	233.54***
		(632.03)	(88.31)	(68.32)
2018Q3		-1,186.78**	238.15***	289.30***
		(586.09)	(77.54)	(90.69)
2018Q4		-943.56*	447.84***	331.94***
		(494.94)	(120.40)	(96.70)
2019Q1		-889.12*	517.83***	370.04***
		(531.15)	(147.08)	(103.39)
2019Q2		-591.13	238.88***	375.19***
		(503.43)	(73.15)	(107.92)
Observations	876	1,422	2,206	2,183
R-squared	0.26	0.18	0.35	0.35
Origin countries	48	83	85	84
Pre-ref mean	163.7	5,205	125	115.4

Note: Sample from 2012Q3 to 2017Q2 (column 1), 2014Q4 to 2019Q2 (column 2), and 2012Q3 to 2019Q2 (column 3-4). *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Includes origin country fixed effects, time fixed effects, quarter fixed effects, and control variables. Migrant stocks are reported in 1,000.

Table 6: Synthetic DD, average treatment effects

	(1) Stock foreign-born residents	(2) NINo registrations	(3) British citizenship applications	(4) British citizenship grants
ATT	15.79	-1,169.48**	267.44***	265.54***
	(13.96)	(511.34)	(68.44)	(62.38)
Observations	820	1,368	2,016	1,904
Pre-ref mean	163.7	5205	125	124.5
% change	9.6	-22.47	214	213.4

Note: Average treatment effect on the treated, mean outcome for EU origin countries in 2016Q2, and treatment coefficient divided by the pre-referendum EU mean. Sample from 2012Q3 to 2017Q2 (column 1), 2014Q4 to 2019Q2 (column 2), and 2012Q3 to 2019Q2 (columns 3-4). Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Migrant stocks are reported in 1,000.

Table 7: Synthetic DD estimates by migrant characteristic, stock foreign-born residents

	Sex			Age category		
	Male	Female	Below 20	20 to 39	40 to 64	Above 65
	(1)	(2)	(3)	(4)	(5)	(6)
ATT	6.42	3.25	2.52	15.62**	2.63	-0.45
	(5.98)	(4.95)	(2.07)	(6.78)	(2.83)	(1.35)
Pre-mean	77.46	86.23	24.36	83.03	42.49	10.20
% change	8.290	3.766	10.33	18.81	6.195	-4.396

			Education level			Current student
	Postgraduate	Graduate	High school	Other	None	
	(7)	(8)	(9)	(10)	(11)	(12)
ATT	0.02	1.59*	4.28*	5.54	1.87	2.37**
	(3.60)	(0.85)	(2.40)	(3.59)	(1.30)	(0.99)
Pre-mean	49.10	11.91	29.89	30.99	12.46	10.58
% change	0.0366	13.39	14.31	17.87	15.01	22.43

	Sector			Industry		
	Agric.	Manufact.	Service	Retail, repair & wholesale	Accomm. & food service	Health & social work
	(13)	(14)	(15)	(16)	(17)	(18)
ATT	0.21	3.72	9.43	2.46	1.21	0.95
	(0.37)	(3.13)	(6.18)	(1.66)	(1.02)	(1.23)
Pre-mean	1.398	25.94	77.29	12.54	10.33	10.79
% change	15.20	14.35	12.20	19.61	11.67	8.847

	Recent (<5y) migrant			UK region		
		England	London	Wales	Scotland	N. Ireland
	(19)	(20)	(21)	(22)	(23)	(24)
ATT	3.68	11.33	-0.98	0.07	1.15	0.37
	(5.38)	(6.94)	(3.20)	(0.41)	(1.24)	(0.76)
Pre-mean	59.34	93.24	51.12	4.197	10.52	4.619
% change	6.209	12.16	-1.917	1.758	10.98	8.083

	Region by voting			EU origin region		
	Remain	Leave	North	East	South	West
	(25)	(26)	(27)	(28)	(29)	(30)
ATT	1.14	13.76*	0.31	43.60	20.26	0.43
	(3.79)	(7.85)	(7.43)	(35.39)	(17.90)	(7.91)
Pre-mean	59.34	59.34	74.15	254.9	137.7	168.7
% change	1.914	23.19	0.416	17.10	14.71	0.252

Note: Average treatment effect on the treated, mean outcome for EU origin countries in 2016Q2, and treatment coefficient divided by the pre-referendum EU mean. Based on UK LFS, 2012Q3 to 2017Q2. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Synthetic DD estimates by migrant characteristic, NINo registrations

	Sex		Age category			
	Male	Female	Below 18	18 to 24	25 to 34	
	(1)	(2)	(3)	(4)	(5)	
ATT	-876.75**	-315.75**	11.42	-150.36	-806.73**	
	(362.57)	(149.54)	(8.91)	(128.14)	(313.43)	
Pre-mean	3098	2107	65.37	1702	1867	
% change	-28.30	-14.99	17.48	-8.835	-43.20	
	Age category			Constituency type		
	35 to 44	45 to 54	Above 54	Borough	County	
	(6)	(7)	(8)	(9)	(10)	
ATT	-306.01***	-102.44**	-29.71	-777.89**	-329.84**	
	(117.55)	(40.82)	(19.99)	(340.08)	(167.21)	
	926.8	485.3	157.6	3369	1483	
	-33.02	-21.11	-18.85	-23.09	-22.24	
	UK region					
	England	London	Wales	Scotland	N. Ireland	
	(11)	(12)	(13)	(14)	(15)	
ATT	-564.84**	-582.88**	-13.00	-58.53*	-11.78	
	(268.82)	(252.63)	(8.28)	(31.93)	(10.34)	
	2957	1811	89.26	253.7	71.26	
	-19.10	-32.18	-14.56	-23.07	-16.53	
	Region by voting		EU origin region			
	Remain	Leave	North	East	South	West
	(16)	(17)	(18)	(19)	(20)	(21)
ATT	-615.10**	-396.53	-244.77	-2,522.80*	-1,175.82*	-365.91
	-265.87	-275.89	-170.59	-1,405.31	-682.72	-270.73
	2573	2279	1394	10241	5951	2077
	-23.91	-17.4	-17.56	-24.63	-19.76	-17.62

Note: Average treatment effect on the treated, mean outcome for EU origin countries in 2016Q2, and treatment coefficient divided by the pre-referendum EU mean. Based on UK Home Office data, 2014Q4 to 2019Q2. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Synthetic DD estimates by migrant characteristic, citizenship applications

	Reason application		Dual citizenship	
	Naturalisation	Registration	Prohibited	Allowed
	(1)	(2)	(3)	(4)
ATT	223.95***	60.37***	199.70*	292.06***
	(57.62)	(14.74)	(103.26)	(83.17)
Pre-mean	78.23	46.73	98.29	134.8
% change	286.3	129.2	203.2	216.7
	EU origin region			
	North	East	South	West
	(5)	(6)	(7)	(8)
ATT	86.07***	346.69**	321.38**	285.62**
	(19.81)	(157.93)	(138.10)	(141.73)
Pre-mean	47.83	204.5	113.3	107.7
% change	179.9	169.5	283.6	265.3

