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A Theoretical Review of Skill Shortages and Skill Needs

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A Theoretical Review of Skill Shortages and Skill Needs

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Foreword

Launched on 1st April 2008, the UK Commission for Employment and Skills is a key recommendation in Lord Leitch's 2006 review of skills *Prosperity for All in the Global Economy: World Class Skills*. The UK Commission aims to raise UK prosperity and opportunity by improving employment and skills. Its ambition is to benefit individuals, employers, government and society by providing independent advice to the highest levels of the UK Government and Devolved Administrations on how improved employment and skills systems can help the UK become a world class leader in productivity, in employment and in having a fair and inclusive society.

Research and policy analysis plays a fundamental role in the work of the UK Commission and is central to its advisory function. In fulfilling this role, the Research and Policy Directorate of the UK Commission is charged with delivering a number of the core activities of the UK Commission and has a crucial role to play in:

- assessing progress towards making the UK a world-class leader in employment and skills by 2020
- advising Ministers on the strategies and policies needed to increase employment, skills and productivity
- examining how employment and skills services can be improved to increase employment retention and progression, skills and productivity
- promoting employer investment in people and the better use of skills.

We produce research of the highest quality to provide an authoritative evidence base; we review best practice and offer policy innovations to the system; we undertake international benchmarking and analysis and we draw on panels of experts, in the UK and internationally, to inform our analysis.

Sharing the findings of our research and policy analysis and engaging with our audience is very important to the UK Commission. Our Evidence Reports are our chief means of reporting our detailed analytical work. Our other products include Summaries of these reports; Briefing Papers; Thinkpieces, seminars and an annual Research and Policy Convention. All our outputs are accessible in the Research and Policy pages at www.ukces.org.uk

This review, commissioned jointly with the Migration Advisory Committee (MAC), serves to improve our understanding of the workings of the labour market and the ability of the labour market to meet the skill needs of employers. The analysis within this review will help inform the methodology used by the MAC to identify occupations that are considered to be skilled, suffering from shortages and which it would be sensible to fill through migration.

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Executive Summary

Context

It is widely recognised that where skill shortages exist they are economically damaging, and that meeting employers' skill needs is essential for economic success. Reducing skill shortages would contribute to the UK Commission's ambition of raising prosperity and opportunity in the UK, both by enabling employers to operate with greater efficiency, and by helping individuals to access the opportunities available to them. And the Migration Advisory Committee (MAC) has been charged with identifying occupations in which shortages of skilled labour cannot readily be filled from within the domestic labour market, potentially justifying inward migration of individuals from outside the European Economic Area (EEA).

But do we have a clear and unambiguous understanding of what the terms 'skill shortage' and 'skill needs' mean? Do we understand how such shortages and needs are generated? And do we have measures of skill shortages and skill needs that correspond to those concepts?

Definitions

Surprisingly perhaps, mainstream economic theory is not particularly focused on the subject of skills, and tends to work with the broad concepts of labour supply and demand. This means that expecting any empirical measure of skill shortages to conform to 'best-practice' economic theory is probably not a sensible approach.

Applied labour market research has, however, settled on a generally accepted understanding of 'skill', to mean the ability to perform specified tasks. The usual practice is, more specifically, to classify skills in two dimensions, according to what the particular tasks are and according to what level of ability (or amount of training) is needed. This implies that a job can be described in these terms, and that so too can a person. Jobs are then classified into occupations on that basis.

Skill needs are defined in terms of the jobs that employers require done, and skill shortages refer to shortages of relevant suitably skilled people available in the labour market, relative to the jobs that employers are offering.

Explanations for skill shortages

Such imbalances in the skills market, and specifically skill shortages, can be represented by a simple Marshallian supply and demand diagram, but for a richer understanding economists have developed the idea of the Matching Function. This seeks to identify factors influencing how well the market matches individuals to jobs.

In practical terms it is useful to think of skill shortages operating within boundaries: and occupations are perhaps the most obvious set of boundaries to use. If all individuals and all jobs were homogenous there would arguably be no skill shortages (or at least not as far as micro-economic causes are concerned: excess demand in the macro-economy could still generate skill shortages, something that the Beveridge Curve articulates).

So the existence of skill shortages can be explained partly in terms of factor substitution: that is to say, the unwillingness or inability of individuals and employers to consider switches between different occupations – and also different locations and industries.

But skill shortages also reflect information short-falls. These exist when individuals have poor information on jobs, and/or employers have poor information on individuals. This is especially problematic since, unlike in most markets, both parties have a continuing vested interest in any hiring decision, post-signing. That may generate risk aversion and a bias not to contract, and hence skill shortages.

The mitigation to this – and it may be a large one – is that individuals and employers also often have the option to be flexible in how they interpret the employment contract, after the contract has been put in place, and when they are in a better position to trust one another than they were, before the contract was agreed.

One peculiarity in the labour market which may help to generate skill shortages is when employers cluster geographically, and gain a reputation as a desirable or prestigious employer to work for, partly because of their location. High-status employers may receive an unmanageable number of applications for jobs, while low-status rivals in different locations receive very few. Both find their recruitment decisions slowed down, the former because of a congestion effect and the latter because of a desert effect. This is an extreme example of the proposition that barriers to mobility generate skill shortages.

How will skill shortages, once they have arisen, manifest themselves? Mechanisms include wage pressure (although not always), unfilled vacancies, plus other phenomena such as increased over-time working. As indicated above, skill shortages will also be generated by strong growth in demand in the economy – something which can be assessed by comparing the ratio of reported vacancies or skill shortage to unemployment.

Measurement of skill shortages

On that basis the various measures of skill shortages used by the UK Commission and by the MAC correspond pretty closely to the set that one would expect to see. Indeed there is no single 'correct' measure of skill shortages and no theoretical benchmark, and so the MAC's choice of indicators seems a reasonable one – and similar in practice to the selections made in other countries. We have some modest suggestions for improvement, but no fundamental disagreements. Similarly, we believe that existing measures of skill shortages are likely to be helpful to the UK Commission in the work that it does.

There is, however, a case for researching the derivation of a possible new measure of skill shortages, based on data from web-based employment sites. Such online sources are rich in digital information, making collection cheap and potentially continuous. We recommend research into the possibilities of such an approach, including whether or not their coverage would add to the information base currently available and the ability to identify skill shortage vacancies specifically through this information source.

Tracking skill needs: occupational projections

Another possibility is to consider the use of information on skill needs. The occupational profile of employment gives a measure of such needs – the pattern is admittedly distorted by supply-side factors, but that is something that can be allowed for.

Particularly interesting is perhaps the use of occupational projections to generate estimates of future skill needs. Such a methodology would mean that skill shortages could be taken as a measure of current labour market imbalances and occupational projections as early warning signs of future skill needs and hence, potentially, future imbalances. Congruence between the two indicators (shortages today that might grow larger in the future) for particular occupations might then be a powerful message.

One issue with the use of such projections is that skill needs within occupations may change with time. Another is that both skills and occupations will change as the economy evolves. Indeed the ability to model the drivers of skill needs (the environment, technology, trade, tastes and business models) is critical to success, but it is likely that both parameters and underlying structural forms will shift and that past structural relationships will not hold in the future.

The issue of strategic skills

Indeed, those who advocate identifying 'strategic skills' are seeking for this to be just the case – that is to say, for consideration of labour market interventions to be influenced by what labour 'ought' to be needed, as much as by what probably will be needed. This, by definition, cannot be done purely on the basis of identifying the functional forms and parameter values of past economic relationships.

Economic research is, however, proceeding on what are likely to be the key drivers of skill needs, even if not normally for the purpose of making such predictions. Strengthening the links between research in such areas and skills modelling could generate powerful benefits to the Commission, MAC and others.[1]

[1] See for example UKCES (2010).

1 The issues

Chapter summary

- Skill shortages are usually regarded as being economically damaging, while meeting employers' skill needs is thought to be essential for economic success.
- The UK Commission has an over-arching interest in equipping the UK with the skills it needs today and in the future.
- In a more particular way, the MAC is charged with advising on whether migration of qualified and experienced people from outside the EEA should be permitted, to address shortages of skilled labour in particular occupations that the MAC identifies.
- This paper asks whether we have a clear and unambiguous understanding of what the terms 'skill shortage' and 'skill needs' mean and how they are generated, and whether we have measures of skill shortages and skill needs that correspond to those concepts.
- We ask whether a strong theoretical grounding matters for the choice of measures that are used, and whether there are useful changes to be made in the ways in which the MAC, UKCES and others think about and identify skill shortages and skill needs.

Researchers and policy makers, in the UK and elsewhere, recognise the existence of skill shortages, and the problems that such shortages may create for employers and for the wider economy.[2] These problems include both likely short-run impacts on output and productivity and longer run impacts on competitiveness and the ability of businesses to innovate. They could also manifest themselves in other forms of welfare loss, such as a deterioration in the natural environment if there is a shortage of people with land management skills, or a reduced quality of life for vulnerable people if there is a shortage of care skills.

A number of measures of skill shortages are used to inform judgements on these matters. When such measures are discussed more widely there is often an underlying assumption that the concept of 'skill shortage' is self-evident and that the choice of indicator is a straight-forward matter. In this paper we seek to discover whether or not that is true, and whether there might be improvements to be made in the way in which skill shortages are conceptualised and measured.

[2] See for example UKCES (2009a).

We also discuss a related but different concept, which is 'skill needs'. Knowing what skills are needed by employers would seem to be a necessary precondition for avoiding skill shortages. So one possible explanation of the existence of skill shortages is that they are a consequence of poor understanding of skill needs. Alternatively, skill needs may be self-evident, implying that skill shortages must either be a reflection of a supply-side failure, or that they reflect difficulties in matching supply to demand (or of course some combination of these explanations).

Another possibility is that both 'skill shortages' and 'skill needs' are conceptually problematic, but that the measurement of skill needs is in some ways more straightforward than the measurement of skill shortages, perhaps because it can be picked up directly by the occupational structure of the employed workforce, on which we have information. If so, this might have implications both for future research agendas and for policy choices, including perhaps paying more attention to skill needs to guide decisions, probably alongside a continuing focus on skill shortages.

A particular area where these issues arise is the making of decisions about who should be permitted to migrate into the UK in search of work. The MAC is the body charged with providing recommendations to government on whether migration from outside the EEA of suitably qualified and experienced people should be permitted, with the intention of reducing shortages in specific skilled occupations. The MAC uses a set of indicators to inform its advice, and there is an important question as to how well-grounded in terms of economic and statistical theory that choice of indicators is.

More generally, there are five key questions to address:

1. Do we have a clear and unambiguous understanding of what the terms 'skill shortage' and 'skill needs' mean?

2. Do we have a similarly clear understanding of how skill shortages and skill needs are generated?

3. Do we have ways of measuring shortages and needs that correspond closely to those concepts?

4. If the correspondence is not close, does that matter?

5. Are there useful changes to be made in the ways in which we think about these issues, and by implication in the ways in which skill shortages and skill needs are addressed?

2 Skill shortages and skill needs: the concepts

Chapter summary

- Surprisingly perhaps, much of the mainstream economic theory is not particularly focused on the subject of skills, which does not appear as a topic in most micro- or macro-economic textbooks, and is mostly confined to more specialist publications.
- Applied economists tend to use a pragmatic approach to understanding 'skill' as the ability to perform specified tasks. The usual practice is to classify skills in two dimensions, according to what the particular tasks are and according to what level of ability is needed.
- This implies that a job can be described in these terms, and that so too can a person. Jobs are then classified into occupations on that basis.
- Skill needs are defined in terms of the jobs that employers require done, and skill shortages refer to shortages of relevant suitably skilled people available in the labour market, relative to the jobs that employers are offering.
- Key issues in understanding skill shortages are concerned with their geographical extent, their likely duration, the ways in which different skill needs and other attributes are combined, and their economic impact or importance.

Given the ubiquity of the term in popular discussion, it may be surprising how little attention economic theory pays to the notion of 'skill'. It is not a term to be found in the indexes of many mainstream macro- or micro-economic textbooks.[3] The concept that economic theorists who seek to simplify the issue tend to use for much of their work is 'labour', typically taken to be homogenous across all participants in the labour market. Thus in simple models economists will talk of labour and capital being the two factors of production that are used to generate output for the purposes of profit maximisation by the firm, with the implication that labour demand is derived from the demand for goods, subject to a given set of technologies. Similarly the supply of labour is understood to be determined by individuals (or households) trading off income against leisure via a concave utility function, and hence supplying the amount of labour that maximises their personal welfare. The 'labour market' is the interaction of these two functions.

Even when in other respects economists' theoretical models become very complex, they are often constructed in terms of labour as a homogenous variable, with little or no differentiation between types of labour and with the concept of 'skill' playing no explicit role in the modelling.

[3] See for example Carlin and Soskice (2005). Of course the concept does feature much more explicitly in specialist labour market textbooks such as Bosworth *et al.* (1996).

The unintended consequence of keeping the models to this level of simplicity is, therefore, that theoretical economists have not shed a huge amount of light on what the term 'skill' might mean. That in turn means that the associated notions of 'skill shortage' and 'skill needs' are also not very deeply rooted in pure abstract economic theory.

An exception to this disregard by mainstream theoretical economics of the notion of skill is the approach used in some models of splitting labour into two types: skilled and unskilled. Different combinations of demand for and supply of skilled and unskilled labour are then shown to have different – and potentially very important – macroeconomic implications. Even so, the meaning of 'skilled' versus 'unskilled' is generally taken to be pretty self-evident in such models. We return to this important exception later in this paper.

In the more specialist field of labour market economics the situation is, not surprisingly, different. Labour market researchers typically understand 'skill' to refer to the ability to perform certain specified tasks. Thus the definition used by the International Labour Organization is 'the ability to carry out the tasks and duties of a particular job'[4]. In addition, the usual practice is to classify skills in two dimensions, according to what the particular tasks are and according to what level of ability or training is needed. Elias (1997) is an example of this usage. This in turn generates the notion that a job can be described in these terms, and that so too can a person be defined in such terms.[5] Jobs are then classified into occupations on that basis. Skill needs can be defined in terms of the jobs that employers require done, and skill shortages refer to shortages of relevant suitably skilled people available in the labour market, relative to the jobs that employers are offering.

An important distinction that is normally drawn is between a skill shortage, which relates to a deficiency in the external labour market, and a skill gap which relates to a deficiency in the skills of existing employees. Our concern here is primarily with the former, although there are obviously links between the two, some of which we explore where they are relevant.

It is probably reasonable to assume as a first generalisation that employers generally seek to meet all of their labour needs first from their existing workforces, and after that from external recruitment, either because they simply need to increase the quantity of labour that they are using, or because their employees lack skills that are needed. Skills gaps may therefore sometimes be the drivers of skill shortages, if it transpires that the necessary skills are hard to find in the external labour force.

4 International Labour Organisation (1990).

5 The Migration Advisory Committee particularly use qualifications and earnings to identify skill levels, alongside the Standard Occupational classification into which a job falls; they may also make qualitative judgements with regard to the on the job training or experience needed to do a job and 'innate' ability. Migration Advisory Committee (2008b).

There are other important features of the concepts of shortage and need that require attention. Ideally in both cases one would always define them in terms, not just of specific occupation but also in terms of geography and time.

That is to say a shortage of, for example, theatre nurses in the south west of England could be combined with a surplus in the north east of England and would be invisible at the national level; and a shortage of theatre nurses in one year might be resolved in a subsequent year by newly trained individuals becoming available. The choice of geography and time period therefore has a big impact on whether or not shortages are identified and what explanations are offered for their existence – and much the same is true for skill needs.

A second feature is that the demand in the market is always for combinations of skills, and probably for skills combined with other personal attributes. This also makes the measurement and in particular the aggregation of skill shortages inherently difficult. So identifying skill needs in terms of occupations is in that sense essentially an approximation, and hence one which needs to be defended in terms of how the labour market actually works. This is also a topic to which we return.

