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STRUCTURAL ISSUES NOTE

STRUCTURAL ECONOMIC ANALYSIS

The impact of migration on the UK economy

27th November 2015

Main Message

Using a macro-econometric approach we find that positive migration shocks boost GDP and participation in the labour market. There is little impact on unemployment in the short-run but unemployment is pushed up with a lag. That may help to explain the pickup in unemployment in the run-up to the financial crisis. Counterintuitively, wages are pushed up by migration, but the uncertainty around these estimates is substantial.

- In contrast to the micro-econometric studies that dominate the academic literature, this note adopts a macro-econometric approach to assess the impact of migration on the UK economy.
- Our structural VAR model suggests that GDP is boosted by positive migration shocks, consistent with migration boosting demand as well as supply. An extended version of the model points to a positive effect on investment.
- Migration shocks are found to boost participation. The impact on unemployment is small in the near-term but the unemployment rate is pushed up over the medium-term. A lagged response is surprising – migration might be expected to lead to slack in the short-run as it takes time to absorb the additional labour. One interpretation could be that migrants become more substitutable for native workers over time, leading to some displacement.
- The impact on wages is *positive*, which is also a surprising result. But the confidence intervals around the responses of both unemployment and wages are very large and encompass responses of the opposite sign.
- These findings are broadly in line with several micro-econometric studies, which suggest that migration has, on average, a limited impact on unemployment and wages in the short-term.
- On average over the sample period used (1973-2015), migration shocks explain a very small part of the variation in unemployment and wages (less than 1%), but they can be more important at particular points in time. For example, the effects of the 2004 EU enlargement may have pushed up unemployment in the run-up to the financial crisis. Given the estimated lags in the unemployment response, the peak effect is 0.3pp in 2009. That might also imply some upward pressure to come from the latest pickup in migration.
- This type of analysis is hampered by the poor quality of the migration data, with data in the early part of the sample only available at an annual frequency. It is also likely that the impact of migration shocks will vary from episode to episode, depending on the circumstances prevailing at the time.

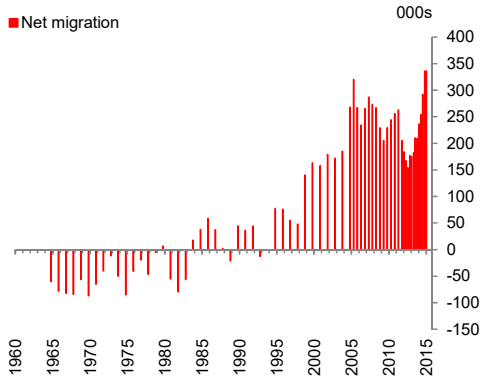
1. Net migration into the United Kingdom

Net international migration to the United Kingdom has become a key driver of population growth, accounting for over half of annual growth over the past fifteen years. The latest data shown in **Chart 1** suggests that net international migration in the UK was 336,000 in the year to June 2015. Net migration has been steadily rising over time. In the fifteen years to 1985 more people left than arrived into the UK (**Chart 2**). This demographic pattern changed in the 1980s, when net migration into the UK turned positive.

Migration is an important driver of population growth

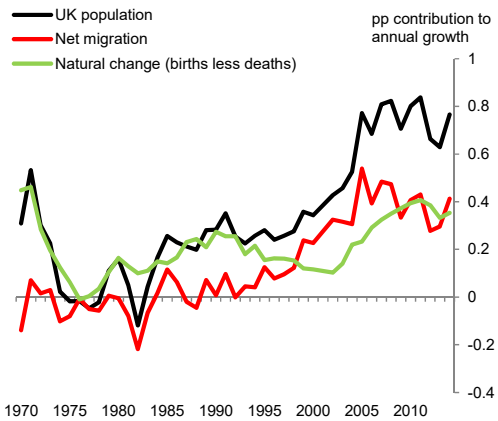
Chart 2 shows that, from the late 1990s until the early 2000s, net migration was the main contributor of population growth; since the early 2000s, the rise in population due to natural change (births minus deaths) has contributed to increasing the rate of annual population growth. This sharp increase in population has raised a series of questions regarding the sustainability of the current levels of international migration into the UK.[1] High levels of migration can increase the productive capacity of the UK economy but they can also generate slack in the short-run. The chart also suggests that long-term international migration is cyclical.

Chart 1: Net migration to the UK[(a)]



[(a)] Source: Long-term international migration (LTIM) data based on the ONS International Passenger Survey (IPS).

Chart 2: Contributions to annual population growth [(b)]



[(b)] Source: ONS mid-year population estimates and own calculations.

Migrants come to the UK for different reasons…

Many people come to the UK motivated by economic reasons, seeking to improve their job prospects. **Chart 3** shows the number of people coming to the UK with a definite job and in search for a job. A recent study by Mitchell et al (2011) argues that **economic migration** is determined by relative income differences. Glover et al (2001), Hatton (2005) and Mitchell et al (2011) find evidence that, while the unemployment rate negatively influences migration inflows, economic growth encourages it. Borjas (1987) and Hatton (2005) find that more unequal income distributions tend to offer higher returns to skilled migrant and native workers.

