“Can immigration constitute a sensible solution to sub-national and regional labour shortages?”

Report for the Migration Advisory Committee (MAC)

Final Report

Christian Dustmann, Tommaso Frattini and Ian Preston

December 2010

Executive Summary

The Migration Advisory Committee (MAC) commissioned this research report to address the question "Can immigration constitute a sensible solution to sub-national and regional labour shortages?" The aim of this research is to provide analysis that helps to assess whether a sub-national or regional shortage of skilled labour within the UK can be sensibly addressed by immigration from outside the European Economic Area (EEA) through the national shortage occupation list.

- The notion of "labour shortage" is not unambiguously defined in the economic literature, nor unambiguously understood by employers and policy-makers. We stress that it is important to define shortages within well defined labour markets. Geographic immobility between different sub-markets may be one major reason why regional labour shortages arise. The existence of geographic boundaries may mean that differences across local labour markets cannot often be easily arbitraged away by labour or capital mobility.

- We consider regional labour shortages in a simplified setting with a single good produced using two factors, labour and capital, in two regions, A and B, and labour indifference between the two regions (which means that workers are indifferent about where they live). Within this setting, labour shortages can be defined as occurring if the marginal product of labour in one region is higher than in the other region. (i) If there are institutional barriers to wage differences between regions then this will show up in an excess demand for labour in that region. (ii) If wages in that region are free to adjust, then this will show up in differences in factor prices across regions. In (ii), the

price of labour adjusts, resulting in different wages across regions, and a lower return to capital in one region as a result of scarcity of labour. In (i), firms are unable or unwilling to pay the necessary wages in an area, and an excess demand opens up.

- In a model of regional production, using identical production technologies, labour- and/or capital mobility across regions will always address a shortage situation. Only if both capital and labour are immobile will a persistent shortage situation occur.

- Immigration can be effective in reducing regional disparities between wages, and therefore labour shortage. If the problem of regional labour shortage is the existence of unexploited gains to regional labour allocation (e.g. through mobility costs) then the use of immigration rather than internal regional labour mobility to address the problem will lead to the gains going largely to immigrant rather than native labour.

- If there exist regional labour shortages, regional movement of local labour may be the most obvious way of capturing locally the implied potential gains from regional labour reallocation. However, immigration may be more economically attractive than it would be in other circumstances if regional shortages exist and if immigrant location is sensitive to regional wage differences, for two reasons: (i) Immigrant concentration tends to increase the size of the immigration surplus in comparison to cases where immigration is more regionally dispersed. (ii) If local labour is discouraged from moving to regions of labour shortage by mobility costs associated with regional dislocation then the tendency of immigrants to locate naturally in ways that reduce regional disparities eliminates the need for these local costs to be incurred to restore an efficient distribution of the labour force.

- If the production technology between two regions differs, capital is mobile, but labour is immobile, wages will differ across the two regions. Immigration into the region with higher wages will lead to capital flows, which will counteract the wage equalising effect.

- If workers regard one region as more attractive than another, and if capital is immobile, then wages in the less attractive region may be higher than wages in the more attractive region, and the return of capital is lower. However, (controlled) immigration to the less attractive region will not lead to wage equalisation, as native workers will leave the region when wages decrease. In the intermediate case where preferences about locations are heterogeneous among native workers, immigration will lead to a partial, but not to a complete reduction in the wage gap. If immigrants do not react to locational amenities, existing wage differentials will lead them to settle in areas with higher wages; thus, no allocation of immigrants to areas is necessary in this case.

- For more than one labour type, the same conclusions hold as for the one labour type model. If locational amenities are perceived differently across skill groups, then this induces labour shortages in one region for one skill type, but not for another. Immigration can to some extent **a**lleviate this problem, subject to the caveats discussed above. Whether immigrants need to be confined to a particular region or not by regulation depends on whether immigrants have similar locational preferences to natives.

- In a model with one traded and one non-traded good, and labour being immobile in addition to capital, or partially mobile (due for instance to amenity differences),

labour shortages can exist and regionally specific immigration can be partially effective in ameliorating them.

- If wages and return to capital are regionally differentiated then so will be the price of the non-traded good. Shortages of labour manifest themselves in shortages of labour-intensive non-traded production and therefore in high prices of labour-intensive non-traded goods. Allowing regional specific immigration has the scope to ameliorate the problem.

- The existence of multiple sectors opens the question as to whether immigration that is not only region-specific but also sector-specific may be a particularly well targeted response to shortages. However, even if immigrant labour can be tied, through visa conditions, to employment in a particular sector, non-immigrant labour cannot. Provided that both sectors use non-immigrant labour, mobility will prevent any intersectoral differentiation in wages for labour and therefore render sectoral restrictions on immigration ineffective as an instrument for addressing labour shortages.

- If a particular sector employs only immigrant labour, sectoral immigration restrictions can tie immigrant workers to specific sectors and become a useful policy tool.

- The observations made above about labour shortages and non-traded goods prices carry over to questions relating to labour shortages and cost of public sector provision. High public sector costs will arise as symptoms of regional labour shortages if there are barriers to full labour mobility and public provision is relatively labour intensive. Caps on public sector wages or restrictions on interregional wage inequality in the public sector will be manifested in excess demand for labour in the public sector and

difficulty in supplying public services in high wage areas. Local crises of public provision may therefore be indicative of labour market problems to which regionally specific immigration may be one possible policy response.

- Our empirical analysis tests whether there is any evidence in the data that immigrants are more responsive than natives to skill-specific local labour market imbalances. We correlate changes in the relative distribution of recent immigrants by skill group across UK regions with changes in a regional skill-specific wage index. Investigating the period between 2001 and 2006, we find that in particular male immigrants react to regional wage differentials. This effect is stronger the more recent immigrant populations are. The effects are only driven by regional wage differentials in the private sector.

- When we use alternative measures for shortages our estimates are mainly insignificant, maybe due to the difficulties in computing these indices in a precise manner based on the available data sources.

- Investigating the possibilities of measuring alternative measures of shortages at local level, we conclude that this is extremely problematic, both using LFS- and JCP-based indicators, due to measurement issues and the very small number of observations in each cell.

- We have investigated the possibility of alternative measures of shortages at local level for six out of the twelve shortage indicators used by the MAC. However, this investigation can be informative also for the three ASHE-based and the three NESS-based indicators. Previous MAC reports and MAC commissioned research have highlighted the difficulties of computing ASHE- and NESS- based indicators for four

digit occupations on a national level due to small sample size. Thus computing these indicators at the Government Office Region level means that the sample falls on average by 1/12, which greatly exacerbates these problems.

- We conclude that all top-down indicators of local shortages can be computed, for a sufficiently large number of occupations and regions, at most at the 2- digit level (3-digit for volume-based indicators).

1. Introduction and Background

Migration policies, in particular those that are based on point based systems, use immigration as a tool to address "labour shortages". For instance, Tier 2 in the UK Point Based System (PBS) is designed to address shortages: the shortage occupation list identifies occupations where there is an understanding both that a shortage exists and that this shortage should be addressed through labour immigration. Thus, systems like the UK's PBS seem to offer a solution to addressing labour shortages on national level, through a regulated system of immigration control that reacts flexibly to the demands of the national industry.

In this report we look into the issues involved with specifically regional labour shortages. Even if there are no national shortages it is possible for excess demand for labour to exist in specific regions if there are inflexibilities in wage adjustment at regional level as for instance with institutional barriers to regional wage differences between regions. Such shortages are problematic if they imply a potential for welfare-improving regional reallocation of labour. Indeed even if wages do adjust locally to clear regional labour markets it is possible for unexploited potential for welfare-improving regional labour reallocation to exist if there are barriers to factor mobility between regions. We explore these ideas further below.

There are (at least) three key assumptions on which PBS policies are based: First, the regulator can identify a "shortage". Secondly, this shortage can be addressed by immigration, leading to a welfare gain. And finally, all this is done quickly enough to address the shortage problem before it has created damage to the economy. All these three assumptions may be problematic at the stage of implementation. In this report, we will focus on the first and the

second assumption as they apply in the regional setting. The first assumption implies that a "shortage" is measurable, and that a particular measure identifies a shortage, and we will discuss the difficulties that arise. The second assumption implies that this shortage can be addressed by immigration – meaning that immigration – by relieving this shortage – leads to economic welfare gains.

We will look into this in detail, and we will show that understanding the usefulness of immigration in the context of regional labour shortage requires an understanding of the nature and the causes of the shortage. We will show that "measures" of shortages that are commonly used may not always be sufficient to answer the question whether a shortage can be addressed through immigration policy. We will point out that whether immigration is helpful a shortage will depend on the exact underlying reasons of the shortage situation.

Typically a "labour shortage" is defined as a situation where – at a particular wage – demand for labour (of a particular skill type) is higher than its supply (although there are many other, but related, definitions – see section 3). The challenge for the policy maker is then to identify labour markets where shortages occur, and to allow immigration to equilibrate these markets.

However, in much of the debate about shortages it remains unclear which exact circumstances are responsible for creating a "shortage". The definition of a shortage situation within a well-defined model, which clearly points out the mechanisms under which a shortage may arise, and why, is in our view important to assess the scope of policy to address the shortage situation. In section 3, we develop such a framework. In most situations where there exists a regional labour shortage the most obvious prima facie response is regional labour movement to eliminate the inefficiency in regional labour allocation to the benefit of local factors of production. Immigration can also close wage gaps between regions,

eliminating inefficiency in regional labour allocation but to the benefit primarily of immigrating labour.

Our analysis may imply that immigration policy becomes more complex: if there are different types of shortages, some of them being meaningfully addressed by controlled immigration, but others not, then distinctions between these situations become important for immigration policies.

2. Literature on Shortages

We precede discussion of *regional* shortages with a discussion of shortages in general. If there is a consensus among economists and policy-makers about the concept of "labour shortages", it is that the term has no universally agreed upon definition. We do not aim here at providing a comprehensive review of the literature on labour and skill shortages, as several such reviews exist, the most recent and relevant for our study being WM Enterprise (2010) and York Consulting (2008).

Our goal here is simply to summarise the main concepts of shortages typically used in earlier studies, to provide a background and motivation for our conceptualisation and modelling.

A non-technical definition of a shortage, which is sometimes used in the public discourse, is the following: a situation where the number of workers in an occupation is less than what is considered the socially desired number. As pointed out by Arrow and Capron (1959), in economic terms this means that the demand for a given type of workers ought to be greater than its supply.

The earlier academic literature dealing with shortages has originated from studies of wage movements in scientists' labour markets. According to Blank and Stigler (1957) *"A shortage exists when the number of workers available (the supply) increases less rapidly than the number demanded at the salaries paid in the recent past. Then salaries will rise, and activities which were once performed by (say) engineers must now be performed by a class of workers less well trained and less expensive"*. In this model, therefore, shortages arise because increases in demand exceed those in supply, and an occupation can be identified as having a shortage if it is experiencing a rapid wage growth.

Arrow and Capron (1959) develop an alternative definition of shortages, which they call "dynamic shortages". In their model, shortages exist as a disequilibrium phenomenon during the transition of the labour market to a new equilibrium, and are essentially due to wage stickiness. Shortages exist therefore as the result of a labour demand shock that is not immediately matched by a wage increase. After the shock, firms would like to hire more workers, but there are no available workers at the going wage rate. It takes time for the wages to adjust to the new equilibrium. Shortages will disappear faster the greater the so called reaction speed (i.e. the rate of wage rise to the excess of demand over supply), and the higher the elasticity of supply. Shortages may persist only if the demand curve moves steadily upwards. In this model, therefore, shortages are identified through an increase in vacancies for an occupation. The MAC (2008) also built on the distinction between static and dynamic shortages when reviewing theories of shortages to use in order to build shortage indicators.

Harrington and Sum (1984) review a number of shortage definitions. Within the "rate of return" model, the researcher has to compute the so called "rate of return" for each occupation. The occupational rate of return is the interest rate that equates the present values of costs of investing in a given occupation (direct and indirect costs for education and

training) with the present value of benefits (stream of wages in the occupation). An occupation is defined as in shortage if its rate of return is higher than average. This definition however has both empirical and theoretical weaknesses. Firstly, other factors, like e.g. compensating wage differentials, may explain different rates of returns between occupations, rather than shortages. Secondly, the computation of the rate of return is hard to achieve as future wages are not observable.

A common and generic definition of labour shortages, used for instance in Barnow et al. (1998), is "*a market disequilibrium between supply and demand in which the quantity of workers demanded exceeds the supply available and willing to work at a particular wage and working conditions at a particular place and point in time*". This definition is very similar to the definition adopted by many other authors like Veneri (1999), Boswell, Stiller, and Straubhaar (2004), and Shah and Burke (2005), according to whom shortages occur *"when the demand for workers for a particular occupation is greater than the supply of workers who are qualified, available, and willing to do that job"*.

Shortages in this definition are therefore considered as a disequilibrium condition, and can disappear if wages increase, provided that there are enough workers who can potentially be employed.

Shortages may arise because of an *increase in labour demand*, due e.g. to an increase in the demand for the goods produced by those workers or by an increase in the prices of factors that are used as substitutes. Shortages may also arise because of a *decrease in labour supply*; the decrease in supply might arise because, for instance, wages in another occupation have increased, leading workers to switch occupations, or because of a decrease in the size of population due to an historical decrease in fertility, or because of restrictions in the access to

particular labour markets. Finally, *wage rigidities* are another cause of labour shortages. If wages in an occupation cannot adjust to changes in demand and supply, because institutional settings keep them lower than what they would be if they were determined on the market, then this may also lead to a shortage of labour in that occupation.

The above definition can be – and usually is – made operational for the empirical analysis as *"Skills shortages arise when there are more vacancies with certain skills needs than there are people available with those skills"*, as in Frogner (2002). In this case, labour shortages may be identified by looking at the number of hard-to-fill vacancies in each occupation. This is for instance the approach taken by Haskel and Martin (1993).

Green, Machin and Wilkinson (1998) focus on the concept of shortages from the viewpoint of employers. They do not provide a theoretical framework to define shortages, but rather explore how employers responding to the Employer Manpower Skills Practices Survey interpret the notion of skill shortages. In particular, they investigate whether the notion that shortages can be identified as "hard-to-fill vacancies" is justified according to employers' shortages perceptions. Their results show that the experience of a skill shortage overlaps only partially with the experience of a hard-to-fill vacancy or the experience of a deficiency in the workforce. The authors conclude that although employees do not have any problem in interpreting for themselves the questions on skill shortages, not all employers do perceive them uniformly. Haskel and Martin (2001) in their investigation of skill shortages in the UK look at three types of shortages: skill shortages, hard-to-fill vacancies, and hiring difficulties. Their analysis relies on survey data from the Employer Manpower Skills Practices Survey and from the Workplace Employee Relations Survey that has direct questions about each of the three shortage types.

The importance of defining explicitly the dimensions across which shortages are identified has been noted by several authors. This is obviously crucial when we are concerned with sub-national shortages. Boswell, Stiller, and Straubhaar (2004) stress the importance of defining first the scope of the labour market under analysis across three dimensions: (i) Occupations and/or skills. (ii) Sector, and (iii) Geographical area

They then distinguish between two types of shortages:

1) *Aggregate labour shortage:* occurring when there is full employment, and a general difficulty in finding workers to fill vacancies

2) *Through mismatch on the labour market:*
    a. *Qualitative mismatch*: mismatch between workers' skills and skills required for vacancies
    b. *Regional mismatch:* unemployed workers looking for a job and firms offering jobs located in different regions, and jobs and/or workers are immobile
    c. *Preference mismatch:* mismatch between types of jobs that unemployed workers are willing to do and existing vacancies, despite such jobs matching their qualifications and being located in the same region
    d. *Mismatch due to information deficits:* unemployed workers and firms do not have enough information for the match to occur.

WM Enterprise (2010) also notes the importance of analysing several sub-markets within the overall labour market, to understand the commonly observed phenomenon of the coexistence of unemployment and skill shortages. In practice, skills can usefully be defined as occupations. Shortages may exist in a particular labour market, even in the presence of

aggregate involuntary unemployment, if there is not enough arbitrage across labour markets. If the labour market is segmented not only across occupational lines, but also by industry and geographically, this adds more dimensions across which shortages may arise. Therefore shortages may exist due to the inability or unwillingness of individuals to move across regions, occupations and industries. Crucially, WM Enterprise shows that the inability of individuals to move across segmented labour markets may also arise because of imperfect information: even if unemployed workers may be willing to move across labour markets, they may not be aware of all job opportunities. More generally, the match between workers and employers may not be immediate, and therefore shortages may arise. WM Enterprise note that, although the concept of a "matching function" has been present in labour economics for several years, no strong micro-economic foundation of such a function is available. Rather the authors review a number of factors that are thought to affect the efficiency of the matching function. Notably, workers' and employers' mobility is one of such factors.

2.1 Conclusion

The notion of "labour shortage" is not unambiguously defined in the economic literature, nor unambiguously understood by employers and policy-makers. One issue that often emerges in the definitions of shortages that have been proposed in the literature is the need of defining shortages within well defined labour markets. While a national (or even international) labour market certainly exists, it is clear that such a labour market is segmented across occupational as well as across geographical lines. Geographic immobility between different sub-markets limit the extent to which workers and employers may move across them, and are one major reason why labour shortages arise. In particular, the existence of geographic boundaries means that differences across local labour markets cannot often be easily arbitraged away by

labour or capital mobility. Local labour shortages may therefore exist even in the absence of national shortages. Even though this fact is acknowledged by most authors, the local dimension of shortages is one of the least explored in the literature. This is what we will explore in the next sections.

3. Conceptual Considerations: A Model of Labour Shortages

In what follows, we will set out a simple model that helps us defining various situations that create a regional shortage of some sort.

3.1 Basic model

We begin by considering regional labour shortages in a simplified setting with a single good produced using two factors, homogeneous labour (with immigrants and natives being identical) and capital, in two regions, A and B. Workers are assumed for the moment to be indifferent as to which region they reside and work in. We will relax this assumption later on. We suppose for the moment that the output good is sold on world markets at a world price which is unaffected by anything happening in the country and which we normalise to 1. Labour and capital employed in the two regions are distinguished by superscripts so that labour used in region A is denoted L^A and capital used in the same region is denoted K^A. National supplies are $L=L^A+L^B$ and $K=K^A+K^B$. Factor prices are also distinguished by region so that labour in region A, say, is paid a wage w^A and capital is paid r^A.

Production in each region has constant returns to scale and we assume competitive input markets. Efficient input choice therefore associates input price ratios w/r with labour-capital ratios in production L/K in each region

$$g^A(w^A/r^A)=L^A/K^A \qquad (1a)$$

$$g^B(w^B/r^B)=L^B/K^B \qquad (1b)$$

where the downward-sloping functions g^A and g^B are determined by the technologies in the two regions, which we allow to differ. As the ratio of wage to capital price increases in either region cost-minimising firms move around isoquants to produce using less labour-intensive techniques in production.

Firms earn zero profits in equilibrium so we can also equate the values of unit cost functions c^A and c^B to the output price in each region, which – as said above- we normalise to 1:

$$c^A(w^A,r^A)=1 \quad (2a)$$

$$c^B(w^B,r^B)=1. \quad (2b)$$

These four conditions together determine equilibrium input prices in the two regions given supplies of labour and capital.

3.2 Defining regional labour shortage

What defines a *regional* labour shortage in this simple setting? The most sensible definition would seem to be that there is a *regional labour shortage* in one region - let us say region A - *if there exists an opportunity to increase the welfare of the country's residents by movement of labour from the other region*.

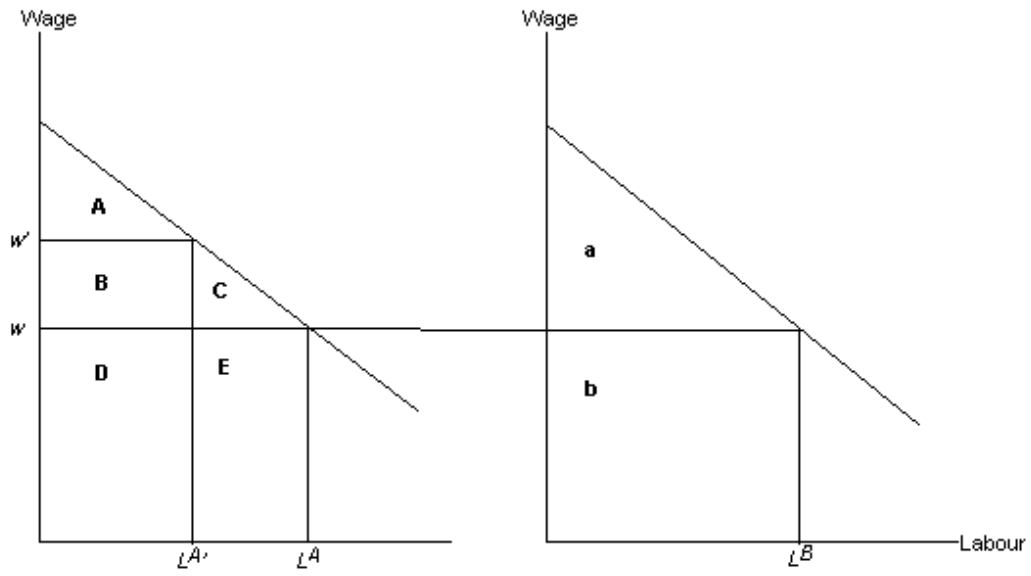
This is not a straightforward matter to assess. We need firstly to consider *economic* gains by which we can think mainly of gains in output. A reallocation of labour from B to A has the potential to raise national output if the marginal product of labour is higher in A than in B. However the distribution of that gain across factors may be quite complex and depend upon how large the movement of labour is and whether the initial position is one of economic equilibrium or not.