A third issue is that different skill shortages may have different degrees of significance. This might be understood in terms of the value that is placed on the output or activity that is lost as a result of the shortage. So a shortage of social workers or teachers might be seen as more or less damaging in terms of overall social welfare than a shortage of journalists or musicians, depending on the respective values placed on them by society. Alternatively, the significance of the shortage could be understood in terms of the ability to substitute individuals with other skills in place of the ones that are in short supply. The latter is most likely to be difficult when the individuals concerned require licenses to practice, and when it takes them several years to train. Such considerations do not make it impossible to identify or measure shortages, but they probably imply that simple aggregations (for example, across occupations) can sometimes be misleading.

3 Explaining skill shortages: theoretical approaches

Chapter summary

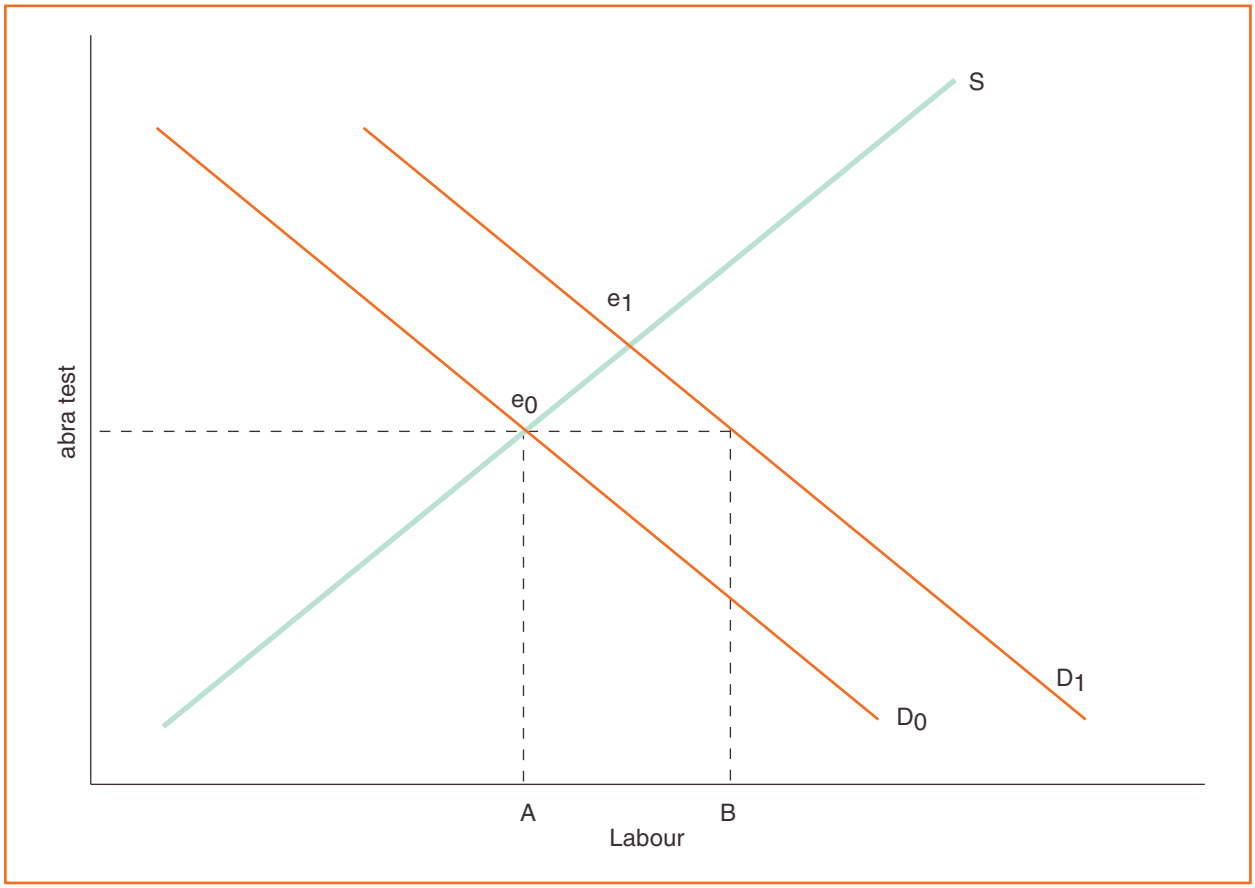
- Skill shortages can be represented by a simple Marshallian supply and demand diagram, but for a richer understanding economists have developed the idea of the Matching Function. This seeks to identify factors influencing how well the market matches individuals to jobs.
- Inefficient matching (and hence skill shortages) may reflect a range of factors including limited and asymmetric information and the heterogeneity of both individuals and jobs. If either or both parties are too specific in their requirements there is likely to be inefficiency in matching – although insufficiently careful matching also has welfare costs.
- A skill shortage within an occupation is always dependent upon the scope for substitution across occupations – and also substitution between different qualification levels.
- When applicant numbers swamp the jobs available, the efficiency of the labour market suffers and skill shortages can thus coexist with high unemployment levels. This can be particularly problematic when employers are geographically clustered.
- The willingness of individuals and employers to be flexible post-hiring makes the hiring decision easier and helps to dampen skill shortages.
- Employers' decisions about skill needs reflect internal bargaining. Because of principal-agent problems the signals may not be reliable. This may cause exaggerated claims of skill shortages.
- Equally, if employers are pessimistic about the skills available in the labour market and so do not attempt to recruit at the requisite level, that may cause skill shortages to be under-reported.
- The actual level of skill shortages in the economy will depend both on the institutional or micro-economic factors picked up by the Matching Function and by aggregate demand conditions, driven by macro-economic factors such as inflation and the policy of the central bank.

Microeconomic analysis 1: supply and demand

Our second question, as set out in the Introduction, is whether or not we can identify what the causes of skill shortages are and what the generators of skill needs are.

As we noted in the previous section, the core or central models of economic theory tend not to use such concepts: instead they are constructed in terms of 'labour'. The paradigmatic model here is the standard Marshallian supply and demand diagram, with an upward sloping supply curve for labour and a downward sloping demand curve.

Figure 3.1: Labour supply and demand



This model, though simple, has strong heuristic power. For example, from an initial point of equilibrium (point e in the diagram) it is assumed that the demand for labour shifts to the right (perhaps demand for goods and services in the economy suddenly expands, generating more demand for labour). The conventional expectation is that in a freely functioning market this ought to cause wages to rise to draw more labour into the jobs market, thus re-establishing equilibrium at higher levels of both employment and wages (point e1 in the diagram). But if for some reason wages do not adjust, then there will be excess demand for labour at the prevailing wage (B-A).

For this to be a model of the supply of and demand for skills, we need to understand the supply curve in the diagram to represent the number of skilled people offering themselves for work, and the demand curve to be the number of skilled jobs offered for people to do. B-A is then a measure of vacancies, a proportion of which will be due to skill shortages, understood in terms of an excess of job opportunities over suitable individuals available, or to put the same point in a different way, a shortage of suitably skilled individuals available to undertake the jobs being offered.

Of course the statement made above would not really make sense if the excess of demand over supply lasted only momentarily. That is to say, implicit in the notion of a skill shortage is a sense of a recruitment difficulty that persists through time. Empirical researchers typically seek to capture this by considering only those vacancies that employers identify as 'hard-to-fill' – and perhaps more specifically those that are not just hard-to-fill but that employers attribute to shortages of suitably skilled candidates. And a related distinction is sometimes drawn between 'frictional' vacancies and those that are either cyclical or structural – replicating the commonly used typology for discussing unemployment.

Our question is whether the explanation for skill shortages that the model provides is a compelling one. While the Marshallian diagram is one of the oldest and most powerful modelling devices used by economists, many researchers are sceptical whether the diagram offers a particularly useful portrayal of the labour market. The most common criticism is that the model puts all the explanation for skill shortages onto the assumed stickiness of wages, without explaining why wages might be sticky. When employers can afford to pay higher wages (which is implicit in the shift of the demand curve) and when individuals prefer higher wages (implicit in the slope of the supply curve) it is not obvious why wages should not adjust in a mutually beneficial way. Is it because employers and individuals are prevented from adjusting wages, or is it because they have reasons to believe that wage adjustments will not work and so are not worth trying? Possible arguments can be advanced for either explanation, and we address them in later parts of this paper, but such arguments are not captured by the Marshallian diagram itself.[6]

Strictly speaking the stickiness of wages is not the only feature of the model which generates skill shortages. If the labour supply curve were to shift to the right, then that would clear the market and the skill shortages would disappear. This might involve for example former skilled workers re-entering the labour market, or migration into the labour market from external areas (recall here the remark in the previous section about how any analysis is always specific to a

[6] Empirical evidence on wage stickiness is inconclusive. For example, Haskel and Martin (1993) find that at the company level offering higher wages does not reduce skill shortages. They do, however, find that high wage industries or regions have fewer skill shortages than low wage ones, because more highly skilled people seek to work in the region or industry. This draws attention to the possibility that at the heart of the issue is a micro/macro distinction. And yet the same researchers, in Haskel and Martin (1996), contrarily find that at the establishment level high relative wages are correlated with low skill shortages. This second result would seem to imply that the problem is not so much that wage adjustments do not work, as that wage adjustments are in some cases unavailable (or undesirable for some other reason).

particular geographical area). Or individuals might train to acquire the skills to offer themselves to fill surplus jobs – which would take time, implying a period of skill shortage followed by the market clearing (again this issue of time-specificity has been foreshadowed above).

So why does the model not predict such supply responses? The reason is that in this simple model, the response that we expect individuals to make is to shift along the supply curve, not to shift the location of the curve: nothing has happened to change their welfare-maximisation trade off, since wages have not adjusted. So the stickiness of the supply curve is also a feature of the model, though in a different way to the stickiness of wages.

There is another feature of the Marshallian diagram that is significant. If the diagram is taken to be a summary of the entire labour market, then it does not lend itself to explaining a commonly observed empirical phenomenon, which is the coexistence at the macroeconomic level of (involuntary) unemployment and skill shortages at the same time. Within the constraints of the simple model, such a coincidence seems to imply that wages are simultaneously both too low and too high, which makes no sense.[7]

The problem does not apply if we assume that the diagram relates only to part of the labour market. As discussed in the previous section, there might for example be two types of labour, skilled and unskilled, and hence two parallel labour markets each with its own Marshallian diagram. The coexistence of shortages and unemployment at the macro level can then be explained on the basis that in the market for skilled labour, wages are set too low and skill shortages prevail, while simultaneously in the market for unskilled labour wages are too high, and unemployment prevails (or vice versa). There might for example be a shortage of teachers because individuals with the relevant skills can get better financial rewards elsewhere, but a surplus of people with elementary IT support skills because those jobs have been outsourced to employers overseas where wages are significantly lower than those prevailing in the UK.

Occupations have different skill needs and therefore a more developed version of this approach would be to relate the Marshallian diagram only to a single occupation, or even to an occupation specified geographically and by industry. This is equivalent to saying that there are many labour markets that not only experience diametrically opposed pressures, but also experience little or no arbitrage between them. Yet the exploitation of arbitrage opportunities is a basic mechanism through which economists expect a market economy to work, flowing directly from behavioural axioms. The absence of arbitrage (the inability of individuals to switch occupations and perhaps to be flexible in other regards) is therefore fundamental to the explanation of the existence of skill shortages alongside unemployment, but itself receives no explanation.

[7] An alternative proposition is that the supply and demand diagram relates to an underlying unobserved structural relationship in the economy, while vacancies (and unemployment) are temporary frictional phenomena observed in the real world. This again leaves the observed phenomenon unexplained by the theory.

Microeconomic analysis 2: the matching function

Sticky wages, a labour supply schedule that does not adjust to labour shortages and lack of arbitrage between sub-sets of the overall labour markets are therefore all features associated with the Marshallian diagram's explanation of skill shortages, but on which the diagram itself does not shed much light. Economists have therefore sought to gain further understanding into all of these.

An early explanation for sticky wages was provided by Arrow and Capron (1959). Their suggestion was that wage stickiness exists essentially as a temporary phenomenon, explained by such factors as the time that it takes employers to recognise that they have a recruitment problem, and the time that it takes them to adjust wages once they are aware of the problem. However, Arrow and Capron also suggest that the labour demand curve is almost perpetually shifting outwards (assuming growth), thus creating in their terminology 'dynamic shortages'. The result is that the skill shortages appear to be persistent rather than temporary, and wages always appear to be behind where they ought to be. There is an acceptance in their model that the extent of shortages will fluctuate according to the ups and downs of the economic cycle, but the fluctuations will occur around an underlying or longer run trend of economic growth.

The Arrow and Capron model was developed specifically to explain persistent shortages of engineer-scientists in the US, and makes continuing growth in demand the overall driver of shortages, implying that in the absence of growth there will be no shortages.[8] But if growth is persistent and hence predictable, it is unclear why those responsible for training (in this case) scientist-engineers lack the foresight to plan ahead for future needs. The model therefore seems to be inconsistent with the modern practice of modelling expectations as endogenous or 'rational'.

An analytical framework that is intended to encompass the Marshallian diagram and also the Arrow-Capron argument within a wider-ranging and more flexible way of thinking about skill shortages is provided by the notion of a matching function, in which individuals offer themselves for work, employers offer jobs for people to do, and the market then matches the individuals to jobs with more or less efficiency.

An influential modern formulation of the notion of the Matching Function is provided in Pissarides (2000) – see Box 1. The simplest version of the Pissarides model assumes that there is no on-the-job search by workers already in employment, and that the supply of unemployed workers is neither swollen nor shrunk by potential workers being drawn into, or

[8] That is to say the demand for labour curve continually shifts out. Clearly there could be other examples of it shifting inwards, for example where types of jobs are being lost due to factors such as new technology, or tastes. We refer to this in Chapter 4.

withdrawing from, the labour market (including by migration). These are simplifications rather than necessary features of the model (and Pissarides develops the complexity of the model in a number of important respects, as have other authors). Unemployment therefore occurs because existing jobs disappear, and vacancies occur because new production opportunities emerge (via technological innovation, essentially).

Box 1: The Matching Function (Pissarides 2000)

Pissarides writes the matching function as

$$mL = m(uL, vL) \quad (1)$$

where L is the size of the labour force, u is the unemployment rate and v is the number of vacancies, and m indicates the number of job matches occurring per unit of time. The equation is assumed to be increasing in both arguments, concave and homogenous of degree 1.

The last of these implies that there are constant returns to scale i.e. that matching does not become more or less efficient as the overall size of the labour market grows, and so the rate of matching is a function of the tightness of the labour market, i.e. v/u, but not of the absolute sizes of v and u. Pissarides then re-specifies the model in terms of tightness, denoted by θ rather than in terms of the vacancy rate v. The speed at which vacant jobs are filled is given by

$$q(\theta) = m(u/v, 1) \quad (2)$$

Unemployed workers find jobs according to a stochastic process in which jobs and workers are matched sequentially but the order in which the matching occurs is random. (We return to this assumption below.) The stochastic process is given by m(uL, vL)/uL which can be written as $(\theta)q(\theta)$.

During a short interval of time, δt, there is a positive probability that a hiring firm will not find a worker and a positive probability that an unemployed worker will not find a job. These can be represented as $1- q(\theta)\delta t$ and $1-\theta q(\theta)\delta t$ respectively. As the ratio of hiring firms to searching workers increases, the probability of rationing increases for firms and declines for workers. The rationing can be thought of as congestion – firms increasingly get in one another's way in the search for workers, while workers experience less competition from other workers in the search for jobs.

As noted above, workers become unemployed because jobs are destroyed – perhaps by changing tastes, perhaps by changing technologies. The rate at which this occurs is given by λ and it is assumed that the incidence of job losses is randomly distributed (again, we return to this below). So for any given work at any time the probability of job loss is $\lambda\delta t$. Since in this simple version of the model it is assumed that outsiders never enter the labour market, the number of workers becoming unemployed at any given time is $(1-u)\lambda L\delta t$.