Chart 3 also shows that people come to the UK for **non-economic** reasons. This type of migration is less cyclical than economic migration. Foreign students coming into the UK account for around half of net migration. However, the impact of foreign students on labour market outcomes is unclear. After completing education, some students may seek job opportunities and remain in the UK thereafter. International students can work in the UK on a part-time basis and EU students on a full-time basis. Other migrants come to the UK driven by family reasons or to join friends. Hatton (2005) emphasises that network effects (a proxy for 'friends and family') are an important factor. Many of these migrants may enter

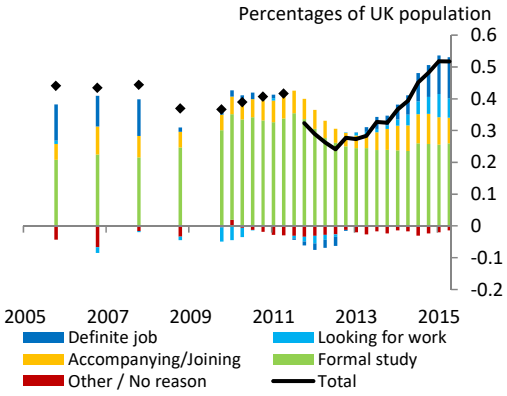
[1] See Dustmann et al (2010b) and Preston (2013) for an analysis on the impact of migration on public finances.

the labour force at a later stage (if not immediately after arrival).[2]

…and from different countries.

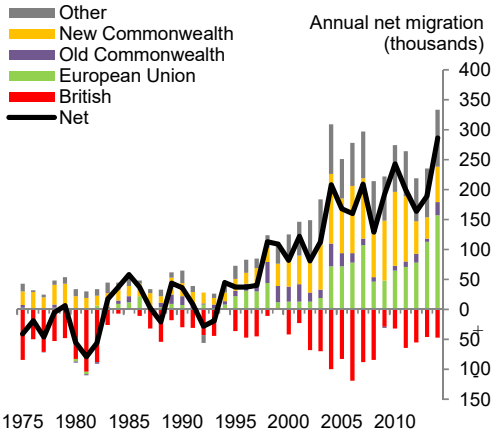
Migrants come to the UK from different countries. **Chart 4** shows that, prior to the 1990s, inward migration mainly originated in New Commonwealth countries.[3] Since then, the European Union has become the predominant source region; the EU15 countries and the new EU member states are the main contributors before and after 2004 respectively.[4,5] EU enlargements helped, to a large extent, account for the recent rise in net migration into the UK. Inward migration from other countries, such as Russia and China, has been on a long-term upward trend, accounting for about a third of the net flows in mid-2013.

Chart 3 – Net migration by reason



Source: LTIM data based on the ONS International Passenger Survey (IPS).

Chart 4 – Net migration by country



Source: Data from the ONS IPS (different from LTIM estimates, which use additional data and make further adjustments).

Economic factors, migration policy and network effects are important determinants.

Migration flows across country borders are regulated. Immigration policies are implemented to limit numbers and to select across potential migrants. Hatton (2005) and Mitchell et al (2011) find that looser policies tend to encourage immigration into the UK. In particular, the relaxation of non-economic migration in 1997 (together with the allocation of work permits) and subsequent EU enlargements have had the largest impact. From 2007Q1 until 2013Q3, Romanian and Bulgarian citizens were granted limited access to the UK labour market. Since 2008 a Points-Based System (PBS) has been implemented to regulate migration flows from outside the EU. Tier 4 visas are granted to international students. Dependants apply for visas under the same category as the main family member. The number of months that international students can stay in the UK after graduation can be used as a policy tool.[6] In April 2012 the post-study work visa, which allowed international students to stay for two years without a working permit, was scrapped. Since then undergraduate students on long-term courses can only stay in the UK for up to four months.[7]

These facts suggest that the economic impact of migration is likely to be complex. In this note we attempt to quantify the effects of migration on the UK economy at business cycle frequencies. The questions we attempt to address are: what is the economic impact of unexpected migration inflows and what are the implications for monetary policy?

[2] Some people migrate into the UK driven by safety concerns (escaping war and political persecution). The Syrian civil war, amongst other armed conflicts in the Middle East, has been a key determinant of the recent EU migration crisis. The economic impact on the receiving countries is likely to remain uncertain for some time. It is unlikely that the UK economy will be affected significantly given the announced quota of 20,000 Syrian refugees over five years. Refugees are excluded from the IPS and are not considered in this analysis.

[3] This measure includes all Commonwealth countries except Australia, Canada, New Zealand and South Africa. From 2004, the definition excludes Malta and Cyprus.

[4] EU15 countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Republic of Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden.

[5] New EU Member States include Bulgaria, Croatia, Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. Croatia recently joined the EU in 2013Q3, Romania and Slovakia in 2007Q1, the remainder in 2004Q2.

[6] PhD students can extend this to a year.

[7] For an update on recent developments, .

2. A macro-econometric approach to modelling net migration

Migration can affect the economy through different channels. Conventional thinking associates inward migration with a rise in labour supply and a fall in wages. Higher inward migration tends to increase the productive capacity of the economy and is generally associated with higher levels of employment.[8] Positive aggregate supply developments are likely to put downward pressure on prices, at least in the near term.

Short-term developments in migration affect the economy through both demand and supply channels.

However, net inward migration is also likely to impact the economy through demand developments. Migrants increase the demand of goods and services in the destination country, which can generate a further expansion in employment and output. In addition, positive aggregate demand developments tend to exert upward pressure on prices and wages (through a shift in labour demand). The extent to which employment, real activity and inflation respond to inward migration depends upon the balance between supply and demand developments. Because the strength of these channels is not known a priori, it is unclear which one is likely to dominate. This ultimately remains an empirical question.[9,10]

To assess the impact of unexpected developments to inward migration on economic outcomes, we estimate a mixed-frequency Structural Vector Autoregression (SVAR). We find that migration increases economic activity and the rate of labour market participation. There is considerable uncertainty around the responses of the unemployment rate and nominal wages. The response of the unemployment rate is, on average, limited over the short-term but is pushed up over the medium-term. Nominal wages increase after an unexpected shock to migration. The contribution of migration shocks on labour market outcomes is, on average, small and highly uncertain. The magnitude and timing of migration shocks, however, can be important for understanding medium-term labour market developments.