We need also however to consider other gains and losses. In particular if workers have other reasons to prefer region A to region B then the gain in output may not compensate them for the loss of amenities suffered by moving. A better definition of labour shortage than simply the existence of differences in marginal product of labour may therefore be the existence of differences, which are more than enough to compensate workers for the difference in amenity values of living in the different regions.

3.3 Regional labour shortages without differing amenity values

Suppose we start from a position of equilibrium as illustrated in Figure 3.1. Factor returns are equal in the two regions with labour, in particular, paid *w* in both. Payments to labour are **D+E** in A and **b** in B and payments to capital are **A+B+C** in A and **a** in B, these payments collectively exhausting output in each region. Labour has no economic incentive to move between regions and there is no output gain to be realised by their moving.

Figure 3.1



Now suppose that there occurs somehow[1] - through demographic change, movement abroad or other reasons - a decline of $\Delta = L^A - L^{A'}$ in the number of workers in A. With no change in wages there will now be an excess demand for workers in A. The employed workforce there falls to $L^{A'}$ and output falls to **A+B+D.** With unchanged wage of *w,* payments to labour fall to **D** and, with unchanged capital price, the unchanged capital stock is still paid **A+B+C** meaning that a loss is now incurred. The value of the marginal product of labour now exceeds the wage in region A which is still the same as that in region B. The marginal worker in region A is more productive than the marginal worker in region B and a movement of labour from B to A would raise national output. In this sense, it makes sense to talk of a regional labour shortage since a reallocation of the national workforce between regions could achieve an increase in output.

Note that returns to capital also differ between the two regions. Because capital in region A now works with less labour its marginal product will be lower and there will be an excess supply of capital in region A. Just as national output would be increased by movement of labour from region B to A so also could it be raised by movement of capital in the other direction. A higher rate of return to capital in one region than another will often be a natural concomitant and symptom of a regional labour shortage of the type under discussion.

If no factor movement occurs between regions then the excess demand for labour and excess supply of capital will put pressure on input prices in region A. Wages will tend to rise and capital price to fall until a new equilibrium is reached with a new wage at w' and labour demand equals again labour supply at $L^{A'}$. Payments to labour increase to **B+D** while payments to capital fall to **A** with payments exhausting the value of output. Although the

[1] We take the case of a regional supply shift for expositional simplicity. Similar points could be made in discussion of a demand shift.

excess demand for labour has been eliminated the disparity in marginal product of labour has not. Labour is still more productive at the margin in region A than region B (and capital less productive). Regional factor reallocation would still therefore be beneficial and it still makes sense to think of there being a regional labour shortage. The symptom may have changed from the existence of an *excess demand* for labour to the existence of an *interregional wage* (and capital price) *difference* but the problem is the same.

This shows that we can think about labour shortages in different ways. We can think of one region having a labour shortage if the marginal product of labour in that region is higher than in the other region. In a disequilibrium context, this will show up in an excess demand for labour in that region; in an equilibrium context, this will show up in differences in factor prices. This latter is not the conventional definition in terms of regional excess demand for labour. However, if we were to introduce into the model any temporary or permanent barrier to wage inequality between regions, preventing wages from rising to their equilibrium level in the area with scarce labour, then a labour shortage in the conventional sense would arise from exactly the same regional misallocation of labour. To an extent, these are just different ways of looking at the same thing. In the one case, the price of labour will adjust, resulting in different wages across regions, and a lower return to capital in one region as a result of scarcity of labour. In the other case, firms are unable or unwilling to pay the necessary wages in an area, and an excess demand opens up

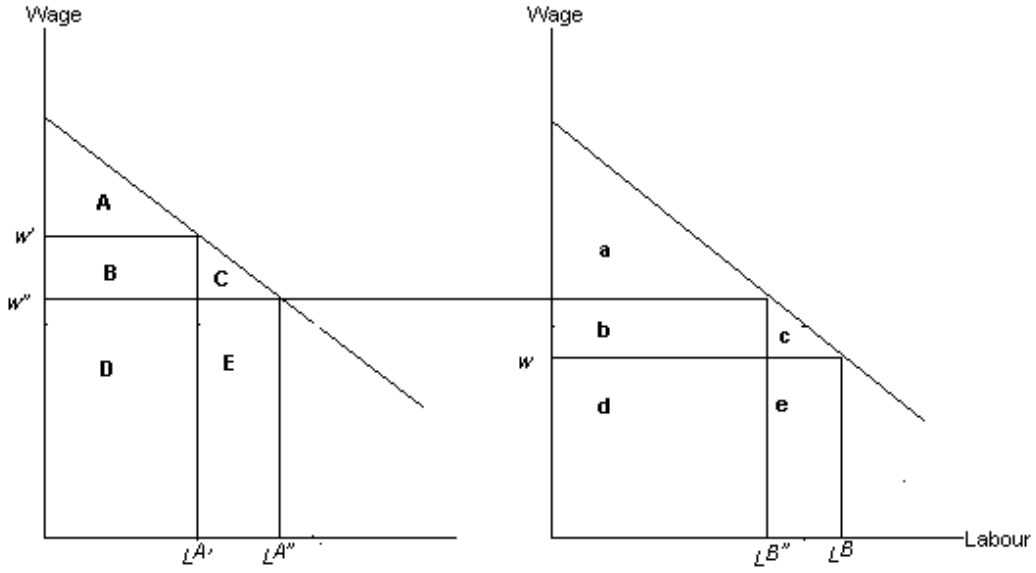
3.4 Comparing regional labour movement and immigration as responses to labour shortage

The higher wage paid to labour in region A will naturally attract, if there are no barriers to regional labour mobility, movement of labour from region A to region B. A worker moving

from A to B replaces a wage of w in region B with a wage of w'. Moreover this wage difference is exactly equal to the increase in national output resulting from the move. Output therefore increases and that increase is entirely captured at the margin by the moving worker.

Labour movement will put downward pressure on wages. The incentive to move will continue until wages are equated between the two regions. Consider then a new equilibrium with return to labour equated between regions but with national workforce at the new lower level of $L^A+L^B-\Delta$ as in Figure 3.2.

Figure 3.2



The wage in region A will have fallen from w' to w'' as a consequence of the inflow of workers from region B. Total output in region A will have risen from **A+B+D** to **A+B+C+D+E** but the changes in payments to different factors will be complex.

- The pre-existing workforce in region A will have seen their factor receipts fall from **B+D** to **D** as the wage paid to them falls.

- The newly arrived workforce will receive **E** (as opposed to **e** received previously in region B).
- Total payments to labour in Region A will therefore have changed from **B+D** to **D+E**.
- Capital located in A will see payments rise from **A** to **A+B+C** as newly arrived labour enhances its marginal product.

Meanwhile in region B, wage rises from *w* to *w''*, workers leave and output falls from **a+b+c+d+e** to **a+b+c**. The effects here are the opposite to those seen in region A.

- The remaining workers see receipts rise from **d** to **b+d**.
- Payments to labour as a whole therefore change from **d+e** to **b+d** as workers previously earning **e** leave.
- Payments to capital fall from **a+b+c** to **a**.

Across the country as a whole, national output rises since the increase of **C+E** in region A exceeds the decline of **c+e** in region B, due to the workforce moving from **B** to **A** receiving a higher wage w'' instead of w. However the increase does not benefit all factors. Capital as a whole will typically lose to the extent that the gain of **B+C** in region A is less than the loss of **b+c** in region B[2]. Labour gains both because the moving workers increase their wages by **E-e** and because the loss of **B** to the workers in A will typically exceed the gain of **b** to those in B[3].

[2] This will certainly be true if *w''* is roughly half way between *w* and *w'* and the final workforces in the two regions are roughly similar.

[3] This will be true under the same conditions as those ion which capital loses

Internal labour movement is therefore beneficial overall with the gains in output captured in payments to local factors, mainly to the moving labour force.

Movement of labour from region B is not, however, the only means by which the return to labour in region A could be brought down to equate to that in region B, eliminating the regional disparity. Immigration of labour from outside the country can increase the labour supply in the region of labour shortage just as effectively.

To illustrate this we can return to Figure 3.1. Suppose immigration of Δ has expanded the labour force in region A back to its initial level of *L*. The wage in region A will accordingly fall back to *w* and equality between factor returns in regions A and B will be restored.

Both output and factor payments are unchanged in region B. Output rises in region A by **C+E**. Payments to capital rise from **A** to **A+B+D** as capital productivity is increased by the arrival of new labour. Payments to the pre-existing workforce fall from **B+C** to **C** as wages are driven down. The arriving immigrants receive **E**. Overall there is therefore a redistribution from local labour to capital and an increase of **D** in total payments to local factors because the immigrants are paid less **E** than they add to production **D+E**.

The excessive return to labour in region A relative to region B has now been eliminated but note that the gains in output from so doing have accrued predominantly in the payment of **E** to immigrating rather than local labour. There has been a small gain of **D** to local factors but this is just the immigration surplus that arises routinely because of labour immigration in models of this sort and its existence has nothing particularly to do with the existence of a regional labour shortage, and there has been an increase in output. Immigration can therefore

be effective in reducing regional disparities between wages and therefore in reducing labour shortage. However, if the problem of regional labour shortage is the existence of unexploited gains to regional labour allocation then the use of immigration rather than internal regional labour mobility to address the problem allows the gains to accrue largely to immigrant rather than local labour.

3.5 Greasing the wheels of the labour market

George Borjas (2001) has addressed the welfare effects of immigration in contexts such as these and his comments point to two positive features of immigration in the context of regional labour shortages. Immigration, wherever located, creates a surplus accruing to the owners of capital as a consequence of the downward sloping nature of labour demand curves, the downward pressure placed on wages and the consequent fact that immigrants receive remuneration less than the value of what they add to production, as explained above. Since immigrants do not have the same ties to particular regions as does local labour, immigration may locate naturally in regionally concentrated fashion in areas of labour shortage where wages are higher.[4] This concentration tends to increase the size of the immigration surplus in comparison to cases where immigration is more regionally dispersed. The existence of labour shortages and potential for advantageous concentration of immigration may therefore be expected to increase the size of the potential surplus from immigration.

Furthermore if local labour is discouraged from moving to regions of labour shortage by mobility costs associated with regional dislocation then the tendency of immigrants to locate

[4] Immigrants may have other ties than local, labour, due to networks , which may create particular locational preferences.

naturally in ways that reduce regional disparities eliminates the need for these local costs to be incurred to restore an efficient distribution of the labour force. This is referred to as immigration "greasing the wheels" of the labour market.

Both of these arguments suggest that if there exist regional labour shortages then, albeit that regional movement of local labour may be the most obvious way of capturing locally the implied potential gains from regional labour reallocation, immigration may be more economically attractive than it otherwise would be. Both arguments rely however on immigrant location being sensitive to regional wage differences. The empirical section of this report below addresses this issue.

In the following we explore in further detail equilibrium outcomes under differing assumptions regarding

1. mobility of labour between regions
2. mobility of capital between regions
3. identity of technology between regions
4. attractiveness of regions to labour

3.6 Same technology, same amenities

To begin with, we consider the case in which both factors are fully mobile, technology is the same in both regions and labour is indifferent regarding location. Labour mobility requires that wages are equated between regions and capital mobility requires that the capital price is equated

$$w^A = w^B$$

$$r^A=r^B$$

From (1a,b) the labour-capital ratio is therefore equated between regions and equal in both to the country-wide labour-capital ratio L/K

$$L^A/K^A=L^B/K^B=L/K$$

These assumptions are stronger than we need to reach this conclusion. In fact, assuming mobility of either factor alone is sufficient, given the assumption of nationally homogeneous technology. Suppose that capital alone, for example, is mobile between regions. Then $r^A=r^B$ and from the zero profit conditions (2a-b) it follows that $w^A=w^B$ so that equality of labour capital ratios $L^A/K^A=L^B/K^B=L/K$ follows. Similar reasoning shows that mobile labour and immobile capital also ensures equality of factor prices and factor proportions across regions. In none of these cases is there anything interpretable as a regional labour shortage.

It is only if we assume that both labour and capital are regionally immobile that factor proportions and input prices differ. If we suppose that labour and capital are unable to move between regions then each region is required to employ inputs in the proportions set by the immobile region-specific supplies $L^A/K^A \neq L^B/K^B$. From (1a-b) factor price ratios also differ correspondingly between regions $w^A/r^A \neq w^B/r^B$ and then from (2a,b) $w^A \neq w^B$ and $r^A \neq r^B$. This is a case where we could reasonably describe the situation in the region with lower labour-capital ratio as one of labour shortage. Labour supply in that region is low relative to capital and labour therefore earns a higher return. If labour or capital were mobile then the shortage could be eliminated by movement of labour between regions but, since they are not, some other means of increasing labour relative to capital in the region with the shortage is required if equality of factor returns is desired. In this situation, immigration into the region would

succeed as a means of bringing about this objective. However, this situation requires completely immobile factors across regions, which is probably quite implausible.

Conclusion: In a simple model of regional production, using identical production technologies, labour- and/or capital mobility across regions will always address a shortage situation. Only if both capital and labour are immobile will a shortage situation occur.

3.7 Different technologies

Now suppose that we relax the assumption of identical technologies but suppose that capital and labour are mobile between regions. As above, input prices must be equated $w^A=w^B$, $r^A=r^B$ but this will not now ensure equality of factor proportions between regions $L^A/K^A \neq L^B/K^B$. One region produces with a lower ratio of labour to capital than the other. This is an efficient response to technological differences between the two regions, however. Capital and labour earn the same returns in the two regions and the difference in factor proportions cannot be interpreted as constituting any sort of regional labour shortage. Immigration into the region with low labour-capital ratio would lead to a corresponding regional reallocation of mobile factors to restore equilibrium with regional factor proportions, which would remain regionally differentiated.

Now suppose that technology differs but capital alone is mobile. Returns to capital are equated between regions $r^A=r^B$ but it is not necessary that wages are equated $w^A \neq w^B$. Obviously, factor proportions in production will differ between regions. Capital mobility alone does not guarantee an absence of difference in returns to labour. In these circumstances immigration concentrated in regions where labour returns are high can reduce wage differences but if capital is mobile then there will be capital flows in response to immigration which will reduce its effectiveness in that respect.

Conclusion: If the production technology between two regions differs, capital is mobile, but labour is immobile, wages will differ across the two regions.

3.8 Different amenities

Suppose now that capital is immobile and technologies are the same. Labour can move but regards one region as more attractive than the other. For instance, workers could be mobile between Scotland and England, but would prefer to be in either England or Scotland. Specifically suppose that region B is more attractive so that wages in region A need to be higher by an amount ξ in order to persuade workers to live there.[5] In equilibrium

$$w^A = w^B + \xi > w^B$$

Hence, from (2a,b),

$$r^A < r^B$$

and from (1a,b)

$$L^A/K^A < L^B/K^B.$$

Returns to labour are higher in the less attractive region and immobile capital earns a lower return because of the short supply of labour.

We can analyse this sort of labour shortage similarly to the case with no amenity differences if we wish to concentrate attention on the potential for increasing national output. The existence of differences in the marginal product of labour, reflected in regional wage

[5] What we refer to as "amenities" could also be called "costs" (either "real costs" or "psychic costs" of residing in one area vs. another. Such costs may be location preferences due to different (climatic) conditions in the two regions, environmental considerations, family links, or could be simply the consequence of inertia in preferences.

differences, do imply that movement of labour from region B to region A can increase output. However it would be wrong to regard this as a gain in *social welfare*. The required labour movement creates amenity losses which, at the margin, exactly offset the output gain and which, for greater changes, imply losses in total worker welfare. Any description of such wage differences as involving regional labour shortage in region A is therefore highly dubious.

Furthermore, this is a sort of labour shortage which cannot be addressed by immigration. An influx of foreign labour to region A, even if it would be possible to require immigrants to remain in that region, would lead to outmigration of native labour as wages in region A were depressed and living in region A rendered unattractive to natives.[6]

This rather stark conclusion arises because of the extreme nature about the assumption about location preferences. More reasonably, we can consider a case with a distribution of heterogeneous preferences ξ with some workers more attracted to one region, and some to the other. In such a setting, wage differences can arise with some people (those with high ξ) choosing to reside in A and the others (those with low ξ) choosing to reside in B. Returns to labour and capital will not be equated between regions in equilibrium. Differences in attractiveness of regions to workers mean that mobile labour will be happy with different remuneration in different regions and immobile capital will not be able to earn the same return in different regions[7].

[6] Note that the assumption of capital immobility is essential here. If capital were mobile then, given the identical technologies in the two regions, it would follow labour out of region A and production would all be transferred to region B.

[7] An outline of such a model is sketched out in the Appendix.

Immigration into regions with low returns to capital will depress wages, changing the position in the distribution of ξ at which workers are indifferent between the two regions, and therefore inducing some counteracting out-migration by native workers, but not to the extent that the original difference in factor returns is restored. Regional immigration policy can therefore be effective, though imperfectly, in reducing wage gaps.

Such an immigration policy might be one that directed immigrants towards regions of known labour shortage under visa conditions that required them to remain in that region. However, such a policy might be difficult to implement, and labour shortages may not be easy to identify. Even if it is impossible to regulate the location of immigrants, it is still the case that, if immigrants' location decisions are less sensitive to amenity differences and more driven by wages than those of natives, immigration may be an effective policy in reducing wage gaps. Most importantly, such a situation would not require the policymakers to identify where labour shortages occur (as long as immigrants choose regions according to higher wages), though it might nonetheless allow an improvement in the effectiveness of immigration as a policy instrument if they could. Our envisaged empirical work, which relates relative labour supply of immigrants to natives to relative wage differences, will address exactly this point.[8]

Conclusion: If workers regard one region as more attractive than another, and if capital is immobile, then wages in the less attractive region may be higher than wages in the more attractive region, and the return of capital lower. However, (controlled) immigration to the less attractive region will not lead to wage equalisation, as native workers will leave the region when wages decrease. Also wage gaps are not evidence that there is any regional

[8] This is similar to Borjas' idea that immigrants "grease the wheel" of the labour market. However, Borjas, although starting off with a situation where wages are different across regions, does not develop a model for the exact sources of labour mobility.

labour shortage in the sense of a potential for welfare gain through regional labour reallocation. In the intermediate case where preferences are heterogeneous among native workers, immigration will lead to a partial, but not to a complete reduction in the wage gap. If immigrants don't react to locational amenities, existing wage differentials will lead them to settle in areas with higher wages; thus, no allocation of immigrants to areas is necessary in this case.

This discussion shows also the importance in understanding labour shortages of being clear about the exact reasons for factor immobility. Without a clear framework of the type we outline above, it is impossible to precisely pin down cases where immigration policy may meaningfully address regional labour shortages.

4. Extensions

So far, we have considered only one type of labour. However, much of the shortage discussion is about shortages of particular types of labour (skilled or unskilled), and below we will extend the above framework to allow for different labour types, so that we can talk about shortages of specific skills.

Furthermore, we have so far assumed that there is only one output good, the price of which is exogenously given. Again, much of the debate about shortages distinguishes between shortages in the traded, and the non-traded sector – or, equivalently – shortages in the public (non-traded) and private sector. We will extend below our exposition to cover these cases as

well. We will introduce a non-traded goods sectors, and we will consider shortages in the public sector.

4.1 Different labour types

One natural extension of the model is to allow for different labour types, distinguished by skill and type of human capital. Suppose that there are *n* such types. In equilibrium, efficient input choice means that the labour capital ratio for each type will stand in a given relationship to the wage for that labour type

$$g_i^I(w_i^I/r^I)=L_i^I/K^I, \qquad I=A,B,\ i=1,\ldots,n \qquad (3)$$

while the requirement that firms earn zero profits will also continue to hold

$$c^I(w_1^I,\ldots,w_n^I,r^I)=1, \quad I=A,B \quad (4)$$

The features of such an extended model and in particular the possibility of labour shortages will mirror those of earlier discussion. Assume capital is regionally immobile. If labour is mobile and indifferent between regions and technology is regionally undifferentiated then wages will be equated for each labour type. From (4) it follows that so will the returns to capital. No regional shortages will therefore exist. On the other hand, labour immobility or mobility with a distribution of amenity values (presumably specific to each labour type) will create regional differences in returns to factors, which can be reduced by regionally specific immigration. As in earlier discussion, the output gains from immigration are accruing largely to immigrants.

What is new in this extended model is the possibility of labour shortages for skills of particular types. Even if mobility, say, of unskilled labour allows wages for unskilled labour

to be equated across regions, shortages can still occur as a consequence of barriers to the mobility of, say, skilled labour.

Alternatively, if skilled resident labour was more responsive to locational amenities than unskilled labour, then a shortage situation for skilled labour could occur. Consider for instance the case of, say, the medical profession where individuals might, hypothetically, have stronger preferences for locational amenities, like cultural goods. This may create a shortage situation for skilled labour in culturally depleted areas. If immigrants in the medical profession do not exhibit the same preferences, or can be forced by visa conditions to remain in the shortage area, then immigration managed in that way may address the problem, subject to the caveats of earlier sections. In the former case immigration, being reactive to regional differences in wages, will direct itself to address the problem. If immigrants exhibit the same cultural preferences, however, migration needs to be directed by regulation: If not confined to the region where the shortage situation occurs, immigrants would – as natives – move to the region with higher amenities. This case is similar to the one we discus under 3.4, where we consider only one labour type.