Note: Average treatment effect on the treated, mean outcome for EU origin countries in 2016Q2, and treatment coefficient divided by the pre-referendum EU mean. Based on UK Home Office data, 2012Q3 to 2019Q2. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Synthetic DD estimates by migrant characteristic, citizenship grants

	Sex		Age category			
	Male	Female	Below 18	18 to 29	30 to 49	
	(1)	(2)	(3)	(4)	(5)	
ATT	115.96***	148.14***	60.49***	22.48***	172.48***	
	(27.43)	(36.58)	(14.00)	(4.88)	(46.32)	
Pre-mean	59.62	64.62	51.54	12.21	52.83	
% change	194.5	229.2	117.4	184.2	326.5	
	Age category		Reason application			
	50 to 69	Above 70	Residence	Minor	Other	Marriage
	(6)	(7)	(8)	(9)	(10)	(11)
ATT	22.01***	0.70	161.53***	55.05***	10.72***	45.36***
	(8.29)	(0.77)	(42.27)	(12.67)	(3.48)	(11.20)
Pre-mean	7.125	0.750	58.58	44.96	12.12	8.792
% change	309	93.37	275.7	122.4	88.40	516
	EU origin region				Dual citizenship	
	North	East	South	West	Prohibited	Allowed
	(12)	(13)	(14)	(15)	(16)	(17)
ATT	75.27***	342.14**	369.36**	275.95**	172.16	303.45***
	(20.78)	(149.70)	(154.35)	(137.37)	(109.23)	(87.22)
Pre-mean	52.83	227.9	101	95	100.9	134.2
% change	142.5	150.2	365.7	290.5	170.7	226.2

Note: Average treatment effect on the treated, mean outcome for EU origin countries in 2016Q2, and treatment coefficient divided by the pre-referendum EU mean. Based on UK Home Office data, 2012Q3 to 2019Q2. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Exchange rates and uncertainty indices, DD

	(1) Stock foreign-born residents	(2) NINO registrations	(3) British citizenship applications	(4) British citizenship grants
A. Baseline DD				
EU x post	12.73	-955.64**	253.87***	220.90***
	(9.06)	(386.25)	(71.22)	(63.52)
	[0.03]	[-0.07]	[0.26]	[0.24]
B. Exchange rate				
EU x post	10.44	-1,107.47**	287.84***	248.31***
	(10.27)	(459.36)	(80.28)	(70.28)
	[0.02]	[-0.08]	[0.30]	[0.27]
Currency change	-24.23	1,527.71**	-28.83	-39.85
	(17.48)	(725.17)	(92.90)	(104.29)
	[-0.008]	[0.01]	[-0.003]	[-0.005]
EU x post x currency change	-60.35	-12,176.28	3,029.64***	2,521.49***
	(163.04)	(9,517.32)	(965.14)	(796.02)
	[-0.006]	[-0.03]	[0.09]	[0.08]
C. Uncertainty indices				
EU x BUI	0.27	-9.57*	3.38***	2.54***
	(0.17)	(4.89)	(1.04)	(0.89)
	[0.04]	[-0.04]	[0.19]	[0.15]
EU x BUI (imm.)	13.46	-348.28**	110.60***	61.98*
	(8.18)	(169.15)	(39.36)	(32.28)
	[0.04]	[-0.03]	[0.12]	[0.07]
EU x BUI (twitter)	828.47	-21,854.57*	10,158.46***	7,705.89***
	(517.26)	(10,995.71)	(3,043.40)	(2,566.82)
	[0.03]	[-0.03]	[0.18]	[0.14]
EU x EPU	0.10**	1.03	0.26	-0.01
	(0.05)	(0.94)	(0.16)	(0.15)
	[0.07]	[0.02]	[0.06]	[-0.00]

Note: Sample from 2012Q3 to 2017Q2 (column 1), 2014Q4 to 2019Q2 (column 2), and 2012Q3 to 2019Q2 (column 3-4). BUI indices available starting 2013Q1. *** p<0.01, ** p<0.05, * p<0.1. Cluster-robust standard errors in parentheses. Standardised coefficients in brackets. Includes origin country fixed effects, time fixed effects, quarter fixed effects, and control variables. Panel B shows the regression results when including the exchange rate variable and its interaction with the treatment effect. Panel C lists the results of four separate regressions with each a different uncertainty index as continuous treatment indicator. All indices are scaled differently.

Table 12: Google searches and (social) media, synthetic DD

	(1) Stock foreign-born residents	(2) NINO registrations	(3) British citizenship applications	(4) British citizenship grants
A. Newspaper articles on 'Brexit'				
Lowest number of articles				
ATT	15.85	-992.09*	320.00***	332.62***
	(12.26)	(569.83)	(113.47)	(104.03)
pre-ref mean	110.5	5553	126	117
% change	14.35	-17.87	254	284.3
Highest number of articles				
ATT	14.95	-1,030.30	296.77**	273.45**
	(25.42)	(888.97)	(116.84)	(121.00)
pre-ref mean	243.3	3393	148.2	137.1
% change	6.15	-30.36	200.2	199.4
B. Google searches containing 'Brexit'				
Lowest number of Google searches				
ATT	22.56	-1,581.26*	251.77***	238.36***
	(19.66)	(830.64)	(87.12)	(77.97)
pre-ref mean	175.3	6703	143.3	148.2
% change	12.87	-23.59	175.7	160.8
Highest number of Google searches				
ATT	8.30	-658.50	287.80***	302.47***
	(9.08)	(420.57)	(99.44)	(111.05)
pre-ref mean	149.8	3332	99.91	91.20
% change	5.538	-19.76	288.1	331.7
C. Share of negative tweets using #Brexit				
Lowest share of negative tweets				
ATT	56.28	-3,459.76	631.83**	589.61**
	(53.90)	(2,210.86)	(273.31)	(239.39)
pre-ref mean	335	11402	297	262
% change	16.80	-30.34	212.7	225
Highest share of negative tweets				
ATT	-3.19	-420.57	414.30**	400.71**
	(9.58)	(362.26)	(171.45)	(181.79)
pre-ref mean	158.6	2710	146.5	129.2
% change	-2.008	-15.52	282.8	310

Note: Sample from 2012Q3 to 2017Q2 (column 1), 2014Q4 to 2019Q2 (column 2), and 2012Q3 to 2019Q2 (columns 3-4). Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Each panel lists the results of two separate regressions with each a different subsample.