We adopt a macro-econometric approach to study short-term effect of migration.

Our modelling approach is complementary to the existing literature and more suitable for monetary policy analysis. In contrast to most papers which use microdata to assess the impact of migration, we adopt a new mixed-frequency SVAR model using Maximum Likelihood and Kalman filtering techniques. The model is written in state space form to facilitate the joint estimation of the parameters of a reduced-form VAR and the latent measure of migration. This is due to the fact that migration data are mixed frequencies – annual in the earlier part of the sample, then semi-annual and quarterly more recently. The data are also reported as migration over the previous year. The Kalman filter turns irregularly spaced data into a quarterly series using other sources of information observed at quarterly frequencies. The Box at the end of the note provides technical details.

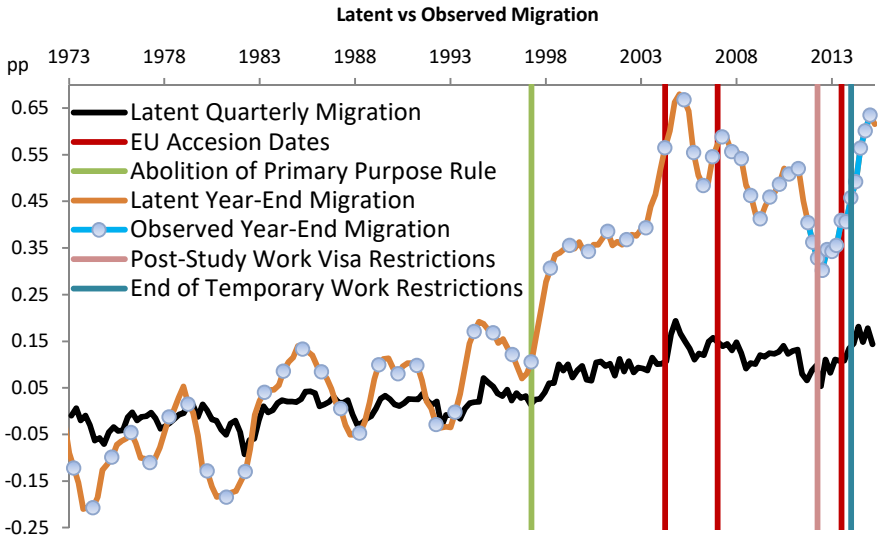
The variables included in the baseline model are as follows: the contribution of migration to quarterly 16+ population growth (henceforth referred to as migration), the 16+ quarterly rate of population growth, the rate of labour force participation, the unemployment rate, nominal wages (AWE) and real GDP.[11] Except for migration, all variables are observed at quarterly frequencies. The population series used contains key information for the construction of the quarterly measure of latent migration. The estimation uses quarterly data from 1973Q2 to 2015Q2, covering the entire length of UK membership in the EU.

Chart 5 plots the observed year-end ONS migration data against the year-end and latent measures. It shows that the latent quarterly data exhibits higher volatility relative to the observed year-end ONS data. All series respond to key policy changes. The year-end data displays an upward shift as a result of the abolition of the primary purpose rule in 1997Q2. Net migration responds positively to EU enlargements (2004Q2, 2007Q1 and 2013Q3). Work restrictions imposed on Romanian and Bulgarian citizens, implemented temporarily from 2007Q1 until 2014Q1, may have delayed the response of migration until

[8] The extent to which migration affects employment and wages depends on the degree of substitutability between migrants and native workers (or the skill composition of the labour force) in the production process.
[9] See Ravn et al (1997), Canova et al (2000), Razin et al (2007), Bentolila et al (2008) and Mandelmann et al (2012) for examples as to how migration may affect economic activity in a general equilibrium setting.
[10] See Box in page 30-31 in May IR 2015 for an explanation of the different channels by which population changes can affect the economy.
[11] Following . 16+ population has been adjusted to take into account stronger recent periods of migration.

recently. The series display a downward shift in 2012. This may be due to the scrapping of post-work study visas in 2012Q2 (the number of foreign students falls, see **Chart 3**).

Chart 5: Contribution of net migration to 16+ population growth [e]



[e] The black line is the latent migration series constructed using the observed year-end data (grey dots and blue line). The orange line is the latent year-end data and is equal to the sum of the four quarterly observations. Vertical lines denote key events and policy changes.