By a similar argument, workers leave unemployment because they fill job vacancies. This is given by $mL\theta t$, which Pissarides rewrites as $u\theta q(\theta)\lambda L\delta t$. The change in unemployment is then given by the volume of people flowing into unemployment minus the volume flowing out of unemployment

$$\Delta u = (1-u)\lambda L\delta t - u\theta q(\theta)L\delta t \qquad (3)$$

For a given level of unemployment $\Delta u = 0$ and hence

$$(1-u)\lambda L\delta t = u\theta q(\theta)L\delta t \qquad (4)$$

Which in the model is rewritten as

$$u = \lambda/(\lambda+\theta q(\theta)) \qquad (5)$$

Which specifies the level of unemployment u in terms of λ (the rate of job destruction) and θ (the degree of labour market tightness). When plotted back into unemployment/vacancies space this function is downwards sloping and convex to the origin – that is to say that unemployment and vacancies can co-exist, but there is nevertheless a non-linear inverse relation between them.

In this account there is no micro-based a priori expectation that the market will clear instantly, and so both skill shortages and involuntary unemployment are plausible outcomes – including simultaneously. The economist's task is to explain such phenomena by understanding how the matching function works, and why the function has the degree of efficiency or inefficiency that it does have.

The concept of a matching function originates in the economic search theory that was developed in the 1960s and 1970s, notably by Phelps (1968), but also by Alchian (1969) and Mortensen (1970). The central notion is to think of search for work, or searching for workers, as distinct economic activities in their own rights, which will therefore need to take place in real time and which will involve costs and returns to be traded off against one another.

The matching function tells us that the extent of skill shortages will be a function of tightness in the labour market. It does not normally tell us what that function is – so skill shortages will be higher when the market is tighter, but to an extent that depends on factors that are not themselves formally modelled. Pissarides, who has developed influential versions of this model (a very basic example is set out in Box 1) justifies this in the following way:

> *'Of course if an empirically successful microfoundation for the matching function were known, that would make it more convincing, but it is not uncommon to find aggregate functions in the macroeconomist's tool kit without explicit microfoundations. Empirical success and modelling effectiveness are usually sufficient.'*
>
> (Pissarides (2000) p4)

There is therefore a list of possible reasons that may explain the efficiency of the matching function, and the issue of which items on the list are most important in providing the explanation (and by how much) is to be decided empirically rather than via micro-economic priors.

Indeed the model as described above explicitly refuses to offer any scope for explaining the efficiency of the matching function, since it assumes that jobs and individuals are matched by stochastic processes. The mechanism is an example of the so-called urn-ball game. The proposition is that the labour market operates as if workers take it in turn to remove balls from urns, with some of the balls being labelled 'job' and some labelled 'no-job'. The overall efficiency is determined by the ratio of job/no job balls, and the effectiveness with which players remove balls from urns, but how long it takes any particular individual to get a job is random. (An equivalent process operates on the employers' side.)

Factors affecting the efficiency of the matching function

It is worth noting that in the context of the matching function the definition of 'efficiency' is itself not a simple matter. If all jobs and all individuals are identical then efficiency is reflected primarily in the speed at which jobs and individuals are matched, which at any point in time will reveal itself through the extent of skill shortages and also the extent of unemployment (for a given level of aggregate demand in the economy). But efficiency is also determined by the costs incurred by individuals engaged in the matching process (for example the cost of advertising vacancies, or the opportunity cost for individuals).

Furthermore, it is an advantage of the matching function approach that it does not presume or require homogeneity. Once jobs and individuals are heterogeneous there is a risk that the wrong people get placed into the wrong jobs, and so the accuracy of the matching function should also be taken into consideration when considering its efficiency. We return to this point later in this paper.

Various attempts have been made to provide micro-foundations for the matching function, or at any rate to link the function informally to key microeconomic labour market concepts that can explain the degree of efficiency or inefficiency that the matching function displays.

One strand, present in the early literature mentioned above, contends that workers have a 'reservation wage', i.e. that the labour market does not clear because workers reject low-wage jobs in the hope that higher wage-jobs will come along. That behaviour may be predicated on for example the belief that it will be difficult to leave jobs once they have been accepted, or even on the belief that refusing low-wage jobs will itself cause higher wage opportunities to come along (most obviously by forcing employers to raise wage offers). The prevalence of such behaviour is likely to be influenced by the generosity of welfare benefits and income support available to the unemployed, and also perhaps the stigma of unemployment, among other factors.

Another possible micro-economic explanation for inefficiency in the matching function places the emphasis on employers rather than individuals. One proposition is that employers, rather than setting wage offers by reference to external market conditions, will often ignore such information and act as monopolistic price-setters. This could be because raising wage-offers to external candidates would either damage the motivation of existing staff on lower pay, or would result in those staff having to be paid more, thus undermining the employer's overall economic performance. This is equivalent to saying that the demand for labour curve may not be downward sloping but may instead be horizontal, implying no unique level of employment for a given wage, and hence multiple equilibria including ones involving skill shortages.

Indeed there is no fundamental theoretical consensus for accepting any particular explanation of the efficiency of the matching curve while simultaneously rejecting other explanations. Instead, several alternative typologies of explanations exist. For example, Boswell, Stiller and Straubhaar (2004) suggest that explanations for skill shortages fall into four categories: qualitative mismatches, regional mismatches, preference mismatches and mismatches due to information deficits. In contrast, Cohen and Zaidi (2002) offer a taxonomy comprising *efficiency wage theories, insider-outsider theories, barriers to mobility and path dependency*. Pissarides (2000) has a three-fold classification based on the widely-applied microeconomic concepts of *heterogeneity* and *imperfect information*, plus *other frictions*. A detailed discussion of the last of these appears in Petrongolo and Pissarides (2001).

These taxonomic differences reflect not so much fundamental disagreements as the absence of fundamentals: that is to say, an absence of a widely accepted formulation for rigorously deriving the matching function in a precisely specified way from any limited set of unambiguously defined micro-economic foundations.

We are therefore left with a menu of potential candidates, rather than a blue-print that can be universally applied. The list below summarises the most widely cited candidates for explaining the (in)efficiency of the matching function.

Wages: The economist's default suspicion, as reflected in Figure 3.1, is that shortages may simply reflect reluctance on the part of employers to pay the market wage. But some employers may, contrarily, deliberately pay more than the market rate – or more correctly, introduce higher wages so that there is no single market rate – in order to encourage higher loyalty and productivity and attract the best candidates.[9] Other employers may not be able to match these so-called 'efficiency wages', because, for example, they have less power over price-setting in the market for their products, or because they are anxious to avoid consequent upward pressure on the wages of all their existing employees. Those employers may then face shortages in the labour market.[10] Other problems may arise because employers do not reveal the wage offer when they advertise, creating a bargaining situation that slows the closure of a deal once they have chosen their preferred candidates. This is a straight informational imperfection.[11] Or some employers may indeed reveal their offers, causing individuals to have unrealistic expectations about what they personally can expect to receive from those or other employers, given the relative marginal productivity of their own labour. This is a mixture of an informational and a heterogeneity problem (i.e. job applicants do not have good information on the heterogeneity of the pool of applicants – and in particular, how much better some applicants are, relative to themselves).

State benefits: A very generous unemployment benefits system, or a system that is not particularly geared towards assisting the unemployed with their job search, or just not very well designed, may encourage or force individuals to take a lot of time with their job search. The consequence would be likely to be that jobs would tend to remain unfilled for long periods of time, even in the presence of unemployed people with the skills needed to do the jobs.

Differences between individuals and jobs: The efficiency of the matching function will depend partly on the efforts and resources that individuals and employers devote to finding good matches, but it will also depend on the scale of the task: i.e. just how heterogeneous both jobs and individuals are and hence how difficult it is to find easy matches.

[9] The assumption is that the employer is a price-giver. In models such as Pissarides (2000) this assumption is not present – adjustment occurs through volumes.
[10] See Akerlof and Yellen (1986).
[11] Burdett and Mortensen (1998) is an example of a model that investigates this possibility.

Employers may sometimes need very narrowly defined skills – for example, not just chemistry but catalytic chemistry, not just the ability to use accountancy software but the ability to use a specific package. Such skill shortages, almost by definition, are unlikely to be widespread but there may be many of them and their significance may be disproportionately high. Stevens (2007) is a model built on the heterogeneity of both jobs and individuals, in which both parties consider a number of possible matches before selecting a 'best fit' – subject to the need to trade off search costs against the importance of a good fit.

Education and training: Following on from the previous point: all else being equal, a highly educated workforce and a high volume of training provision should result in individuals being closely matched to jobs, and hence vacancies remaining open only for short periods of time.[12] Perhaps even more important than the volume of training is its relevance. The speed at which training supply can alter may lag the speed at which training needs change, and this may be a factor pushing up skill shortages.

Regulation: An extension of insufficient training as a cause of shortages is labour market regulation. If legislation dictates that people must pass certain hurdles before filling particular jobs, such as earning a legal qualification, or a gas-fitter qualification, then that may generate shortages, especially in the short term.

Information shortages: Precisely because the labour market is so large, and hiring/employment decisions are so multi-faceted, it can be difficult for both employers and individuals to get sufficient information to know what choices are available and to make sensible decisions about those choices that are known about. The majority of vacancies are not advertised by Jobcentres; private advertisements are only seen by a part of the potential market; and many jobs are not advertised. Both individuals and employers may be unrealistic about the scale of resources they need to devote to searching, given these informational failings. Many opportunities may be missed, and choices deferred by risk-averse individuals or employers who feel they have insufficient information to make commitments that are hard to unwind. The importance of these factors was set out as a key theoretical characteristic of the labour market in Spence (1973). The problems perhaps apply particularly to higher skilled labour, which may be why skilled labour shortages appear to greatly outnumber unskilled shortages. A corollary of such problems is that employers, feeling themselves unable to judge the skills of candidates, may instead recruit only candidates with particular backgrounds – social, educational or employment, thus severely restricting the available pool. Individuals may similarly confine their search to a limited number of very well known employers, or those located in key locations.[13]

[12] Strictly speaking if a high level of education or training means a lot of people withdraw from the labour market, then in the short term there could be more skill shortages not fewer, simply because there are fewer candidates available. Haskel and Martin (1993) find low educational attainment in a region to be associated with high skill shortages in that region but Haskel and Martin (1996) find no evidence either way for an impact from training within a business to hard-to-fill vacancies.

[13] Strategies for limiting search in this way may be rational. A company with a brand name to protect may be a better employer as a result. The individual uses that factor to reduce their own risks.

Numbers of individuals seeking work: All else being equal, the greater the ratio of people seeking work to jobs being offered, the fewer skill shortage vacancies there are likely to be. In the simple Pissarides model described earlier the only job seekers are those who have been made unemployed, so the pool is limited. In reality, and in more complex versions of the model, people are attracted into the labour market, partly by the number of opportunities available, and many of those searching for new opportunities will already be in work, swelling the numbers considerably. The sheer numbers of candidates may be a problem: effectively, each applicant has a tendency to crowd our other applicants, and employers may be flooded with so many applications that assessing candidates becomes very time-consuming, which slows down the process of filling vacancies. Stevens (2007), mentioned above, incorporates this feature.

Differences in the desirability of certain employers: This is an extension of the previous point. Congestion in the employment market is likely to be particularly a problem when the attractiveness of employers varies. Employers that are top payers or that have very strong reputations or brand recognition may receive so many applications that they experience congestion, which slows down their recruitment, while the bottom payers do not receive enough applications to fill their posts, and that also slows down the matching process and hence generates shortages.[14] Clearly here there are issues of heterogeneity, and arguably of informational shortcomings (applicants have unrealistically high opinions about the likelihood that they will win work with a prestigious employer, and unrealistically low opinions about what the less prestigious employers have to offer).

Flexibility: Skill shortages may also reflect employers' inability or unwillingness to offer flexible working conditions, or individuals' unwillingness to be flexible themselves by, for example, working unsocial or unusual hours. In addition, employment contracts by their nature build inflexibility into the labour market in a way that is scarcely true of other markets. Employer compensation packages may increase the cost to an employee of quitting an existing job and hence reduce the number of candidates potentially available to fill opportunities at other employers. This is a form of 'efficiency wage' – so total remuneration packages are designed to reduce turnover.

[14] An alternative story can be told. High wage firms do not lose many employees to rivals and can recruit easily so have few skill shortages; low wage firms have high vacancies but low costs. Both may have made a rational decision.

Mobility: If individuals find it difficult to relocate for work, perhaps because of rigidities in the housing market, or find it difficult to commute to work because of for example poor public transport, then that may make it harder for employers to find the people they need.[15] Equally, if employers are unable or unwilling to relocate to where relevant skilled workers live, that may cause skill shortages to be higher than they might otherwise be. This is another example of heterogeneity as a problem: because individuals and jobs differ, and contrary to the basic Pissarides model described earlier, scale improves job matching, but scale is difficult to achieve where geographical mobility is low. A consequence is that this creates pressure for employers to cluster together geographically, so as to create a richer pool of both workers and employers. Furthermore, if individuals respond to the fact that the best employers in their industry or occupation are clustered together, they may conclude that their own status and so future earnings-potential will be enhanced by working for firms within the geographical cluster. As a result they may apply only for jobs within the cluster and eschew those elsewhere. The time taken for employers within the cluster to fill positions will then increase because of the congestion of applications, but employers will carry this cost because to locate elsewhere would be to risk not receiving the best applications. It should be clear that the greater the return on the skills involved, the more likely this is to occur – hence the extreme geographical clustering displayed by investment banking, for example. A model in which geographical clustering is driven by the need to improve labour market matching efficiency is provided in Amiti and Pissarides (2004), while Lagos (2000) is a model in which mismatches between the location choices of individuals and employers explain the degree of efficiency of the matching function. Green *et al.* (1991) have provided a taxonomy of local labour markets (high status growth areas, unemployment problem areas, etc) which are intended to reflect such patterns of geographical segmentation.

Some implications of the above account

The discussion in the previous section suggests several important observations:

A key issue is how closely jobs and individuals need to be matched – or to make this more specific, how important occupations and qualifications are. The issue of heterogeneity and how easy it is to substitute one type of person for another has already been identified as being of considerable importance. It is, for example, something that affects the kind of advice that the MAC might offer, because of the specific focus of the MAC on assessing skill shortages at the occupational level. It is possible, for example, that employers have an exaggerated belief that the only people who can fill a particular job are those who are already working in the same occupation, or indeed in the same industry, or who have certain narrowly defined qualifications. It is also possible that individuals are similarly too narrow in their thinking. If that is so, the implication is that the scale of skill shortages will in consequence be exaggerated.

[15] As evidence of this, Haskel and Martin (1993), comparing employers in different locations, find housing costs to be a predictor of skill shortages.

Possible implications might include a decision to allow increased inward migration of individuals with the specific occupational backgrounds and qualifications, when (perhaps with re-training) candidates from other occupational backgrounds would be just as suitable. The resultant migration/domestic unemployment balance might then be sub-optimal from the point of view of total domestic welfare.

Conversely, we have also already made the point that low levels of reported skill shortages could be a sign that the labour market is being insufficiently discriminatory in its matching behaviour. If either employers or individuals are insufficiently choosy in the matches that they agree to, then resources may be misallocated – individuals may accept jobs that do not make full use of their skills, while employers may accept candidates who do not really have the skills that they need. Encouraging cross-occupational flows could be damaging to overall economic productivity and welfare, if it generates a mismatch between skills needed and skills supplied.

Search costs, alongside the costs of being unemployed or in the wrong job, and the cost to employers of not addressing shortages, are likely to affect the efficiency of the matching function and hence the extent of skill shortages. In principle this may not be a serious problem if the costs of matching are low and if labour market participants can quickly identify and undo mismatches – i.e. there is a 'hire and fire' market. But if it takes time for a new job entrant to reach his or her full potential (through the post-recruitment acquisition of company specific skills and knowledge), or if there are large costs associated with job market churn, then such flexible arrangements could generate lower overall welfare than arrangements under which both individuals and employers were more cautious about their matching decisions.