Table 13: Robustness checks, alternative specifications

	(1) Stock foreign-born residents	(2) NINo registrations	(3) British citizenship applications	(4) British citizenship grants
A. Excluding anticipation period (2016Q1-Q2)				
ATT	21.77	-1,423.23***	238.31***	261.40***
	(13.45)	(524.55)	(63.89)	(65.12)
B. Placebo test (2015Q3)				
ATT	18.22*	323.00	25.19***	9.74
	(9.34)	(297.07)	(9.69)	(23.74)
C. Yearly control variables				
ATT	14.73	-1,140.46**	255.89***	245.89***
	-13.9	-551.28	-62.33	-63.09
D. Quarterly control variables (OECD countries)				
ATT	4.36	-1,473.58***	238.68***	236.23***
	-6.96	-526.06	-62.81	-73.56
E. UK quarterly control variables				
ATT	15.79	-1,174.48**	267.42***	265.55***
	(13.96)	(516.89)	(68.46)	(62.37)
F. Shorter post-period (1.5 years)				
ATT	15.79	-558.65*	198.81***	169.53***
	(13.96)	(316.80)	(47.02)	(39.76)
G. Logarithmic outcome				
ATT	0.02	-0.24***	267.44***	265.54***
	(0.07)	(0.06)	(68.44)	(62.38)

Note: Synthetic DD estimator with alternative samples and specifications. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 14: Robustness checks, alternative control units

	(1) Stock foreign-born residents	(2) NINo registrations	(3) British citizenship applications	(4) British citizenship grants
G. Schengen, EFTA and other EU-agreement countries as treated units				
ATT	-1.18	96.31	9.48	12.87
	(5.94)	(66.77)	(14.53)	(9.95)
H. Schengen, EFTA and other EU-agreement countries as control units				
ATT	13.6	-1,570.06**	265.68***	250.48***
	-9.8	-635.2	-64.27	-67.8
I. 20 most common (control) origin countries				
ATT	15.53	-1,181.95**	281.45***	262.68***
	-14.65	-537.35	-69.94	-61.85
J. Excluding Middle Eastern and North African countries				
ATT	5.54	-1,183.15**	261.73***	249.38***
	(8.25)	(504.28)	(62.84)	(52.85)
K. Excluding Commonwealth countries				
ATT	3.71	-1,486.77**	295.83***	248.30***
	(9.52)	(589.89)	(67.16)	(62.16)

Note: Synthetic DD estimator with alternative control units. Sample from 2012Q3 to 2017Q2 (column 1), 2014Q4 to 2019Q2 (column 2), and 2012Q3 to 2019Q2 (columns 3-4). Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: Sensitivity of the LFS

	Threshold for weighted migrant stock			
	<10000	< 20000	<30000	<50000
	(1)	(2)	(3)	(4)
Foreign-born residents				
ATT	15.79	18.42	23.06	31.15
	(13.96)	(15.77)	(16.90)	(22.04)
Observations	820	680	580	400
Origin countries	41	34	29	20
Foreign citizens				
ATT	12.65	22.19	19.87	30.49
	(13.03)	(17.07)	(22.61)	(20.34)
Observations	820	540	400	320
Origin countries	41	27	20	16

Note: Synthetic DD estimator with sample from 2012Q3 to 2017Q2. Columns vary the thresholds for which the migrant stock is considered reliable; first column is the baseline. Rows vary the definition of migrant stock; first row is the baseline. Bootstrapped standard errors (200 replications) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix

A Timeline Brexit referendum and process

Table A1: Brexit referendum timeline

2013 Jan	Prime Minister David Cameron promises referendum if Conservative Party wins 2015 general election.
2015 May	Conservative Party wins election. Bill to hold referendum is introduced to Parliament.
2016 Feb 22	Cameron announces referendum date: 23/06/2016. Start unofficial campaigns.
2016 Apr 14	Official EU referendum campaign period opens.
2016 Jun 23	Brexit referendum asking 'Should the UK remain a member of the EU or leave the EU?'. Majority of 51.9% (17,410,742 votes) elect Leave.
2016 July	Theresa May is new Prime Minister.
2017 Mar 29	Article 50 (legal mechanism for EU member to formally leave) is triggered. UK is set to leave EU in 2 years.
2017 Jun	May forms new government after General Election.
	UK-EU exit negotiations begin.
2018 Jun	Minister for Immigration gives statement on new settlement scheme for resident EU citizens.
2018 Dec	Future skills-based immigration system white paper is published and sets out new system, ending free movement.
2019 Jan 15	May loses 'Meaningful Vote', the final vote on Brexit deal.
2019 Mar	May loses 'Meaningful Vote 2' and 'Meaningful Vote 3'.
	May obtains permission from EU to extend Article 50. Brexit is postponed.
	Introduction of EU Settlement Scheme: registration of EU citizens in the UK to secure future residence in the UK.
2019 Apr	May obtains permission from EU to extend Article 50.
2019 May	May announces resignation.
2019 Jul	Boris Johnson is new Prime Minister.
2019 Oct	Johnson proposes new Brexit deal.
	European Union (Withdrawal Agreement) Bill introduced to Parliament and voted through.
	Johnson obtains permission from EU to extend Article 50.
2019 Dec 19	Government publishes EU (Withdrawal Agreement) Bill.
2020 Jan 23	EU (Withdrawal Agreement) Act becomes law, having received Royal Assent.
2020 Jan 31	At 23:00 GMT, UK officially leaves the EU. Start transition period.
	Start negotiations on new trade deal.
2020 Dec 31	End of transition period: UK leaves EU single market and customs union.

Note: More detailed information provided by the Electoral Commission (2016), General Secretariat of the Council (2023), and Home Office and UK Visas and Immigration (2018a, 2018b).

B Migration regulations in the UK

Before Brexit, the UK had no control over EU migration. Britain entered the European Economic Community (now the EU) in 1973, which introduced free movement among member states. EU rules do not allow a country to control or regulate immigration levels among member countries. Migrants originating from the EU or migrants that previously entered the EU and acquired citizenship in any EU member state, had an automatic right to live and work in the UK prior to Brexit.

Non-EU migration is governed by a points-based system of immigration that admits migrants based on their qualifications and potential benefit to the UK. The system categorizes migrants into 5 Tiers: highly skilled workers (1), sponsored skilled workers (2), low skilled workers (3), students (4), and special categories of temporary migrants (short-term or voluntary visas) (5). Non-EU workers generally require a suitable job offer or prospective to work in the UK, often need a visa sponsored by a UK-based employer, and must demonstrate skill and language proficiency. Students need a place offer at an institution and must prove they can support themselves financially and pay a healthcare surcharge. Temporary visitors from some countries are able to enter the UK and stay for up to six months without a visa but are never permitted to do paid or unpaid work. In the UK, asylum seekers must convince the authorities they are unable to live safely in their own country and they fear persecution if they return. The EU asylum policy (1990 Dublin Convention) sets out which state is responsible for processing an asylum application. (Gower, 2018)

The key aspects of the UK immigration system did not change around the time of the referendum. Table B1 below summarises the most relevant changes within our considered time period.