Conclusion: If we extend the model to more than one labour type, the same conclusions hold than for the one labour type model. What is now new is that locational amenities may be perceived differently across skill groups, allowing for the possibility of wage differences between regions for one skill type, but not for another. Immigration can to some extent reduce such wage differences. Whether immigrants need to be confined to a particular region or not by regulation to achieve this depends on whether immigrants have similar locational preferences to natives.

4.2 Non-traded sector

A further development is the introduction of a non-traded goods sector. By this we think of introducing production of a good not only not traded on international markets but also not traded between regions so that its price p^I, $I=A,B$, can differ between regions. One example could be services, like hairdressing. In the following section we discuss the possibility of interpretation as public services, including health services.

Total regional supply of labour and of capital each have to be split between the two sectors. Let subscripts N and T distinguish the non-traded and traded sectors. Then

$$L_N^I+L_T^I=L^I$$

$$K_N^I+K_T^I=K^I$$

Cost minimising input choice will lead to conditions applying to each sector in each region

$$g_i^I(w^I/r^I)=L_i^I/K^I, \qquad I=A,B,\ i=N,T \quad (5a, b)$$

and a zero profit condition will hold in each sector in each region:

$$c_T^I(w^I, r^I)=1, \quad I=A,B \quad (6a, b)$$

$$c_N^I(w^I, r^I)=p^I, \quad I=A,B \quad (6c. d).$$

The additional markets, for non-traded output in each of the regions, need to clear locally adding an extra equilibrium condition in each region to determine the extra price variable p^I. For this we need new terminology and also some further precision on the determination of local incomes. For simplicity assume that local incomes come solely[9] from locally provided

[9] We neglect here, for simplicity, the possibilities either that income might accrue from capital held abroad or that any of the flow of income from capital used in the country might flow out of the country.

labour $w^I L^I$ and from shares s^{IA} and s^{IB} of payments to capital in the two regions $r^I K^I$, $I=A,B$. Assume also that the distribution of income is irrelevant to the determination of local demand for the non-traded good[10], which can therefore be written as a function of aggregate local factor receipts and of the local non-traded good price, $D^I(w^I L^I + s^{IA} r^A K^A + s^{IB} r^B K^B, p^I)$, which needs to be equated to local production, $F_N^I(L_N^I, K_N^I)$,

$$D^I(w^I L^I + s^{IA} r^A K^A + s^{IB} r^B K^B, p^I) = F_N^I(L_N^I, K_N^I), \quad I=A,B \quad (7a, b)$$

As in previously discussed models, we assume that capital is immobile. If there is unrestricted mobility of labour with all workers indifferent between regions and undifferentiated technology, then this will lead wages to be equated across regions and, from (6a, b), the return to capital will also be equated. No labour shortages therefore arise. Furthermore, from (6c, d) the price of the non-traded good is also regionally unvarying.

If on the other hand labour is immobile in addition to capital, or partially mobile (due for instance to amenity differences) then wages will differ between regions and, from (6a, b) again, so will return to capital. Labour shortages can therefore exist and regionally specific immigration can be partially effective, depending upon assumptions, in reducing them. Again, if the source of labour immobility is regional amenities, and immigrants are indifferent between regions, then immigration will direct itself to address shortages, reacting to regional wage differentials in the not-traded sector. As before the degree to which that happens depends on the reaction of natives in unattractive areas to changes in the wage. If in

---

Neither of these would be difficult to incorporate - the former by incorporating an additional income source unconnected to production decisions in the country and the latter by allowing $s^{IA}+s^{IB}<1$ - but neither adds much insight.

[10] Again, it is easy to elaborate the model specification to account for this - by, say, assuming quasi-homotheticity in preferences - or to extend the model to incorporate deviations from this, but neither route is particularly illuminating about anything of interest.

turn immigrants exhibit similar preferences to natives, migration needs to be directed to address shortages. As in earlier discussion, the output gains from immigration accrue largely to immigrants.

While the aetiology of labour shortages is therefore similar to that of previous discussions, the development of the model creates scope for a new symptom. From (6c, d), if wages and return to capital are regionally differentiated then so will be the price of the non-traded good. The nature of the difference will depend upon the relative labour intensity of production in the traded and non-traded sectors. Say, for example, that non-traded production is relatively labour intensive and that region *A* is suffering a labour shortage. The greater wage and lower return to capital in region *A* will lead to a higher price for the non-traded good. Shortages of labour manifest themselves also in shortages of labour-intensive non-traded production and therefore in high prices of labour-intensive non-traded goods.

Just as above, allowing regional specific immigration has the scope to address the difference though with gains accruing largely to immigrants. However, the existence of multiple sectors opens the question as to whether immigration that is not only region-specific but also sector-specific may be a particularly well targeted response to shortages. The answer to this question must depend on the possibility of intersectoral rather than interregional labour mobility. Even if immigrant labour can be tied, through visa conditions, to employment in a particular sector, non-immigrant labour cannot. Provided that both sectors use non-immigrant labour, mobility will prevent any intersectoral differentiation in wages for labour and therefore render sectoral restrictions on immigration ineffective as an instrument for addressing labour shortages. If, however, a particular sector employs only immigrant labour then wages for that sector can fall below wages in the other, sector-specific wages can differ across regions and sector-specific shortages open up. Evidently, sectoral immigration restrictions can tie immigrant

workers to specific sectors and become a useful policy tool. Certain seasonal agricultural sectors may be examples.

4.3 Public sector

The importance of this particular development is that it helps understand public sector labour shortages. We can reinterpret the non-traded sector as a public sector producing a non-traded publicly provided good such as education or health care. If public sector production is still cost-minimising then (5a, b) will still hold and the zero profit condition (6c, d) can now be viewed as an expression determining the unit cost of public sector provision.

Determination of demand is now the issue. If the public service is something determined by local democratic processes then the market clearing conditions (7a, b) can be reinterpreted as equating demand and supply in the publicly provided sector with D^I capturing not a privately-expressed market demand but a publicly-expressed demand arising through local democratic processes. The nature of that demand will depend on the political economy of public provision and its funding but dependence on local income and cost of provision should be expected to remain the key feature. For example, in a simple majority voting model, D^I would be the demand expressed by the median voter. On the other hand, if the level of service is nationally determined then we would not expect local income or local prices to play the same role and we would need to replace the left hand side of (7a, b) with a nationally determined level of demand.

The model is formally unchanged and the observations made above about labour shortages and non-traded goods prices should carry over to questions relating to labour shortages and cost of public sector provision. High public sector costs will arise as symptoms of regional labour shortages if there are barriers to full labour mobility and public provision is relatively

labour intensive. Caps on public sector wages or restrictions on interregional wage inequality in the public sector will be manifested in excess demand for labour in the public sector and difficulty in supplying public services in high wage areas. Local crises of public provision may therefore be indicative of labour market problems to which regionally specific immigration may be one possible policy response[11].

5. Theoretical Concepts and the Relationship to the MAC's Shortage Definitions

In this section, we relate the conceptual definitions of shortages to the four definitions of shortage adopted by the MAC (2010). We should emphasise however that the MAC's definitions refer to national shortages, while we define in our analysis regional shortages. We define this as a case where the marginal product of labour in one region exceeds that in another by more than the difference in workers' willingness to pay to reside in the two regions. This can show up as an excess demand for labour in that region, if there is some institutional resistance to wage differences between regions, or in a higher wage. Below we briefly state the MAC's definitions of shortage, and explain how they relate to the model we have developed in the previous sections.

The MAC distinguishes between static and dynamic shortages. These shortages can manifest themselves in terms of four broad categories of labour shortage.

[11] If immigrants change the nature of the demand for public provision then it may be that, as often claimed, immigration may also aggravate demands on the public sector. In such a case, the balance between the supply and demand effects of immigration may require careful consideration.

1. A cyclical shortage. "This shortage may occur when demand for skilled labour is more than the supply at the prevailing wage at a particular point in the economic cycle. This can occur where wages or the supply of suitably skilled labour cannot keep pace with growth in labour demand due to labour market frictions such as 'sticky wages'. A cyclical labour shortage may therefore persist even though wages are observed to be increasing. Such shortages will most likely occur during periods of economic growth, and decline or disappear during an economic downturn. Indeed, we might expect the inverse to occur during a downturn with downward pay inflexibility causing unemployment to increase." (MAC, 2010, 5.10)
2. A structural shortage. "This may exist where some kind of failure in the labour market means that occupational or sectoral supply does not match demand for reasons unrelated to the economic cycle. In some cases sufficient numbers of skilled people may not be available to satisfy the labour demand within an occupation at the prevailing wage level. In these circumstances, the domestic supply of and/or demand for labour is inflexible, or even fixed in the short term. Wage adjustments should, in the long-term, influence the number of domestic workers who obtain the relevant skills. But the market may remain in disequilibrium for some years as this adjustment takes place." (MAC, 2010, 5.11)
3. Constraints on public sector spending may prevent wages from rising in response to a shortage of labour. "Such constraints may mean that in the event of a mismatch between supply and demand, market forces cannot bring the labour market back into equilibrium. This type of shortage can exist alongside and reinforce structural shortage." (MAC, 2010, 5.12)

4. "In cases where there is a global market for talent, the ability to increase labour supply in response to labour shortage may be severely limited. This is similar to structural shortage, in the sense that there is a shortage of skilled labour that exists independently of the economic cycle. It differs from structural shortage in that the cause of the shortage is primarily due to a lack of individuals with the required 'innate' ability rather than historically low pay or a lack of trained individuals. In some global labour markets the demand for the 'very best' may outstrip the supply of the most talented labour. Because of the inherent lack of sufficiently skilled individuals, labour markets may remain in a state of disequilibrium where demand exceeds supply in the long term." (MAC, 2010, 5.13)

How do these definitions relate to our analysis? Note again that our analysis related to regional shortages rather than national shortages. As we explain in Section 3, we can think about labour shortages in different ways. One way to define a labour shortage is a state where the marginal product of labour in that region is higher than in the other region. In a disequilibrium context, this will show up in an excess demand for labour in that region. A disequilibrium could be maintained at least in the short run if wages can not adjust immediately to the new supply of labour. In an equilibrium context, a higher marginal product of labour will show up in differences in factor prices. These are just different ways of looking at the same thing. In the one case, the price of labour will adjust, resulting in different wages across regions, and a lower return to capital in one region as a result of scarcity of labour. In the other case, firms are unable or unwilling to pay the necessary wages in an area, and an excess demand opens up.

How does our regional shortage definition relate to the MAC's first definition of a cyclical shortage, which "may occur when demand for skilled labour is more than the supply at the prevailing wage at a particular point in the economic cycle"? Obviously, this is exactly the situation where the price of labour is not adjusting to the new supply conditions, thus leading to an excess demand for labour. The cause of the shortage is stickiness in the national level of wages. We add in our analysis the insight that – in a regional context - regional shortages could arise from region-specific cyclical shocks through institutional barriers to regional wage differences. This situation could be adjusted if labour would move across regions. It will also be adjusted through capital movements. These movements will lead to an overall welfare gain. We also show that immigration will help in a similar way to eliminate the regional disparity. However, as we show also, the gain will mainly go to immigrants; native capital owners will only obtain the standard migration surplus. While we generate the excess demand for labour through a reduction in labour supply, this excess demand is generated in the "cyclical" definition of the MAC through an outward shift of the demand curve, possibly induced by a demand shock for the product produced. In our model, such a demand shock would generate similar implications than the negative supply shock.

The MAC's second definition is referred to as a "structural shortage", defined as occurring "…where some kind of failure in the labour market means that occupational or sectoral supply does not match demand for reasons unrelated to the economic cycle". We do not investigate occupational or sectoral supply. However, this definition is again related to a failure of the market to equilibrate an excess demand for labour – as before. The difference is that a "structural" reason is responsible for this disequilibrium. This could – again – in the national context be stickiness in the national level of wages,

whereas it could arise in the regional setting through institutional barriers to regional wage differences. It could also be induced by barriers to mobility, perhaps arising from what we refer to as different amenities (section 3.8), where some workers prefer living in one region rather than another. This induces a shortage situation if capital is immobile. In section 4.1, we discuss this case for different labour types.

The MAC's third definition of a shortage refers to the public sector. Again, the situation is one where there exists an excess demand for labour, due to wages not responding, as we discuss in section 3. Now the interpretation of the wage rigidity is more explicit: It happens because public spending restrictions keep wages down. In a regional setting, shortages could arise through public sector wage setting mechanisms that do not allow for regional differences or from public sector wage caps as discussed in section 4.3. We also emphasise in section 4 that the public sector has to be thought of as a sector with a non-traded good.

The MAC's fourth definition relates to the unavailability of highly skilled workers. "Because of the inherent lack of sufficiently skilled individuals, labour markets may remain in a state of disequilibrium where demand exceeds supply in the long term". In our setting, this is – as before – a situation where demand out-strips supply, and where wages have not adjusted (or cannot adjust) upwards to equilibrate the market.

6. Empirical Analysis and Measurement

The goal of our empirical exercise is to test whether there is any evidence in the data that immigrants are more responsive than natives to skill-specific local labour market imbalances. If this were the case, then this would provide some evidence in favour of the possibility that immigration can constitute a solution to sub-national and regional labour market imbalances, under some, but not all the scenarios we discuss in sections 3 and 4 for why the wage difference is created in the first place. *This does not necessarily mean that immigrants are alleviating a shortage situation: If for instance wages are higher in region A because of locational dis-amenities perceived by native workers, and immigrants are not sensitive to these amenities, then immigration into A will be followed by outmigration of natives, as we discuss in section 3.8.*

In practice, we correlate changes in the relative distribution of recent immigrants by skill group across UK regions with changes in a regional skill-specific wage index.

It is worth stressing that the results of these regressions are only informative about the extent to which, over the time period analysed, immigrants have responded to regional labour market imbalances or not. We are not identifying any deep structural parameters, and therefore the results of the regression analysis may vary according to the time frame considered. Indeed, we show in our analysis that our results are different in the pre-crisis years (until 2006) and in the most recent, post-crisis, years.

We define skills as occupational groups, based on the SOC 2000 classification. We group the nine major occupational groups in three macro categories, based on their average hourly earnings. The highest earners groups are "Managers and Senior Officials", "Professional occupations", and "Associate Professional and Technical"; the intermediate earners group "Administrative and Secretarial", "Skilled Trades Occupations" and "Process, Plant and Machine Operatives", while the lowest earners are "Personal Service Occupations", "Sales and Customer Service Occupations", and "Elementary Occupations". The occupational classification in the LFS changed in 2001 from SOC 1990 to SOC 2000, and the two classifications are not comparable over time. For this reason, defining skill groups in terms of occupations means that our analysis is confined to years 2001-2009.

For each of these groups we construct a wage index measuring the skill-specific wage differential between regional and UK wages in every year, net of compositional effects. We define such an index as $\widetilde{w}_{jst}$, where j denotes regions, s denotes occupation groups, and t denotes years. The index is computed as follows. For each year t we run separate log-wage regressions of the form:

$$(6.1) \quad \ln w_{ijst} = X_{ijst}\beta^t + \phi^t_{js} + u_{ijst}$$

where X_{ijst} is a vector of individual characteristics like gender and age, ϕ^t_{js} denotes skill-region specific fixed effects in every year t, and u_{ijst} is the error term. We normalize ln w_{ijst} and all variables in X_{ijst} to have mean zero in each year t. ϕ^t_{js} denotes in every year t the percent wage differential between the average wage (adjusted for individual characteristics) for individuals in skill group s in region j and the mean national wage, and we can therefore define $\widetilde{w}_{jst} \equiv \phi^t_{js}$. Comparison of this index across regions allows to evaluate the extent of

regional wage dispersion, net of regional composition but without accounting for differences in regional cost of living. We will account for such differences in the regression analysis, which we perform in the second step.

Our regional units are based on the variable "region of usual residence" from the LFS. The LFS originally identifies 20 regions[12]. We unify Inner and Outer London into Greater London, and Strathclyde and the Rest of Scotland into Scotland, to create territorially homogeneous regions, so we end up with 18 regions. Figure 6.1 shows the amount of wage dispersion existing across regions, and over time.

Figure 6.1: Regional dispersion of wage indices by occupation group

[12] Tyne & Wear, Rest of Northern Region, South Yorkshire, West Yorkshire, Rest of Yorkshire & Humberside, East Midlands, East Anglia, Inner London, Outer London, Rest of South East, South West, West Midlands (Metropolitan counties), Rest of West Midlands, Greater Manchester, Merseyside, Rest of North West, Wales, Strathclyde, Rest of Scotland, Northern Ireland.

We have plotted, for all occupational groups, the wage index for each region in 2001 versus the wage index in 2009. For each occupational category, there are two regions that display higher wages in both years: these are London and the rest of South East, which have higher wages than the rest of the UK for all skill levels. However, the correlation between wages for different skill levels is lower in other regions. For instance, in 2009, the correlation between wages for the high and low earners groups, considering all regions, is 0.87, while excluding London and the rest of South East it is 0.37. It is worth stressing that, as noted above, we are not controlling for regional living costs in the construction of the index, although we will do that in the final regressions through the inclusion of region-year fixed effects. Therefore the higher wages in London and the rest of South East are also due to the higher cost of living in those regions. We are not able, however, to disentangle the effects of higher living costs and higher productivity at this stage.

Once we have constructed the wage index, we have also to construct the regional relative supply of recent immigrants and natives in each region. We define R_{jst}, the relative supply of recent immigrants and natives in each region j, skill group s, and year t as:

$$(6.2) \qquad R_{jst} = \frac{M_{jst} / M_{st}}{N_{jst} / N_{st}}$$

where M denotes recent immigrants and N denotes natives. R_{jst} takes value 1 if recent immigrants and natives of skill level s are equally concentrated in region j in year t, and is greater than 1 if recent immigrants of type s are relatively more concentrated than natives in region j.

In our empirical implementation we will alternatively define recent immigrants as those who have been in the UK for less than two years, or as those who have been in the UK for less

than ten years. While the former definition would be the preferred, due to the small sample size we might measure the number of recent immigrants with considerable error in a skill-region group. This would lead to measurement error also in our dependent variable R_{jst}, which is exacerbated by estimation with fixed effects. Measurement error in the dependent variable leads to less precision in the estimate: although the estimated coefficient is still unbiased and consistent, the standard errors may be large. For this reason, we also use, as an alternative definition, that of "recent immigrants" as immigrants who have been in the UK for less than ten years, which has the advantage of increasing the sample size and hence the precision of the measurement. Table 6.1 reports basic descriptive statistics for all variables used in the estimation. The mean value, across regions and years, of R_{jst} is about 0.8, although the values change according to the criteria we choose to define recent immigrants. However, the variable exhibits great variation across regions. For instance, the mean value of R in London is about 5, indicating that on average immigrants are five time more concentrated in London than natives, while it is less than 0.3 in the "rest of North West". The occupation category where immigrants are more concentrated relative to natives is, on average, the intermediate earners category. However, the skill-region cell with the highest relative supply of immigrants is, on average, low-earners in London.

The mean value of the wage index across all regions and years is, by construction, very close to zero. Wages in the private sector are higher than in the public sectors for high and intermediate earners, while the opposite is true among low earners. As we have already noted in Figure 6.1, the regions with the highest average wages are for all skill groups London and the Rest of South East.

Our basic regression equation is of the form:

(6.3-a) $R_{jst} = \beta \tilde{w}_{jst} + \phi_j \times \tau_t + \phi_j \times \xi_s + \xi_s \times \tau_t + u_{jst}$

where we correlate in every year *t* the relative supply of immigrants in a region-skill cell with the deviation in the cell wages from the national mean. We control for differences in living costs in different regions over time with the interaction of region and year dummies ($\phi_j \times \tau_t$), for any factor that may affect a specific skill group in a year and is common to the whole UK with the interaction of skill group and year dummies ($\xi_s \times \tau_t$), and for any region-skill specific effect with the interaction of region and skill group dummies ($\phi_j \times \xi_s$). The inclusion in the model of the region-skill specific interaction implies that in (6.3-a) β is identified through the variation in wage differentials over time within region-skill cells. In other words, the excluded variation is $(\phi_j \times \xi_s \times \tau_t)$. Equivalently, region-skill specific effects can be removed through first differencing, so that the regression equation becomes:

(6.3-b) $\Delta R_{jst} = \beta \Delta \tilde{w}_{jst} + \Delta(\phi_j \times \tau_t) + \Delta(\phi_j \times \xi_s) + \Delta u_{jst}$

A positive estimate of β in (6.3-a) or (6.3-b) would indicate that recent immigrants are more responsive than natives to regional wage changes.

In our analysis, we will run regressions of the form in (6.3-b), and every observation will be weighted by the total number of individuals in the skill-region-year cell.

6.1 Results

Table 6.2 reports results from regressions of the form in (6.3-b) when the dependent variable is the relative supply of immigrants who have been in the UK for less than two years (column 1), less than ten years (column 2), or of all immigrants (column 3), and the years analysed are 2001-2006. Results show that the occupation-specific wage differential between regional and

national wages is positively correlated with the relative supply of immigrants from the same skill group in the region, and that the correlation is stronger for more recent immigrants. The coefficient β is estimated at 3.2 when the dependent variable is the relative supply of the most recent immigrants and natives, although the coefficient is only significant at 10%. When the dependent variable is the relative supply of immigrants in the UK for less than 10 years, β becomes smaller in magnitude (1.6), but it is more precisely estimated, which is due to the larger sample. Finally, when we consider all immigrants (results reported in column 3), the point estimate becomes much smaller, and the estimated coefficient is not significantly different from 0.