The availability of information, both overall and with regard to what one party knows and the other does not, are also likely to affect how efficiently jobs and individuals are matched. This issue of the (lack of) substitutability of skilled labour across occupations has already been identified in the discussion of the Marshallian diagram. It is one that in reality recruiters face on a daily basis, where they have to make judgements about whether or not a candidate's experience is sufficiently close to make them a good fit for the job on offer. In trying to make that judgement, they inevitably have to rely on inadequate information. The question for organisations such as the MAC is whether they have the research information that allows them to accept or reject the evidence that is provided to them on skill shortages, bearing in mind that employers themselves do not have as much information as they would ideally wish on which to base their decisions.

Another key issue is the extent of geographical mobility, combined with location as a signalling mechanism for the quality of jobs and by implication the quality of individuals. The issue of geography is in some respects similar to the issue of occupational flexibility. If a skill shortage is the consequence of people's inability or unwillingness to move from one location to another

because of inflexibilities in for example the housing system, then the obvious implication would be that it was the housing market that was failing and not the labour market. This is similar to inflexibility in shifts across occupations, and there is a genuine question whether the optimal response is to free up the domestic housing market (in this example) or to free up inward migration from low wage economies (or indeed neither and to let the shortage persist).

The more challenging issue is where the signalling effect of location causes employers and candidates to geographically cluster their job offers and their job searches, generating self-reinforcing tendencies for some locations to experience increasing employment, rising wages but also (demand-driven) skill shortages, while others experience increasing unemployment, stagnant wages – but again also (lack-of-supply driven) skill shortages. In this case arbitrage has broken down. While it is not clear how widespread this phenomenon is in reality, it is clear that if it occurs, then simply allowing or encouraging a larger supply of labour will not necessarily address the problem.

Skill shortages or shortages of skilled labour?

There are at least two other and rather broader reasons why we should not be surprised if there are weaknesses or inefficiencies in the matching function.

The first is concerned with the distinction that can be drawn between skill shortages and shortages of skilled labour. We have so far treated these two as if they are effectively interchangeable, and in particular we have defined skill shortages as shortages of relevant suitably skilled people available in the labour market, relative to the jobs that employers are offering.

However, we have also made the point that jobs require and individuals offer not just single but multiple skills, and also other attributes alongside skills (such as punctuality, reliability or a strong work ethic). Since the combinations of skills and attributes that individuals might offer and employers might need are mathematically enormous, the chances of making a match would appear to be much lower than if there was only ever one skill involved in each matching decision.

It is true of course that the possession of more than one characteristic is not something unique to those who trade in the labour market: the same is true for most markets. One difference, however, is that in the labour market both parties have a substantial continuing interest in the outcome of the transaction, combined with very imperfect information about what the other party is offering. Job descriptions and candidate resumes are brief documents, and interviews are brief meetings: the amount of information that is exchanged and its reliability are imperfect, relative to the importance of the hiring decision.

So, if agents are risk averse because of the costs of undoing transactions, then it is reasonable to expect that the labour market will have more difficulty clearing than most markets, and especially with regard to those jobs and individuals where skill levels are highest. Even if they are not risk averse, and hiring decisions are made speedily, the risk is that employers will often feel that the candidates that they are choosing between lack skills, simply because they want each candidate to possess many skills.

However, there is also a reverse argument to be made. The existence of multiple skills associated with any job and any individual may imply that individuals, once recruited, are generally malleable, and that often jobs are too. In that sense a poor match can be unmade without cancelling the employment contract, by adjusting the individual to the job or vice versa (or both). Indeed employers will often recruit for precisely that quality of flexibility, and the same quality from employers will make individuals more willing to accept opportunities.

Principal-agent problems within employers

The issues of insufficient and asymmetric information have been discussed above in the context of the relationship between employers and potential recruits. But information problems also exist within the internal organisations of employers, and they may have an impact on the scale of shortages that exist – or that appear to exist.

Information flows within organisations are generally highly imperfect, and recruitment intentions arise out of bargaining processes between for example line managers and their seniors. Differential access to information and knowledge may play a major role in determining what messages get put into the marketplace. The organisation's main skill needs may as a result be misrepresented.

This is a classic example of a principal-agent problem. Our formal understanding of it was first developed by Milgrom and Roberts (1988). Within large firms, line managers typically express recruitment needs to senior managers, directly or via HR departments, and those recruitments that appear to offer the best return are approved. Implicitly, a large recruitment need reported to senior managers is a signal to them that those already employed in similar positions are particularly valuable – and a large unmet recruitment need is an even stronger signal to the same effect. It may therefore reflect bias and not be reliable (the 'principal-agent problem').

In circumstances where it is difficult for employers to directly identify the contributions of particular employees or groups of employees, there is an incentive for employees to inflate their recruitment needs and then under-recruit. The resultant skill shortage is a signalling mechanism to their employers, which may generate higher wages or more secure employment.

The underlying issue is that senior managers lack independent information, and more junior managers provide them with information that may seek to influence their decisions in a biased or self-interested manner. Watson, Webb and Johnson (2006) discuss this in detail.

The argument can also be run in the reverse direction. Where individual effort and individual output is hard to identify, employers may find it difficult to raise the productivity of employees. Agreeing delivery targets and associated recruitment for specific areas of business, and then under-recruiting, may then be a mechanism for raising the productivity of those business areas. In this example the skill shortage is an explicit but unacknowledged choice made by the employer. As a productivity-raising device this can be regarded as analogous to an efficiency wage, except that the cost is paid by the employee and not by the employer. Millward and Stephens (1986) argue that productivity is indeed partly negotiated between employers and individuals.

What these phenomena have in common is that reported skill shortages may be exaggerated, because employers have less information about employees' skills, efforts and output than the employees have about themselves.[16] This principal-agent problem is most likely to occur where the employees utilise knowledge in their jobs that is tacit rather than codified, and where they provide deliverables that are measured more by quality than quantity. Hence, it is more likely to occur in higher skilled professional and managerial work.

Macroeconomic causes of skill shortages

In the previous sections we have looked at explanations for skill shortages, first in terms of a simple description of market failure, and then in terms of a range of explanations for why matching jobs to individuals might be difficult. All of these can be regarded as essentially micro-economic in nature.

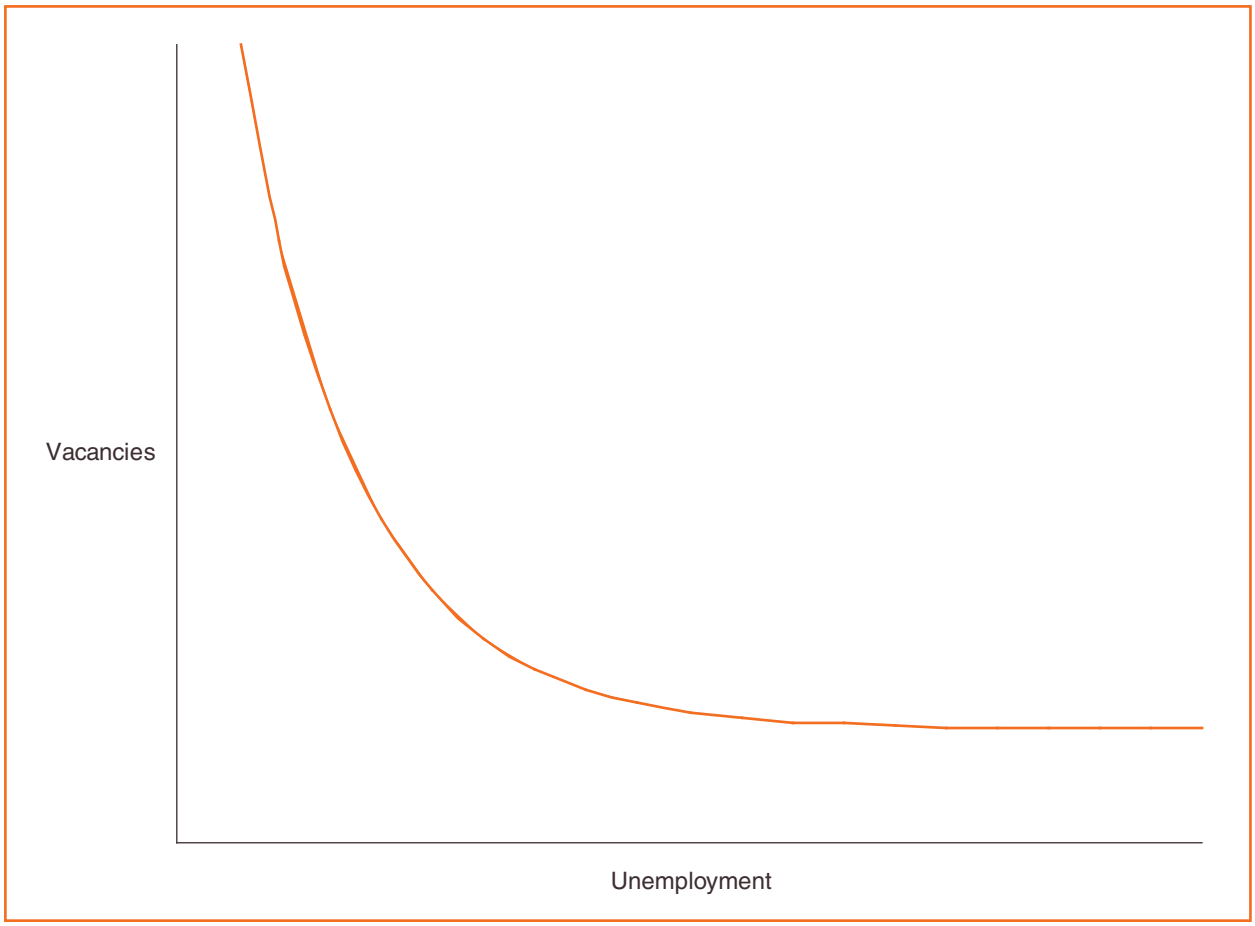
An alternative view would be that skill shortages are simply the consequence of the economy operating at a high level of aggregate demand. This is captured by the notion of the *Beveridge Curve*, which articulates the suggestion that an inverse relationship exists between skill shortages and unemployment, as depicted in Figure 3.2. The curve was first formulated by Beveridge (1944) and developed further by Dow and Dicks-Mireaux (1959) in the UK and Hansen (1970) in the USA.

[16] A contrary view is expressed by Wilson (1999).

In Hansen's model there is not so much a single inverse relationship as a range of markets each with a different vacancies/unemployment locus. Blanchard and Diamond (1989) derive the Beveridge Curve from the matching function and this is taken up in Pissarides (2000) while Bosworth *et al.* (1996) show a derivation of the Beveridge Curve essentially from the Marshallian diagram. In this latter approach skill shortages, measured by a sustained excess of jobs over applicants, are combined with frictional vacancies (which reflect the ordinary efficient functioning of the labour market) to derive an overall figure for unfilled opportunities.

The core proposition of the Beveridge Curve is that a tight labour market with few people out of work is likely to be associated with a lot of skill shortages, with employers unable to fill the opportunities that they are offering. Equally, when there are many people out of work, employers are likely to be able to fill most of their positions because there will be plentiful candidates, and so there will be few skill shortages. Figure 3.2 illustrates this.

Figure 3.2: Beveridge Curve



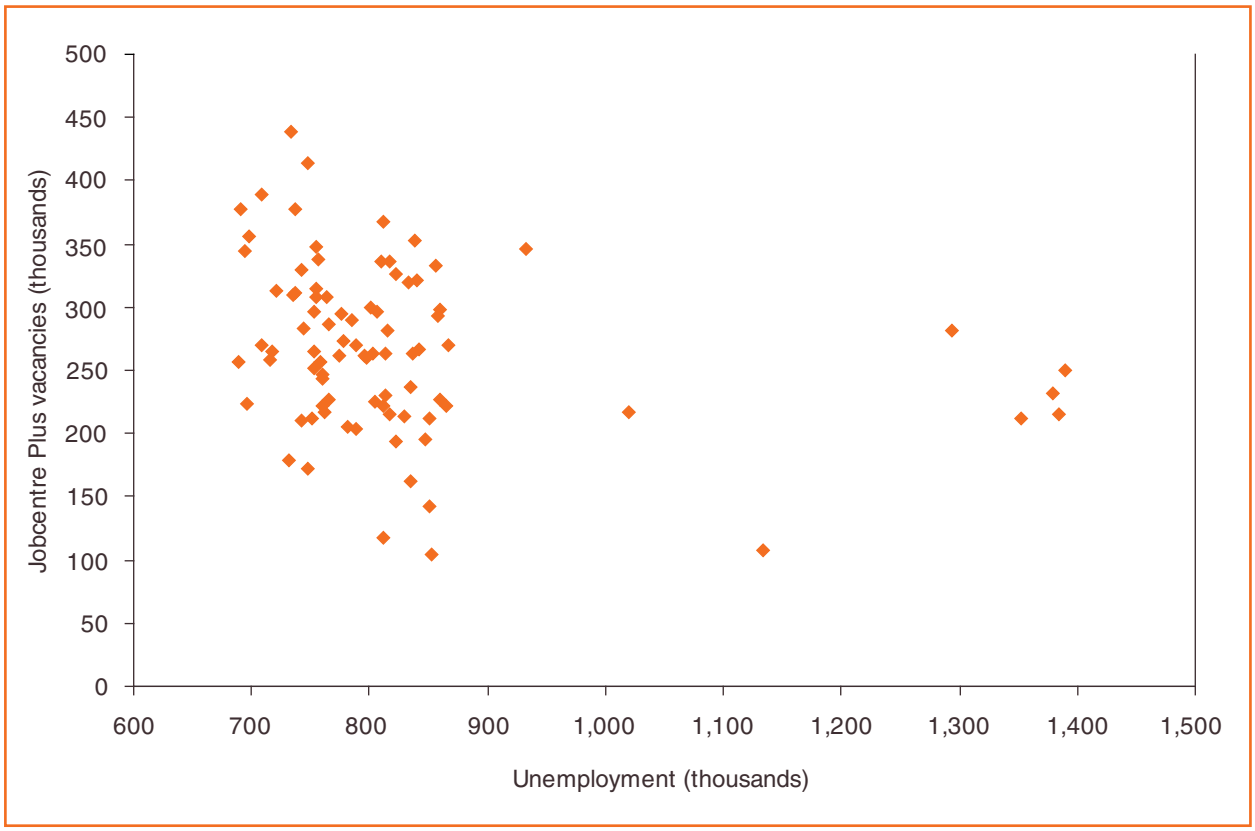
The diagram is drawn with the Beveridge Curve convex to the origin. At unusually low levels of unemployment a relatively large increase in vacancies is needed to generate even a small further decline in unemployment, whereas at very high levels of unemployment, a further large increase in unemployment will do very little to fill existing vacancies and hence reduce skill shortages.

One possible set of explanations for this pattern is that when unemployment is low, it is those with the lowest skills, or whose skills are least in demand, who are left looking for work. A lot of vacancies therefore need to be created if suitable opportunities are to be found for such people. Equally, when the economy is doing badly the only jobs that will be hard to fill will be very unusual ones, so that the number of people who need to be in a state of unemployment before suitable candidates can be found is likely to be large. In both circumstances, vacancies and skill shortages may 'feel' as if they are higher than they ought to be, compared with what happens when the economy is in less extreme states of the economic cycle.

The Beveridge Curve can be seen as the manifestation of a set of available matching functions, generating different combinations of vacancies and unemployment. If for some reason these matching functions become more efficient, the Beveridge Curve will shift downwards and to the left towards the origin, through v/u space (to use the terminology of the Pissarides model described earlier). For example, as discussed earlier, a reduction in benefits provided to those without work would be likely to speed up the job-search of such people and so make the matching function more efficient. Conversely, if the matching functions become less efficient, the Beveridge Curve will move away from the origin. This might occur if, for example, the housing market becomes less liquid (impeding migration), or if public transport becomes more expensive (impeding commuting).