Table B1: British migration policy or legislation changes

Feb-2008	Points-based immigration system launched through successive Statements of Changes to Immigration Rules.
Jan-2010	Target of reducing net migration < 100,000 introduced.
Jan-2014	Transitional restrictions on Bulgarians and Romanians (joined EU in 2012) lifted.
May-2014	Immigration Act 2014 introduces measures aimed at creating ‘hostile environment’ for illegal immigrants.
Oct-2014	Introduction of the British-Irish Visa Scheme.
Apr-2015	Immigration Rules for visitors consolidated and clarified.
Apr-2015	Changes to Tier 2 Shortage Occupation List.
Nov-2015	Nurses and four occupations in the digital technology sector added to Shortage Occupation List for Tier 2.
Apr-2016	Pay threshold of £35,000 implemented for Tier 2 settlement applications, excl. shortage and PhD-level occupations.
Jun-2016	**Brexit referendum**
Apr-2017	Small adaptations in Tier 4 regulations: minimum age requirement short-term study reduced, etc.
Jan-2018	Small adaptations in Tier 4 regulations: some part-time studies covered, some overseas elective courses allowed, etc.
Jun-2018	Transitional restrictions on Croatians (joined EU in 2013) lifted.
Jul-2018	Documentary requirements for Tier 4 applications reduced for 11 countries.
Jul-2018	New settlement category for Turkish workers and their families in the UK, under the EU-Turkey European Communities Association Agreement.
Jul-2018	Doctors and nurses exempted from the Tier 2 limit.
Jul-2019	Target of reducing net migration below 100,000 scrapped.

Note: More detailed changes and updates in British migration policy or legislation are provided by the UK Home Office, https://www.gov.uk/government/publications/policy-and-legislative-changes-affecting-migration-to-the-uk-timeline.

C Choice of control countries

In order to compare treated EU origin countries to comparable untreated origin countries, we limit our control group to non-EU high- and upper-middle-income economies following the World Bank's country classification of 2016 as shown in Table C1 (World Bank, 2022). Countries in bold are EU countries; these are the 27 treated origin countries. The Faroe Islands and Greenland were added to Denmark and the Macao Special Administrative Region of China was added to China, as these distinctions usually do not exist in the available data. Aruba, Curacao, Guam, Marshall Islands, Nauru, Northern Mariana Islands, Palau, Sint Maarten (Dutch), and St. Martin (French) were excluded; these nations do not appear in any of the data or consist mainly of missing observations. Countries that were re-classified as lower-middle-income economies (Mongolia, Algeria and Iran) or became unclassified (Venezuela) in the years after the referendum were excluded. Iraq, despite classifying as upper-middle-income economy throughout the relevant period, was also excluded due to ongoing conflicts. The British dependency islands (Channel Islands and Isle of Man) and British Overseas territories (Gibraltar) in Europe are closely related to the UK or officially belong to the UK. As they were also part of the EU or the EU's customs area, we consider them neither treated nor untreated and exclude them. British overseas territories outside Europe were not excluded, as they are suitable control countries: the Brexit referendum should not have affected migration between these territories and the UK. In total, 72 origin countries are considered to be a suitable control unit.

Table C1: High- and upper-middle-income economies, as classified by the World Bank 2016-2020

	High-income economies			Upper-middle-income economies		
Europe and Central Asia	Andorra[2]	**Greece**	Monaco[2]	Albania[2]	**Croatia**[H]	Russian federation
	Austria	Greenland	**Netherlands**	Azerbaijan	Kazakhstan	Serbia[2]
	Belgium	**Hungary**	Norway[1]	Belarus	Montenegro[2]	Türkiye[2]
	Channel Isl[3]	Iceland[1]	**Poland**	Bosnia & Herzeg.[2]	North Macedonia[2]	Turkmenistan
	Cyprus	**Ireland**	**Portugal**	**Bulgaria**	**Romania**	
	Czech Republic	Isle of Man[3]	San Marino[2]			
	Denmark	**Italy**	**Slovak Republic**			
	Estonia	**Latvia**	**Slovenia**			
	Faroe Isl	Liechtenstein[1]	**Spain**			
	Finland	**Lithuania**	**Sweden**			
	France	**Luxembourg**	Switzerland[1]			
	Germany	**Malta**	United Kingdom			
	Gibraltar[3]					
Oceania	Australia	New Caledonia	French Polynesia	Fiji	Palau[H]	Tuvalu
	Nauru	Northern Mariana Isl	Guam	Marshall Isl	Tonga	American Samoa
	New Zealand					
Asia and Pacific islands	Brunei Darussalam	Korea, Rep.	Singapore	Malaysia	Thailand	Maldives
	Hong Kong SAR	Macao SAR	Taiwan	Mongolia[LM]	China	
	Japan					
Latin America and Caribbean	Antigua & Barbuda	Chile	Trinidad & Tobago	Argentina	Dominican Republic	Paraguay
	Aruba	Puerto Rico	Turks & Caicos Isl	Belize	Ecuador	Peru
	Bahamas, The	Sint Maarten (Dutch)	Uruguay	Brazil	Grenada	St. Lucia
	Barbados	Saint Kitts and Nevis	Virgin Isl (US)	Colombia	Guyana	St. Vincent & Gren.
	Virgin Isl (UK)	St. Martin (French)	Curaçao	Costa Rica	Jamaica	Suriname
	Cayman Isl			Cuba	Mexico	Venezuela[U]
				Dominica	Panama	
Middle East and North Africa	Bahrain	Oman	Saudi Arabia	Algeria[LM]	Iraq	Libya
	Kuwait	Qatar	United Arab Emirates	Iran[LM]	Lebanon	
North America	Bermuda	Canada	United States			
Sub-Saharan Africa	Seychelles			Botswana	Gabon	Namibia
				Equatorial Guinea	Mauritius	South Africa

[1] Schengen Area or EFTA; [2] Stabilisation and Association Agreement/bilateral Customs Union arrangement; [3] Part of or closely related to the UK; [H] Became higher-income economies by 2020; [LM] Became lower-middle-income economies by 2020; [U] Became unclassified by 2020.