Table 6.2 – All immigrants

	(1) *Less than 2 years in UK*	*(2)* *Less than 10 years in UK*	*(3)* *All immigrants*
Wage index	3.189* (1.788)	1.641** (0.816)	0.724 (0.698)
Region & year interaction	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes
N	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of immigrants and natives for immigrants who have been in the UK for less than two years (column 1), immigrants who have been in the UK for less than ten years (column 2), and all immigrants (column 3) on the change in a wage index for each occupation group. See text for details on occupation groups and on construction of the variables. Years 2001-2006.
Standard errors in parenthesis are clustered at the region-occupation group level.

This offers some support to the hypothesis that more recent immigrants are more responsive than earlier immigrants to regional wage differentials. Also, the coefficient in column 3, indicating the correlation of the regional wage differentials with the relative supply of all immigrants is the smallest (though not statistically significant at conventional significance levels).

The estimated coefficients can be interpreted in terms of the relative elasticity of supply of immigrants and natives: $\varepsilon = \frac{d \ln R}{d \ln w}$. Remember from (6.1) that our wage index $\tilde{w}_{jst}$ measures average log- wages in each occupation-year-region cell, so that $\varepsilon = \frac{\beta}{R}$. As the mean value of R between 2001 and 2006, across all regions and cells, was 0.83 for the most recent immigrants (see Table 6.1), the estimate of column 1 implies an elasticity of supply of 3.8 for recent immigrants relative to natives.[13]

We have so far considered all immigrants pooled together. However it may well be that some groups of immigrants are more responsive to wage differentials than others. In particular, while male immigration is almost exclusively labour migration (except for refugees and asylum seekers), female immigration is partly motivated by family re-unification, and many females may follow their spouses after they have settled in the UK. We would therefore expect male immigrants to exhibit a higher than average responsiveness to regional wage differentials. This is confirmed in Table 6.3, which reports results from regressions of the form in (6.3-b) where the dependent variable is the relative supply of male immigrants to male natives.

Table 6.3 – Males only

	(1) *Less than 2 years in UK*	*(2)* *Less than 10 years in UK*	*(3)* *All immigrants*
Wage index	6.625** (3.093)	3.055*** (1.105)	1.774*** (0.609)
Region & year interaction	Yes	Yes	Yes

[13] Borjas (2001) estimates imply an elasticity of 1.3 for immigrants who have been in the US no more than 5 years, looking at the period between 1960 and 1980. However, Borjas uses data from the census, which means he relies on decennial changes in regional wages, while we look at annual changes. Our estimates for immigrants who have been in the UK for less than 10 years imply an elasticity of 2, which is still larger, but closer to Borjas.

Occupation & year interaction	Yes	Yes	Yes
N	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of male immigrants and natives for immigrants who have been in the UK for less than two years (column 1), immigrants who have been in the UK for less than ten years (column 2), and all immigrants (column 3) on the change in a wage index for each occupation group. See text for details on occupation groups and on construction of the variables. Years 2001-2006.
Standard errors in parenthesis are clustered at the region-occupation group level.

Men make up 58.3% of immigrants in the UK for less than two years, 57.4% of immigrants in the UK for less than ten years, and 55.7% of all immigrants. For all immigrant groups the estimated coefficients are about twice as large as when men and women were pooled, and more precisely estimated. Even the coefficient in column 3, when the dependent variable is the relative supply of all male immigrants to natives is now positive and statistically significant, although smaller in magnitude.

Do wage differentials in the private and the public sector have the same effect on immigrants' location choices? Table 6.4 indicates that the positive correlation between relative immigrants supply and regional wages is due to private sector wages only.

Table 6.4 – Public and private sector wages, all immigrants

	Private sector wages			***Public sector wages***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Wage index	2.764*	1.657**	0.876	0.631	-0.292	-0.511
	(1.585)	(0.783)	(0.639)	(1.081)	(0.600)	(0.476)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	270	270	270	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the change in a wage index for the private (columns 1-3) and public sector (columns 4-6) for each

occupation group. See text for details on occupation groups and on construction of the variables. Years 2001-2006.
Standard errors in parenthesis are clustered at the region-occupation group level.

The leftmost columns of Table 6.4 (columns 1-3) report results from regressions where the regressor of interest is a private sector regional wage index, while columns 4-6 report results from regressions where the regressor of interest is a public sector wage index. The estimates show very clearly that only private sector wage differentials are correlated with immigrants' relative supply, while public sector wages have no effects. Table 6.5 shows that this is the case also for the group of male immigrants, who are the most responsive to regional wage differentials.

Table 6.5 – Public and private sector wages, males only

	Private sector wages			***Public sector wages***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Wage index	6.296**	2.773**	1.869***	0.537	-0.072	-0.589
	(2.730)	(1.091)	(0.682)	(1.548)	(0.721)	(0.556)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	270	270	270	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of male immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the change in a wage index for the private (columns 1-3) and public sector (columns 4-6) for each occupation group. See text for details on occupation groups and on construction of the variables. Years 2001-2006.
Standard errors in parenthesis are clustered at the region-occupation group level.

In interpreting results of tables 6.4 and 6.5, however, one should also take into account that public sector wages exhibit much less variation, within occupation cells, than private sector

wages, as is shown in the bottom three panels of Table 6.1. Moreover, public sector employment is also more prevalent among women than men, although the pattern is less evident for recent immigrants. While only 35.5% of natives employed in the public sector are men, the male share of public sector employees is 48.6% among the most recent immigrants, 44% among immigrants who have been in the UK for less than ten years, and 38.9% among all immigrants.

As we discuss above, our estimates are not identifying any structural parameters, they are simply describing what happened over the time period considered. For this reason, repeating the same exercise for different years may give different results. This is demonstrated in Table 6.6, where we report estimates for years 2001-2009 for all immigrants (columns 1-3) and for male immigrants only (columns 4-6). In both cases, there is no correlation between regional labour market imbalances, as measured by wage deviations, and relative immigrants' supply.[14]

Table 6.6 – Analysis for years 2001-2009

	All immigrants			***Males only***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Wage index	-0.421	0.166	-0.236	0.997	0.909	0.213
	(1.228)	(0.730)	(0.721)	(2.007)	(0.603)	(0.494)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	432	432	432	432	432	432

The table reports coefficients from regression of the annual change in the occupation-specific relative supply

[14] If we consider the period between 2007 and 2009 only, the estimated coefficient is negative. These years were pre-recession or recession years, which saw substantial out-migration in particular of Eastern European immigrants, which may partly explain the perverse effects we find. It suggests that re-migration rates were higher from regions where wage growth is higher.

of all (columns 1-3) and male (columns 4-6) immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the change in a wage index for each occupation group. See text for details on occupation groups and on construction of the variables. Years 2001-2009. Standard errors in parenthesis are clustered at the region-occupation group level.

Endogeneity

Our OLS regressions are not explicitly considering the direction of causality. In other words, it may be the case that it is not changes in regional skill-group specific wages that influence the relative supply of immigrants and natives in a region-skill cell, but rather changes in the relative supply of immigrants that affect wages. However, if immigrants increase the relative supply of labour of a given skill group, this should lead wages for that skill group to go down (see Dustmann, Frattini and Preston, 2008). This means that, if anything, our regressions under-estimate the positive correlation between wage changes and immigrants' relative supply, and therefore our estimated coefficients can be interpreted as a lower bound.

Finer occupational breakdown

As we explain above, we have defined throughout this analysis skills in terms of broad occupational groups. Defining skills in terms of occupations, rather than based on years of education, is advisable when studying immigration in the UK context. It is in fact well documented (see e.g. Dustmann, Frattini and Preston, 2008) that immigrants downgrade considerably upon arrival on the UK labour market, and they are employed in occupations for which they are over qualified. Immigrants' education levels are therefore not a good indicator of the type of jobs they will take up in the UK labour market, in particular for recent immigrants. On the other hand, our occupational categories are defined very broadly, pooling together several 1-digit SOC groups. It would certainly be better to conduct the analysis at a

more disaggregated SOC-level. However, given the nature of our data, we are forced to pool SOC groups together due to the small number of sampled immigrants in each group.

Table 6.7 – Mean and median number of sampled immigrants in region-occupation-year cells

		(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*
High earners	*Median*	12	75.5	223.5
	Mean	31	189.4	540.7
Intermediate earners	*Median*	10	53.5	162.5
	Mean	19.3	109.6	299.0
Low earners	*Median*	20	77	150
	Mean	38.1	163.8	333.1

The table reports for each occupation group the median and mean number of immigrants sampled annually in each region, pooling all years 1993-2009.

Table 6.7 shows that, even using our three categories occupational breakdown, the median number of recent immigrants observed in each occupation-region-year cell is only 12, 10, and 20 in the high, intermediate, and low wage occupation group.

6.2 Alternative measures of regional imbalances

LFS-based indicators

The measure of local labour market imbalance we have used as main regressor of interest, the regional wage index obtained from (6.1) is essentially an adaptation at the local level of the measure used by the MAC to construct the shortage indicator P3 "Return to an occupation, given NVQ3, controlling for region and age". In our case, we are computing region-specific returns to broad occupational classes, and we control for age and gender. However, the LFS allows us to compute two other measures of labour market imbalances that the MAC uses as shortage indicators (see section 6.3.1 for an extensive discussion on the computation of these indicators at the local level): "Percentage change in employment in an occupation"(V2) and

"Absolute change in proportion of workers in occupation less than one year". These are volume-based indicators, and should therefore capture other features of a shortage situation. We can use (changes in) each of these indicators alternatively as regressors in our equation (6.3-b). Tables 6.8 and 6.9 in the Tables Appendix report results from these regressions. None of these indicators seem to be correlated with the relative supply of immigrants to natives in a region and occupation. Moreover, even when we restrict our sample to males, coefficients remain insignificant (as shown in columns 4-6 of Tables 6.8 and 6.9). Unreported results which distinguish between private and public sector confirm the lack of significance in both sectors[15].

JCP-based indicators

We also use as regressors the three MAC shortage indicators based on Job Centre Plus data: "Absolute change in median vacancy duration" (L1), "Annual percentage change in unemployment by sought occupation" (V1), "Live unfilled vacancies/unemployment by sought occupation" (L2). Using these indicators poses two problems. First, we cannot exactly map the LFS regional definition we use above (*uresmc*), and have to rely on data aggregated at Government Office Region level (9 regions in England, plus Wales and Scotland). Second, data on vacancies are only available since 2004, and data on unemployment benefit claimants since 2005. For this reason, we are not able, as we did before, to analyse only pre-recession years, and we use the years 2004(2005)-2009 together. All data we use refer to April of each year, and are obtained from the ONS Nomis service.

[15] The only exception is a negative and significant coefficient in the public sector for immigrants in the UK for less than 10 years.

Tables 6.10-6.12 in the Tables Appendix report results from regression with each of these indicators, for all available years. As before, we distinguish between immigrant who have been in the UK for less than two years, less than ten years, and all immigrants, and we look separately at male immigrants. Table 6.10 shows no correlation between the annual change in median vacancy duration and changes in the relative supply of immigrants to natives in a region and occupation. On the contrary, results of Table 6.11 display a strong negative correlation between percentage change in unemployment and the relative supply of immigrants, and show that this relationship is statistically significant for recent immigrants only. Similarly, Table 6.12 demonstrates the existence of a positive correlation between the relative supply of recent immigrants (in the UK for less than two and less than ten years), and the vacancy/unemployment ratio. Surprisingly, however, this correlation only holds when we consider all immigrants, and it disappears when we look at male immigrants in isolation.

Results with two out of three JCP-based indicators are therefore consistent with our main finding that immigrants react more than natives to local labour market imbalances; however, overall these estimates are quite volatile[16].

6.3 Measurement of shortages at the local level

6.3.1 LFS-based indicators

6.3.1.1 Measurement at 4-digits SOC 2000 level

In this section we assess the extent to which it is possible to compute some of the MAC shortages indicators at the 4 digit SOC level in each region. We will focus first on the three indicators of shortages that are computed from the LFS:

[16] We cannot distinguish, for JCP-based indicators, between private and public sector.

a) Return to an occupation, given NVQ3, controlling for region and age (P3, in MAC notation)

b) Per cent change in employment (V2)

c) Absolute change in proportion of workers in occupation less than 1 year (V4)

We attempt to calculate each indicator separately for every region and each of the 192 4-digit occupations in the "skilled" occupation list reported in Table 6.2 of MAC (2008), pooling together all quarterly waves in every year. All indicators are computed on the working-age population (men aged 16-64 and women aged 16-59). For the sake of exposition, we will comment on the analysis for year 2009 only.

Columns 1 and 2 of table 6.13 report, for every region, the mean number of observations used to compute the returns to an occupation (indicator P3), and the number of occupations (out of 192) for which a regional indicator can be computed. Columns 3 and 4 do the same for the percent change in employment (indicator V2), while columns 5 and 6 for the change in proportion of workers in occupation less than one year (indicator V4).

Table 6.13

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs.	*No. Occupations*	*No. Obs.*	*No. Occupations*	*No. Obs.*	*No. Occupations*
	1	*2*	*3*	*4*	*5*	*6*
North East	5.2	147	26.6	125	26.7	124
North West	9.8	172	50.6	161	50.3	161
Merseyside	3.3	109	15.8	89	15.8	89
Yorkshire & Humbers.	10.4	163	52.2	150	52.1	150
East Midlands	8.8	163	46.9	149	46.7	149
West Midlands	9.0	160	50.6	147	50.3	147
Eastern	9.7	175	59.8	160	59.4	160
London	11.6	158	70.7	146	70.1	146
South East	15.8	179	85.1	171	84.6	171
South West	9.8	164	51.8	156	51.6	156
Wales	5.2	145	27.1	131	27.1	131

Scotland	10.4	172	49.1	165	48.9	165
Northern Ireland	3.4	106	30.2	84	30.0	84

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 4-digit SOC occupations, and the number of occupations for which an index can be computed in 2009.

P3 is the indicator that can be computed for most occupations. Still, it cannot be computed for all 192 occupations in any region: in the South East, the region where the indicator can be computed for most occupations, it is available for 179 occupations, while in Northern Ireland it can be computed for 106 occupations only. However, in all regions the indicator is computed on a very limited number of observations: the mean number of observations for each occupation ranges between 15.8 in the South East and 3.3 in Merseyside. The number of observations is therefore extremely limited, and any indicator based on such a small sample size would be extremely unreliable. The two remaining indicators are based, on average, on a larger number of observations, ranging between 15.8 in Merseyside and about 85 in the South East. The problem in this case is rather that both V2 and V4 can be computed for a smaller number of occupations, from a minimum of 84 in Northern Ireland to 171 in the South East.

Obviously, the mean number of observations by region hides substantial differences in the sample sizes across indicators. Table 6.14 in the Tables Appendix reports the mean number of observations on which each indicator is computed for every 4 digit SOC codes, and the number of regions for which the indicator can be computed, across all regions. It is evident that the average sample size is quite large across all indicators for some occupations, for which indices are also computable in all 13 regions. For instance “1121 - production workers and maintenance managers”, or “3211 – nurses”, for which the sample size is 38 for P3 and 210 for V2 and V4 and 79.8 for P3 and about 283 for V2 and V4, respectively. Conversely, indicators for some other occupations are computable for few regions only, and based on an

extremely limited number of observations. There are only 68 occupations (out of 192) for which P3 can be computed in all regions, and only 52 occupations for which V2 and V4 are computable in all regions. Moreover, even when an index is computed in all regions, it may still be based on a small number of observations: for instance P1 for "5315 - carpenters and joiners" is computed on average on only ten observations per region.

6.3.1.2 Measurement at 4-digits SOC 2000 level, pooling two years

One way to increase the sample size, and the number of occupations and regions where shortage indices are computable could be to pool together eight, rather than four, quarterly LFS waves, to obtain two years of data. We have replicated tables 6.13 and 6.14 pooling together all 2008 and 2009 quarters. Results are presented in tables 6.15 (below) and 6.16 (at the end of the report).

Table 6.15

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. (1)	*No. Occupations (2)*	*No. Obs. (3)*	*No. Occupations (4)*	*No. Obs. (5)*	*No. Occupations (6)*
North East	10.1	159	50.6	142	50.5	142
North West	18.8	177	97.8	170	97.3	170
Merseyside	5.3	134	29.5	109	29.3	109
Yorkshire & Humbers.	19.4	176	97.4	164	97.1	164
East Midlands	16.3	176	86.8	166	86.5	166
West Midlands	16.9	175	93.0	166	92.4	166
Eastern	18.6	182	112.4	175	112.0	175
London	22.3	174	133.8	166	132.7	166
South East	32.3	188	166.5	186	165.9	186
South West	18.3	179	100.1	169	99.9	169
Wales	10.1	160	52.3	151	52.2	151
Scotland	20.3	182	95.4	178	95.2	178

Northern Ireland	5.8	135	53.1	112	52.8	112

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 4-digit SOC occupations, and the number of occupations for which an index can be computed in 2008-2009 pooled.

When we consider two years jointly, the average number of observations per region almost doubles for all regions and indices, and the number of occupations for which an index can be computed increases in all regions. For instance, P3 can now be computed for 135 occupations in Northern Ireland, and 188 in the South East, while when only 2009 was considered, these numbers where 106 and 179 respectively. Similarly, V2 and V4 can now be computed for 112 occupations in Northern Ireland and 186 occupations in the South East, up from 84 and 171 when only 2009 data were used. Table 6.16 shows that the number of occupations for which indices are computable in all regions are now up to 95 for P3 and to 80 for V2 and V4. However, there are still many occupations for which the index is computed on average on a limited number of observations: P3 for half of the occupations in our list is computed on an average number of regional observations of less than 8.1, while for half of the occupations V2 and V4 are computed on an average number of regional observations of less than 46.

Pooling two years therefore increases the number of occupations and regions for which an indicator can be meaningfully constructed, but does not completely solve the problems of small sample size. Moreover, two years may be too long a period over which to identify occupational shortages.

6.3.1.3 Measurement at 3-digits SOC 2000 level

An alternative to pooling two years is to compute the shortage indices at a more aggregated level. Table 6.17 reports for each region the average number of observations on which P3, V2

and V4 can be computed at the 3-digits SOC level (minor occupation group), and the number of 3-digit occupations for which the indices can be calculated. We have attempted to compute the index for the 50 minor groups which comprise the 4-digit skilled occupations we have considered previously. In four regions (North West, West Midlands, South East, Scotland) P3 is calculated for all 50 occupations, and it is only in Northern Ireland that the index is calculated for just 43 occupations. Similarly, V2 and V4 are computed for at least 49 occupations in 6 regions. What is more, the average sample sizes on which indices are computed are now larger. Especially for V2 and V4 the average sample size in most regions is now large enough to potentially produce reliable indices. Table 6.18 in the Tables Appendix displays for each index and occupation the average sample size across regions and the number of regions for which each index can be computed. P3 (V2 and V4) can be calculated in all 13 regions for 39 (38) occupations, and the average sample size on which indices are computed is usually quite large for these occupations[17], although the average number of observations may hide substantial differences across regions.

Table 6.17

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs.	*No. Occupations*	*No. Obs.*	*No. Occupations*	*No. Obs.*	*No. Occupations*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
North East	17.5	47	94.1	44	93.8	44
North West	36.0	50	184.9	50	184.0	50
Merseyside	8.6	45	44.8	43	44.6	43
Yorkshire & Humbers	36.6	49	184.5	48	184.2	48
East Midlands	30.9	49	163.3	49	162.6	49
West Midlands	30.7	50	174.2	49	173.0	49
Eastern	36.4	49	214.0	49	212.8	49
London	39.6	48	238.1	47	235.7	47
South East	58.9	50	313.7	50	312.1	50

[17] Some exceptions are for instance "117 - protective service officers" and "232 - research professionals".

South West	34.6	49	184.9	49	184.3	49
Wales	17.0	47	92.5	47	92.4	47
Scotland	38.5	50	186.1	49	185.6	49
Northern Ireland	9.0	43	81.2	43	80.6	43

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 3-digits SOC occupations, and the number of occupations for which an index can be computed in 2009.

6.3.1.4 Measurement at 2-digits SOC 2000 level

In an effort to go towards a more reliable measure of regional shortages, we have also tried to compute the indices at the 2-digits SOC level (sub-major groups), for each of the 16 occupational groups where the original 4-digits occupations belong. Table 6.19 shows that now all indices can be computed in all regions for all occupations, and that the average sample sizes have now considerably increased. Even Merseyside and Northern Ireland, that are typically the two regions with the smallest average sample sizes underpinning each index, exhibit now large enough average sample sizes for V2 and V4 (about 149 in Merseyside and about 280 in Northern Ireland). Computation of P3 is however still problematic in both regions as the average sample size is only 27.3 and 28.5 respectively.