So how realistic is this model of the labour market? Figure 3.3 shows evidence on the actual relationship between vacancies and unemployment in the UK over the past 10 years (the dots indicate measurements at different points in time). It is clear that it bears little relationship to the neat convex curve just described.

Figure 3.3: Claimant count (unemployment) and Jobcentre Plus (vacancies), England and Wales, May 2002-June 2009



This apparent lack of success for the Beveridge Curve might just reflect data weaknesses. In the diagram, vacancies reported to Jobcentres are used to measure skill shortages, so one possibility is just that they are a poor measure (not least because they do not differentiate skill shortage vacancies from any other). We return to this question of data suitability later in the paper.

It is also possible that if the analysis were to be undertaken for particular sub-divisions of the labour market such as occupations, better relationships would emerge. But since the overall scatter is so poor, that cannot be true for the majority of instances. An approximate inverse concave relationship might be decomposed into a set of precise inverse concave relationships, but a scatter with no pattern at all cannot be decomposed into a set of relationships all of which are inverse and concave.

An alternative possibility is that the economy has repeatedly slipped off the Beveridge Curve, or perhaps spiralled around it. If this is a significant phenomenon, however, then it rather calls into question the usefulness of the Beveridge Curve as a descriptive or explanatory device.[17]

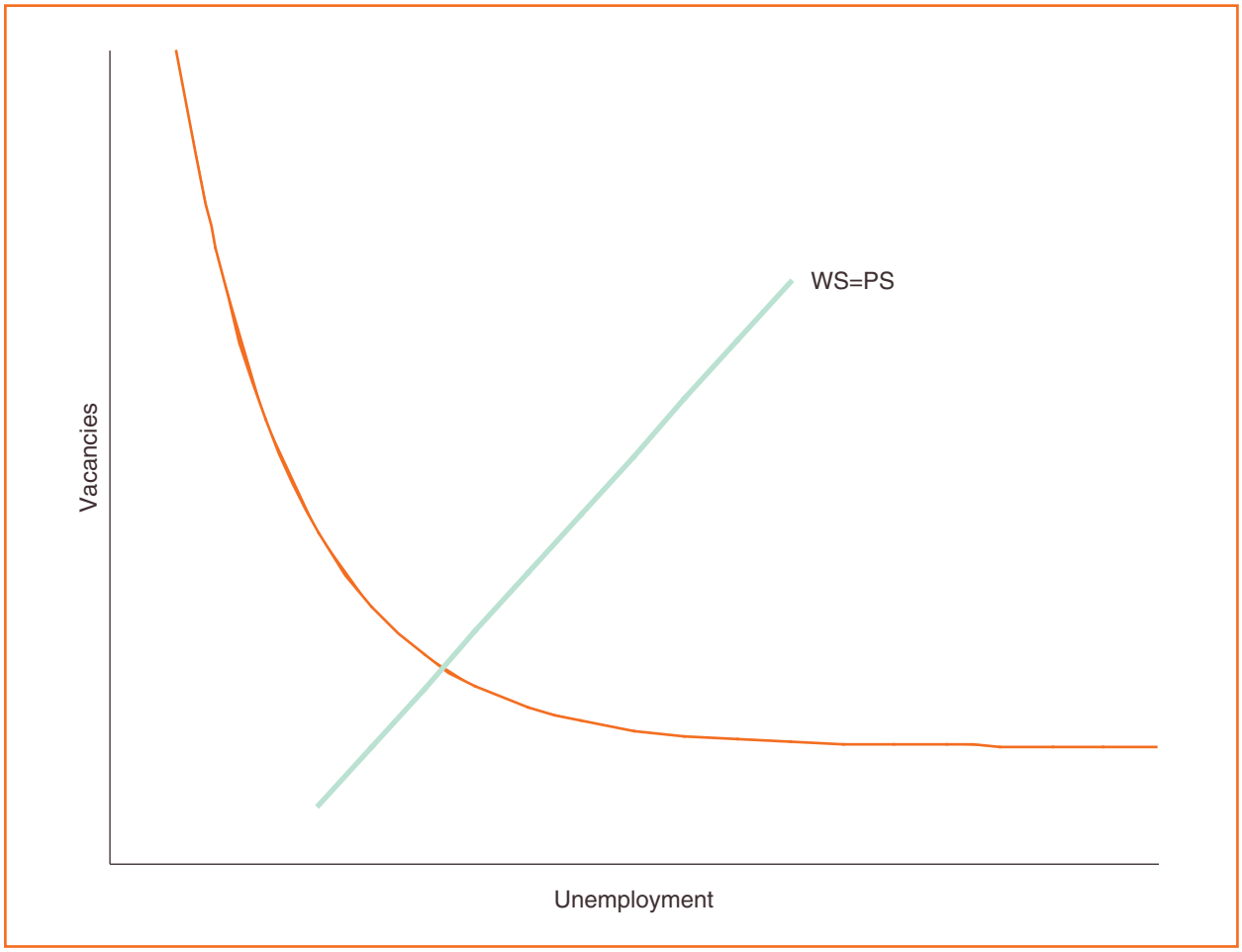
The more likely explanation is that over the period in question the Beveridge Curve has been moving forwards and backwards, as discussed above, while at the same time the economy has been sliding up and down the Beveridge Curve. If these two changes have been occurring simultaneously, then that combination might easily have generated the set of points shown in Figure 3.3, or indeed almost any other set of points. The fact that we do not observe a text-book Beveridge Curve in practice is therefore not surprising, and does not undermine the underlying proposition – the Curve assumes unchanged many factors that in practice are subject to change. Blanchard and Diamond (1989), and Bleakley and Fuhrer (1997) discuss evidence for such combinations of movements in the context of the US labour market, and Nickell *et al.* (2003) provide evidence across various countries.

Macroeconomic or microeconomic explanations for skill shortages?

The position of the Beveridge Curve is essentially determined by the microeconomic factors discussed above: factors such as the benefits system, the housing market, the recruitment practices of employers, the wages being offered, and so on. In contrast, movements along the curve are largely determined by macroeconomic drivers and the extent of demand in the economy. In aggregate terms these are likely to be the factors that act upon the market for goods and services, the relationship between saving and investment, the supply of and demand for money, and the policy link between expected inflation and the consequent behaviour of the monetary authorities. If the impact of all of these on the labour market can be reduced to a single relationship which can be drawn as a line intersecting the Beveridge Curve, then the position of that line determines where the economy sits on the curve, and hence what the equilibrium level of vacancies in the economy is. A line which does precisely that is the WS=PS schedule, which is drawn in Figure 3.4.

[17] Blanchard and Diamond (1989) nevertheless discuss such moves away from the Beveridge Curve.

Figure 3.4: Beveridge Curve with WSPS curve



The WS=PS line is a set of points at which all the factors that influence wage setting (hence WS) deliver a level of employment and hence unemployment which is consistent with all the factors that determine price setting (hence PS). The line's underlying derivation is beyond the scope of this paper.[18] What concerns us is the position of the WS=PS schedule. This will depend on a wide range of underlying factors. For example, if competition becomes tougher in the markets for goods and services then this is likely to reduce mark-ups and hence wage demands. This should cause the WS=PS schedule to shift upwards towards the top of the diagram. Conversely, if for some reason inflation is expected to rise, then workers are likely to bargain for increased pay, while the monetary authorities are likely to raise interest rates: both of these may cause employers to scale down their recruitment plans and hence reduce the number of vacancies for any existing level of employment. This would tend to cause the WS=PS schedule to be located towards the bottom of the diagram.

[18] For a textbook account see Carlin and Soskice (2005) especially Chapter 4.

The position of the WS=PS schedule along the Beveridge Curve will therefore depend on the balance between a very large range of factors. The key point is that from the macro-economic perspective a high level of skill shortages is not necessarily a sign of labour market failure: it may instead be a reasonable response to the prevailing set of non-labour market circumstances, such as the policy of the monetary authorities, and in particular the strength of overall demand. Instead the efficiency of the labour market, as described in terms of the efficiency of the matching function market, is captured by the distance of the Beveridge Curve from the origin. And this is determined by the list of factors discussed previously, plus any that it might be appropriate to add to that list.

4 Measuring skill shortages: the MAC indicators

Chapter summary

- Previous sections of this report have implied that, given the imperfections of the labour market, the existence of skill shortages is to be expected, but that we should also expect the reporting of such shortages to sometimes be unreliable.
- The MAC uses various indicators of skill shortages. Some may have a propensity to under-predict shortages and some a propensity to over-predict, while others are hard to evaluate.
- We recommend that where indicators of wage pressure are used to identify skill shortages, consideration be given to measuring changes in wages rather than levels, and that hours worked should be compared against numbers employed.
- We also recommend that consideration be given to tracking online recruitment advertising and responses. This is likely to be an inexpensive but rich data source.

If economic theory could be used to predict what level or pattern of skill shortages we might expect to see in the economy, then we could use the resultant predictions as a benchmark against which to assess the measures of skill shortages that we have. But in the previous sections we have argued that at present, economic theory does not give us strong indications for what the patterns of skill shortages are likely to be, either in aggregate or by occupation. This implies that in trying to assess the quality of existing measures of skill shortages, current economic theory is unlikely to provide strong guidance.

In terms of our original questions, therefore, we have reasons for thinking that while skill shortages are likely to occur under many normal circumstances, their extent and distribution will often be hard to measure with confidence, and the distinction between a skill shortage and some other form of institutional or market inflexibility will not necessarily always be clear cut.

This counsels us against being over-demanding in looking for clear theoretical justifications for the measures of skill shortages that researchers or practitioners choose to use. Prominent among the indicators of skill shortages that are in use are those adopted by the MAC to inform its advice to government. The MAC uses 12 indicators as well as informal 'bottom up' information to decide how to allocate points to occupations thought to be subject to skill shortages. These points are used to index the strength of the case for permitting migration of people with the necessary skills, qualifications and experience, who would otherwise not be eligible to migrate into the country.

Although we are reluctant to rate the indicators chosen against the standards of high economic theory, there is nevertheless merit in asking three questions of each indicator:

1. Whether they at least broadly correspond to the concepts discussed in the previous sections.
2. Whether we have confidence in the way in which the information has been collected and presented.
3. Whether as a result of 1 and 2 they are likely to suffer from a tendency to under- or over-report skill shortages.

It should be noted that our main focus in this paper is on 1 (and its impact on 3) rather than 2 (and its impact on 3). Nevertheless in Annex 2 we set out some statistical principles that can be used to organise answers to questions 2, and these principles are reflected in what is written below.

Box 2: Type 1 and Type 2 errors

A useful taxonomy distinguishes between Type 1 and Type 2 errors. If our default view is that the labour market works pretty well and skill shortages are the exception not the rule, then a Type 1 error exists when our measure tells us that there is a skill shortage but in fact there is none. A Type 2 error would be when a measure fails to identify the existence of a shortage which actually does exist. Standard research methodology is to prefer to make Type 2 errors rather than Type 1. But the policy choice could go either way, depending on the broader agenda.

In the table we have grouped the MAC's 12 indicators under three headings (note that these are not the headings used by the MAC itself). There are five indicators of vacancies, three indicators of wage pressure, and four indicators of broad labour market pressure. We offer very summary observations in the table, and fuller comments in the text that follows.

Measures currently used by the MAC to identify skill shortages	Theoretical correspondence	Type 1 or Type 2 error?
Vacancies indicators		
E1 Skill shortage vacancies (SSVs) as a percentage of vacancies	May indicate whether labour market imbalances reflect skill shortages but not the absolute level of such shortages	Either
E2 SSVs as a percentage of hard-to-fill-vacancies	As above	Either
E3 SSVs as a percentage of total employment	May indicate how hard skill shortages bite, but again not their absolute level	Either
L1 Absolute change in median vacancy duration	May indicate the efficiency of the matching function	Type 2
L2 Live unfilled vacancies/ unemployment by sought occupation	Indicates a point on the Beveridge Curve but changes in observations will not distinguish shifts in the curve from movements along it	Type 2
Wage pressure indicators		
P1 Annual percentage change of median hourly pay for all employees	Possibly a good indicator of skill shortages although will sometimes under report when wages are subject to control	Type 2
P2 Annual percentage change of mean hourly pay for all employees	As above – arguable which is the better measure of average wages	Type 2
P3 Return to an occupation at NQF3, with age and region controls	Measures level not change in earnings, which fails to capture the dynamic notion of a shortage	Type 1
Broader labour market pressure indicators		
V1 Annual percentage change in unemployment by occupation sought	Measures broad economic growth as it affects the labour market	Either
V2 Annual percentage change in employment	As above	Either
V3 Annual percentage change of median total paid hours, for all employees	May be a good measure of how employers respond to shortages and hence an indicator of them – especially if expressed as per cent of employment	Type 2
V4 Absolute change in proportion working for employer for less than one year	If it measures churn, a high level may mean that vacancies over-predict skill shortages – but depends on how vacancies are captured. Could also indicate employment growth which would have reverse implications	Type 1

Vacancies indicators

The most intuitively immediate ways to capture evidence on skill shortages are to ask employers about recruitment problems, or to record their search activities and the vacancies that they report – and especially those vacancies that they describe as hard-to-fill.

Of the various vacancy measures used by the MAC, the first three (E1, E2 and E3) are drawn from the National Employer Skills Survey (NESS) – a survey conducted roughly every two years specifically for the purpose of informing research and hence, indirectly, policy. It currently covers only England. The vacancies are specifically defined as skill shortage vacancies. The survey's large sample size gives it credibility but its lack of frequency is an obvious problem. This does not just mean that the indicators will not keep up with (for example) the economic cycle, but that they might misrepresent relative shortages between industries or occupations if they are affected by the cycle differently. This could imply either Type 1 or Type 2 errors (see Box 2).

The last two indicators (L1 and L2) are from Jobcentre Plus administrative data – they are frequent and also up to date but cover only those vacancies reported to Jobcentres. Since we know that higher skilled vacancies are less likely to be reported to Jobcentres, we can infer that these indicators are likely to under-report vacancies i.e. there will be Type 2 errors. Unfortunately we have no reason to believe that the degree of under-reporting will be constant – the data is likely to be affected by the changing performance metrics applied to Jobcentre Plus, for example.

Of these two, the measure of vacancy duration (L1) is potentially powerful. A core notion in Section 3 of this paper was that the scale of skill shortages is a function of the efficiency of the matching function. Thinking of this in terms of how quickly jobs and applicants are matched to one another makes intuitive sense, and hence vacancy duration corresponds closely to the theory, notwithstanding the limitations of the data generation procedure and data coverage.

The ratio of vacancies to unemployment (L2) is essentially telling us about the position of the economy on the Beveridge Curve, and/or the position of the curve in space. It thus tells us whether or not the labour market is tight or slack but does not discriminate whether this is a reflection of overall macroeconomic growth or of the efficiency of the microeconomic/institutional matching function. If one believes that the explanation is that economic growth is strong then the key issue in policy terms is whether this is a temporary or a longer term phenomenon. The policy response differs markedly between the two. If economic growth is slow and vacancies are high, then the implication would seem to be that the matching function is inefficient. That would almost certainly also imply that there are skill shortages.

There is an issue whether it matters if the data refer to total vacancies, hard-to-fill vacancies or skill shortage vacancies. The third is a sub-set of the second which is in turn a sub-set of the first. The distinction between hard-to-fill and total vacancies seems to be a genuine one, given the proposition that a vacancy quickly filled implies no real shortage in the market (rather as frictional unemployment is not normally regarded as a policy problem).

We are less convinced that a clear analytical distinction can be drawn between hard-to-fill vacancies that are caused by skill shortages and ones that are caused by other factors. Some empirical researchers use this distinction to draw a clear line between genuine skill shortages (the people with the right skills just don't exist) and other recruitment difficulties (the people with the right skills do exist, but they do not or cannot apply for the jobs; or they apply and have the skills but not the other attributes that employers want).[19]

Our own view is that in practice most vacancies are likely to reflect a wide range of factors and straddle both explanations. Nevertheless the distinction may tell us something about the relative importance that employers attribute to skill shortages as an explanation for a given vacancy being hard-to-fill. Particularly since the MAC is concerned with the specific question of whether it is appropriate to respond to a skill shortage by allowing non-EEA migrants, as opposed to other responses that might be pursued such as stimulating internal migration through for example a more flexible housing market, or stimulating cross-occupation career shifts via subsidised retraining, the distinction between skill shortage vacancies and other hard to fill vacancies is probably a useful one.