D Non-EU migration in the UK

Our identification strategy is based on the stable unit treatment value assumption, stating that the Brexit referendum only affected EU migration (treated units) and had no impact on non-EU immigrants (control units). This section provides descriptive evidence to illustrate the validity of this assumption and resolve any concerns that non-EU migration increased after the vote as a result of labour market pressures

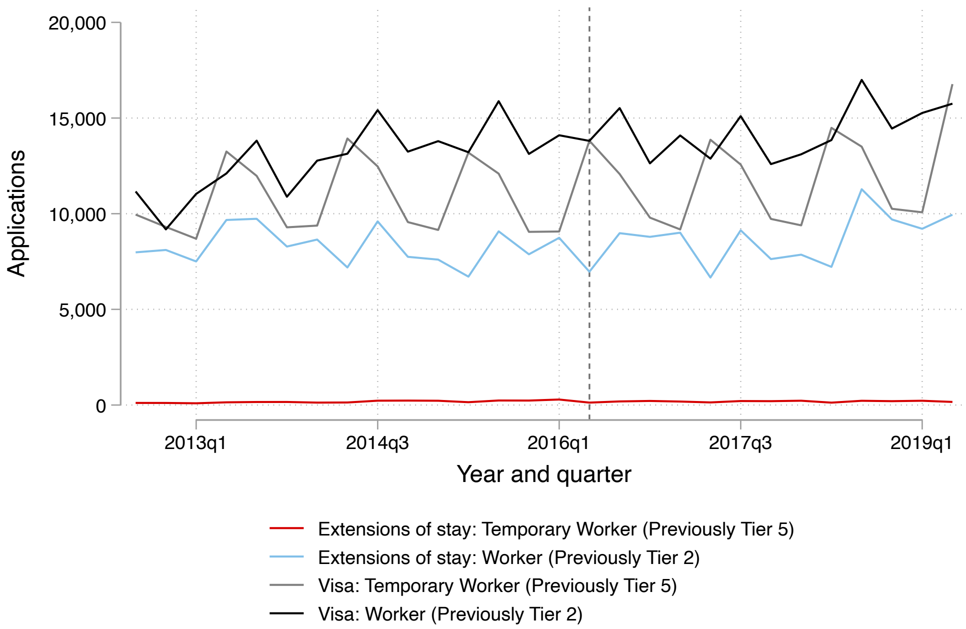
Figure D1 plots the evolution of visa and extension of stay applications over time. The numbers include applications from all nationalities, not only origin countries in our sample. The figure plots applications of different types and for the ten most common industries. We observe a steady trend over time, with no change around the time of the referendum. For both the number of visa applications and extension of stay applications, we fail to reject the null hypothesis of no structural break (p-value Supremum Wald test 0.97 and 0.44, respectively). When focusing only on visa applications, we observe the applicants' country of origin and the specific types of visas requested. Figure D2 plots the visa applications by type for the origin countries in our sample. The largest number of applications are for visitors, followed by students. When specifying the type of visa further, these categories are excluded, as the large numbers distort the figure. In addition, visitors (short-term migrants up to six months) and students are generally not captured in any of our main outcome variables. We observe that the majority of visa applications are made for work-related reasons, often following seasonal movements. Overall, none of the categories show a break around the time of the referendum, supporting our assumption.

Finally, we test whether the referendum had a significant impact on non-EU migration outcomes using a linear fixed effects regression. We estimate the following equation:

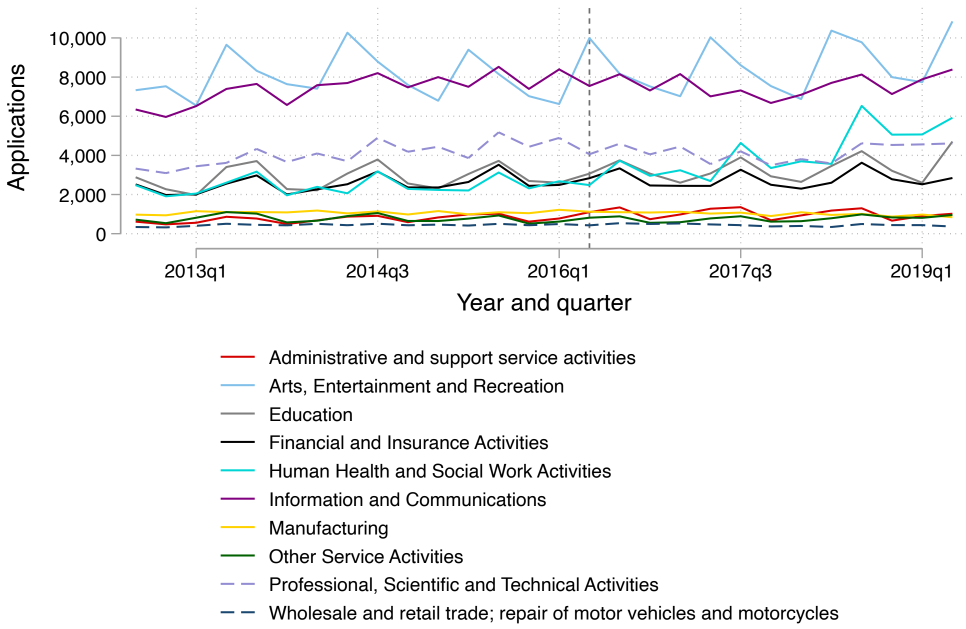
$$y_{it} = \beta referendum_t + \delta_i + \alpha_t + \gamma_t + \varepsilon_{it} \tag{2}$$

The outcome variable y_{it} is the number of NINo registrations or visa applications from non-EU migrants in our sample. We include a linear time trend (γ_t), quarter fixed effects (α_t), and origin country fixed effects (δ_i). The dummy $referendum_t$ captures the impact of the vote. Figures D4 and D3 summarize the estimated β. We find a significant negative impact on various categories of NINo registrations and a few categories of visa applications. Other types experienced no significant change. These results support our assumption. We do not find evidence of any opposite spillover effects on our control units. The negative coefficients even indicate that non-EU migration slightly decreased after the referendum, perhaps driven by the changes in the British economy and politics. As we aim to isolate the impact of non-economic factors, namely uncertainty and anti-immigration attitudes, this justifies the use of this suitable control group in our analysis.