Table 6.19

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs.	*No. Occupations*	*No. Obs.*	*No. Occupations*	*No. Obs.*	*No. Occupations*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
North East	58.6	16	321.2	16	320.0	16
North West	126.4	16	701.4	16	698.1	16
Merseyside	27.3	16	149.3	16	148.6	16
Yorkshire & Humbers.	124.6	16	672.6	16	670.9	16
East Midlands	105.6	16	617.4	16	614.9	16
West Midlands	105.8	16	649.9	16	645.6	16
Eastern	122.8	16	783.3	16	778.8	16
London	128.4	16	808.8	16	799.7	16

South East	200.6	16	1154.9	16	1149.0	16
South West	119.4	16	677.6	16	675.3	16
Wales	55.6	16	332.2	16	331.6	16
Scotland	136.8	16	693.1	16	691.4	16
Northern Ireland	28.5	16	281.9	16	279.3	16

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 2-digits SOC occupations, and the number of occupations for which an index can be computed in 2009.

Table 6.20 in the Tables Appendix confirms what we noted in Table 6.19: indices can be computed in all regions, and for V2 and V4 the average sample size is large, the smallest being 181.5 of V4 for "33 - protective service occupations". Conversely, P3 can be computed in all regions and for all occupations groups, but the average sample size is below 50 for seven occupations[18], indicating that the sample is very small at least in some regions.

6.3.2 JCP-based indicators

6.3.2.1 Measurement at 4-digits SOC 2000 level

We assess here the possibility of computing the three shortage indicators based on Job Centre Plus at the local level. These are:

a) Absolute change in median vacancy duration (L1)

b) Annual percentage change in unemployment by sought occupation (V1)

c) Live unfilled vacancies/unemployment by sought occupation (L2)

We obtain Job Centre Plus Data from the ONS Nomis service. As for the LFS-based indicators, we attempt first to calculate each indicator separately for every region and for

[18] "12 - Managers and proprietors in agriculture and services", "22 - Health professionals", "33 - Protective service occupations", "34 - Culture, media and sports occupations", "53 - Skilled construction and building trades", "54 - Textiles, printing and other skilled trades", "81 - Process, plant and machine operatives".

every 4-digit occupation included in the MAC "skilled" occupation list. We compute the indicator as of April 2009, or where the indicator is constructed as a change, as the change between April 2009 and 2010. Notice that the Nomis classification does not separately identify Merseyside and the North West, and that some indicators are not available for Northern Ireland. Table 6.21 summarises the main results for each region.

Column 1 shows that the absolute change in median vacancy duration (indicator L1) can be computed only for a small number of occupations in every region, ranging from 24 in the North East to 72 in the South East, out of 192 occupations in the skilled list. For all other occupations L1 cannot be computed because in April 2009 and/or in April 2010 the ONS does not distribute the median vacancy duration as the data is statistically unreliable, being based on too small a sample.

Table 6.21

	Vacancy duration (L1)	Change in unemployment (V1)		Vacancies/Unemployment (L2)		
	No. Occupations	*No. Obs*	*No. Occupations*	*Vacancies: No. Obs*	*Claimants: No. Obs*	*No. Occupations*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
North East	24	73	132	15	71	133
North West	72	183	164	49	174	159
Yorkshire & Humbers.	54	144	146	40	140	154
East Midlands	45	106	154	35	99	150
West Midlands	54	167	156	32	156	157
Eastern	62	139	152	33	132	151
London	63	282	166	41	278	169
South East	72	194	161	49	182	164

South West	49	107	142	29	99	159
Wales	26	70	141	20	66	133
Scotland	44	132	149	27	137	153
Northern Ireland		62	112			

The table reports the number of occupations for which the relevant shortage indicator can be computed in each region for 4-digits SOC occupations (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

Indicator V1, the annual percentage change in unemployment by sought occupation, can in principle be computed for all regions and occupations. Since the number of unemployed individuals is computed as the number of people claiming Jobseekers Allowance and National Insurance credits, we do not have in fact the same potential problem of small sample size as with survey data. However, two related issues make the measurement of this indicator at the regional level problematic for finely defined occupations. First, the number of claimants in some region-occupation cell may be very small, or even zero. This may result in very noisy indicators, and the marginal claimant can have a substantial impact on the value of the indicator. Secondly, data are rounded to the nearest 5, so that if, for instance, the actual number of claimants in a region-occupation moves from 7 to 8, the observed number of claimants in our data switches from 5 to 10. This means that a 12.5% increase is measured as a 100% increase instead. Conversely, if the number of claimants increases from 6 to 7 (a 17% increase) the indicator will instead report no changes. For these reasons, indicator V1 can be considered reliable only when it is computed on a sufficiently large number of observations. Just how large this number must be is not a priori clear. In column 2 of Table 6.21 we report the average number of observations on which the indicator is computed in each year across occupations by regions. Column 3 reports instead the number of occupations for which the indicator is not zero or missing. The indicator will be missing if the number of claimants in April 2009 is zero, while it is zero if there is no change in claimants between April 2009 and

April 2010: although zeros are in principle possible, they are likely to be due to the small number of observations joint with the rounding convention. Columns 2 and 3 show that the index can be computed for many occupations in most regions, but the average number of observations is relatively low. For instance, in Northern Ireland, the "worst" region, the index can be computed for 112 occupations, and it is based on average on 62 observations, while in London, the "best" region, the index is computed for 166 occupations, and is based on an average of 282 observations for each occupation.

Indicator L2 is computed as the ratio of unfilled vacancies to claimants by occupation. It shares therefore similar weaknesses as V1, but adds to them measurement issues arising from the vacancies series. Column 4 of Table 6.21 reports the average number of live unfilled vacancies observed in each occupation by region, while column 5 reports the average number of people claiming unemployment benefits by occupation in each region. Finally, column 6 reports the number of occupations in each region for which the indicator can be computed (we exclude cases where the indicator takes value zero). Column 6 shows that in all regions the indicator can be in principle computed for most occupations, ranging between 133 in the North East and in Wales and 169 in London. However, the extremely low average number of vacancies by occupation in each region indicates that the indicator may be extremely noisy. The average number of occupational vacancies ranges between 15 in the North East and 49 in the North West and the South East. However, it is worth noting that the *median* number of vacancies by occupation in each region ranges from only 2 in the North East to 8.5 in the South East. Therefore, in all regions, L2 is computed on an extremely small number of observations for a substantial share of occupations.

Table 6.22 (in the Tables Appendix) reports, for each 4-digits occupation, the number of regions in which indicators L1, V1 and L2 can be computed (columns 1, 3 and 6

respectively), and the average number of observations used to compute each indicator across regions (column 2 for V1 and columns 4 and 5 for L2). The table shows that L1 can be computed in all regions for 15 occupations only, while V1 is available in all regions (including Northern Ireland) for 44 occupations, and L2 for 102 occupations. However, especially for L2, the average number of observations by occupation per region is very small. Even for those occupations where an indicator can be computed in all regions, the average number of notified unfilled vacancies across all regions is only 31.

6.3.2.2 Measurement at 3-digits SOC 2000 level

As for LFS-based indicators, we have also attempted to mitigate small sample size problems in JCB-based indicators calculating them at the 3-digits SOC level. Table 6.23 shows that L1 cannot be computed for all the 50 3-digits occupation in any region. The number of occupations for which L1 can be computed ranges from 24 in the North East to 43 in London and the North West. Conversely, column 3 of Table 6.23 shows that V1 can be computed for most occupations in all regions (all 50 occupations in the North West, the East Midlands, and the South East, 43 occupations only in Northern Ireland), and the average number of observations (column 2) is quite high in all regions. Column 6 shows instead that L2 cannot be computed for all occupations in any region, although it is computed for 49 occupations in 5 out 11 regions. Column 4 shows however that the mean number of observations for unfilled vacancies is quite small in at least a couple of regions: 62 in the North East and 81 in Wales. The (unreported) median number of observations is even smaller: for instance in the North East for 50% of the occupations the number of reported vacancies is at most 15, while it is 22 in Wales and 86 in the South East, which is the region with the highest median.

Table 6.23

	Vacancy duration (L1)	Change in unemployment (V1)		Vacancies/Unemployment (L2)		
	No. Occupations	*No. Obs*	*No. Occupations*	*Vacancies: No. Obs*	*Claimants: No. Obs*	*No. Occupations*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
North East	24	342	46	62	329	44
North West	43	839	50	199	800	48
Yorkshire & Humbers.	39	665	48	164	645	48
East Midlands	35	490	50	143	454	47
West Midlands	38	799	49	136	743	48
Eastern	39	621	47	140	595	49
London	43	1215	45	168	1204	49
South East	42	848	50	203	795	48
South West	36	474	45	122	439	49
Wales	30	326	46	81	308	49
Scotland	36	593	48	111	615	49
Northern Ireland		278	43			

The table reports the number of occupations for which the relevant shortage indicator can be computed in each region for 3-digits SOC occupations (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

Table 6.24 (in the Tables Appendix) demonstrates great heterogeneity across occupations. Column 1 shows that indicator L1 can be computed in all 11 regions for 23 out of 50 3-digits occupations, while the index cannot be computed in any region for four 3-digit occupations. Indicator V2 instead can be computed in all the 12 regions where data are potentially available (including Northern Ireland) for 27 occupation groups, and there is no occupation where the indicator cannot be computed in any region. Nevertheless, the mean number of observations across regions for some occupations is very small, making the indicators unreliable. For instance, there are on average only 59 claimants in each region for protective service officers, and only 54 for transport associate professionals. Indicator L2 seems to perform better than the others: it can be computed in all regions for 44 occupations (out of

50), and there are no occupations for which it cannot be computed in any region. However, the average number of unfilled vacancies by occupation across regions is quite small even for many occupation where the index is computed in all regions. For instance there are on average only 14 notified vacancies for "111 - corporate managers and senior officials", or just 5 notified vacancies for "355 - conservation associate professionals".

6.3.2.3 Measurement at 2-digits SOC level

If we compute the index for the 16 2-digits occupational categories where the original 192 original occupations belong, the results are more encouraging. Table 6.25, column 1, shows that in three regions (East Midlands, London, Scotland) indicator L1 can be computed for all the 16 categories, and it can be computed for only 14 occupations in the North East only. Similarly, V1 can be computed for all the 16 categories in most regions. The only exceptions are the West Midlands, London, the South West, and Scotland, where the indicator is computed for 15 occupations only. In all cases, however, the average number of observations on claimants is reassuringly high. Likewise, L2 can be computed for all 16 occupations in all regions, except for the North East. What is more, in this case also the average number of notified vacancies by occupation is relatively high in all regions, ranging between 269 in the North East and 841 in the North West.

Table 6.25

	Vacancy duration (L1)	Change in unemployment (V1)		Vacancies/Unemployment (L2)		
	No. Occupations	*No. Obs*	*No. Occupations*	*Vacancies: No. Obs*	*Claimants: No. Obs*	*No. Occupations*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*

North East	14	1955	16	269	1858	15
North West	15	4368	16	841	4154	16
Yorkshire & Humbers.	15	3515	16	659	3434	16
East Midlands	16	2563	16	564	2399	16
West Midlands	15	4066	15	573	3786	16
Eastern	15	3179	16	582	3049	16
London	16	5877	15	642	5823	16
South East	15	4103	16	824	3877	16
South West	15	2385	15	523	2194	16
Wales	15	1899	16	318	1777	16
Scotland	16	3058	15	446	3144	16
Northern Ireland		1460	16			

The table reports the number of occupations for which the relevant shortage indicator can be computed in each region for 2-digits SOC occupations (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

The analysis by occupation shows that it is possible to compute L1 in all regions for 14 occupations. The exceptions are 22 - health professionals, which is computed for 10 regions (out of 11), and 33 - protective service occupations, which is only available for 3 regions. V1 and L2 can instead be computed for almost all regions, for most occupations, with a few exceptions and caveats. For instance, V1 for "22 - health professionals" can be computed for 10 regions (out of 12) only, and the average number of observations for each region is only 59. L2 for the same occupation can be computed in all regions, but it is based on a limited number of observations.

6.4 Conclusions

Overall, the analysis of this section shows that measuring labour shortages at the local level is extremely problematic, both using LFS- and JCP-based indicators. While for MAC purposes shortages should be measured at the 4-digits SOC level, our work of sections 6.2 and 6.3 shows that measurement at such a disaggregated level is extremely problematic and unreliable for most occupations, even when we pool together all quarterly waves in every

year as we do for LFS-based indicators. Measurement problems are more severe for the wage-based indicator, as information on wages in available only for 2/5 of the sample. For the other two LFS-based indicators, the number of observations is typically higher, but they require the sample size to be large enough in two subsequent years, as they are based on changes. We have also experimented with pooling together two years (eight waves) of data, to increase the sample size. However, if this makes the indicators computed more reliable for some occupations, pooling two years together poses additional problems regarding the timeliness of the measure. More reliable local indicators can be computed if occupations are less precisely defined, at the 3 or 2-digit level. Especially in the latter case, and for the two volume-based indicators, the sample size appears to be fairly large, and producing reliable shortage indicators would be in principle possible. It still problematic, especially for some regions like Merseyside and Northern Ireland, to reliably compute the wage-based indicator.

Our analysis of JCP-based indicators reaches similar conclusions. While JCP is an administrative data source, and does not therefore suffer of sampling problems, the extremely small number of observations on vacancies and unemployment benefit claimants for some occupations and regions makes JCB-based indicators extremely unreliable at the 4-digits SOC level. We have also demonstrated that problems persist for most occupations also when indices are computed at 3-digit SOC level. More reliable indicators can instead be computed at the 2-digit level.

Our analysis has concentrated on six out of the twelve shortage indicators used by the MAC, but its results can be informative also for the three ASHE-based and the three NESS-based indicators. Previous MAC reports and MAC commissioned research (see e.g. IFF Research (2008) and MAC (2008)) have highlighted the difficulties of computing ASHE- and NESS-based indicators for four digit occupations on a national level due to small sample size.

Computing indicators at the Government Office Region level means that the sample falls on average by 1/12, which exacerbates sample size problems.

The results of this section show therefore that all top-down indicators of local shortages can be computed, for a sufficiently large number of occupations and regions, at most at the 2-digit level (3-digit for volume-based indicators).

7. The MAC's Main Aims and Conclusions for Migration Policy

7.1 The Main Aims

This report is in response to the Migration Advisory Committee's request for research on the question "Can immigration constitute a sensible solution to sub-national and regional labour shortages?". The original specification had four main aims. Here we briefly describe how we have addressed these, and refer for reference to our analysis.

i. Do sub-national and regional labour market shortages of skilled labour exist (even if national shortages do not) and why?

We discuss in detail in sections 3.1 and 4.1 the reasons why regional shortages in (skilled) labour may occur. If there is excess demand in some regions unmatched by excess supply elsewhere then that will always create an excess demand on a national level, through aggregation. However, shortages may be region-specific. We define shortages in terms of potential for welfare gain through regional reallocation of labour. We show in our analysis that such region specific shortages can be addressed by capital or labour moving across

regions. However, these shortages may (at least in the short run) be sustained if capital is immobile (one reason being e.g. location specific capital requirements, like geography), and if labour is (partly) immobile (one reason being locational amenities). We discuss in sections 3 and 4 which situations constitute a shortage situation, where immigration may lead to efficiency gains. We also discuss under which circumstances these gains go to which factors (native labour, immigrant labour, and capital).

ii. Whether it is possible to identify sub-national and regional labour shortages using available data and at what level of resolution?

Possible symptoms of regional shortages include evidence of regional excess demand or of sustained regional wage differences. Our empirical analysis introduces methodology as to how a shortage situation can be measured. One way to achieve this would be to correlate sector- or occupation specific deviations of wages in different regions from the national average with recent immigrant location decisions. We do find that there are correlations, in particular for the pre-recession period (until 2006), between region-specific deviations of sector specific wages from the national average, particularly for males in the private sector. We should note that this does not identify the particular reason for the wage differences, and whether this is due to a shortage situation. Overall however our analysis suggests that precision of constructed shortage measures is a problem on regional level. This is particularly the case for all alternative shortage measures as suggested by the MAC, as we demonstrate carefully in section 6.

iii. What is the current role of immigration in sub-national and regional labour market performance?

We discuss the role migration could have to address an existing shortage situation in sections 3 and 4. Our analysis should make clear that the effectiveness of migration to address a regional shortage situation depends on the underlying reasons for that shortage. Also, the underlying causes for a particular shortage situation also determine the gains that are obtained by local factors of production, and who obtains these gains. Detailed analysis is provided in sections 3 and 4.

iv. How may evidence on sub-national shortages inform us about national shortages in the UK and what factors may determine whether there is an economic basis to include occupations and job titles with sub-national shortages in skilled labour on a national shortage occupation list, making reference to the MAC's definition of 'sensible'?

National shortages are typically associated with national stickiness in the level of wages. Regional shortages, on the other hand, have more to do with institutional barriers to equalisation of wages either across regions or regional immobility of labour. However, conceptually the two types of shortages are different. Suppose a local shortage is created through a negative labour supply shock (a positive demand shock is equivalent). As we explain above, the ensuing sub-national shortage can be eliminated – in principle – through movement of labour (types) across regions (internal migration). This will lead to a new equilibrium where wages in both regions are the same, but production is more capital intensive than in the pre-labour shock period, leading to higher wages in both regions. National shortages can not be eliminated through internal migration. Again, they can be defined as an excess demand for labour at fixed wages, which is a disequilibrium situation, in the sense of Arrow and Capron (1959), which we discuss in Section 2. To eliminate this

excess demand on national level can only be achieved through an increase in wages. At the new equilibrium, production will me more capital intensive, and overall output will be smaller. Of course, an alternative way to address this shortage situation on national level is immigration from abroad.

As we explain in Sections 3 and 4, immigration may be one way to reduce sub-national wage differences. Thus, inclusion of occupations with sub-national shortages to a shortage occupation list seems important if the aim is to address sub-national shortages through immigration.

7.2 Conclusions

What do we learn from all that for migration policies? Our conceptual discussion in Sections 3 and 4 illustrates that what is best recognized as a shortage situation in a particular skill group in a particular region – a marginal product of labour that is higher than that in other regions for the same skill group – can have different causes and different manifestations. We point out in these sections that particular assumptions are required for such a situation to occur, and not to be equilibrated by factor flows. Important is the assumption of immobility of capital, and the only (partial) mobility of labour. Although we assume the immobility of capital in our model to generate situations where factor prices differ across regions, we could also think about other immobile factors like land, or infrastructure.

We discuss as one reason for labour immobility locational amenities, so that native labour - having preferences for particular locations – needs to be compensated for living and working in less popular locations. We discuss several cases – an extreme situation where all native workers have a locational preference for one region, and an intermediate situation where there is heterogeneity about regional preferences.

To understand the way immigration will be a suitable response, we need to understand the nature of immigrants' amenity distribution. If immigrants are indifferent between different areas, then they will move to where wages are highest. We explain that if – as a reaction – wages decrease, natives may move out of the region as they are not compensated any more for the dis-amenity of living there. As a result, wages will rise again. Thus, the extent to which immigration can be a means to address shortages depends on the nature of shortages.

Further, if all immigrants care about are wages, then no allocation to regions is necessary as long as immigrants are sensitive to wage differentials. However, if immigrants have similar amenity distributions than natives, a more directed migration policy is required, in conjunction with regulations that allow immigrants to work only in particular regions or sectors.

Our empirical work does to some extent support that immigrants do react to regional wage differentials: We find that those occupation-skill-region cells that experience a positive wage shock are also cells that experience an increase in the fraction of immigrants.

What are our conclusions? Besides the points we raise above, which suggest that not every shortage situation can be equally well addressed by immigration, our empirical work also demonstrates the immense difficulties in measuring shortage occupations, based on data we have available. But even if measurement was not an issue, the time it takes to collect data that allows identifying shortage occupations is likely to be too long for effective policy responses, and the lagged response to labour shortages through processes of setting quotas deprives the industry from reacting quickly to labour demand situation.

All this suggests that the task of the MAC to assign shortage indicators to occupations suffers from time delays, and is based on quite imprecise empirical analysis, apart from the other

problem we point out above, which is the ability to distinguish between shortage situations that are addressable by immigration policy.