Wage pressure indicators

Two of the three wage pressure indicators (P1 and P2) tell us about pay increases through time. Economic theory makes this a good candidate for a measure of skill shortage. This is partly because of the theoretical expectation that any shortage in any market will be manifested in a price rise. And although there are strong reasons for assuming that the labour market will work in unconventional ways and that the particular price in question (wages) will be sticky, that does not rule out the likelihood that some wage pressures will sometimes be seen, even if to a lesser extent than might be expected, a priori. Indeed, although there are other reasons apart from skill shortages why, for a single occupation, relative pay might increase, the skill shortage explanation is the core theoretical explanation. So our expectation should be that it will dominate.

[19] See for example Shah and Burke (2005) or Wallis (2002) who refers to 'genuine' skill shortages.

This implies that Type 1 errors are not likely, but that Type 2 errors may be common. For example, if wages are being held down by powerful employers (most obviously in the public sector), there may be recruitment difficulties and consequent skill shortages, which the pay data will clearly not reveal.

The third wage pressure indicator (P3, the employee's premium to working in a particular occupation, given that an individual has a level 3 qualification) is obviously dependent on the ability to adjust for other factors that influence earnings, such as age and location. That may be thought of as a potential weakness. But fundamentally more important in measurement terms is that it is the level of relative earnings that is used and not the change. High wages in a particular occupation may just indicate that the market has successfully cleared and there are no skill shortages. This therefore implies a possibility of Type 1 errors. A much better indicator is likely to be derived from changes in relative pay levels.

The MAC has given consideration to the question of at what wage level (which we would prefer to see expressed as a change in wages) a skill shortage should be considered to exist. Economic theory does not answer this question, but it could be argued that it is precisely when wages do not adjust that a migration solution to a skill shortage is most appropriate. That is to say, the domestic labour market is not clearing, and the price signal needed to bring about clearance is not functioning, so another solution is needed. If so, then there might be an implication that when wage rises are visible they are a reasonable measure of skill shortages, but that they do not signal a need for the MAC to act. Conversely when there are believed to be shortages but no wage response, the case for the MAC to respond is particularly great.

Broader labour market indicators

The indicators of annual changes in unemployment and employment (V1 and V2) give different perspectives on a single phenomenon – the overall growth of the economy. Comparison between these and the vacancy indicators may tell us something about the efficiency of the matching functions (high levels of vacancies with slow economic growth indicating more inefficiencies than high vacancies with high growth). It might also be appropriate to explicitly relate the direct vacancy information to these macroeconomic demand indicators – not to get better measures of the scale of shortages, but as a guide to whether interventions to improve the matching function are needed or not.

The third of the three broad economic indicators (V3, hours worked) is the most complex. It too can be understood as a broad measure of demand growth, but it can alternatively be interpreted as an indicator of skill shortages, if one has reason to believe that a consequence of recruitment difficulties is that existing employees work longer hours. In that sense it is akin to the use of wage changes as a measure of skill shortages. The indicator could be displayed

all the more sharply by looking at hours worked relative to employment. However, the problem here is once again data suitability and quality: the data is drawn from employer survey responses, and even for those employees who are paid by the hour (or who are paid overtime), there may be weaknesses in the knowledge of those who complete the surveys.

Since a large proportion of higher skilled workers are not paid in that way, and indeed often work hours that have little to do with their formal contracts, it is open to question whether this indicator really captures what it is intended to measure. Our concern would be a risk of Type 2 errors.

The final indicator (v4) picks up the degree of turnover in the labour market, measured by how long people have been in their jobs. The justification offered for this is that it provides a check on the vacancies data: a high number of vacancies may indicate a high rate of churn rather than shortages of people with the appropriate skills. Information on turnover allows us to distinguish between the two. But the proposition that high vacancy numbers are an indicator of churn is true only if the measure being used is new vacancies notified, rather than vacancies remaining unfilled. If the number of job vacancies being created is high, and the number of applicants is equally high, then the vacancies will not remain empty for long and the reported number of unfilled vacancies will therefore not be high, even though the number of new vacancies reported is high. Furthermore, it is not clear that a large proportion of employees who have only been in a job for a short period is a measure of churn: it might also be a measure of growth. There is therefore a risk of a Type 1 error.

Possible additional or alternative measures

Our conclusion is that the indicators that the MAC uses are indeed related to the core notion of skill shortages but have different likelihoods of over- or under- predicting the scale of any shortages. Taken as a whole, it seems reasonable to think of them as a workable and pragmatic response to the inherent difficulties in pinning down the concept of skill shortages. In particular, there should be no expectation that one single indicator could be used in preference to a range such as that which the MAC adopts.

Other indicators are also potentially available, largely in the form of variations on the ones currently being used. Annex 1 provides summary information on many indicators used around the world, while the MAC (2008b) sets out those that were considered and rejected before the present 12 were adopted. It is clear from Annex 1 that the measures used elsewhere are generally very similar to the UK indicators, differing essentially because of national data generation methods rather than because of anything deeper.

Indicators which it might be interesting to use but which appear to have little or no take-up internationally include how widely employers advertise and how widely individuals search, and the scale of the fringe benefits that employers offer to induce individuals to apply for or accept work. Lack of data, plus the ambiguity of the evidence when it does exist, doubtless explain the general absence of such indicators across different countries.

The list of the MAC indicators is of course not exhaustive of those available even in the UK. Regular survey information exists from sources such as the Confederation of British Industry (CBI) or the Chambers of Commerce. The former, for example, asks employers about total labour shortages as a constraint on output and also skilled labour shortage as a constraint. There are limitations to the data in terms of coverage, but the periodicity is high (quarterly) and the time series extends back over more than two decades.

It is possible that series such as these might be useful additions or substitutions for indicators already being used, particularly with regard to identifying the cyclical pattern of skill shortages. They are not, however, available at the occupational level, and not across all sectors. Their use is therefore not possible at the detailed level by agencies such as the MAC, where arguably the need for intelligence is greatest.

One possible additional source of information is provided by tracking employment advertising. This has been a long-established practice in the USA (where it is known as 'help-wanted'). It suffers from various limitations: imperfect coverage of the labour market activity and a bias towards certain types of jobs; ambiguities over how many jobs each advert relates to, and double-counting when the same job is advertised in multiple publications. Nevertheless it is a source of information which is widely used by economic analysts in the USA.

The appeal of this source of information has been significantly boosted by the shift of advertising to the internet. Online recruitment websites contain information on employer searches that are typically differentiated by occupation, sector, location and salary (though not normally qualification). Since the information is all digital, it is easy to collect and process. The sites also have information on how many times job offers are looked at and how many applications are submitted. This therefore gives significant traction on how efficiently the market is matching offers against enquirers. The development of an internet based information base could be a potentially valuable source of additional evidence for MAC, UKCES and other agencies and researchers, and could probably be achieved at relatively low cost.

There is also a general issue with regard to the geography that is used for any indicator or set of indicators. If there is for example an apparent shortage of individuals in a particular occupation in the UK but no shortage across the EEA, then it may be questioned whether there is any justification for allowing inward migration of people from that occupation into the UK from outside the EEA. The answer to this perhaps depends on the pragmatic question of how likely it is, within any given occupation, for individuals from across the EEA to migrate into the UK. Such patterns will depend on a variety of factors, including in particular relative wages between countries, but also possibly the extent to which the UK is regarded as a particularly useful place to work from a career perspective, and in some cases restrictions on the legal right to work. Thus for example lawyers are generally less mobile than doctors because their qualifications are less transferable across national boundaries. Information does exist on employment by occupation by nationality, and this could potentially be used to identify occupations in which a high degree of mobility within the EEA implies that the correct geography for analysis should not be the UK (or not exclusively so) and that instead EEA labour market conditions should be taken into account.

5 Explaining skill needs

Chapter summary

- As with skill shortages, pure economic theory tells us little about what determines the skills that employers' need. But the availability of information on employment by occupation gives us insight into what those needs might be.
- That implies that projecting employment by occupation might tell us about future skill needs – and hence might be a useful adjunct to the evidence that MAC currently analyses with regard to current skill shortages.
- However, that does rely on the ability of researchers to model the drivers of skills and hence occupational change – the environment, technology, trade, tastes and business models. All of these are benefiting from disparate research programmes, and the potential to greatly expand our understanding of the drivers of skill needs is therefore considerable. We recommend that consideration be given to how work in this area might be developed.

Skill needs as reflected in occupations

The concept of skill shortages is implicitly predicated on the notion of skill needs. So an alternative way of thinking about labour market issues might be to focus more explicitly on the needs as well as, or instead of, the shortages.

Admittedly, much of what has been said about the conceptual and empirical difficulties of dealing with skill shortages can also be applied to skill needs, and does not need repeating at length: skills are multidimensional so hard to measure; they are entangled with other characteristics of both jobs and individuals; there are principal-agent problems in how the needs are generated; and the information required to capture needs is extremely large, making it inherently hard for the market mechanism to make resource decisions.

So identifying skill needs is not something that we can expect to do with full certainty any more than we can with skill shortages. But we do have a rich source of information on skill needs in the form of data on employment by occupation. Since this information is available retrospectively, the evolution of changes in skill needs can be tracked through time, (subject to certain caveats that we set out below). Furthermore, the existence of back data means that projections of future occupations can be attempted. Indeed, such projections are available for most industrialised economies, not least the UK.[20] This is potentially important since the notion of 'need' has implicit within it some sense of a future as well as a present requirement.

[20] See for example CEDEFOP (2008), UKCES (2009b) and (2010), Bureau of Labor Statistics (2008).

Strictly speaking, the occupations data can only be regarded as genuinely identifying skill needs if the data contain pure demand-side information. In practice they reflect both supply and demand influences. For example, if a shortage of teachers has in the past forced employers to employ less-qualified teaching assistants, then the resultant patterns will under-estimate the need for qualified teachers and over-estimate the need for assistants. Equally, if graduates have been taking jobs that employers would happily give to non-graduates and that do not require graduate qualifications, then the data will over-estimate the demand for graduates.

But these problems can in principle be addressed through standard modelling techniques, and by reference to supplementary information – in particular that provided by relative wage movements.[21] So such difficulties are not fundamental from a research perspective, and they can be allowed for when making assessments of future skill needs as measured by evolving occupational structure.

Another issue with using occupations to capture skill needs is that classifying jobs into different occupations is not easy. Individuals are poor judges of what their own classifications should be, employers often lack the necessary information (or are unwilling to invest the time in getting it right) and outside researchers also have to cope with limited information. Nowadays computer techniques are used to speed the process, and most major national statistical agencies put considerable effort into getting the data quality as high as it can be. But the information remains imperfect.

In addition when thinking about the link between employers' future skill needs and possible consequent skill shortages in the marketplace, it is necessary to consider not just expansion demand for workers by occupation, but also replacement demand. Indeed there is a strong argument for suggesting that the greatest labour market challenges are likely to come from people retiring, rather than from new jobs being created. The complications include the possibility that employers take the opportunity created by those retirements to alter occupational structures. If that has to be taken into account, then it should be clear that the modelling involved could be quite complex.

Perhaps the main difficulty with respect to using occupational trends to track changing skill needs is that the skills needed within occupations may change through time. So tracking changes in occupational numbers may misrepresent changes in skill needs and changing the occupational classification system to reflect this may not solve the problem. Suppose there is a genuine increase in the skills needed to do the job of a doctor's receptionist. Comparing the number of receptionists through time will not pick up the increase in skill needs. But if a new

[21] Elias and McKnight (2001) argue that identifying the qualifications that are needed to be recruited, rather than those held by incumbents, also circumvents the over-under-qualification problem.

classification of advanced receptionist is introduced, it will not be possible to report a rate of growth for that category, since the numbers were initially zero and hence growth is infinite. So classification systems that fail to change may under-report the underlying phenomena, but systems that are subject to continuous change could tell us even less about the real world changes that they are supposed to be recording.

The possible drivers of changing skill needs

Backward looking comparisons of occupational change do not require any underlying explanatory framework. But forward looking projections have to be based on macroeconomic forecasts that link changes in aggregate demand and its determinants (such as exchange rates and interest rates) to trends in sectoral output, productivity and employment. These will then be used to generate occupational and qualifications forecasts, using trends in those relationships.

The use of macroeconomic models is inherently desirable: only by such means can the factors generating changes in skill needs (which can be categorised as long term shifts in the environment, technology, tastes, trade patterns and business models) be taken fully into consideration. However, the modelling challenge is significant, not least because the underlying proposition is that the parameters are shifting and that not all past relationships will continue to hold. So there is a risk that the occupations projections (and indeed qualifications projections) will not pick up the full scale and scope of likely future change. Changes in skill needs will therefore not be fully identified.

The challenge here is not trivial. It is clear that just as economic theory does not focus particularly on skills as a concept, so too theory does not provide us with a single integrated framework identifying optimal sectoral structures for the future economy. So for example textbook economic growth models all operate at very high levels of generality. Thus the three main strands in endogenous growth theory emphasise knowledge spill-overs (Frankel 1962), investment in human capital (Lucas 1988) and investment in R&D (Romer 1986), but they do not go into much more precise detail than that. As a result they offer us little guidance as to whether for example biosciences or material sciences are most likely to achieve rapid but sustainable economic growth, with consequent increases in skill needs.

But in some areas the future is relatively easy to predict. Examples would be rising demand for care workers and declining demand for semi-skilled workers in manufacturing (though the former could still be subject to a possible budget constraint and the latter might be hard to forecast in terms of the speed of adjustment). And in other areas there is a wide range of research underway which, as it gradually becomes more unified, is likely to strengthen our understanding of how the structure of the economy might change and what that could mean for skills, and hence facilitate the development of increasingly plausible macro-occupational-growth models.

So, for example, in the last decade significant efforts have been made by economists to discover whether there is a bias in technological progress towards skill-intensive production.[22] The focus has mainly been on whether this has driven up the wage-premium for highly skilled versus low skilled workers, and also whether it has caused a shift in production, away from low skilled but high wage economies and towards higher skilled higher wage economies. But the research can also address the closely related question of how skill needs might change under different assumptions about future technology regimes. It may therefore be possible to develop a research agenda to inform the development of new models of skill needs, based on how future technological progress could impact on employment demand by industry and occupation.

As an illustration, there is evidence that skill shortages are higher in those establishments that use advanced technology. Haskel and Martin (2001), for example, find a link between the use of advanced technology and the extent of skill shortages in different plants. They suggest that this could be an indication that technological change is a driver of changing skill needs. By implication, if skill supply cannot adapt fast enough, the changing technology would be likely to result in skill shortages.

Admittedly, caution is needed in drawing such time series inferences from cross-sectional data. An economy might exhibit no technological change through time but still have different levels of technology in different establishments – and different degrees of skill shortages associated with those technologies.

Similar caution needs to be applied to evidence that the most commonly cited skill shortages are for technical and practical skills.[23] This may indicate an element of technological drive behind the phenomenon, but it could also reflect other factors such as demographics.

There is also evidence that occupational change is slow, and that the replacement of relatively unskilled labour with more highly skilled labour tends to occur mainly within industries and indeed within establishments, rather than via the replacement of old industries with new ones – which may make it hard to identify, let alone model, large technology-driven shifts in skill needs.[24]

[22] The possible role of tastes in changing skill demand is not much discussed though it sometimes implicit, as for example in Westwood (2004).
[23] UKCES (2009) p.110.
[24] Machin (1996).