The effect of migration shocks on the UK economy

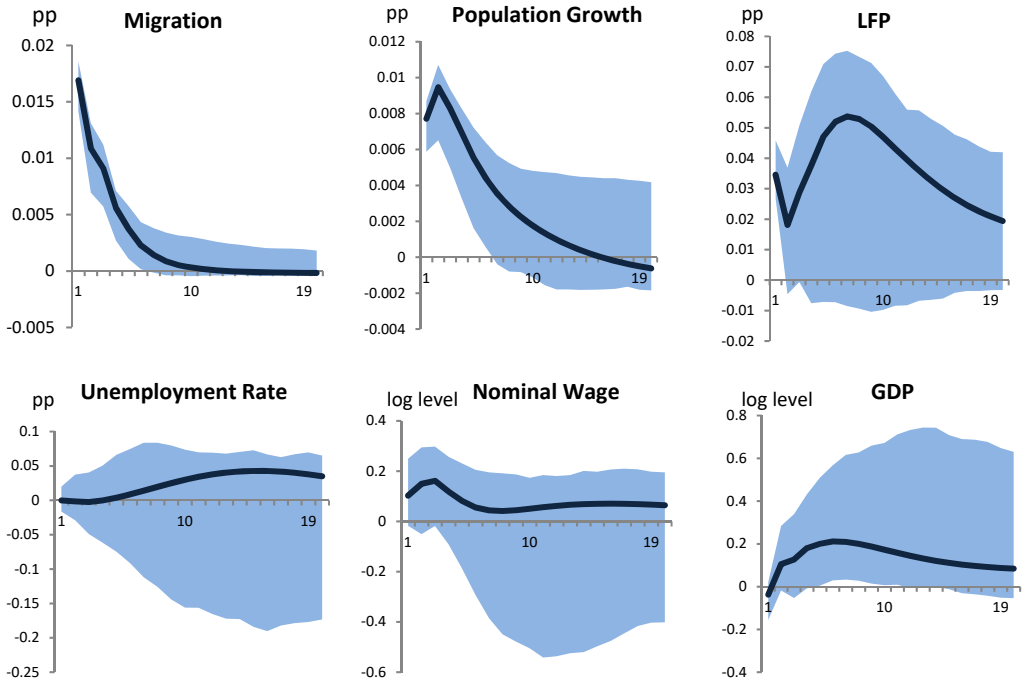
Following Boubtane et al (2013), we identify structural migration shocks through a Cholesky decomposition of the variance-covariance matrix of the reduced form VAR. Migration is ordered first in the VAR and the decomposed variance-covariance matrix is upper triangular. The chosen identification scheme implicitly assumes that migration is the most exogenous variable in the system. An unexpected rise in migration affects all other variables within the period; migration is affected by other variables from the second quarter onwards (see the Box for more technical details).[12]

Structural migration shocks could be due to a number of reasons. They could be the result of unexpected changes in migration policy, the ***relative*** economic performance of the UK (not explicitly modelled but captured partly by including real GDP in the model) and other unexpected international developments. It is likely that the 2004 EU enlargements had a cumulative effect on migration and that much of this migration could not be accounted for by economic drivers alone. There is considerable uncertainty as to how policy may affect migration flows.

Chart 6 shows the impulse responses of the variables of interest to a one standard deviation shock in migration. On average, the rate of migration responds positively on impact by around 0.015pp to a migration shock. The response exhibits some persistence and reverts back to zero after ten quarters. Adding up the first four quarters after the shock gives an *annual rate* of 0.04pp. This rate is equivalent to 21,000 new migrants *in one year* using the latest population data (around a quarter of the increase in migration relative to its average over the past decade).

[12] Sign restrictions (as an identification strategy) can be used to treat migration shocks as labour supply shocks. In the standard New Keynesian model, labour supply shocks are likely to increase economic activity and reduce wages. We leave the unemployment rate unrestricted. Results are available on request but, generally speaking, are in line with the recursive identification strategy.

Chart 6: Impulse Responses to a migration shock [e]



[e] The responses of migration, the rate of population growth, the rate of Labour Force Participation (LFP) and the unemployment rate (UR) are expressed in percentage points. The nominal wage rate and the real GDP are expressed in logs. The bands denote the 90% confidence intervals reflecting model and parameter uncertainty.

The rate of population growth also increases on impact by around 0.01pp but it is relatively more persistent. Note that the population measure excludes the young and that migration is only one of the components of population growth. The response of the rate of labour force participation is positive and hump-shaped, peaking after two years. This finding suggests that, while some migrants come to the UK for work-related reasons, it is possible that those migrants that arrive in the UK to study or to join families may at a later stage enter the labour market.[13]

An unexpected rise in migration has no effect on the unemployment rate for some time …

A shock to migration has a small average impact on the unemployment rate for the first year but it pushes up on unemployment over the medium-term. On average, *the unemployment rate rises by around 0.05pp after 4 years.* This lagged effect on unemployment is surprising. We might expect migration to affect unemployment in the near term as it takes time for the additional labour to be absorbed. One interpretation is that the labour market in the UK is able to absorb labour market slack reasonably fast in the near term but that migrant and native workers become more easily substitutable in the medium-term. There is considerable uncertainty around the sign response as illustrated by the confidence intervals in **Chart 6**.

… and the impact on wages is highly uncertain.

The impact on the level of real GDP is positive and persistent. The quarterly rate of GDP growth, not shown in the chart for brevity, increases around 0.15pp after two quarters and falls back to trend growth after one and half years. *The response of the log level of nominal wages is on average positive but considerable uncertainty remains about the direction of the impact. The quarterly rate of nominal wage growth, not shown in the charts, increases on impact by 0.1pp, falls to -0.05pp in the fourth quarter and returns to trend thereafter. In this baseline specification, the sign of the response of wages is, on average, opposite to what conventional wisdom would suggest.* The rise in the unemployment rate and nominal wages is not contemporaneous. It is worth noting that, while most of nominal wage growth occurs over the short-term, the unemployment rate tends to increase only after four quarters.

[13] The fact that the participation rate changes only by little should not be confused with the fact that the size of the labour force is likely to increase after a positive migration shock.

How important is migration over the economic cycle?

An alternative way of illustrating the result of the model is to assess the amount of information that migration shocks contribute over time to the variables in the autoregression. **Table 1** shows the *average forecast error variance decomposition* of the key variables over different horizons. On impact up to 62% of the forecast error variance of population growth can be attributed to migration shocks. The proportion of the variance explained declines over time. One interpretation of this result is that population growth due to natural change takes longer to adjust. Another interpretation is that population growth is mainly driven by natural change over the first part of the sample.[14]

Migration plays, on average, a key role in explaining population developments and the rate of participation.