Figure D1: Visa and extension of stay applications from all nationalities



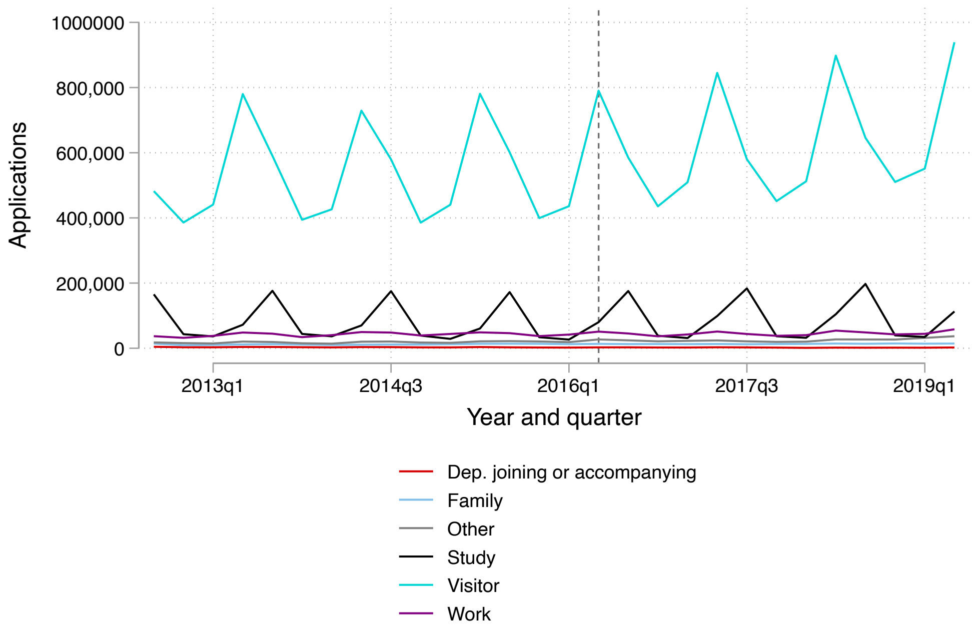
(a) Type of application



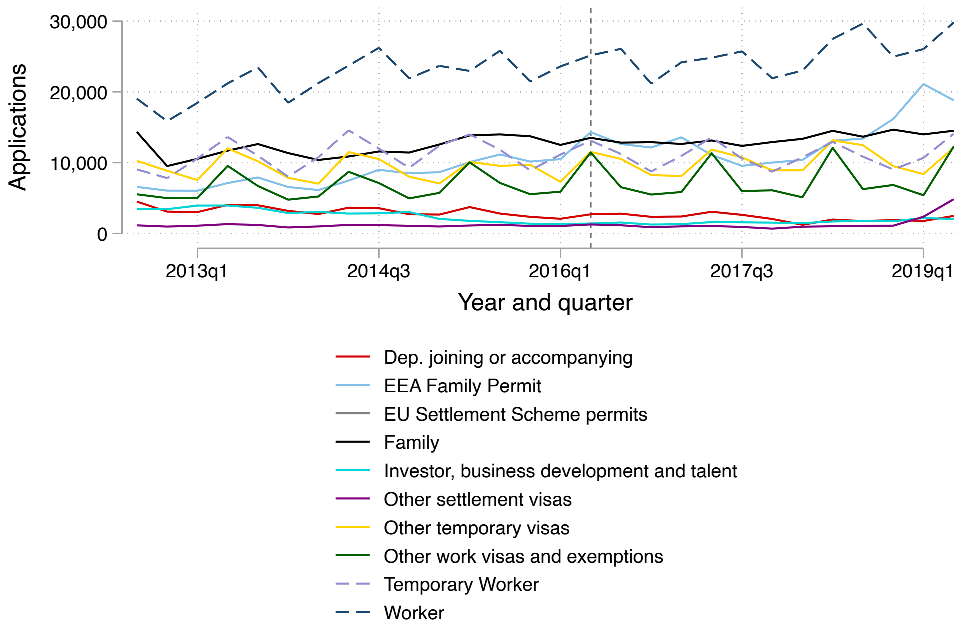
(b) Industry of application

Note: Authors' estimations based on the Home Office's visa data. The dotted line indicates the quarter in which the referendum took place.

Figure D2: Visa applications from sample nationalities



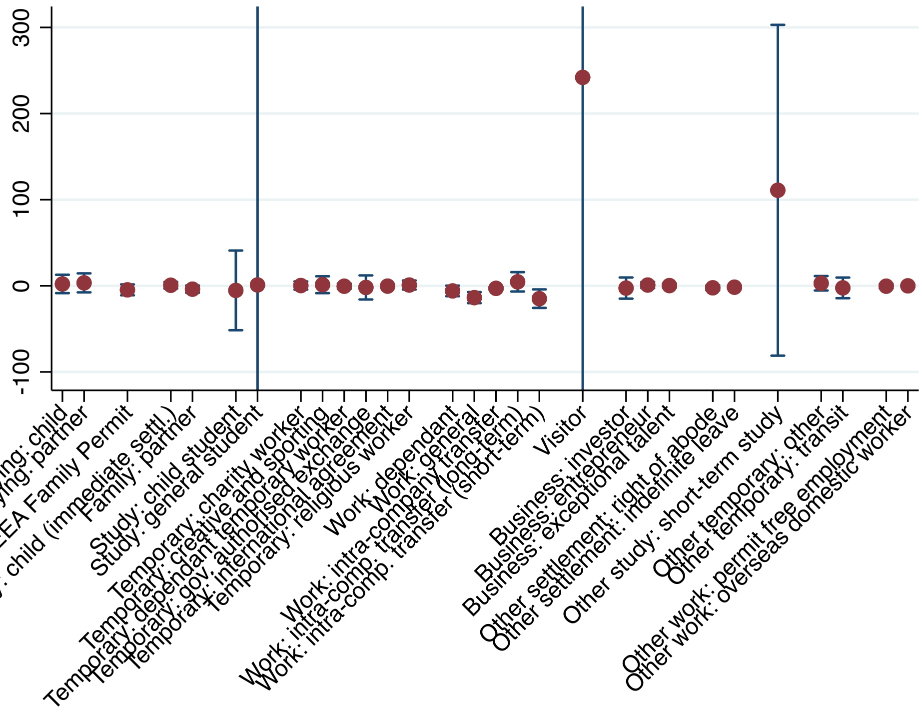
(a) Type of application



(b) Sub-type of application

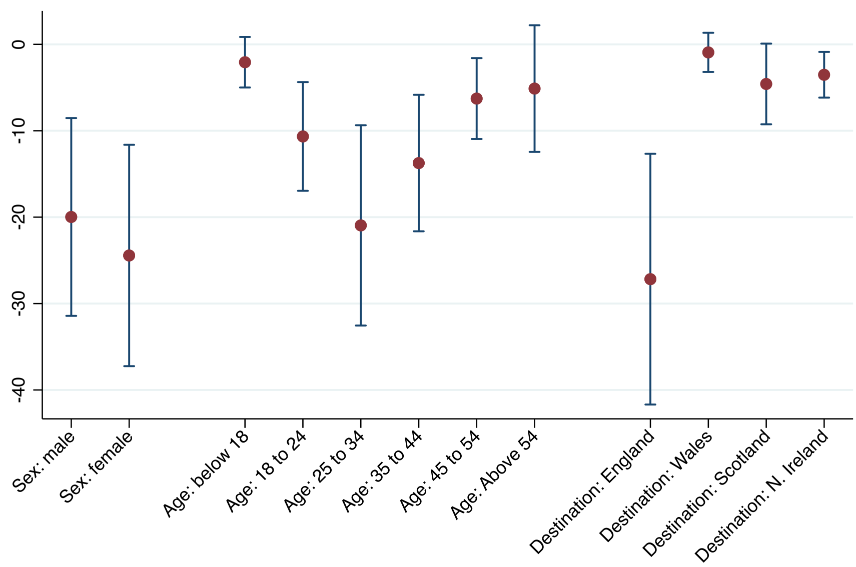
Note: Authors' estimations based on the Home Office's visa data. The dotted line indicates the quarter in which the referendum took place.