Nevertheless all these examples illustrate at least the possibility that the link between technology, industrial change and skills can be modelled in a broad and systematic way. Hence we may be able to develop scenarios in which views taken on new technologies generate new perceptions of what the UK's strategic skills needs might be.[25]

A related issue that researchers have been examining is globalisation. One theory is that the process of globalisation of trade has been causing low skilled work to relocate from long-industrialised to newly-industrialising economies, and that this has caused a decline in the demand for low-skilled workers in countries such as the UK. The evidence for this idea, originally thought to be strong, has been questioned by some researchers, but if it were found to be correct then the implication would be that any return to full employment following the current recession would depend on a shift in the skills and production base towards high-value added activities. Indeed, much public policy proceeds on that basis.

More specifically, it might be argued that specialisation based on existing comparative strengths provides a basis for some judgements about how the future structure of the UK economy can reasonably be expected to evolve – so that the UK economy is comparatively successful in pharmaceuticals but not in advanced telecoms, and the likelihood is that because of path-dependency, this will become more and not less true through time. This could then be used to generate projections of skill needs, as represented by occupations.

Other possible drivers of skill needs are employers adopting new business models; individuals' tastes and values changing; and potentially most important: changes in the environment as measured by climate change. All of these are areas of economic research, and so scope exists for developing reasonably rigorous views on future skill needs under different combinations of assumptions. For example, Green, Machin and Wilkinson (1998) found that among manual workers, skill shortages were more behavioural and social than technological, and they discovered little evidence that among non-manual workers, those in increasing demand were the ones for which skill shortages were most frequent. These may be indications that changing business models do more to drive skill needs than changes in technology or trade. Again, care needs to be taken in drawing such conclusions, but the scope for model development surely exists.

[25] Even the humble Beveridge Curve may convey some information. High unemployment with low vacancies may imply that the unemployment is caused by lack of aggregate demand, whereas high unemployment with high vacancies implies it is caused by economic restructuring. The Beveridge Curve clearly cannot describe let alone explain the restructuring, however.

The idea of strategic skill needs

An extension is to consider, not what skills are and what skills will be needed as the economy continues along its most likely path, but what skills would be needed if the economy were to be operating instead at its full potential. Much depends here on what is meant by 'full potential'. The question has been discussed in some policy circles in terms of 'strategic skill needs', while perhaps the most relevant theoretical approach has been the distinction drawn by Finegold and Soskice (1988) between high-skill and a low-skill equilibria for the economy.

The Finegold-Soskice proposition is that if firms are constrained to compete primarily in terms of price rather than product sophistication, then they are unlikely to need particularly high skilled workers and might damage rather than improve their own competitiveness if they sought to employ them. Similarly individuals who invest in higher skills are unlikely to achieve the returns that they seek, and could reduce their own lifespan welfare by engaging in training that does not generate the return that they hoped for.

This way of thinking leads to the proposition that employers may have latent skill needs, and by implication skill gaps and skill shortages, that they are not aware of. An employer might, for example, be more demanding about its skill needs if it adopted more ambitious product or market strategies. Or alternatively, employers may be aware of such needs but be discouraged from seeking to address the problems. For example it is possible that the volume of reported skill shortages is held artificially low by employers being discouraged from looking for staff because of pessimism about who might be available with the required skills. There is a possibility that this could be self-reinforcing, if individuals do not invest in the necessary skills because they believe that the opportunities to use those skills will not arise. Snower (1996) developed a model along those lines.

The key implication of the Finegold-Soskice model is that it is very difficult for the economy to traverse the no-mans-land of disequilibrium from low skill equilibrium to high skill equilibrium. In particular, a simple increase in overall skill supply is unlikely, in the absence of an increase in the demand for skills, to have any beneficial impact on economic performance.[26] Nevertheless, a high skills equilibrium does exist in the model, and once attained the economy will tend to remain on the equilibrium (that is to Finegold and Soskice assume that the equilibrium is stable rather than having knife-edge properties).

[26] Finegold and Soskice (1988), Snower (1996).

There are two very different issues here. In a high-skill equilibrium, what might the skill needs be? And how might the economy get there? The second of these is not the subject matter of this paper. With the first, the difficulty is to know how the question might be answered. By definition there will be no market signals, and generating forecasts based on existing economic parameters will similarly not answer the question. In practice the identification of strategic skill needs probably therefore involves both a sector-by-sector exercise (or technology-by-technology) and a full-economy modelling exercise involving an allowance for structural change.[27]

Relevance to the UKCES and the MAC?

It is not clear that static data on occupational structure tells us much about current problems in the labour market – essentially because the data relates to those who are in employment as opposed to mismatches. Projections about future occupational structures may tell us about rising (and falling) demands for people with different skills, qualifications and experience, and hence about future pressures in the labour market. Those projections are likely to have various limitations which mean that they cannot be accepted uncritically, but that is not the same as saying that they do not have a role to play.

One way of conceptualising this is that skill shortage indicators provide short term signals of labour market imbalances, while employment projections, used as measures of future skill needs, tell us about possible future market imbalances. A coincidence of the two indicators would perhaps convey a particularly powerful message for any given occupation, indicating the possibility that a current skill shortage was in danger of growing worse, thereby giving a stronger justification for allowing inward migration (particularly if, as is currently the case, such inward migration was often likely to be permanent).

There would therefore seem to be a case for the MAC to investigate the possibility of using employment projections as a factor in influencing the advice that the committee provides with regard to individual occupations and for agencies to consider such data in light of longer-term domestic solutions. Particularly by deepening research into the underlying drivers of skills, it is reasonable to think that there could be a net positive gain in the information base used by the committee, and hence in the quality of its advice.

More widely, it is possible that if thanks to such projections, employers have wider knowledge of alternative futures and opportunities available to them, they will identify their emerging skill needs differently, and may become more ambitious in their skills investment as a result. The argument is analogous to the principle that the central bank, by setting credible policy targets for inflation, will alter behaviour and hence make the targets more achievable. The key issue is that of credibility – as, in economics, it so often is. In that respect an examination of past forecasting track records might provide a useful starting point.

[27] See for example UKCES (2010).

6 Conclusions

Such is the range of factors inhibiting good decision-making and market clearing in the labour market that it may be a surprise that skill shortages are not more widespread. Many commentators and researchers have indeed been impressed by how few skill shortages there appear to be in the labour market. For example, Blanchard and Diamond (1989) say of the labour market that it is: '…extremely efficient. It is simply not infinitely efficient' (p8).

In practical terms it is necessary to think of skill shortages operating within boundaries: and occupations are perhaps the most obvious set of boundaries to use. If all individuals and all jobs were homogenous there would arguably be no skill shortages (or at least not as far as micro-economic causes are concerned: excess demand in the macro-economy could still generate shortages across many or all markets). So the existence of skill shortages can be understood in terms of the unwillingness or inability of individuals and employers to consider switches between different occupations – and also different locations and industries.

The point can be extended in terms of the individual's unwillingness or inability to substitute between employment and non-employment, and employers' unwillingness or inability to substitute between labour and other factors of production. Essentially, and almost by definition, if arbitrage was infinite then there would be no (micro-economic) skill shortages.

But skill shortages also reflect information short-falls, and not just in the sense that economic agents do not necessarily know whether the boundaries that they use are appropriate (and might therefore have been set needlessly and unhelpfully high or in the wrong places). Information shortfalls also exist because individuals have poor information on jobs, and/or employers may have poor information on individuals. This is especially problematic since both parties have a continuing vested interest in the deal, post-signing, which may generate risk aversion and a bias not to contract.

The mitigation to this – and it may be a large one – is that individuals and employers often have the option to be flexible in how they interpret the employment contract, after it has been put in place, and when they are in a better position to trust one another than they were, before the contract was agreed.

One peculiarity in the market may exist when employers cluster geographically, and gain a reputation as a desirable or prestigious employer to work for, because of that location. Those high-status employers may receive an unmanageable number of applications for jobs, while low-status rivals elsewhere receive very few. Both find their recruitment decisions slowed down, the former because of a congestion effect and the latter because of a desert effect. This is an extreme example of the proposition that barriers to mobility generate skill shortages.

Skill shortages, once they have arisen, are likely to manifest themselves through wage pressure (but not always) or unfilled vacancies (but information on these is problematic) and may also be associated with other phenomena such as increased over-time working (but again there are limitations and ambiguities to the information base). Skill shortages will also be generated by strong growth in demand in the economy.

On that basis the measures of skill shortages used by MAC, and by agencies in other countries around the world, correspond to the set that one would expect to see. There is certainly no single 'correct' measure of skill shortages and no theoretical benchmark, and the choice of indicators seems a reasonable one – although we do have some modest suggestions for improvement. Our view is that the measure of the employee's premium to working in a particular occupation, given that an individual has a level 3 qualification, could be couched in terms of relative wage growth rather than relative wage levels. In addition, the measure of hours worked might be expressed better in terms of hours worked relative to numbers employed, rather than in absolute terms.

There are, in addition, some potential measures not currently being used, of which the interrogation of data from online employment sites seems by far the most promising. Such sources are rich in digital data, making collection cheap and potentially continuous. We recommend consideration of this option.

Another possibility to consider is the use of information on skill needs. The occupational profile of employment gives a measure of such needs – the pattern is admittedly distorted by supply-side factors, but that is something that can be allowed for. Particularly interesting is perhaps the use of occupational projections to generate estimates of future skill needs, which would then mean that skill shortages could be taken as a measure of current labour market imbalances and occupational projections as early warning signs of future imbalances. Congruence between the two indicators (shortages that might grow larger) would then be a particularly powerful message.

One issue with the use of such projections is that skill needs within occupations may change with time. Another is that both skills and occupations will change as the economy evolves. Indeed the ability to model the drivers of skill needs (the environment, technology, trade, tastes and business models) is critical to success, but it is possible (likely) that parameters will shift and that past relationships will not hold in the future. Indeed, those who advocate identifying 'strategic skills' are seeking for this to be just the case. Economic research is, however, proceeding on all these drivers: strengthening the links between research in these areas and skills modelling could generate powerful benefits to the MAC and others.

At the most fundamental level, skill shortages exist, and skill needs go unmet, because there are limitations to the flexibility of the market (the boundaries mentioned above) and because there are limitations to the information available to market participants. When these are purely temporary or frictional problems, the welfare costs are likely to be slight. When the problems persist, the likely consequences are that resources are under-utilised, inefficiencies result and welfare almost certainly suffers.

Measures to improve both the flexibility of the market and the information available to participants, if they are available, are therefore likely to reduce skill shortages and reduce unmet skill needs, for example outcome-based course information. Giving permission to potential workers from outside the EEA to take work within the UK is clearly an example of how the inflexibility can be addressed. Introducing an additional strand of labour market information based on tracking internet job searches is possibly a way of addressing a part of the informational shortfall, at least for researchers and policy makers, and possibly for participants as well. But the inherent difficulty of achieving easy matches in the labour market, relative to most other markets, clearly means that skill shortages and unmet skill needs will never be entirely eliminated.

Annexes

Annex 1: Some international comparisons

In general there seems to have been a good international flow of ideas about how to measure skill shortages, and it is unlikely that countries outside the UK have any radically better approaches than are followed here. Nevertheless there are differences, and some examples are reported in the table below.

Assessment of alternative measures of skill shortage

Measure	Underlying concept	Closeness of fit
Skilled Vacancy Index (Australia -Mitchell and Quirk, 2005; see also Borghans *et al.*, 1998)	• Uses a survey-based methodology to identify trends in the number of skilled vacancies available each month. • Can be used to identify skill shortages, or rather sectors and occupations where the number of skilled vacancies are increasing.	• Data generation process: The Skilled Vacancies Index is based on a count of skilled vacancies in the major metropolitan newspaper of each State and the Northern Territory. The data is published as an index and so provides an indication of the trends in skilled vacancies. • Provides an indication of the sectors and occupations where skill shortages may be being felt. Where the number of skilled vacancies is increasing, it is not unreasonable to assume a skill shortage exists. There may be some confounding effects, such as the influence of employer recruitment habits etc, which may weaken the causality between skill shortage and vacancies. Overall, this appears to be quite a strong measure of skill shortages.

Measure	Underlying concept	Closeness of fit
		• This is a relative measure, showing the trends in skilled vacancies. It therefore needs to be interpreted as showing where skill shortages are developing, rather than their extent. • Care needs to be taken in interpretation as this measure is based on a particular sample of vacancies (skilled, urban). This may provide skewed results, though this particular methodology may work for a country like Australia, where employment is concentrated in the cities. • The source/data generation process appears fairly solid: 1. data collected and published on a monthly basis, though subject to revision; 2. likely to be a relatively stable measure unless employers change recruitment practices significantly.

Measure	Underlying concept	Closeness of fit
Growth in skilled vacancies (Australia – Smith, 2002; Borthwick *et al.*, 2000)	• Measure of the trend in skilled vacancies. • Sectors where significant growth in number of skilled vacancies implies skill shortages. • Provides a very similar measure to the skill vacancy index, though based on actual numbers, not an index, and so provides an indication of scale as well.	• This measure provides an indication of the sectors and occupations where skill shortages may be being felt. Based on employers interpretation of skill shortages/skilled vacancies. • This is a relative measure, showing the trends in skilled vacancies, but also gives an indication of the scale of shortages. Though not a particularly specific measure – only gives a board indication of skill shortages, which then needs to be followed up with further research to identify specific occupations suffering from skill shortages. • Data obtained by Department of Employment, Workplace Relations and Small Business (DEWRSB) (now Department of Education, Employment and Workplace Relations (DEEWR)) in Australia, through a periodic skilled vacancy survey. This appears to be similar to the NESS in the UK.
Vacancy/ unemployment and vacancy/employment ratios (New Zealand/Australia – Infometrics, 2006; Shah and Burke, 2003; 2005)	• Similar to UK. It is suggested by these papers that a relative measure of the importance of vacancies provides insights into skill shortages. • Is a measure of imbalance in the hiring market.	• Interpretation of the measure is difficult as the ratio may not be linked to skills – a large proportion of the unfilled vacancies can be accounted for by temporary or frictional unemployment. • The measure also suffers from bias in the way in which vacancies are measured.

Measure	Underlying concept	Closeness of fit
Measure of the importance of skilled labour (UK – Frogner, 2002; Canada – WorkBC, 2009)	• Uses the skilled labour indicator from the CBI Quarterly trends survey. • The importance of skilled labour increases where skill shortages exist.	• Similar to UK CBI survey. The Canadian Federation of Independent Business survey contains questions which ask employers members if they have concerns about shortages of skilled workers. This is based on a quarterly survey.
Vacancy fill rates (New Zealand/Australia – Infometrics, 2006; Shah and Burke, 2003; 2005)	• This is a measure of the efficiency of the hiring market. • It can be used to indicate skill shortages where vacancy fill rates are relatively low.	• Difficulties in interpretation have been highlighted by Infometrics (2006) in relation to what classifies as a low fill rate which leads them to suggest that this measure needs further testing against other skill shortage measures. • Informetrics (2006) report that this measure has currently been developed on the basis of the Survey of Employers who have Recently Advertised (SERA) in New Zealand. • On a conceptual level, this measure is also weakened due to the fact that it covers all temporary vacancies. It may be susceptible to flagging skill shortages where only temporary ones exist.

Measure	Underlying concept	Closeness of fit
Difficulties in recruitment/ease of recruitment (Australia/New Zealand – Infometrics, 2006; DEEWR, 2008)	Examples include: Survey of Employers who have Recently Advertised (Australia) – records not only the number of skilled vacancies and fill rates, but also the number and suitability of applicants. Overall, these measures can highlight skill shortages, particularly in the case of SERA, where a small number of suitable applicants can suggest skill shortages.	• At a conceptual level, this has the potential to be an interesting measure of skill shortage. In particular, the approach used by SERA would enable analysis of the relationship between vacancies, the supply of labour and the quality/skill levels of applicants. It therefore shows quite a close fit with the way in which skill shortages are generally conceptualised. • The measure does have a number of limitations: 1. the suitability of the candidates may also include other factors, including experience and wage demands, though is likely to focus on the skills and knowledge required for the job advertised; 2. to make this a more useable measure, it would be beneficial to view absolute and relative figures in order to understand the difference between the numbers of applicants that might be expected for a particular occupation and the numbers actually seen.