Migration shocks help explain up to around 14% of the variation in the rate of participation over the medium-term. It is likely that, over the short-run, participation rates of migrants are similar to those of natives. Although the contribution of migration increases over the forecast horizon, changes in the rate are quantitatively small given that the magnitude of the average shock is small.

Table 1 - Percentage of variation explained by an unexpected change in migration

Quarters after the shock	Migration	Population Growth	LFP	Unemployment	Nominal Wages	GDP
1	100.0	62.4	11.1	0.0	1.4	0.2
4	89.5	55.1	4.7	0.0	1.6	1.9
8	80.7	40.9	9.0	0.1	0.8	2.8
20	66.8	19.4	13.6	0.8	0.4	2.2

Migration shocks explain only 0.8% and 0.4% of the medium-term fluctuations in the unemployment rate and nominal wages respectively. Nearly all of the forecast error variance of nominal wages and the unemployment rate is, on average, explained by other structural shocks. As forecast error variance decompositions are computed as a function of the impulse responses, it should be noted that considerable uncertainty remains about the contribution of migration shocks in explaining labour market outcomes. On average, however, short-run migration shocks convey little information. The average contribution of migration shocks is only slightly larger for output, around 3% after 2 years and 2% after five years.

The impact of recent migration on the economy

The analysis so far provides an average representation of the economic impact of migration. It is possible, however, that the economic impact of migration (and the risks around the unemployment rate and nominal wage growth forecasts) may be larger at particular points in time.

But recent unexpected changes in migration may have larger effect in future.

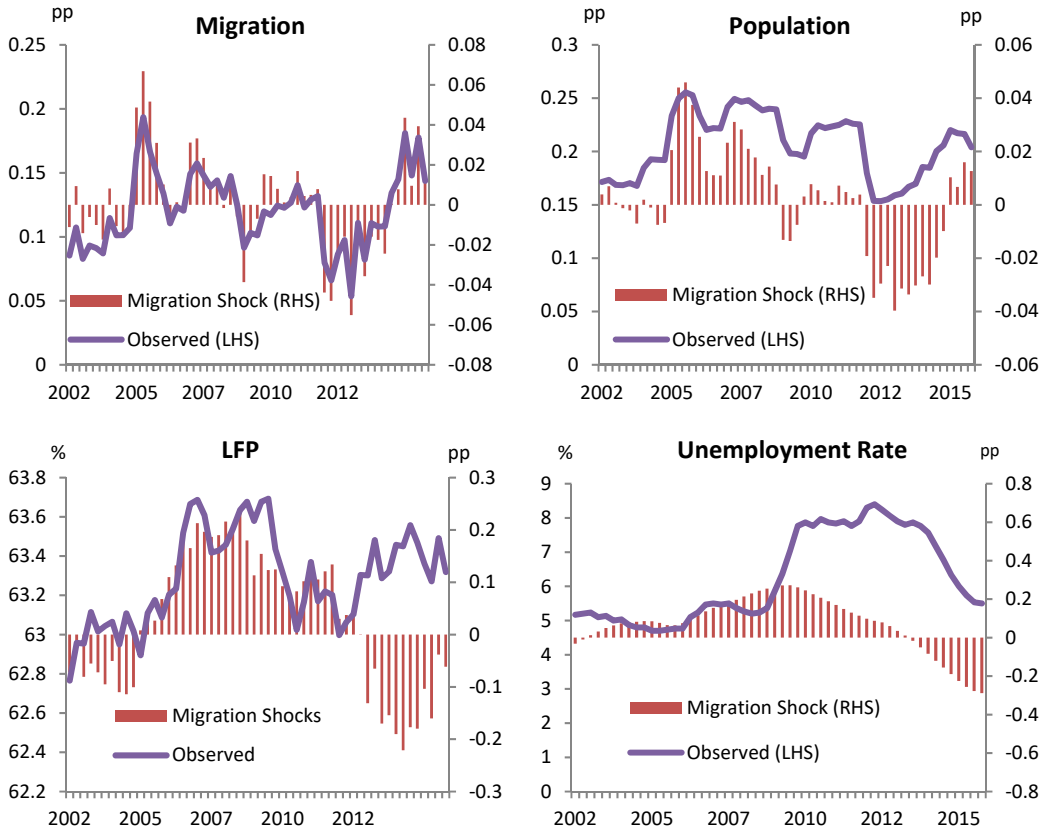
Chart 8 shows the historical contribution of migration shocks for selected variables. Unexpected changes in migration explain a large part of the historical variation in migration and the rate of population growth over the last 15 years. The first subplot shows the contribution of migration shocks to migration from 2002. After detrending, it shows that the contribution of shocks in explaining migration has been positive during the following periods: 2004Q3-2005Q3, 2006Q1-2007Q3 and 2014Q1-2015Q2. The 2004 EU enlargement and recent events are likely to have the largest impacts. Using latest population estimates, a *quarterly* migration shock in the order of 0.04, as observed in both 2014Q3 and 2015Q1, is equivalent to receiving 56,000 new migrants over one year.

Part of the strength in the participation rate, on average around 0.2pp from 2004Q3 until 2012Q2, can be explained by the inflows that follow the 2004 EU enlargement. More recently, migration has been exerting downward pressure on participation rates, possibly a

[14] Note that due to the definition of population used in this analysis, natural change refers to the change in population due to native citizens entering working age.

delayed effect of the fall in migration at the outset of the financial crisis. This pattern is likely to reverse in future given the subsequent pickup in migration.

Chart 8: Historical Variance Decompositions [g]



[g] The chart shows the decomposition of the variance from a historical viewpoint. Purple lines (scaled on the LHS) denote the actual values of the series of interest. Red bars (scaled on the Right Hand Side - RHS) show the contribution of migration shocks over time.