Tables

Table 6.1 – Descriptive statistics

	Years 2001-2006		*Years 2001-2009*	
Whole sample	Mean	Std. Dev.	Mean	Std.
R_{jst} (imm<2 years)	0.83	1.12	0.84	1.05
R_{jst} (imm<10 years)	0.80	1.26	0.82	1.17
R_{jst}	0.81	1.12	0.82	1.08
R_{jst} (males, imm<2 years)	0.85	1.14	0.85	1.08
R_{jst} (males, imm<10 years)	0.82	1.28	0.83	1.19
R_{jst} males	0.83	1.13	0.84	1.09
Wage index	0.03	0.29	0.03	0.28
Wage index private sector	0.06	0.28	0.06	0.27
Wage index public sector	-0.06	0.29	-0.07	0.28
High earners				
R_{jst} (imm<2 years)	0.74	0.84	0.73	0.87
R_{jst} (imm<10 years)	0.71	0.82	0.72	0.81
R_{jst}	0.72	0.68	0.73	0.69
R_{jst} (males, imm<2 years)	0.73	0.83	0.72	0.86
R_{jst} (males, imm<10 years)	0.72	0.83	0.72	0.82
R_{jst} males	0.73	0.68	0.74	0.68
Wage index	0.41	0.08	0.40	0.08
Wage index private sector	0.42	0.11	0.41	0.10
Wage index public sector	0.32	0.05	0.31	0.05
Intermediate earners				
R_{jst} (imm<2 years)	0.90	1.20	0.91	1.10
R_{jst} (imm<10 years)	0.84	1.32	0.86	1.22
R_{jst}	0.84	1.16	0.86	1.12
R_{jst} (males, imm<2 years)	0.96	1.40	0.96	1.31
R_{jst} (males, imm<10 years)	0.91	1.52	0.92	1.43
R_{jst} males	0.90	1.32	0.91	1.29
Wage index	-0.06	0.07	-0.06	0.07
Wage index private sector	-0.02	0.08	-0.02	0.07
Wage index public sector	-0.16	0.07	-0.16	0.07
Low earners				
R_{jst} (imm<2 years)	0.86	1.28	0.87	1.17
R_{jst} (imm<10 years)	0.86	1.54	0.88	1.40
R_{jst}	0.87	1.39	0.88	1.33
R_{jst} (males, imm<2 years)	0.87	1.12	0.88	1.03
R_{jst} (males, imm<10 years)	0.84	1.38	0.86	1.24
R_{jst} males	0.84	1.29	0.86	1.20
Wage index	-0.25	0.05	-0.26	0.05
Wage index private sector	-0.21	0.06	-0.22	0.05

Wage index public sector	-0.35	0.05	-0.35	0.05

Table 6.8 – Regressor of interest: annual percentage change in employment

	All immigrants			*Males only*		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Percent change in employment	-0.147	-0.518	-0.104	1.06	-0.203	0.227
	(0.955)	(0.422)	(0.229)	(1.231)	(0.538)	(0.391)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	270	270	270	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of all (columns 1-3) and male (columns 4-6) immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the annual percentage employment change in each region and occupation. See text for details on occupation groups and on construction of the variables. Years 2001-2006.
Standard errors in parenthesis are clustered at the region-occupation group level.

Table 6.9 – Regressor of interest: annual change in proportion working with employer for less than one year

	All immigrants			*Males only*		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Percent change in employment	1.663	0.516	-1.727*	1.039	2.264	0.387
	(2.666)	(1.258)	(1.028)	(4.734)	(2.058)	(1.419)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	270	270	270	270	270	270

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of all (columns 1-3) and male (columns 4-6) immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the annual change in the proportion of workers in each region and occupation working with their employer for less than one year. See text for details on occupation groups and on construction of the variables. Years 2001-2006.

Standard errors in parenthesis are clustered at the region-occupation group level.

Table 6.10 – Regressor of interest: annual change in median vacancy duration

	All immigrants			***Males only***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Change in median vacancy duration	-0.0004	-0.0004	-0.0003	-0.0004	-0.0005	-0.0001
	(0.0009)	(0.0005)	(0.0004)	(0.0009)	(0.0006)	(0.0003)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	165	165	165	165	165	165

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of all (columns 1-3) and male (columns 4-6) immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the annual change in occupation-specific median vacancy duration. See text for details on occupation groups and on construction of the variables. Years 2004-2009. Standard errors in parenthesis are clustered at the region-occupation group level.

Table 6.11 – Regressor of interest: annual percentage change in unemployment

	All immigrants			***Males only***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Percentage change in unemployment	-4.136**	-1.349	-1.208	-3.285***	-1.237	-1.560*
	(1.645)	(0.814)	(0.769)	(1.185)	(0.820)	(0.778)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	132	132	132	132	132	132

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of all (columns 1-3) and male (columns 4-6) immigrants and natives for

immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the annual percentage change in unemployment benefit claimants by sought occupation. See text for details on occupation groups and on construction of the variables. Years 2005-2009.
Standard errors in parenthesis are clustered at the region-occupation group level.

Table 6.12 – Regressor of interest: annual change in vacancy/unemployment ratio

	All immigrants			***Males only***		
	(1) Less than 2 years in UK	*(2) Less than 10 years in UK*	*(3) All immigrants*	*(4) Less than 2 years in UK*	*(5) Less than 10 years in UK*	*(6) All immigrants*
Change in vacancy/ unemployment ratio	0.066***	0.032**	0.015	0.018	0.022	0.003
	(0.017)	(0.012)	(0.011)	(0.023)	(0.013)	(0.010)
Region & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
Occupation & year interaction	Yes	Yes	Yes	Yes	Yes	Yes
N	132	132	132	132	132	132

The table reports coefficients from regression of the annual change in the occupation-specific relative supply of all (columns 1-3) and male (columns 4-6) immigrants and natives for immigrants who have been in the UK for less than two years (columns 1 and 4), immigrants who have been in the UK for less than ten years (columns 2 and 5), and all immigrants (columns 3 and 6) on the annual change in occupation-specific vacancy/unemployment ratio. See text for details on occupation groups and on construction of the variables. Years 2005-2009.
Standard errors in parenthesis are clustered at the region-occupation group level.

Table 6.14

4-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. *(1)*	*No. Regions* *(2)*	*No. Obs.* *(3)*	*No. Regions* *(4)*	*No. Obs.* *(5)*	*No. Regions* *(6)*
1111 senior officials in national gov	2.0	8	5.4	5	5.4	5
1112 directors & chief execs of maj orgs	7.0	9	42.8	8	42.5	8
1113 senior officials in local gov	4.9	11	17.0	11	17.0	11
1114 sen. officials spec interest orgs	4.1	12	15.0	11	15.0	11
1121 prod. works & maintenance managers	37.9	13	210.0	13	209.2	13
1122 managers in construction	22.5	13	135.2	13	134.5	13
1123 managers in mining and energy	1.9	11	10.8	8	10.8	8
1131 financial managers & chartered secs	23.6	13	129.8	13	129.2	13
1132 marketing and sales managers	57.2	13	284.8	13	283.5	13
1133 purchasing managers	7.2	10	29.7	10	29.7	10
1134 advertising & public rel managers	4.5	12	24.8	11	24.8	11
1135 pers training & ind rel mngers	17.6	13	86.9	13	86.3	13
1136 info & communication technol mngers	35.4	13	157.2	13	156.6	13
1137 research and development managers	10.8	12	38.4	12	38.4	12
1141 quality assurance managers	7.3	11	30.1	11	29.9	11
1142 customer care managers	9.7	13	49.5	13	49.3	13
1151 financial institution managers	14.2	13	80.2	13	79.9	13
1152 office managers	23.6	13	139.7	13	139.5	13
1161 transport and distribution managers	6.8	12	48.6	12	48.5	12
1162 storage and warehouse managers	5.4	12	44.8	12	44.8	12
1163 retail and wholesale managers	23.5	13	210.8	13	210.3	13
1171 officers in armed forces	4.4	8	19.4	8	19.4	8
1172 police officers (inspectrs & above)	2.6	10	13.0	8	12.9	8
1173 snr officers fire, amb, prson et al	2.6	10	11.1	9	11.1	9
1174 security managers	2.4	10	12.3	7	12.3	7
1181 hospital and health service mngers	11.2	13	38.7	13	38.2	13
1182 pharmacy managers	1.8	9	7.4	8	7.4	8
1183 healthcare practice managers	2.2	13	14.6	11	14.6	11
1184 social services managers	7.0	13	29.4	12	29.3	12
1185 residential and day care managers	6.5	13	28.9	13	28.8	13
1211 farm managers	1.8	4	28.5	4	28.5	4

1212 natural environ & cons managers	1.9	7	4.3	4	4.3	4
1219 mngr anml hsbndry, frst, fish nec.	1.3	4	6.0	2	6.0	2
1221 hotel and accommodation managers	3.6	9	31.4	9	31.2	9
1222 conference and exhibition managers	2.0	9	17.9	7	17.9	7
1225 leisure and sports managers	3.9	12	25.7	12	25.6	12
1226 travel agency managers	1.0	1		0		0
1231 property, housing and land managers	9.5	13	53.8	12	53.5	12
1232 garage managers and proprietors	1.7	12	22.3	10	21.7	10
1233 hairdrs & beauty slon mngr & props	1.3	4	17.8	4	17.8	4

Table 6.14 (continued)

4-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. *(1)*	*No. Regions* *(2)*	*No. Obs.* *(3)*	*No. Regions* *(4)*	*No. Obs.* *(5)*	*No. Regions* *(6)*
1234 shopkprs, wholesale & retail dealrs	2.6	9	84.0	8	83.4	8
1235 recyc and refuse disposal managers	1.6	8	4.8	5	4.8	5
1239 mngers and prop. in other srvcs nec	16.6	12	108.6	12	107.9	12
2111 chemists	4.7	9	16.3	9	16.3	9
2112 bio scientists and biochemists	13.8	13	46.4	13	46.3	13
2113 physts, geologists & meteorologists	4.8	10	17.4	9	17.3	9
2121 civil engineers	9.7	12	46.0	12	46.0	12
2122 mechanical engineers	8.5	13	41.4	13	41.3	13
2123 electrical engineers	6.8	13	29.9	12	29.8	12
2124 electronics engineers	5.2	10	25.0	10	24.7	10
2125 chemical engineers	2.9	7	9.5	4	9.3	4
2126 design and development engineers	7.3	12	31.4	11	31.4	11
2127 production and process engineers	3.0	12	17.3	11	17.3	11
2128 planning and qlty control engineers	3.8	12	19.1	11	19.1	11
2129 engineering professionals n.e.c.	9.8	13	44.0	13	43.7	13
2131 it strategy and planning prfsnals	12.8	13	69.7	13	68.8	13
2132 software professionals	36.0	13	164.7	13	163.7	13
2211 medical practitioners	24.8	12	120.9	12	120.7	12
2212 psychologists	3.5	13	18.5	11	18.5	11
2213 pharmacists & pharmacologists	4.2	13	20.8	12	20.8	12
2214 ophthalmic opticians	1.4	7	10.6	5	10.6	5
2215 dental practitioners	2.0	8	22.3	8	22.1	8
2216 veterinarians	2.4	9	8.3	7	8.3	7
2311 higher education teaching prfsnals	22.7	12	76.4	12	76.2	12
2312 further education teaching prfsnals	17.5	13	62.7	13	62.3	13
2313 education officers, school inspectr	3.9	11	12.7	10	12.7	10
2314 secondary eductn teaching prfsnals	65.2	13	221.2	13	220.5	13
2315 prim & nurs eductn teaching profs	63.8	13	216.4	13	215.4	13
2316 spec needs education teaching profs	10.3	13	37.4	12	37.3	12
2317 registrs & sen admins ed establish	4.8	13	25.1	11	25.1	11
2319 teaching professionals n.e.c.	11.5	13	68.8	13	68.2	13

2321 scientific researchers	2.3	9	8.9	7	8.9	7
2322 social science researchers	3.2	9	13.1	8	13.1	8
2329 researchers n.e.c.	7.3	12	30.1	12	30.1	12
2411 solic & lawyers, judges & coroners	13.3	13	78.5	13	78.1	13
2419 legal professionals n.e.c.	2.8	12	12.1	11	12.1	11
2421 chartered and certified accountants	15.3	13	74.5	13	74.2	13
2422 management accountants	9.3	13	41.4	13	41.2	13
2423 mngmnt cons, actuar, econs & statn	18.3	13	89.9	13	89.7	13
2431 architects	4.8	10	30.6	9	30.6	9
2432 town planners	3.2	13	11.7	13	11.7	13

Table 6.14 (continued)

4-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. (1)	*No. Regions (2)*	*No. Obs. (3)*	*No. Regions (4)*	*No. Obs. (5)*	*No. Regions (6)*
2433 quantity surveyors	5.6	13	27.3	12	27.3	12
2434 chartrd surveyors (not qntity surv)	7.3	12	34.1	12	33.9	12
2441 public service administrative profs	3.7	13	17.8	13	17.7	13
2442 social workers	15.8	13	66.6	12	66.6	12
2443 probation officers	2.7	11	9.8	11	9.7	11
2444 clergy	4.6	11	22.3	11	22.2	11
2451 librarians	4.8	13	17.8	13	17.8	13
2452 archivists and curators	2.6	7	9.5	6	9.5	6
3111 laboratory technicians	7.5	13	36.4	13	36.4	13
3112 electrical & electronic technicians	3.9	12	15.8	12	15.8	12
3113 engineering technicians	8.3	13	36.3	12	36.3	12
3114 build & civil eng technicians	2.3	12	13.1	10	13.1	10
3115 quality assurance technicians	2.0	11	10.5	10	10.5	10
3119 science & eng technicians n.e.c.	4.6	11	22.4	11	22.2	11
3121 archt technols & town plan technics	3.7	10	16.2	9	16.2	9
3122 draughtspersons	3.8	12	24.9	11	24.7	11
3123 building inspectors	1.5	2	9.0	1	9.0	1
3131 it operations technicians	11.5	13	60.2	13	59.8	13
3132 it user support technicians	6.4	13	31.9	13	31.8	13
3211 nurses	79.8	13	283.8	13	282.6	13
3212 midwives	5.2	13	20.1	13	20.1	13
3213 paramedics	2.6	12	14.2	11	14.2	11
3214 medical radiographers	4.8	13	13.8	13	13.6	13
3215 chiropodists	1.7	10	7.6	5	7.6	5
3216 dispensing opticians	1.0	3	2.0	1	2.0	1
3217 pharmaceutical dispensers	4.3	13	22.6	12	22.3	12
3218 medical and dental technicians	5.5	10	22.9	10	22.3	10
3221 physiotherapists	4.5	13	19.7	13	19.6	13
3222 occupational therapists	5.5	13	19.6	13	19.6	13
3223 speech and language therapists	2.1	11	7.5	11	7.5	11

3229 therapists n.e.c.	3.8	12	36.0	12	35.3	12
3231 youth and community workers	12.4	13	56.9	13	56.9	13
3232 housing and welfare officers	18.8	13	94.2	13	94.1	13
3311 ncos and other ranks	4.3	9	37.7	9	37.6	9
3312 police offcrs (sergeant and below)	18.0	13	90.8	13	90.5	13
3313 fire serv off (leading off & below)	3.9	13	22.3	12	22.3	12
3314 prison serv off (below princ off)	3.5	13	25.3	13	25.1	13
3319 protective servcs assoc prfsnls nec	3.0	12	17.7	11	17.7	11
3411 artists	1.5	2	32.0	2	31.5	2
3412 authors, writers	4.6	10	36.7	9	36.6	9
3413 actors, entertainers	1.5	4	12.0	1	12.0	1

Table 6.14 (continued)

4-digit SOC code	Returns (P3) *No. Obs. (1)*	Returns (P3) *No. Regions (2)*	Employment (V2) *No. Obs. (3)*	Employment (V2) *No. Regions (4)*	Less than 1 year (V4) *No. Obs. (5)*	Less than 1 year (V4) *No. Regions (6)*
3414 dancers and choreographers	1.0	2		0		0
3415 musicians	1.5	6	18.0	3	18.0	3
3416 arts officrs, prdcers and directors	2.7	11	25.4	8	25.1	8
3421 graphic designers	6.9	11	53.6	10	53.1	10
3422 product, clothing & related dsgners	3.4	12	30.8	11	30.8	11
3431 journalists, newsppr & period eds	6.0	12	28.6	12	28.4	12
3432 broadcasting associate prfssnals	4.8	11	31.9	8	31.6	8
3433 public relations officers	4.3	11	19.2	10	19.1	10
3434 photo. & audio-visual equip operats	3.5	8	41.4	7	41.0	7
3441 sports players	1.0	5		0		0
3442 sports coaches, instruc & officials	4.4	12	33.3	12	33.1	12
3443 fitness instructors	2.5	11	20.8	8	20.8	8
3449 sports and fitness occupations nec.	1.3	6	12.0	4	12.0	4
3511 air traffic controllers	1.2	5	6.5	2	6.5	2
3512 aircraft pilots and flight enginrs	3.2	11	15.9	8	15.9	8
3513 ship and hovercraft officers	2.0	8	16.6	5	16.6	5
3514 train drivers	1.9	8	17.0	6	17.0	6
3520 legal associate professionals	5.3	12	33.3	11	33.2	11
3531 estimators, valuers and assessors	8.5	11	35.6	11	35.4	11
3532 brokers	3.4	12	29.7	9	29.3	9
3533 insurance underwriters	3.8	10	19.0	9	19.0	9
3534 fin. & invest. analyst & advisers	11.5	13	81.2	12	80.8	12
3535 taxation experts	3.5	11	14.5	10	14.5	10
3536 importers, exporters	1.3	4	6.0	1	6.0	1
3537 financial and accounting techs	3.6	12	15.3	10	15.2	10
3539 business & related assoc profs nec.	14.1	13	71.4	13	71.2	13
3541 buyers and purchasing officers	6.1	12	34.1	12	34.1	12
3542 sales representatives	16.8	13	104.1	13	103.4	13
3543 marketing associate professionals	11.8	13	58.4	13	58.1	13

3544 estate agents, auctioneers	2.6	9	22.4	8	22.4	8
3551 conservat & environ protection offs	3.6	12	14.0	12	13.9	12
3552 countryside and park rangers	1.4	9	6.0	4	6.0	4
3561 public serv associate professionals	9.8	13	41.3	13	41.2	13
3562 personnel & ind relations offs	13.2	13	72.7	12	72.7	12
3563 vocatn & indust trainrs & instrctrs	16.8	13	79.0	13	78.5	13
3564 car. advis & voction guidnce spcils	3.9	13	15.0	13	15.0	13
3565 inspcts fact, utils & trdng stndrds	2.8	11	8.3	11	8.3	11
3566 statutory examiners	2.0	10	8.9	9	8.9	9
3567 occupl hygnists & health sfty offs	4.0	12	24.3	11	24.3	11
3568 environmental health officers	2.3	13	7.9	10	7.9	10
4111 civil service executive officers	8.4	13	46.5	13	46.5	13

Table 6.14 (continued)

4-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. (1)	*No. Regions (2)*	*No. Obs. (3)*	*No. Regions (4)*	*No. Obs. (5)*	*No. Regions (6)*
4114 officers non-gov organisations	4.2	12	26.9	11	26.6	11
4142 communication operators	3.1	8	18.6	8	18.6	8
5211 smiths and forge workers	1.0	2		0		0
5212 moulders, core makers, die casters	1.0	2		0		0
5214 mtl plate wrkrs, shipwrig, riveters	2.1	8	11.6	7	11.6	7
5215 welding trades	5.3	12	44.2	12	43.8	12
5216 pipe fitters	1.9	8	10.7	3	10.0	3
5221 metal mach setter & setter-operator	5.4	11	33.1	9	33.0	9
5222 tool mkrs, tool fters & markers-out	2.1	10	10.3	9	11.4	8
5223 mtl working prod & maintnce fitter	19.7	13	113.2	13	112.8	13
5224 prec instrument makers & repairers	3.8	6	18.4	5	18.2	5
5233 auto electricians	1.1	7	7.0	5	7.0	5
5241 electricians, electrical fitters	18.2	13	126.2	13	124.8	13
5242 telecommunications engineers	4.3	12	25.8	10	25.6	10
5243 lines repairers and cable jointers	1.2	6	8.3	6	8.3	6
5245 comp engineer, installn & maintnce	3.7	12	22.0	12	21.7	12
5249 elec & electronic engineer n.e.c.	7.2	13	44.2	13	44.0	13
5311 steel erectors	1.3	3	11.0	1	11.0	1
5312 bricklayers, masons	4.1	12	40.9	10	40.0	10
5314 plumb, hea & ventilating engineers	10.8	13	101.8	13	101.3	13
5315 carpenters and joiners	9.9	13	137.4	13	135.1	13
5319 construction trades n.e.c.	4.7	11	138.8	10	136.3	10
5421 orignters, compositors & print preps	1.5	4	2.7	3	2.7	3
5422 printers	2.8	12	21.5	10	21.5	10
5493 pattern makers (moulds)	1.0	1		0		0
5495 goldsmth, slvrsmth, prec stone wrkr	1.5	2		0		0
5496 floral arrangers, florists	2.1	8	11.8	4	11.8	4
8124 energy plant operatives	1.0	4	2.5	2	2.5	2

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 4-digit SOC occupations (cols.1,3,5), and the number of regions for which an index can be computed in 2009 (cols. 2,4,6).