Figure D3: Pre-post comparison non-EU visa applications



Note: Referendum effect and 95% CI for non-EU visa applications, based on UK Home Office data, 2012Q3 to 2019Q2. Includes origin country fixed effects, quarter fixed effects, and linear time trend.

Figure D4: Pre-post comparison non-EU NINo registration



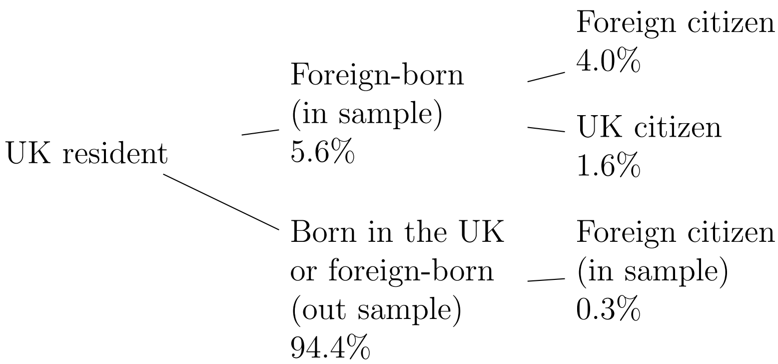
Note: Referendum effect and 95% CI for non-EU NINo registrations, based on UK Home Office data, 2014Q4 to 2019Q2. Includes origin country fixed effects, quarter fixed effects, and linear time trend.

E Details on the UK LFS data cleaning

The LFS is a survey of households residing in private addresses in the UK. It is the largest regular labour survey in the UK, conducted by the Office for National Statistics in Great Britain and by the Central Survey Unit of the Northern Ireland Statistics and Research Agency in Northern Ireland. The designs of both the Great Britain and Northern Ireland surveys are similar. The LFS's target population is the UK's resident population. The LFS attempts to include all people living in private households, residing in National Health Service housing, and young people living in a student residence or similar institution during term time. Each quarter, the sample typically consists of roughly 35,000 households in Great Britain (0.13% of the population) and 2,500 households in Northern Ireland (0.3% of the population). The survey uses a rotational sampling design. Once a household is selected for an interview, it is kept in the sample for five consecutive quarters. After five interviews, spaced exactly 13 weeks apart, a household exits the sample. This means that each quarter, one-fifth of the sample is renewed. Between any two consecutive quarters, about 80% of the selected households are in common (Office for National Statistics, 2022).

We use each quarterly LFS survey from 2012Q2 to 2017Q2. The meaning and classification of variables in each quarter was first inspected. The variable capturing individuals' education became more specific starting 2015 and was therefore re-coded to follow the same categories as previous quarters. Apart from this variable, there were no relevant changes in the registration of any information and the data are thus comparable over time. All quarters were merged and dummy variables were created to indicate migrants, either based on their country of birth or on their nationality. We also differentiate by migrant characteristic. The number of migrants (captured by the dummy variable) was then summed over a quarter for a given origin country, while using the weights provided by the LFS. We create panel data following the stock of migrants over time (quarters) for different units (origin countries). The stocks are divided by one thousand to obtain numbers that are easier to interpret. The number of migrants obtained through this strategy corresponds to estimated migrant stocks provided by other sources. We then only make use of the migrant stocks originating from relevant origin countries as defined above. Furthermore, we avoid stocks smaller than 10,000. Otherwise, certain stocks are based on only a few individuals in the survey, making the observed changes in these stocks and their characteristics less reliable. This leaves us with the stock of migrants from 22 treated EU countries and 27 untreated non-EU countries. Other cut-off values are considered as a robustness check. In the main analysis, migrants are defined as foreign-born residents. An alternative definition considering migrants as foreign citizens is used as a robustness check. In case of dual nationality, the LFS records the first nationality of an individual. Figure E1 shows how the stocks of foreign-born residents and foreign citizens differ for our sample. Foreign-born residents from origin countries in our sample consist of both foreign citizens as well as migrants who have obtained British citizenship in the past. There is also a very small group of foreign citizens included in our sample that do not belong to the stock of foreign-born residents, as they were born in the UK.

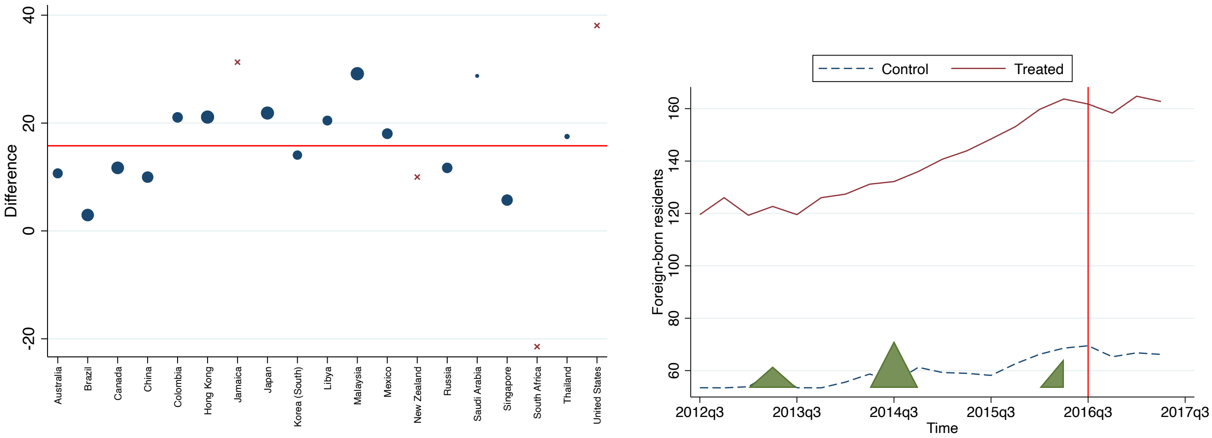
Figure E1: Foreign-born residents and foreign citizens in our UK LFS sample



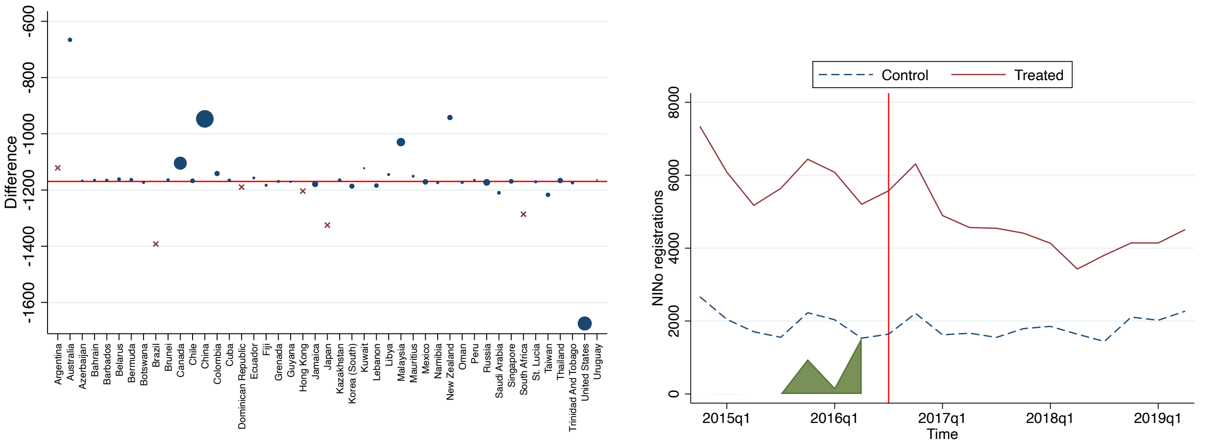
Note: Authors' estimation based on UK LFS, 2012Q3 to 2017Q2.