The impacts may have changed over time…

The rise in the unemployment rate in the run up to the financial crisis can, to some extent, be attributed to migration. Our findings provide support for recent work from SEAD on equilibrium unemployment, which highlighted that the pre-crisis unemployment rate may have risen because of inward migration.[15] Our model estimates that the unemployment rate increased by up to 0.3pp in 2009Q1 due to the high migration flows around the 2004 EU enlargement. According to the model, *the magnitude of migration shocks around this particular enlargement was up to four and a half times larger than the average effect. The UK was repeatedly hit by a series of positive shocks (for over a year) after this accession date.* The lagged response of unemployment in the model means that the upward pressure on unemployment persisted for some time.

…due to changes in policy and labour market institutions.

The subsequent fall in migration following the financial crisis and the abolition of the post-study work visas may have contributed to unwinding these developments. The recent fall in the unemployment rate can partly be attributed to a series of negative migratory developments from 2011Q3. The model would expect the recent short-term migration upturns, which are around two and half times larger than the average effect, to exert some upward pressure on the unemployment forecast over the next few years. The model would estimate that the rise in the unemployment rate could be around 0.15pp higher but again, given the lags in the estimated response, these effects are unlikely to fully materialise before 2018.

The impact of unexpected changes in migration on labour market outcomes is highly uncertain, suggesting possibly that each migration episode is likely to have a different

impact. The economic impact of migration is likely to depend upon the changing policy environment, the gradual expansion of the EU borders, the economic characteristics of migrants and the increasing flexibility of the labour market and the state of the economy.[16]

Effects will depend on the type of migration and the state of the economy.

Migration policy can be designed to encourage migration from specific countries with a particular set of skills. For example, the Point-Based System can affect the level of migration and has the potential to change the skill composition of the labour force.[17] Another example is the temporary work restrictions on Bulgarians and Romanians. The economic characteristic of migrant workers may also depend on international developments that are partly outside the control of policy. Saleheen et al (2006) find that migrants after 2004 were younger and more educated than migrants who came to the UK prior to 2004. This means that, if migrants and native workers are close substitutes, migration may potentially generate more displacement than in the past. In addition, the exact impact of migration on the labour market is likely to depend on the level of qualifications of migrant workers and the job requirements at any given point in time.[18]

Market institutions are also likely to play a role. The extent to which the labour market is able to absorb the additional slack depends, to a large degree, on how quickly the UK labour market can adjust to the characteristics of new migrants (and vice versa). It is likely that the increasing flexibility of the labour market over the period of study may have contributed to reducing the unemployment gap created by immigration.

In addition, there is evidence that migration can have asymmetric effects over the business cycle. Analysis by the Migration Advisory Committee (2012) finds that the impact of migration is stronger on unemployment and wages during economic expansions but not statistically significant during contractions.

Our analysis suggests that the pickup in migration is likely to exert upward pressure on the unemployment rate in the medium-term. As the levels of net migration increase, it is reasonable to expect the impacts on economic outcomes to be larger.

How do aggregate demand components respond and what is the impact on inflation?

Demand channels may be important.

Demand channels are likely to play an important role in the process of adjustment of the economy to migration shocks. In order to understand the demand effects in more detail, we introduce demand components in our analysis (real consumption and investment). Adding investment, in particular, helps control for potential shifts in labour demand due to capital accumulation. The extended VAR, other than containing more information about demand, has additional information about monetary policy such as prices (log CPI) and the Bank Rate. The four data series are added at the same time.

We use a Bayesian VAR to include more demand variables and inflation.

We cannot use the methodology adopted in the baseline approach because adding more variables increases the inaccuracy of the parameter estimates and reduces the reliability of the results. Therefore, we adopt Bayesian methods to estimate a reduced-form VAR and set the priors as loose as possible. We use the measure of quarterly migration that results from the baseline analysis (as represented in **Chart 5**) to estimate the BVAR. The lag structure and identification strategy are left unchanged.[19]

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[16] Several studies show that labour flows increased across Europe due to the 2004 EU enlargements. Jauer et al (2014) show that migration across EU borders has been an important adjustment mechanism during the crisis and that flows have increased significantly after the 2004 and 2007 EU enlargements. Arpaia et al (2014) show that EU membership increases labour mobility considerably across member states. Following Blanchard et al (1992), Beyer et al (2014) find that labour mobility adjust to national shocks faster in the US than in Europe but that labour mobility accounts for 50% of long-run adjustments in the US and Europe.

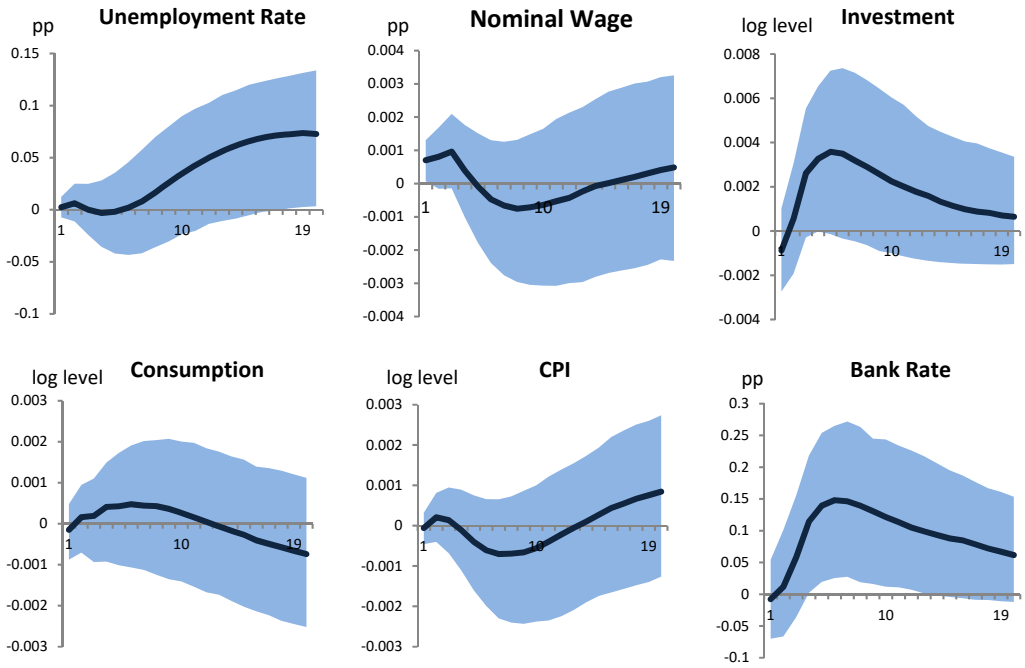
[17] Longhi et al (2012) find that the elimination of barriers appears to have changed the quantity and quality of migrants arriving in the UK.