Measure	Underlying concept	Closeness of fit
Measures of training	Belief that skill shortages are a main driver of training activity	• Infometrics (2006) suggests that a measure of education or training could be used to examine skill shortages. This approach is based on the assumption that individuals will take up training in sectors with skill shortages due to pull-factors, such as higher wages. This measure, however, is weakly conceptualised, as it does not take into account key issues, such as the lag between the emergence of a skill shortage and any response that might be seen in the uptake of training or the fact that the supply of skills is often as odds or moving to a cycle independent of labour market signals. • A variation on this suggested by Infometrics (2006) is to use measures of specialisation. Sectors that are more specialised are likely to have a higher susceptibility to skill shortages. Not clear what the evidence base for this is. This measure may be able to identify potential skill shortages, but cannot be used as an actual measure of them.

Measure	Underlying concept	Closeness of fit
Other labour market indictors	A number of authors, including Shah and Burke (2003, 2005) have suggested that skill shortages can be identified by using measures such as: • hours and intensity of work (e.g. overtime); • production levels; • flows of new entrants and leavers; • levels of subcontracting; • levels of immigration.	• Many of the factors suggested may provide an indication of skill shortages, but require care in interpretation as they measure responses in the labour market resulting from stimuli including but not confined to skill shortages. • Borghans *et al.* (1998) also highlight that these indicators are difficult to interpret: 1. adjustment behaviour may vary substantially between individual businesses and skills concerned; 2. it is difficult to assess whether a response is the result of a change in company policy or a response to skill shortages. • The authors who have suggested these types of measures also raise concerns about the availability and reliability of data. Some of these measures are more practical than others, such as measuring any major changes in the amount of overtime worked.
Help-wanted advertising, USA Conference Board	• More a measure of employment trends than skill shortages	• The Conference Board surveys 'help-wanted' print advertising volume in 51 major newspapers across the country every month. Because ad volume has proven to be sensitive to labor market conditions, this measure provides a gauge of change in the local, regional and national supply of jobs.

Measure	Underlying concept	Closeness of fit
Structural models (USA – national but also regional and local e.g. Dayton Metropolitan Statistical Area, 2007; See also Shah and Burke, 2003; Borghans *et al.*, 1998).	• Used to study imbalances between supply and demand for skills in the labour market. • Can give an indication of skill shortages at the broadest level.	• Based on strong theoretical underpinnings, can possibly be of use for predicting future skill needs and shortages. • Require a large amount of high-quality data to work effectively.
Projections of industrial and occupational growth (Canada – McMullin, Cooke and Downie, 2004; Berube, 2009)	• Projects changes in the structure of the labour market in Canada. • Includes measure of labour shortage based on level of labour supply plus unemployment minus new openings.	• The Canadian Occupational Projection System (COPS) integrates demand and supply side factors in the economy to provide projections relating to the structure of the labour market. The projections cover nearly 140 occupations and five broad skill categories. • Despite its main use being for labour force planning and other administrative uses, the model does provide a specific measure for labour shortages. The measure looks at the supply and demand for skilled labour.

Annex 2: Guidance on indicator choice

Drawing valid conclusions

A core question to ask of any proposed indicator is: are the conclusions that are drawn from the indicator, likely to be valid? Spanos (1986) argues that there is normally no single absolute answer to this question. Instead, he provides a framework based on statistical theory which organises this question into three components:

Theory information: Does the statistical measure capture the key characteristics of the economic concept under scrutiny? What do we mean by 'capture'? Or, if we think it's a useful indirect measure (as the presence of an anti-virus might capture the existence of a virus, or a surge in wages might capture the existence of a labour shortage), what justification do we have for that belief?

Sample information: How has the data been generated, and what does that imply about the properties of the data and our ability to assign measures of reliability to it? Is it for example administrative information generated as the by-product of the delivery of a public service, or has it been produced specifically to inform research?

Measurement information: What manipulations if any do we perform on the data? Do we look at levels or changes? Totals or averages? Do we exclude outliers? Do we attempt to adjust for distorting or temporary factors such as seasonality?

We take each of these in turn.

Theory information

The core issue here is whether or not we have some reason for thinking that a close correspondence exists between theory and measurement. In practice this is a matter of judgement, sometimes informed by information. Researchers working across different areas of applied statistics use a wide range of informal criteria for deciding whether they can justify using particular data to measure the concepts that interest them.[28] These criteria tend to be pragmatic in nature. Examples include:

[28] Abramson, J.H. and Abramson, Z.H. (2001) is an example from the epidemiology field.

Acceptance: Is a measure generally accepted by experts from the field in question as being valid or the most suitable measure to be used? Is this also consistent with the perspective of those under study (usually important in the social sciences and occasionally in some parts of the natural sciences such as medicine)? Neither of these guarantees that the measure is appropriate, but strong disagreement is a warning sign.

Precision: Is the measure tightly defined? Although this seems like an obviously desirable criteria, a measurement which is very sensitive in terms of precisely matching the theoretical concept to the measurement may be so specific that it is unclear how to compare it with other instances. So there may be a trade off with the comparability criteria (below).

Comparability: Is there consistency in application which enables the outcomes of a measure from different contexts to be comparable (either directly or with minimal manipulation)? It is possible for example that a vacancy in nursing is not the same thing as a vacancy in truck driving, if the former refers to a vacancy for permanent employees which can be easily met by hiring agency staff, whereas the latter is a post that remains empty because there are no truck drivers available (at least on the terms being offered).

Scope: Does the measure, or range of measures, contain all the aspects of the concept that we need to capture, in order to gain an accurate understanding of the subject/object of study? If there are several measures needed, do we have the full set?

Exclusiveness: Is it clear that the measure captures the concept in question and not also other concepts? For example, wage pressure may be a signal of skill shortages, but it may also indicate a prior pay agreement that continues in place irrespective of labour market conditions.

Consistency: Is the measure consistent in terms of what it is recording, through time and across e.g. sectors, and is the interpretation of the measure equally consistent? For example, where skill shortages are concerned, not only may the number of vacancies vary with the cycle, but the criticality of filling those vacancies may vary, but this dimension may not be picked up by data which just reports overall numbers. Similarly with public sector employment: a shortage of social workers, doctors or police may be more significant at some times than at others, because of shifting policy priorities and public concerns, but conventional data measures may not identify the shift in importance.

The main way to address these issues is to deepen one's understanding of the data generation process, through research. For example, if an employer states in a survey that there are skill shortages, do we have a reason for believing that the employer has the same understanding of what 'skill shortages' means as we do? Is this an expression in common use with a widely accepted meaning? Or are there perhaps reasons for believing that employers sometimes understand 'skill shortages' to be a reference to the skills of those they currently employ, rather than those they are seeking to recruit?[29]

Pursuing the example, do we have a reason to believe that the employer is likely to be telling the truth? To answer this we may seek evidence on whether the employer has an incentive to tell the truth, or at any rate no incentive not to tell the truth. We can also undertake research to ascertain what evidence employers themselves rely on when they say they are experiencing skill shortages? Research can be undertaken to discover who answers survey questions and whether they have the necessary knowledge. Is there any evidence of informational shortfalls? And if not, do we assume that the employer's information is indeed accurate?

Our understanding is that considerable effort has been made with regard to the NESS surveys to undertake research of this sort, and so the indicators that are based on NESS information are likely to be well grounded in this regard. The problems identified in Section 3 do not imply that we cannot possibly obtain information on skill shortages: they imply that since the concept of a skill shortage is not straight forward we should not expect to find a single pure measure of such shortages. While the surveys do not give perfect information, the questions have been well designed and trialled by researchers aware of the dangers, and research into answering practices can give insight into how appropriate the data is likely to be.

Sample information

Four main issues arise under this heading, all of which are concerned with whether the data is representative of the population being referenced.

Data generation: The first issue is how the data has been generated. There is no perfect method here – even decennial censuses are never 100 per cent comprehensive. For a randomly drawn sample from a normally distributed population we can measure the probability that the sample is representative, but no more than that. For a structured sample we must assume that the sampling frame is accurate. For administrative data the assumption must be that the data is not representative of the population. For example, it is generally recognised that vacancies reported to Jobcentre Plus are a small and non-representative part of the total. This is clearly therefore a problem for the indicators that use such data.

[29] Green, Machin and Wilkinson. York Consulting (2008) suggest that respondents may interpret skill shortages in terms of general labour market tightness rather than basing their assessments on specific recruitment difficulties.

One possible way to address the concern that Jobcentre Plus data is unrepresentative of the wider employment market is by the use of employment advertising. As noted in the main text this has been a long-established practice in the USA but it has always suffered from the criticism that it too is rather crude. Now that advertising is shifting to the internet, the use of 'help-wanted' advertising seems like a significant opportunity for improving the evidence base.

Timeliness: The efficiency of the labour market at matching people to jobs varies with the cycle. It is likely that these variations differ between cycles, across industries and occupations and possibly across regions. This generates issues of interpretation. For example, to draw conclusions about different sectors with different experiences of the economic cycle is difficult, if the data is not frequent enough to pick up any differences in their actual cyclical experience.

It is also clear that in many occupations there are seasonal variations, as there are for some types of recruitment. For example, employers who recruit large numbers of new graduates have a strong annual recruitment cycle. There are also temporary fluctuations in many measures because of one-off events.

This issue may seem quite separate from the purer theoretical considerations, but in practice it is not. For example, in some tourism towns there may be large swings in demand for customer care staff, and recruitment difficulties at certain times of year, because local job seekers lack the required skills. In this example, the skill shortage is actually there all year round but only materialises in the marketplace for short periods. Equally, employers may not in fact report a shortage because they attract temporary workers from elsewhere. But there is a skill shortage in the local population even if it is not reported.

Issues such as these are unlikely to be susceptible to broad-brush quantitative solutions. Research at the sectoral and local levels, of the sort undertaken by Sector Skills Councils (SSCs) for example, is likely to be the best source of intelligence.

Scope, specifically geography: This last example blends into the third sampling issue. It is generally accepted that to understand the extent and severity of skill shortages it is necessary to look at industries and/or occupations. But it was suggested in the main text that the ability and willingness of both individuals and employers to relocate (or in some cases for individuals, to commute) may also have a big impact on the extent of skill shortages. As we indicated, it seems inappropriate to say that localised shortages are not real, and instead it is important to understand that the market for skills has a geographical dimension. So any measurement approach which does not take geography into account is at risk of not picking up properly the geographical dimension of the market.

All recruitment needs are local – what varies is the location of the individuals who respond. For different occupations, the response will have a different geography. A major determinant of this is pay, investment banks can easily recruit internationally because of their ability to pay high salaries. But it is also clear that scientific researchers have a relatively high degree of international mobility, primarily because science itself is conducted internationally and largely in the English language. In other occupations for which there are specific licenses to practice, international migration may be more difficult (although international harmonisation is commonplace – for example in nursing). And cultural variations matter more in some occupations than others – so that for example dancers are internationally very mobile whereas actors are much less so (with the exception of a small though prominent trans-Atlantic flow).

One possible development might be to identify occupations with high levels of non-UK workers, and then collect information on skill shortages in other countries (most obviously across the EU) in those occupations to get a sense of whether a UK shortage is being compounded by an international shortage. It is possible that this could also be done within the UK to get a stronger sense of the severity of local shortages – though the story is more complex since internal migration is more likely to involve occupational shifts than international migration.

Scale: Finally, there is a general presumption that more data is better than less. In the case of random samples from normally distributed populations we can specify this, and it is a familiar result that although for very small samples, the benefits of increasing sample size are large, beyond a certain point the gains in terms of the rising probability that the sample is representative become very small. For other survey methods or data sources, the 'bigger is better' principle holds sway. This is most likely to be a problem when trying to conduct primary research locally – on the whole, those national labour market indicators that we utilise have generous sample or population sizes.

Measurement information

Manipulation of data: Whether the measurement picks up the theory is also likely to be affected by any manipulation that occurs to the data. Usually data comes as absolute measures, and is often then manipulated by looking at changes through time, by looking at rates relative to a base (for example skill shortage vacancies relative to total vacancies) by measuring dispersion from the average, or by the creation of an index, possibly including a composite index.

Underlying such manipulations is usually a prior theoretical proposition. For example, there may be a desire to identify employers or occupations where skill shortages are not just large but are likely to be particularly damaging. Equally there may be a desire to identify employers or occupations where addressing skill shortages by supplying more candidates (e.g. through inward migration) is unlikely to work because the skill shortage seems to be a consequence of a broader problem. In either case, the use of skill shortage vacancies as a proportion of total vacancies might be adopted as a way of identifying the phenomenon. The danger is that in undertaking such manipulation, the transformed data ceases to be independent of the theory. The fact that in this example two different reasons might be offered for one manipulation raises doubts on whether the measure can be used to identify either phenomenon – the exclusivity point raised above.

The use of variations from the average can also be problematic. For example, the mean is generally regarded as a poor measure of wage variations around the average, since wages are skewed to the right (there is a minimum wage of zero but no maximum wage). This can of course be addressed by using a median. Even so, a judgement has been made about what constitutes an average. And more complicated examples exist, not least in the area of measuring shortages. Thus if pay in an occupation is markedly higher than in 'similar' occupations, that may be interpreted as an indicator that there are skill shortages in that occupation – the MAC's P3 indicator of return on qualifications by occupation is an example. But the choice of what counts in measuring similarity (e.g. qualifications, age) requires a prior judgement. Again, there is a possibility that the measure does not quantify so much as express the theory.

But it can also be argued that failure to manipulate data will sometimes be problematic. This may be the case with the example just given, where high pay in a particular occupation is interpreted as an indicator that there are skill shortages in that occupation. However, the reverse interpretation is more intuitive. If people in one occupation get paid more than in another then that may be interpreted as an indication, first that their skills are more valuable, and second that the labour market recognises this, pays more and hence averts a shortage. However, a rise in pay in one occupation relative to another may indicate that relative skill needs have shifted and that the market is adjusting in response. Given the theoretical reasons for thinking that labour markets will often not adjust rapidly and smoothly through wages alone, we have an a priori reason to believe that there will also be skill shortages. But we only have this information because we have looked at wage changes through time, and not simply at absolute levels.

Number of measures: There are two schools of thought in relation to the number of indicators or measures that ought to be used to understand a socio-economic phenomenon. In the econometric and statistical theory literatures the general consensus is that the principal of Occam's razor should be applied and that the study should be parsimonious and use as few variables as possible. Conversely, authors working in the field of performance indicators have taken a more pragmatic approach, highlighting that it may not be possible to use a limited number of indicators to understand how a system works.[30] This literature argues that the number of indicators that may need to be used is related to their quality and closeness of fit with the theory. It may, therefore, be necessary to use multiple measures to take different 'slices' through the available information.

There are two linked concerns with the latter approach. One is that various poor indicators are being given spurious collective credibility by being looked at together. A poor indicator does not become a better one by being printed on the same page as another poor indicator. The second is that two indicators may be very closely correlated with one another but not with a third, and there may be a tendency to assume that the first two gain credibility by giving the same answer and that the third loses credibility – without any justification being advanced for this judgement. A message does not become more correct simply by being repeated by more times.

In formal model building and hypothesis testing, such under-performing or correlated indicators are usually eliminated by standard procedures. In the case of simply looking for indicators of skill shortages, that process is not really available since there is not a model being tested. But this does strengthen the importance of having a theoretical justification for any indicator used. Each indicator must therefore be justified separately as well as collectively.

Part of the answer here may be to deliberately combine indicators which we think are liable to suffer Type 1 errors with indicators that are liable to suffer Type 2 errors. We have made informal judgements above about whether the existing MAC indicators are more likely to suffer from one or the other, and it might be possible to pursue this with a more explicit and formal arrangement for categorising the indicators in this way and taking that into account when interpreting the measures.

[30] Pencheon, D. (2008) The good indicators guide: Understanding how to use and choose indicators, NHS Institute for Innovation and Improvement and APHO.

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