Table 6.16

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
4-digit SOC code	*No. Obs.* (1)	*No. Regions* (2)	*No. Obs.* (3)	*No. Regions* (4)	*No. Obs.* (5)	*No. Regions* (6)
1111 senior officials in national gov	3.4	11	12.5	11	12.5	11
1112 directors & chief execs of maj orgs	13.7	10	74.3	10	74.1	10
1113 senior officials in local gov	9.9	11	32.4	11	32.3	11
1114 sen. officials spec interest orgs	8.3	12	33.6	12	33.6	12
1121 prod. works & maintenance managers	78.7	13	424.1	13	421.9	13
1122 managers in construction	47.4	13	279.7	13	278.3	13
1123 managers in mining and energy	4.2	11	22.9	9	22.9	9
1131 financial managers & chartered secs	48.2	13	262.9	13	262.2	13
1132 marketing and sales managers	110.3	13	571.2	13	569.5	13
1133 purchasing managers	12.4	11	53.5	11	53.5	11
1134 advertising & public rel managers	12.3	12	60.2	11	59.8	11
1135 pers training & ind rel mngers	37.5	13	177.3	13	176.5	13
1136 info & communication technol mngers	74.8	13	325.2	13	324.3	13
1137 research and development managers	20.2	12	73.8	12	73.7	12
1141 quality assurance managers	13.1	13	54.6	13	54.4	13
1142 customer care managers	20.2	13	102.5	13	102.2	13
1151 financial institution managers	31.7	13	173.5	13	172.9	13
1152 office managers	49.4	13	290.0	13	289.5	13
1161 transport and distribution managers	12.1	13	94.2	13	93.9	13
1162 storage and warehouse managers	11.3	12	93.6	12	93.3	12
1163 retail and wholesale managers	49.0	13	446.2	13	444.6	13
1171 officers in armed forces	7.7	10	36.2	9	36.2	9
1172 police officers (inspectrs & above)	4.4	12	22.7	10	22.6	10
1173 snr officers fire, amb, prson et al	4.2	12	19.9	11	19.7	11
1174 security managers	3.3	12	22.8	12	22.7	12
1181 hospital and health service mngers	22.5	13	80.6	13	80.1	13
1182 pharmacy managers	3.4	9	12.8	8	12.6	8
1183 healthcare practice managers	4.4	13	25.6	12	25.4	12
1184 social services managers	14.8	13	58.3	12	58.2	12
1185 residential and day care managers	13.8	13	61.7	13	61.4	13
1211 farm managers	2.8	8	39.9	7	39.9	7
1212 natural environ & cons managers	2.4	10	8.9	9	8.9	9
1219 mngr anml hsbndry, frst, fish nec.	1.6	8	17.0	5	17.0	5
1221 hotel and accommodation managers	5.6	11	59.6	10	59.1	10
1222 conference and exhibition managers	3.5	11	27.4	10	27.4	10
1225 leisure and sports managers	8.3	13	50.8	13	50.7	13
1226 travel agency managers	1.4	7	15.6	5	15.2	5

1231 property, housing and land managers	18.3	13	109.2	13	108.7	13
1232 garage managers and proprietors	3.5	12	46.0	10	45.3	10

Table 6.16 (continued)

4-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs. *(1)*	*No. Regions* *(2)*	*No. Obs.* *(3)*	*No. Regions* *(4)*	*No. Obs.* *(5)*	*No. Regions* *(6)*
1233 hairdrs & beauty slon mngr & props	2.8	5	31.3	3	31.3	3
1234 shopkprs, wholesale & retail dealrs	4.8	12	158.0	11	156.9	11
1235 recyc and refuse disposal managers	2.3	9	8.0	4	8.0	4
1239 mngers and prop. in other srvcs nec	29.6	13	209.2	13	207.8	13
2111 chemists	7.8	12	29.8	11	29.7	11
2112 bio scientists and biochemists	28.1	13	94.3	13	94.2	13
2113 physts, geologists & meteorologists	7.1	12	28.1	11	28.0	11
2121 civil engineers	18.4	13	90.0	13	89.8	13
2122 mechanical engineers	18.6	13	85.1	13	84.9	13
2123 electrical engineers	12.7	13	57.1	13	56.8	13
2124 electronics engineers	10.0	11	47.9	10	47.6	10
2125 chemical engineers	3.6	8	11.7	3	11.3	3
2126 design and development engineers	13.5	13	59.5	13	59.5	13
2127 production and process engineers	8.3	12	41.5	11	41.1	11
2128 planning and qlty control engineers	7.5	12	40.3	11	40.3	11
2129 engineering professionals n.e.c.	21.5	13	93.6	13	93.0	13
2131 it strategy and planning prfsnals	27.7	13	145.1	13	143.8	13
2132 software professionals	75.2	13	330.2	13	328.7	13
2211 medical practitioners	45.8	13	232.1	13	230.9	13
2212 psychologists	7.5	13	30.9	13	30.8	13
2213 pharmacists & pharmacologists	8.1	13	42.7	12	42.7	12
2214 ophthalmic opticians	2.9	10	20.9	9	20.9	9
2215 dental practitioners	3.1	11	45.6	7	45.3	7
2216 veterinarians	4.1	10	17.9	10	17.9	10
2311 higher education teaching prfsnals	40.4	13	133.8	13	133.5	13
2312 further education teaching prfsnals	38.5	13	133.2	13	132.5	13
2313 education officers, school inspectr	6.3	13	23.3	13	23.3	13
2314 secondary eductn teaching prfsnals	134.2	13	435.9	13	435.1	13
2315 prim & nurs eductn teaching profs	131.1	13	437.0	13	435.5	13
2316 spec needs education teaching profs	21.8	13	70.0	13	69.9	13
2317 registrs & sen admins ed establish	9.4	13	41.8	13	41.8	13
2319 teaching professionals n.e.c.	23.9	13	150.9	13	150.0	13
2321 scientific researchers	3.9	12	18.9	10	18.7	10
2322 social science researchers	4.9	12	18.1	11	18.1	11
2329 researchers n.e.c.	14.3	12	58.2	12	58.2	12
2411 solic & lawyers, judges & coroners	27.4	13	165.8	13	164.9	13
2419 legal professionals n.e.c.	5.3	12	24.8	10	24.8	10
2421 chartered and certified accountants	31.8	13	156.4	13	156.0	13

2422 management accountants	18.8	13	83.8	13	83.5	13
2423 mngmnt cons, actuar, econs & statn	34.6	13	175.8	13	175.4	13
2431 architects	7.7	13	47.5	13	47.5	13
Table 6.16 (continued)	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
4-digit SOC code	*No. Obs.* (1)	*No. Regions* (2)	*No. Obs.* (3)	*No. Regions* (4)	*No. Obs.* (5)	*No. Regions* (6)
2432 town planners	6.8	13	26.1	12	26.1	12
2433 quantity surveyors	10.1	13	49.1	13	48.8	13
2434 chartrd surveyors (not qntity surv)	13.4	13	70.3	12	69.9	12
2441 public service administrative profs	7.8	13	35.2	13	35.0	13
2442 social workers	29.8	13	121.6	13	121.1	13
2443 probation officers	4.8	12	16.5	12	16.4	12
2444 clergy	9.8	12	46.0	12	45.9	12
2451 librarians	10.5	13	38.1	12	38.1	12
2452 archivists and curators	3.6	9	21.2	5	21.0	5
3111 laboratory technicians	15.3	13	70.8	13	70.8	13
3112 electrical & electronic technicians	7.5	12	32.2	12	32.2	12
3113 engineering technicians	16.4	13	74.3	13	74.2	13
3114 build & civil eng technicians	4.7	12	24.9	12	24.8	12
3115 quality assurance technicians	3.8	13	16.9	13	16.9	13
3119 science & eng technicians n.e.c.	7.6	13	41.5	13	41.4	13
3121 archt technols & town plan technics	5.8	13	25.8	13	25.8	13
3122 draughtspersons	8.2	13	51.3	12	51.1	12
3123 building inspectors	1.5	6	5.3	3	5.3	3
3131 it operations technicians	23.7	13	122.8	13	122.2	13
3132 it user support technicians	12.7	13	64.6	13	64.3	13
3211 nurses	164.6	13	586.9	13	585.3	13
3212 midwives	11.8	13	42.8	13	42.8	13
3213 paramedics	5.5	12	25.5	11	25.5	11
3214 medical radiographers	9.2	13	28.5	13	28.4	13
3215 chiropodists	2.7	10	17.5	6	17.5	6
3216 dispensing opticians	1.3	9	8.8	8	8.8	8
3217 pharmaceutical dispensers	8.0	13	45.7	13	45.2	13
3218 medical and dental technicians	8.8	12	43.6	12	43.1	12
3221 physiotherapists	9.8	13	41.4	13	41.2	13
3222 occupational therapists	10.4	13	37.7	12	37.7	12
3223 speech and language therapists	4.4	11	15.5	11	15.5	11
3229 therapists n.e.c.	7.1	12	72.7	12	71.5	12
3231 youth and community workers	26.8	13	117.5	13	117.2	13
3232 housing and welfare officers	40.8	13	190.8	13	190.5	13
3311 ncos and other ranks	8.1	12	71.5	11	71.4	11
3312 police offcrs (sergeant and below)	38.4	13	188.7	13	188.5	13
3313 fire serv off (leading off & below)	8.3	13	45.8	13	45.8	13

3314 prison serv off (below princ off)	7.2	13	53.2	12	52.8	12
3319 protective servcs assoc prfsnls nec	6.5	13	32.1	13	32.0	13
3411 artists	3.0	4	83.0	3	82.0	3
3412 authors, writers	7.6	12	60.5	11	60.3	11
Table 6.16 (continued)	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
4-digit SOC code	*No. Obs. (1)*	*No. Regions (2)*	*No. Obs. (3)*	*No. Regions (4)*	*No. Obs. (5)*	*No. Regions (6)*
3413 actors, entertainers	1.6	5	22.0	1	22.0	1
3414 dancers and choreographers	1.0	2	25.0	1	25.0	1
3415 musicians	2.0	7	43.7	6	43.3	6
3416 arts officrs, prdcers and directors	5.4	12	50.2	9	49.6	9
3421 graphic designers	14.8	12	103.3	12	102.8	12
3422 product, clothing & related dsgners	6.8	13	67.5	11	67.5	11
3431 journalists, newsppr & period eds	12.0	12	64.2	11	63.6	11
3432 broadcasting associate prfssnals	7.6	13	47.2	11	47.0	11
3433 public relations officers	8.4	11	39.1	10	39.0	10
3434 photo. & audio-visual equip operats	4.6	13	58.6	13	57.9	13
3441 sports players	1.0	8	22.0	2	22.0	2
3442 sports coaches, instruc & officials	8.8	12	65.6	11	64.9	11
3443 fitness instructors	4.7	11	42.8	9	42.8	9
3449 sports and fitness occupations nec.	2.0	9	19.7	7	19.7	7
3511 air traffic controllers	1.9	7	11.5	6	11.5	6
3512 aircraft pilots and flight enginrs	5.4	12	27.7	10	27.7	10
3513 ship and hovercraft officers	3.0	10	25.6	8	25.6	8
3514 train drivers	3.6	8	28.3	7	28.3	7
3520 legal associate professionals	10.4	13	57.5	13	57.5	13
3531 estimators, valuers and assessors	13.3	13	69.5	13	69.1	13
3532 brokers	7.1	13	56.0	11	55.5	11
3533 insurance underwriters	6.2	12	34.9	11	34.9	11
3534 fin. & invest. analyst & advisers	24.5	13	165.7	13	165.2	13
3535 taxation experts	7.2	12	31.7	11	31.7	11
3536 importers, exporters	1.5	8	11.8	4	11.8	4
3537 financial and accounting techs	7.0	12	29.8	12	29.7	12
3539 business & related assoc profs nec.	29.6	13	146.1	13	145.8	13
3541 buyers and purchasing officers	11.9	13	65.5	13	65.5	13
3542 sales representatives	31.4	13	215.4	13	214.4	13
3543 marketing associate professionals	24.9	13	127.2	13	126.8	13
3544 estate agents, auctioneers	4.9	10	40.8	10	40.8	10
3551 conservat & environ protection offs	7.1	12	30.7	11	30.6	11
3552 countryside and park rangers	1.9	10	9.1	9	9.1	9
3561 public serv associate professionals	18.7	13	84.2	13	84.2	13
3562 personnel & ind relations offs	27.1	13	148.7	13	148.5	13
3563 vocatn & indust trainrs & instrctrs	30.5	13	159.5	13	158.8	13

3564 car. advis & voction guidnce spcils	8.4	13	32.8	13	32.8	13
3565 inspcts fact, utils & trdng stndrds	5.0	12	18.8	12	18.8	12
3566 statutory examiners	3.4	12	20.4	10	20.4	10
3567 occupl hygnists & health sfty offs	9.4	13	49.4	13	49.1	13
3568 environmental health officers	4.2	13	15.3	12	15.3	12
Table 6.16 (continued)	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
4-digit SOC code	*No. Obs. (1)*	*No. Regions (2)*	*No. Obs. (3)*	*No. Regions (4)*	*No. Obs. (5)*	*No. Regions (6)*
4111 civil service executive officers	16.4	13	89.9	13	89.8	13
4114 officers non-gov organisations	9.2	13	50.1	12	49.6	12
4142 communication operators	5.8	12	33.9	12	33.9	12
5211 smiths and forge workers	1.0	3	7.5	2	7.5	2
5212 moulders, core makers, die casters	1.2	5	7.0	1	7.0	1
5214 mtl plate wrkrs, shipwrig, riveters	3.4	8	19.0	8	18.8	8
5215 welding trades	11.0	12	98.5	11	97.6	11
5216 pipe fitters	2.4	10	17.6	8	17.1	8
5221 metal mach setter & setter-operator	9.8	13	64.5	12	64.3	12
5222 tool mkrs, tool fters & markers-out	3.9	12	17.8	12	17.7	12
5223 mtl working prod & maintnce fitter	40.6	13	237.1	13	236.3	13
5224 prec instrument makers & repairers	5.3	8	33.1	8	33.0	8
5233 auto electricians	1.8	10	11.4	7	11.4	7
5241 electricians, electrical fitters	38.0	13	260.1	13	258.3	13
5242 telecommunications engineers	8.5	12	52.8	12	52.4	12
5243 lines repairers and cable jointers	2.4	10	19.3	8	19.3	8
5245 comp engineer, installn & maintnce	7.9	12	46.8	12	46.3	12
5249 elec & electronic engineer n.e.c.	15.4	13	92.0	13	91.5	13
5311 steel erectors	1.5	6	28.7	3	28.7	3
5312 bricklayers, masons	7.3	12	98.0	12	96.8	12
5314 plumb, hea & ventilating engineers	21.8	13	206.8	13	205.7	13
5315 carpenters and joiners	22.6	13	296.1	13	293.1	13
5319 construction trades n.e.c.	10.3	12	266.1	12	261.3	12
5414 tailors and dressmakers	1.0	1		0		0
5421 orignters, compositors & print preps	2.8	4	12.0	3	12.0	3
5422 printers	6.0	13	37.0	13	37.0	13
5493 pattern makers (moulds)	1.5	4	5.5	2	5.5	2
5495 goldsmth, slvrsmth, prec stone wrkr	1.5	4	15.3	3	15.3	3
5496 floral arrangers, florists	3.1	9	24.3	7	24.3	7
8124 energy plant operatives	1.6	5	7.8	4	7.8	4

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 4-digit SOC occupations (cols.1,3,5), and the number of regions for which an index can be computed (cols. 2,4,6) in 2008-2009 pooled.

Table 6.18

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
3-digit SOC code	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
111 corporate managers & senr officials	15.2	12	68.4	12	68.3	12
112 production managers	62.0	13	353.3	13	351.7	13
113 functional managers	153.4	13	739.6	13	736.6	13
114 quality and customer care managers	15.8	13	75.4	13	75.1	13
115 financial instit and office managers	37.8	13	219.9	13	219.4	13
116 mngrs in distrib, storage and retail	34.8	13	298.2	13	297.6	13
117 protective service officers	8.5	13	41.8	13	41.6	13
118 health and social services managers	28.2	13	113.3	13	112.7	13
121 mngrs in farming, hort, forestry etc	3.1	8	34.6	8	34.6	8
122 managers in hospitality and leisure	17.2	13	165.8	13	164.7	13
123 managers in other service industries	29.5	13	252.3	13	250.4	13
211 science professionals	20.7	13	71.2	13	71.1	13
212 engineering professionals	52.5	13	241.4	13	240.5	13
213 info & communication technology	48.8	13	234.4	13	232.5	13
221 health professionals	34.3	13	185.5	13	185.0	13
231 teaching professionals	197.3	13	707.4	13	704.5	13
232 research professionals	10.6	13	43.5	13	43.5	13
241 legal professionals	15.9	13	89.2	13	88.8	13
242 business & statistical professionals	42.9	13	205.8	13	205.0	13
243 architects, town planners, surveyors	19.2	13	92.9	13	92.7	13
244 public service professionals	25.8	13	108.7	13	108.3	13
245 librarians and related professionals	6.2	13	24.5	13	24.4	13
311 science and engineering techinicians	27.1	13	124.8	13	124.7	13
312 draughtspersons and building inspect	6.5	13	36.0	13	35.8	13
313 it service delivery occupations	17.9	13	92.1	13	91.6	13
321 health associate professionals	102.2	13	381.6	13	379.5	13
322 therapists	15.3	13	79.7	13	78.9	13
323 social welfare assoc professionals	31.2	13	151.1	13	151.0	13
331 protective service occupations	31.2	13	182.1	13	181.5	13
341 artistic and literary occupations	8.0	12	113.5	11	112.4	11

342 design associate professionals	9.0	13	72.2	13	71.8	13
343 media associate professionals	15.4	13	97.8	13	97.2	13
344 sports and fitness occupations	7.8	12	65.3	12	64.9	12
351 transport associate professionals	5.5	13	37.3	11	37.2	11
352 legal associate professionals	5.3	12	33.3	11	33.2	11
353 business & finance assoc professnls	45.4	13	248.9	13	247.7	13
354 sales & related assoc professionals	35.9	13	210.9	13	209.9	13
355 conservation associate professionals	4.7	12	18.8	12	18.7	12

Table 6.18 (continued)

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
3-digit SOC code	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
356 public service and other assoc prof	53.6	13	248.8	13	248.2	13
411 administrative: government & related	45.5	13	279.5	13	278.4	13
414 administrative: communications	3.7	10	28.6	10	28.6	10
521 metal forming, welding and related	10.0	12	76.8	12	76.1	12
522 metal machning, fitting, instr makng	27.6	13	158.1	13	157.4	13
523 vehicle trades	18.6	13	131.9	13	131.2	13
524 electrical trades	33.8	13	225.2	13	223.2	13
531 construction trades	30.8	13	444.1	13	438.5	13
541 textiles and garment trades	1.3	7	21.3	3	21.3	3
542 printing trades	4.8	12	32.8	12	32.8	12
549 skilled trades n.e.c	4.8	10	54.0	9	53.8	9
812 plant and machine operatives	8.5	13	94.8	13	94.3	13

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 3-digits SOC occupations (cols.1,3,5), and the number of regions for which an index can be computed in 2009 (cols. 2,4,6).

Table 6.20

	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
2-digit SOC code	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
11 - Corporate Managers	354.5	13	1904.8	13	1897.8	13
12 - Managers And Proprietors In Agriculture And Services	48.6	13	441.9	13	438.9	13
21 - Science And Technology Professionals	122.0	13	547.0	13	544.2	13
22 - Health Professionals	34.3	13	185.5	13	185.0	13
23 - Teaching And Research Professionals	207.9	13	750.8	13	747.9	13
24 - Business And Public Service Professionals	110.0	13	521.0	13	519.2	13
31 - Science And Technology Associate Professionals	51.5	13	252.9	13	252.2	13
32 - Health And Social Welfare Associate Professionals	148.8	13	612.4	13	609.5	13
33 - Protective Service Occupations	31.2	13	182.1	13	181.5	13
34 - Culture, Media And Sports Occupations	39.0	13	330.2	13	327.8	13
35 - Business And Public Service Associate Professionals	149.6	13	788.2	13	785.2	13
41 - Administrative Occupations	172.7	13	1265.2	13	1258.7	13
52 - Skilled Metal And Electrical Trades	89.3	13	587.5	13	583.1	13
53 - Skilled Construction And Building Trades	35.8	13	565.7	13	558.7	13
54 - Textiles, Printing And Other Skilled Trades	21.3	13	261.5	13	259.8	13
81 - Process, Plant And Machine Operatives	33.1	13	456.9	13	454.5	13

The table reports the mean number of observations used to compute the relevant shortage indicator in each region for 2-digits SOC occupations (cols.1,3,5), and the number of regions for which an index can be computed in 2009 (cols. 2,4,6).