[18] Sectoral (and skill) mismatch may arise as a result of the changing characteristics of incoming migrants. Firms may be unable to fill vacancies in those sectors (skills) whose demand increases due to inward migration. Equally, not enough vacancies may be posted in those sectors (skills) with excess labour supply. Economic migration can potentially be driven by skill shortages; i.e. migrants may have a high change of getting a job in the UK than in their countries of origin. Our approach is less likely to pick up this effect in the short-run.

[19] The estimation of the Bayesian VAR assumes a Minnesota prior. The hyperparameters are set such that a relatively loose prior is implemented. However, the use of prior information restricts the amount of feedback between variables. This means that the approach is not fully efficient. A fully efficient estimation strategy would require estimating a mixed-frequency Bayesian VAR that uses all the quarterly information to compute latent data.

Chart 9 shows the impulse responses of investment, consumption, CPI and the Bank Rate to a one standard deviation shock to migration. After a positive migration shock, the response of aggregate investment is positive, persistent and subject to sizeable uncertainty. The peak responses of the quarterly growth rate of investment are around 0.2pp (not shown in the Charts), taking place after three quarters and returning to trend after six quarters. This finding is indicative that migration increases investment. The response of consumption is more uncertain and the median response is positive over the first six quarters. A shift in aggregate demand also pushes up the demand for labour.

Chart 9: Impulse Responses to a Migration Shock [h]



[h] The bands reflect parameter uncertainty.

The overall impact on nominal wages in this version of the model is, on average, small and close to zero but is again positive in the medium-term. The responses of CPI and nominal wages are very similar. This result suggests that supply and demand channels tend to be broadly balanced, adjusting reasonably quickly. The extent to which the Bank Rate reacts to a migration shock is large. This relationship could be spurious and due to the fact that a) the unconditional correlation between migration and the nominal interest rate for the whole sample is high and b) the sample includes the period of the zero lower bound. These other results are robust to excluding the Bank Rate from the analysis.

3. Conclusion

Migration increases aggregate demand and labour demand.

We adopt a macro-econometric approach to modelling short-term developments in migration and assess their impact on the economy. The note suggests that unexpected changes in migration affect the economy through the traditional supply channels but also through developments in demand. We argue that the increase in the productive capacity of the economy is matched relatively quickly by an expansion in aggregate demand. The findings suggest that migration can contribute to explaining a large part of the fluctuations in the rates of population growth and participation. Migration has, on average, limited

This route was pursued but tight priors had to be implemented in order to a) guarantee stability of the system and b) generate latent migration series with reasonably low volatility. A problem with implementing tight priors in this setting is that it considerably restricts the feedback between the variables. The results from the mixed-frequency BVAR are in line with both the classical approach conducted in the first part and the BVAR implemented in the second part of the analysis.

impact on the unemployment rate over the short-run but pushes up on unemployment over the medium-term. The impact on nominal wages is positive in the baseline model. However, the behaviour of prices resembles that of wages in the extended model.

But aggregate demand and supply tend to offset each other…

The results are tentative and subject to considerable uncertainty. The confidence bands are large and leave the sign of the response of unemployment and wages ambiguous.

The effects of migration are also likely to be time-varying. The economic impact of migration depends upon the changing policy environment, the expansion of the EU, the progressive flexibility of the labour market, the state of the economy and migrants' characteristics.

…generating little inflationary pressure.

The analysis has little to say about potential distributional effects of migration, which may be relevant for monetary policy analysis. In addition, migration data are subject to considerable measurement errors. It is possible that other important sources of information for the construction of the latent migration series have been omitted. A caveat with the identification strategy chosen is that it depends on the estimation and filtering techniques adopted. Non-linearities may be present but are not modelled.