F Synthetic DD, unit and time weights

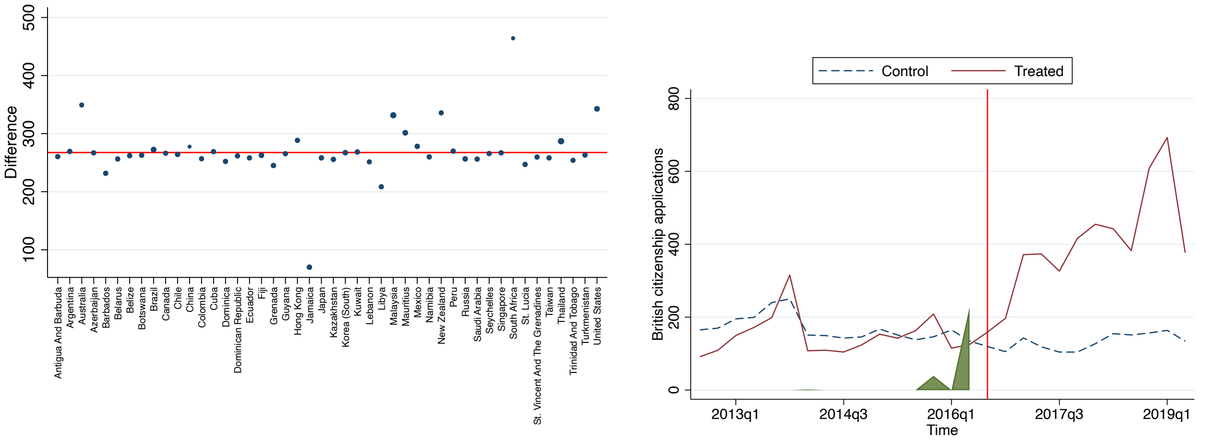
Figure F1: Synthetic DD, unit and time weights



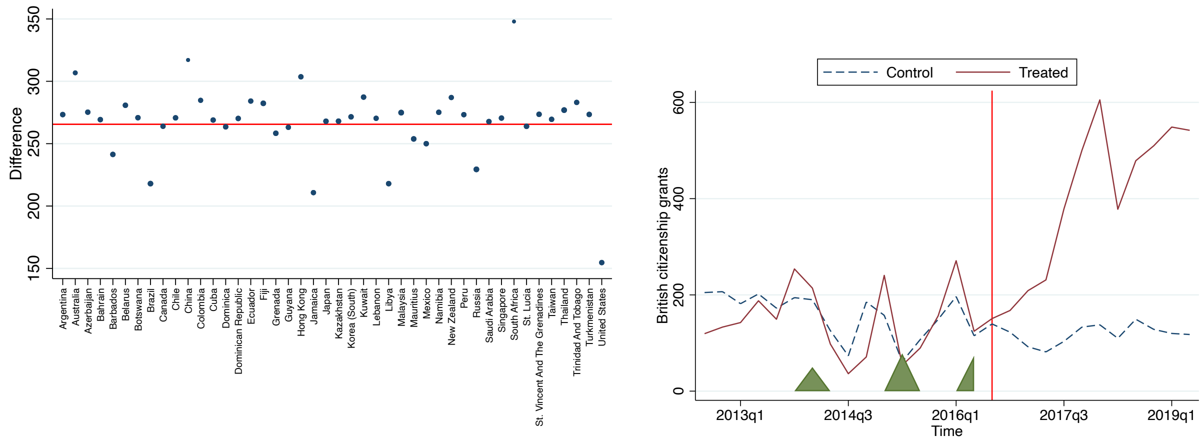
(a) Stock of foreign-born residents



(b) NINo registrations



(c) British citizenship applications



(d) British citizenship grants

Note: Unit-specific weights (left) and treatment and synthetic control outcome trends and time-specific weights (right), from synthetic DD results in Table 6. Sample from 2012Q3 to 2017Q2 (fig. a), 2014Q4 to 2019Q2 (fig. b), and 2012Q3 to 2019Q2 (fig. c-d).

Table F1: Synthetic DD weights, top 15 countries

Stock foreign-born residents		NINo registrations		British citizenship applications		British citizenship grants	
Malaysia	0.1044	China	0.2025	Thailand	0.0340	Malaysia	0.0275
Hong Kong	0.1027	United States	0.1255	Malaysia	0.0319	Russia	0.0271
Japan	0.1019	Canada	0.1071	Brazil	0.0266	Thailand	0.0268
Canada	0.0940	Malaysia	0.0655	United States	0.0263	Brazil	0.0255
Brazil	0.0912	Russia	0.0404	Mauritius	0.0256	Fiji	0.0252
China	0.0755	Libya	0.0280	South Korea	0.0242	Mauritius	0.0249
Singapore	0.0739	Mexico	0.0272	Fiji	0.0238	Grenada	0.0242
Mexico	0.0645	Colombia	0.0240	Russia	0.0238	St. Lucia	0.0240
Colombia	0.0614	Thailand	0.0200	Jamaica	0.0231	South Korea	0.0240
Russia	0.0609	Taiwan	0.0180	Japan	0.0225	Japan	0.0240
Australia	0.0552	Jamaica	0.0161	Grenada	0.0224	St. Vincent	0.0239
Libya	0.0527	Chile	0.0149	Mexico	0.0222	Kazakhstan	0.0238
South Korea	0.0469	Kazakhstan	0.0147	Argentina	0.0220	Singapore	0.0236
Thailand	0.0106	Hong Kong	0.0147	St. Lucia	0.0220	Kuwait	0.0236
Saudi Arabia	0.0044	Lebanon	0.0142	Chile	0.0220	Belarus	0.0236
Zero weight:							
Jamaica, New Zealand, South Africa, US		Australia, Argentina, Japan					

Note: Unit-specific weights for top 15 countries, from synthetic DD results in Table 6. Countries with zero weight reported in lower part of the table.