Table 6.22	*Vacancy duration (L1)*	Change in unemployment *(V1)*		Vacancies/Unemployment (*L2*)		
4-digit SOC code	*No. Regions (1)*	*No. Obs. (2)*	*No. Regions (3)*	*Vacancies: No. Obs (4)*	*Claimants: No. Obs (5)*	*No. Regions (6)*
1111 senior officials in national gov	0	132	9	1	151	2
1112 directors & chief execs of maj orgs	0	116	10	5	122	9
1113 senior officials in local gov	0	27	7	5	30	11
1114 sen. officials spec interest orgs	0	19	7	2	23	6
1121 prod. works & maintenance managers	9	373	11	29	352	11
1122 managers in construction	7	483	12	17	463	11
1123 managers in mining and energy	0	14	7	2	15	5
1131 financial managers & chartered secs	2	175	12	11	177	11
1132 marketing and sales managers	11	1003	12	230	947	11
1133 purchasing managers	1	63	9	5	63	11
1134 advertising & public rel managers	0	114	11	9	110	10
1135 pers training & ind rel mngers	6	194	12	28	188	11
1136 info & communication technol mngers	4	381	12	17	385	11
1137 research and development managers	1	54	10	7	53	11
1141 quality assurance managers	0	63	12	5	60	11
1142 customer care managers	4	147	10	13	154	11
1151 financial institution managers	0	121	10	13	126	10
1152 office managers	9	334	12	29	332	11
1161 transport and distribution managers	0	147	12	7	141	11
1162 storage and warehouse managers	1	303	11	11	310	11
1163 retail and wholesale managers	11	646	12	192	632	11
1171 officers in armed forces	0	16	8	14	18	3
1172 police officers (inspectrs & above)	0	3	3	0	4	0
1173 snr officers fire, amb, prson et al	0	1	1	0	1	0
1174 security managers	0	39	10	2	48	6
1181 hospital and health service mngers	2	24	10	8	28	11
1182 pharmacy managers	0	3	2	4	4	5
1183 healthcare practice managers	1	11	9	4	12	8
1184 social services managers	2	14	8	7	15	11

1185 residential and day care managers	11	33	10	56	41	11
1211 farm managers	0	7	5	1	7	3
1212 natural environ & cons managers	0	58	10	1	61	5
1219 mngr anml hsbndry, frst, fish nec.	0	7	5	0	8	4
1221 hotel and accommodation managers	6	86	12	20	82	11
1222 conference and exhibition managers	0	78	10	5	80	8
1225 leisure and sports managers	0	56	11	8	61	11
1226 travel agency managers	0	10	6	1	10	5
1231 property, housing and land managers	4	111	11	13	114	11
1232 garage managers and proprietors	1	32	11	6	29	11

Table 6.22 (continued)

	L1	*V1*		*L2*		
4-digit SOC code	*No. Regions* (1)	*No. Obs.* (2)	*No. Regions* (3)	*Vacancies: No. Obs* (4)	*Claimants: No. Obs* (5)	*No. Regions* (6)
1233 hairdrs & beauty slon mngr & props	0	42	10	4	54	11
1234 shopkprs, wholesale & retail dealrs	0	80	8	9	83	11
1235 recyc and refuse disposal managers	0	18	8	4	22	9
1239 mngers and prop. in other srvcs nec	9	124	11	46	123	11
2111 chemists	0	33	8	2	32	9
2112 bio scientists and biochemists	3	79	11	11	82	11
2113 physts, geologists & meteorologists	0	23	8	2	23	7
2121 civil engineers	4	181	12	8	197	11
2122 mechanical engineers	9	314	10	29	333	11
2123 electrical engineers	9	122	11	26	135	11
2124 electronics engineers	1	95	9	7	100	11
2125 chemical engineers	0	15	10	1	18	5
2126 design and development engineers	7	101	12	17	98	11
2127 production and process engineers	3	90	10	22	85	11
2128 planning and qlty control engineers	2	54	11	8	47	11
2129 engineering professionals n.e.c.	10	140	11	28	145	11
2131 it strategy and planning prfsnals	1	196	10	6	205	8
2132 software professionals	10	462	11	54	473	11
2211 medical practitioners	3	12	5	60	12	11
2212 psychologists	0	28	9	4	30	11
2213 pharmacists & pharmacologists	2	11	6	13	11	10
2214 ophthalmic opticians	0	2	3	1	3	2
2215 dental practitioners	0	1	1	3	2	4
2216 veterinarians	0	4	3	0	4	3
2311 higher education teaching prfsnals	7	70	12	68	83	11
2312 further education teaching prfsnals	10	156	9	49	176	11
2313 education officers, school inspectr	0	10	8	6	12	9
2314 secondary eductn teaching prfsnals	10	154	12	103	176	11
2315 prim & nurs eductn teaching profs	9	139	12	94	160	11

2316 spec needs education teaching profs	2	38	11	21	45	10
2317 registrs & sen admins ed establish	0	16	6	6	19	9
2319 teaching professionals n.e.c.	9	192	12	103	216	11
2321 scientific researchers	5	55	10	23	56	11
2322 social science researchers	0	54	10	4	58	9
2329 researchers n.e.c.	7	70	12	46	73	11
2411 solic & lawyers, judges & coroners	4	131	11	16	118	10
2419 legal professionals n.e.c.	2	37	9	6	37	11
2421 chartered and certified accountants	4	138	11	10	142	11
2422 management accountants	2	98	10	6	102	10
2423 mngmnt cons, actuar, econs & statn	1	136	8	34	136	11
2431 architects	0	115	11	4	101	7

Table 6.22 (continued)

	L1	*V1*		*L2*		
4-digit SOC code	*No. Regions (1)*	*No. Obs. (2)*	*No. Regions (3)*	*Vacancies: No. Obs (4)*	*Claimants: No. Obs (5)*	*No. Regions (6)*
2432 town planners	0	19	10	2	20	9
2433 quantity surveyors	2	94	11	5	95	11
2434 chartrd surveyors (not qntity surv)	4	93	12	10	81	11
2441 public service administrative profs	1	121	12	12	138	11
2442 social workers	11	112	12	52	134	11
2443 probation officers	0	10	7	1	13	4
2444 clergy	0	11	8	3	15	6
2451 librarians	0	30	7	1	35	6
2452 archivists and curators	0	37	9	0	41	2
3111 laboratory technicians	5	151	11	12	159	11
3112 electrical & electronic technicians	4	96	12	51	101	11
3113 engineering technicians	10	146	11	56	153	11
3114 build & civil eng technicians	0	68	11	4	72	11
3115 quality assurance technicians	3	67	11	13	63	11
3119 science & eng technicians n.e.c.	0	27	8	9	27	11
3121 archt technols & town plan technics	0	87	12	2	79	8
3122 draughtspersons	2	154	12	14	152	11
3123 building inspectors	0	11	6	2	11	7
3131 it operations technicians	10	506	12	37	554	11
3132 it user support technicians	7	583	12	17	640	11
3211 nurses	11	83	12	600	90	11
3212 midwives	0	6	4	1	6	5
3213 paramedics	0	7	5	2	8	5
3214 medical radiographers	0	4	3	4	4	6
3215 chiropodists	0	3	0	2	4	6
3216 dispensing opticians	0	6	3	1	6	6
3217 pharmaceutical dispensers	9	22	7	21	26	11

3218 medical and dental technicians	0	19	7	6	22	11
3221 physiotherapists	0	15	6	3	17	9
3222 occupational therapists	5	12	8	9	14	11
3223 speech and language therapists	0	9	5	2	10	9
3229 therapists n.e.c.	2	74	10	8	85	11
3231 youth and community workers	11	421	12	107	480	11
3232 housing and welfare officers	11	169	10	55	194	11
3311 ncos and other ranks	1	39	10	338	37	10
3312 police offcrs (sergeant and below)	0	54	8	0	55	1
3313 fire serv off (leading off & below)	0	31	10	1	32	4
3314 prison serv off (below princ off)	0	28	9	5	29	6
3319 protective servcs assoc prfsnls nec	0	5	2	0	5	2
3411 artists	0	140	10	1	150	6
3412 authors, writers	2	165	12	141	190	11

Table 6.22 (continued)

	L1	*V1*		*L2*		
4-digit SOC code	*No. Regions (1)*	*No. Obs. (2)*	*No. Regions (3)*	*Vacancies: No. Obs (4)*	*Claimants: No. Obs (5)*	*No. Regions (6)*
3413 actors, entertainers	5	178	9	29	192	11
3414 dancers and choreographers	1	28	9	8	30	8
3415 musicians	0	118	10	1	125	3
3416 arts officrs, prdcers and directors	0	148	10	6	161	7
3421 graphic designers	8	538	12	20	560	11
3422 product, clothing & related dsgners	0	180	10	55	178	11
3431 journalists, newsppr & period eds	0	158	11	3	165	9
3432 broadcasting associate prfssnals	0	120	11	1	134	4
3433 public relations officers	0	63	9	4	62	10
3434 photo. & audio-visual equip operats	0	291	12	13	316	11
3441 sports players	0	12	7	0	12	0
3442 sports coaches, instruc & officials	8	201	11	52	240	11
3443 fitness instructors	6	164	12	12	192	11
3449 sports and fitness occupations nec.	6	65	12	38	75	11
3511 air traffic controllers	0	4	5	0	4	0
3512 aircraft pilots and flight enginrs	0	28	8	0	33	0
3513 ship and hovercraft officers	0	9	4	1	9	4
3514 train drivers	0	13	9	0	17	0
3520 legal associate professionals	3	104	11	20	104	11
3531 estimators, valuers and assessors	10	61	11	42	61	11
3532 brokers	3	67	9	18	70	11
3533 insurance underwriters	3	35	9	11	36	10
3534 fin. & invest. analyst & advisers	11	238	12	57	230	11
3535 taxation experts	0	15	8	1	15	6
3536 importers, exporters	0	23	4	4	24	10

3537 financial and accounting techs	1	88	9	5	96	11
3539 business & related assoc profs nec.	9	138	11	37	147	11
3541 buyers and purchasing officers	4	139	11	13	128	11
3542 sales representatives	11	653	12	1463	620	11
3543 marketing associate professionals	11	227	11	219	222	11
3544 estate agents, auctioneers	5	95	9	34	93	11
3551 conservat & environ protection offs	0	77	12	3	84	10
3552 countryside and park rangers	0	30	11	2	32	6
3561 public serv associate professionals	1	14	6	6	16	10
3562 personnel & ind relations offs	11	221	11	55	194	11
3563 vocatn & indust trainrs & instrctrs	11	133	11	90	146	11
3564 car. advis & voction guidnce spcils	2	40	9	11	46	11
3565 inspcts fact, utils & trdng stndrds	0	9	4	1	10	4
3566 statutory examiners	0	6	5	1	7	8
3567 occupl hygnists & health sfty offs	0	57	10	5	61	10
3568 environmental health officers	0	14	7	2	16	8

Table 6.22 (continued)

	L1	*V1*		*L2*		
4-digit SOC code	*No. Regions (1)*	*No. Obs. (2)*	*No. Regions (3)*	*Vacancies: No. Obs (4)*	*Claimants: No. Obs (5)*	*No. Regions (6)*
4111 civil service executive officers	0	129	10	1	141	4
4114 officers non-gov organisations	2	35	9	14	37	10
4142 communication operators	2	20	8	10	21	11
5211 smiths and forge workers	0	18	8	0	20	5
5212 moulders, core makers, die casters	0	33	9	2	30	5
5214 mtl plate wrkrs, shipwrig, riveters	0	74	9	4	72	8
5215 welding trades	8	712	12	36	663	11
5216 pipe fitters	0	133	11	17	140	10
5221 metal mach setter & setter-operator	8	248	12	72	220	11
5222 tool mkrs, tool fters & markers-out	0	57	9	4	47	11
5223 mtl working prod & maintnce fitter	11	423	12	65	413	11
5224 prec instrument makers & repairers	0	23	6	2	24	8
5233 auto electricians	0	33	11	4	31	8
5241 electricians, electrical fitters	11	1004	12	69	1047	11
5242 telecommunications engineers	1	165	12	7	168	9
5243 lines repairers and cable jointers	0	48	10	2	50	7
5245 comp engineer, installn & maintnce	4	340	11	15	365	11
5249 elec & electronic engineer n.e.c.	9	178	9	37	183	11
5311 steel erectors	1	128	11	9	126	11
5312 bricklayers, masons	3	1146	12	42	929	11
5314 plumb, hea & ventilating engineers	11	924	12	182	938	11
5315 carpenters and joiners	10	2021	12	73	1821	11
5319 construction trades n.e.c.	5	530	10	38	534	11

5414 tailors and dressmakers	0	26	5	2	30	9
5421 orignters, compositors & print preps	0	26	9	0	26	3
5422 printers	0	156	12	6	145	10
5493 pattern makers (moulds)	0	5	4	0	5	2
5495 goldsmth, slvrsmth, prec stone wrkr	0	18	5	0	19	3
5496 floral arrangers, florists	0	41	10	3	50	11
8124 energy plant operatives	0	10	6	2	11	5

The table reports the number of regions for which the relevant shortage indicator can be computed for each 4-digits SOC occupation (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

Table 6.24

	Vacancy duration (L1)	Change in unemployment (V1)		Vacancies/Unemployment (L2)		
3-digit SOC code	*No. Regions (1)*	*No. Obs. (2)*	*No. Regions (3)*	*Vacancies: No. Obs (4)*	*Claimants: No. Obs (5)*	*No. Regions (6)*
111 corporate managers & senr officials	2	293	12	14	325	11
112 production managers	10	870	12	48	831	11
113 functional managers	11	1984	12	308	1925	11
114 quality and customer care managers	5	210	11	19	215	11
115 financial instit and office managers	10	456	11	42	459	11
116 mngrs in distrib, storage and retail	11	1096	12	209	1084	11
117 protective service officers	0	59	9	16	70	8
118 health and social services managers	11	84	11	79	100	11
121 mngrs in farming, hort, forestry etc	0	73	11	2	76	7
122 managers in hospitality and leisure	11	651	9	157	691	11
123 managers in other service industries	11	408	12	82	424	11
211 science professionals	6	134	10	15	138	11
212 engineering professionals	11	1111	11	145	1157	11
213 info & communication technology	10	657	12	60	676	11
221 health professionals	10	59	10	80	63	11
231 teaching professionals	11	775	12	449	888	11
232 research professionals	11	178	11	73	187	11

241 legal professionals	5	168	12	22	155	11
242 business & statistical professionals	10	371	11	50	380	11
243 architects, town planners, surveyors	9	320	10	21	299	11
244 public service professionals	11	253	12	68	298	11
245 librarians and related professionals	0	67	11	1	75	6
311 science and engineering techinicians	11	555	11	146	575	11
312 draughtspersons and building inspect	5	253	11	18	243	11
313 it service delivery occupations	10	1089	12	54	1194	11
321 health associate professionals	11	152	12	637	166	11
322 therapists	7	109	12	22	126	11
323 social welfare assoc professionals	11	590	12	162	674	11
331 protective service occupations	3	157	11	345	157	10
341 artistic and literary occupations	11	776	12	186	849	11
342 design associate professionals	10	719	12	75	738	11
343 media associate professionals	6	630	12	21	676	11
344 sports and fitness occupations	11	442	12	102	520	11
351 transport associate professionals	0	54	10	1	63	4
352 legal associate professionals	3	104	11	20	104	11
353 business & finance assoc professnls	11	664	12	176	681	11
354 sales & related assoc professionals	11	1113	12	1730	1062	11
355 conservation associate professionals	1	107	11	5	115	11

Table 6.24 (continued)

3-digit SOC code	Returns (P3)		Employment (V2)		Less than 1 year (V4)	
	No. Obs.	*No. Regions*	*No. Obs.*	*No. Regions*	*No. Obs.*	*No. Regions*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
356 public service and other assoc prof	11	495	12	172	496	11
411 administrative: government & related	9	883	12	50	951	11
414 administrative: communications	8	55	9	19	58	11
521 metal forming, welding and related	11	1077	11	68	1035	11
522 metal machning, fitting, instr makng	11	753	12	143	706	11
523 vehicle trades	11	1189	11	205	1244	11
524 electrical trades	11	1818	12	140	1904	11
531 construction trades	11	5697	12	370	5264	11
541 textiles and garment trades	5	115	11	20	108	9
542 printing trades	1	271	12	16	260	11
549 skilled trades n.e.c	7	232	12	18	234	11
812 plant and machine operatives	11	835	12	74	774	11

The table reports the number of regions for which the relevant shortage indicator can be computed for each 3-digits SOC occupation (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

Table 6.26

	Vacancy duration (L1)	Change in unemployment (V1)		Vacancies/Unemployment (L2)		
2-digit SOC code	*No. Regions*	*No. Obs.*	*No. Regions*	*Vacancies : No. Obs*	*Claimants: No. Obs*	*No. Regions*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
11 - Corporate Managers	11	5050	12	734	5009	11
12 - Managers And Proprietors In Agriculture And Services	11	1132	12	241	1190	11
21 - Science And Technology Professionals	11	1902	12	220	1971	11
22 - Health Professionals	10	59	10	80	63	11
23 - Teaching And Research Professionals	11	953	12	522	1075	11
24 - Business And Public Service Professionals	11	1180	11	163	1208	11
31 - Science And Technology Associate Professionals	11	1896	12	218	2010	11
32 - Health And Social Welfare Associate Professionals	11	850	12	820	966	11
33 - Protective Service Occupations	3	157	11	345	157	10
34 - Culture, Media And Sports Occupations	11	2568	12	384	2785	11
35 - Business And Public Service Associate Professionals	11	2536	12	2102	2521	11
41 - Administrative Occupations	11	11400	12	951	11688	11
52 - Skilled Metal And Electrical Trades	11	4835	12	556	4886	11
53 - Skilled Construction And Building Trades	11	8753	12	418	8307	11
54 - Textiles, Printing And Other Skilled Trades	11	1947	12	590	2013	11
81 - Process, Plant And Machine Operatives	11	6021	12	733	5780	11

The table reports the number of regions for which the relevant shortage indicator can be computed for each 2-digits SOC occupation (columns 1, 3, 6). It also reports the mean number of observations on which each component of the indicator is calculated. Data refer to April 2010 and, where appropriate, April 2009.

References

Arrow, K.J. and W.M. Capron (1959), "Dynamic Shortages and Prices Rises: the Engineer-Scientist case", *Quarterly Journal of Economics*, Vol. 73, No.2, pp. 292-308.

Barnow, B.S., Trutko, J., and R. Lerman (1998), "Skill Mismatches and Worker Shortages: The Problem and Appropriate Responses", Urban Institute Policy Memorandum prepared for the U.S. Department of Labor, Washington D.C.

Blank, D.J, and G.J. Stigler (1957), "The Demand and Supply of Scientific Personnel", New York: National Bureau of Economic Research.

Borjas, G.J. (2001), "Does Immigration Grease the Wheels of the Labor Market?", *Brookings Papers on Economic Activity*, Vol. 2001, No. 1, pp. 69-119.

Boswell, C., Stiller, S. and T. Straubhaar (2004), "Forecasting Labour and Skills Shortages: How Can Projections better Inform Labour Migration Policies?", *Paper Prepared for the European Commission, DG Employment and Social Affairs*, Hamburg.

Cohen and Zaidi (2002), "Global Skill Shortages", Edward Elgar Publishing Inc.

Dustmann, C., Frattini, T. and I. Preston (2008), "The Effect of Immigration along the Distribution of Wages", CReAM Discussion Paper No.03/08.

Frogner (2002), "Skills shortages", *Labour Market Trends*, vol. 110 (1), pp. 17-27

Green, F., Machin, S. and Wilkinson, D. (1998), "The Meaning and Determinants of Skills Shortages", *Oxford Bullettin of Economics and Statistics*, Vol. 60, No. 2, pp. 165-187.

Harrington, P.E. and A.M. Sum (1984), "Skills Shortages and Employment and Training Policy in the U.S.: Past Relationships and Desirable Future Directions", Boston, Center for Labor Market Studies, Northeastern University

Haskel, M. and C. Martin (1993), "The causes of skills shortages in Britain", *Oxford Economic Papers*, Vol. 45 (4), pp. 573-588.

Haskel, M. and C. Martin (2001), "Technology, wages, and skill shortages: evidence from UK micro data", *Oxford Economic Papers*, Vol. 53 (4), pp. 642-658.

IFF Research (2008), "Customised assessment and analysis of NESS data", Report prepared for the Migration Advisory Committee.

MAC (2008), "Skilled, shortage, sensible. The recommended shortage occupation lists for the UK and Scotland", London, Migration Advisory Committee

MAC (2010), "Skilled, shortage, sensible. Review of Methodology", London, Migration Advisory Committee.

Shah, C. and Burke, G. (2005), "Skill shortages,: Concepts, measurement, and implications", *Australian Bullettin of Labour*, vol. 31, no.1

Veneri, C.M. (1999), "Can occupational labor shortages be identified using available data?", Monthly Labor review, March, pp. 15-21

WM Enterprise (2010), "A theoretical review of skill shortages and skill needs", Report prepared for the Migration Advisory Committee.

York Consulting (2008) "A review of labour shortages, skills shortages and skill gaps", Report prepared for the Migration Advisory Committee.

Appendix

A model of regional labour shortages with heterogeneous locational preferences

As in Section 3.1, equilibrium involves cost minimising input choice and zero profits in both regions

$g^A(w^A/r^A)=L^A/K^A$ (1a)

$g^B(w^B/r^B)=L^B/K^B$ (1b)

$c^A(w^A,r^A)=1$ (2a)

$c^B(w^B,r^B)=1.$ (2b)

Capital is immobile. Labour can move between regions and a worker chooses to work in region A if and only if

$w^A \geq w^B+\xi$

where ξ is a locational preference parameter distributed in the population according to distribution function *F*. Labour supply in the two regions is given by

$L^A=L\,F(w^A-w^B)$

$L^B=L(1-F(w^A-w^B))$

Substituting into (1a, b) gives equilibrium conditions

$g^A(w^A/r^A)=L\,F(w^A-w^B)/K^A$

$g^B(w^B/r^B)=L\,(1-F(w^A-w^B))/K^B$

and, using (2a, b) to express r^A and r^B as functions of w^A and w^B, we can rewrite this as

$h^A(w^A) = L\, F(w^A\text{-}w^B)/K^A$

$h^B(w^B) = L\,(1\text{-}\, F(w^A\text{-}w^B))/K^B$

for some functions h^A and h^B. Inverting and subtracting gives

$$w^A - w^B = H^A\left(\frac{L}{K^A}F\left(w^A - w^B\right)\right) - H^B\left(\frac{L}{K^B}\left(1 - F\left(w^A - w^B\right)\right)\right)$$

where H^A and H^B denote the inverses of h^A and h^B. Solving this expression for w^A-w^B determines the equilibrium which is unique since the left hand side is increasing and the right hand side decreasing in the wage difference. This equilibrium will typically require regional wage differences and any barrier to regional wage differences of the required magnitude will result in labour shortage

Suppose it is region A that is the region of labour shortage. Introducing region-specific immigration M to region A modifies the condition to become

$$w^A - w^B = H^A\left(\frac{LF\left(w^A - w^B\right) + M}{K^A}\right) - H^B\left(\frac{L}{K^B}\left(1 - F\left(w^A - w^B\right)\right)\right)$$

from which it is apparent that the equilibrium regional wage difference can generically be reduced by region-specific immigration M.