Appendix: Technical overview of the model

Model Estimation

A model in state space form is specified. The model includes a mixture of latent variables, unknown parameters and known data observations. This mixture model separates between observation and state equations. Note that the state space equation, equation (2) below, is a Vector Autoregression (VAR) model in canonical form. The model is written to allow a mapping from annually observed data into quarterly latent data. The state space model reads:

$$\boldsymbol{X_t} = \boldsymbol{C}\,\boldsymbol{x_t} + \boldsymbol{\epsilon_t} \qquad (\mathbf{1}),$$

$$\boldsymbol{x_t} = \boldsymbol{A_0} + \boldsymbol{A_1}\,\boldsymbol{x_{t-1}} + \boldsymbol{u_t} \quad (\mathbf{2}),$$

where

$$\boldsymbol{A_0} = \begin{bmatrix} \Phi_0 \\ \mathbf{0}_{(\max(p,4)n-n)x1} \end{bmatrix}, \boldsymbol{A_1} = \begin{bmatrix} \Phi^1 & \Phi_{\max(p,4)} \\ \boldsymbol{I}_{\max(p,4)n-n} & \mathbf{0}_{nxn} \end{bmatrix}, \Phi^1 = \left[\Phi_1 \dots \Phi_{\max(p,4)-1}\right], \Phi = \left[\Phi_1\ \Phi_{\max(p,4)}\right],$$

$\boldsymbol{X_t} = [\,\boldsymbol{M_t}\ \boldsymbol{Y_t}]'$ is a vector composed of quarterly observed series $\boldsymbol{Y_t}$ and the irregularly spaced year-end migration series $\boldsymbol{M_t}$, $\boldsymbol{x_t} = [\,\boldsymbol{m_t}\,\boldsymbol{Y_t}]'$ a vector containing quarterly observed variables and latent migration data, $\boldsymbol{m_t}$, $\boldsymbol{u_t} = [\boldsymbol{v_t}\ \mathbf{0}_{(\max(p,4)n-n)x1}]'$ a vector containing the error term, $\boldsymbol{v_t}$ (with mean zero and variance-covariance matrix $\boldsymbol{\Sigma_v}$), $\boldsymbol{\epsilon_t}$ a vector of idiosyncratic components uncorrelated with $\boldsymbol{x_t}$, whose variance-covariance is $\boldsymbol{Q}$, $\boldsymbol{n}$ the number of variables and $\boldsymbol{p}$ the number of lags. As net migration data are irregularly spaced (and reported on a year-end basis), writing the state space equation with a minimum of four lags is required. The matrix $\boldsymbol{C_{nx(max(p,4)xn)}}$ is known and it is written so as to provide a mapping from $\boldsymbol{x_t}$ into $\boldsymbol{X_t}$. The lag order of the VAR is, however, not restricted to being greater or equal to 4. In order to choose the lag structure of the VAR, some of the elements of matrix Φ are set to zero. We use the Bayesian Information Criteria (BIC) to choose the lag structure of the VAR.

In models with latent variables, finding a maximum likelihood solution directly is not possible. Following Stock et al (2002), Metaxoglou et al (2007), Mariano et al (2012), the model is estimated by implementing the expectation-maximisation (EM) algorithm. This method is an iterative procedure used to find (locally) maximum likelihood estimates of models featuring latent variables. The EM iteration alternates between an expectation (E) step, which creates a function for the expectation of the log-likelihood evaluated using the previous estimates, and a maximisation (M) step, which computes new estimates that maximise the expected log-likelihood in the E step. This procedure is repeated until convergence of the log-likelihood. The algorithm must be initialised by choosing arbitrary parameters. We set $\boldsymbol{\Sigma_v} = \boldsymbol{I_n}$ and $\Phi^1 = \mathbf{0.9}\boldsymbol{I_n}$. The reduced form of the VAR reads as

$$\tilde{\boldsymbol{x}}_t = \boldsymbol{F_0} + \boldsymbol{F}(\boldsymbol{L})\,\tilde{\boldsymbol{x}}_{t-1} + \boldsymbol{\mu_t} \quad (\mathbf{3}),$$

where $\boldsymbol{F}(\boldsymbol{L})$ is a matrix of finite order polynomial, $\boldsymbol{F_0} = \Phi_0$, $\boldsymbol{\mu_t}$ is a vector of innovations and $\tilde{\boldsymbol{x}}_t$ the vector of quarterly variables.

Recursive Identification

We assume a structural model of the form

$$\boldsymbol{A}\tilde{\boldsymbol{x}}_t = \boldsymbol{B_0} + \boldsymbol{B}(\boldsymbol{L})\,\tilde{\boldsymbol{x}}_{t-1} + \boldsymbol{S}\boldsymbol{\varepsilon_t} \quad (\mathbf{3}),$$

where $\boldsymbol{A}$ describes the contemporaneous relations among the variables and $\boldsymbol{B}(\boldsymbol{L})$ is a matrix of finite order polynomials. $\boldsymbol{\varepsilon_t} \sim \boldsymbol{N}(\mathbf{0}, \boldsymbol{I})$ is a vector of containing the structural shocks. The matrix $\boldsymbol{S}$ is a diagonal matrix and $\boldsymbol{A}$ is an upper triangular matrix with ones along the diagonal.

The VAR (equation 2) may be represented in reduced form

$$\tilde{x}_t = A^{-1}B_0 + A^{-1}B(L)\,\tilde{x}_{t-1} + \mu_t \quad (4),$$

The relationship between the residuals in μ_t and structural shocks ε_t is $S\varepsilon_t = A\mu_t$ from which a relationship between the variance-covariance matrices of ε_t and v_t can be derived, $\Sigma_v = A^{-1}SIS'A^{-1\prime}$. We attain identification of the structural shocks through a Cholesky decomposition of Σ_v. We make the assumption that migration is ordered first and has no contemporaneous effect on other variables in the system.

Data

The VAR contains the following information: year-end Long-Term International Migration data divided by the level of UK (+16) population the previous year, rate of (+16) quarterly population growth, the rate labour force participation, the unemployment rate, Bank rate, AWE, real consumption, real investment, real GDP, CPI. Level data is expressed in log scale. The source of LTIM data is from the International Passenger Survey, labour market data is taken from the Labour Force Survey (LFS) and real GDP and CPI data from ONS national accounts. The quarterly data spans from 1973Q2 to 2015Q2. Migration data is reported annually from 1973Q4, semi-annually from 2005Q1 and quarterly from 2011Q4.

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