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Mid-term skills supply and demand forecast

Modelling skills mismatch – further development of the MLME

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Preface and Acknowledgements

This paper summarises some of the latest results from the Cedefop *Skillsnet* project on *Forecasting skill supply and demand in Europe to 2022.* It is still very much a work in progress and should not be quoted without first referring to the authors.

It forms part of an ongoing *Framework Agreement* which extends over 4 years. This paper documents part of the work carried out in Year 2 (2014). The researchers are grateful to Cedefop for financial support (the Framework Agreement relates to open invitation to tender No: AO/RPA/AZU-VKVET/skill-forecast/003/12).

The results are the outcome of a team effort. The authors are grateful to all of the team including the Country Group Experts for their contributions. Thanks are also due to the various experts from individual countries who have taken time to review and comment on the emerging findings

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Glossary

AM - Alphametrics

CE - Cambridge Econometrics

CGE Modelling - Computable General Equilibrium Modelling

CGEs - Country Group Experts

CM - Computable model

DTI - Danish Technological Institute

E3ME the multisectoral macroeconomic model underlying the projections

EPC - Education Policy Centre

ERC - Economix Research & Consulting, Munich

FGB - Fondazione Giacomo Brodolini, Roma

ICEs - Individual Country Experts

IER - Institute for Employment Research

IHS - Institute for Advanced Studies, Vienna

MLME – the Melbourne (previously Monash) Labour Market Extension (CGE module to extend the results from E3ME

NTF - National Training Foundation, Prague

ROA - Research Centre for Education and the Labour Market, Maastricht

VA - Visionary Analytics, Vilnius

VA – Value Added (projects)

WLME – the Warwick labour Market Extension – the various modules developed to extend the E3ME model to cover the demand for and supply of skills

Abstract

This paper presents further developments to and applications of computable general equilibrium (CGE) modelling used to extend the quantitative modelling. This has been developed to enhance the projections from the main Cedefop forecasting model based around E3ME. The paper updates the previous MLME and explores it application to throe light on labour market adjustment to skills imbalances. It uses data from selected countries, which are now consistent with the latest classification and data from the main project and cover the full set of counties. It shows how the use of CGE modelling techniques can add valuable information to the econometric based modelling work. It is still very much a work in progress and should not be quoted without first referring to the authors.

Summary

This paper describes further developments to the Computable General Equilibrium extension to the main Cedefop skills forecasting model. It is a revised version of a paper presented at a Cedefop Skills net Workshop in Rome September 2014.

The so called Melbourne labour Market Extension (MLME) was developed by Meagher *et al.* (2013) to run alongside the so called Warwick Labour Market Extension (WLME). The WLME describes the various modules used to translate the general labour market projections from the Cambridge Econometrics multisectoral macroeconomic model (E3ME) into implications for skills as measured by occupation and qualification.

The focus of the present paper is on using the MLME to help interpret the imbalances and mismatches in skills demand and supply that emerge from the Cedefop projections. In order to set this into context the paper also includes a general review of previous work on skills imbalances and mismatches.

Previous work on the MLME has been updated to be consistent with the most up to date classifications of industries and occupations. The MLME has also been extended to cover all countries.

The paper describes the MLME CGE module in detail, including showing how it can be used to develop useful indicators of labour market pressure based on both quantities of labour (employment) and prices of labour (wages). These can be compared with the indicators already available from the WLME.

The paper concludes by sketching out possibilities for further work.

1 Introduction -previous work and latest developments

Motivation

In the main Cedefop quantitative projections the skills forecasts are generated using a modular modelling approach (see Wilson *et al*. (2012). The approach involves two major components: a multi-sector macro-econometric model of European countries (E3ME), primarily developed and operated by Cambridge Econometrics, and the Warwick labour market extension (WLME), primarily developed and operated by the Institute for Employment Research at the University of Warwick.

Countries are treated as an integrated system in E3ME model, but separately within the WLME extension. Furthermore, forecasts of employment by industry are determined by E3ME; forecasts of employment by occupation and qualification are determined by the WLME extension, which includes the following modules:

- EDMOD which determines the forecasts of changing employment levels by occupation (Expansion Demands (ED);
- QUALMOD which determines provisional forecasts of employment by qualification;,
- STOCKMOD which determines labour supply by qualification; and
- BALMOD which revises the provisional forecast of employment by highest qualification held to conform to the labour supply projections from STOCKMOD.

These modules rely mainly on time series econometric techniques to generate their forecasts. (See Wilson *et al*. (2010) for an overview of the combined E3ME-WLME forecasting system, with references to further documentation.)

In 2012, Meagher *et al*. described how the WLME can be replaced with an alternative extension which uses computable general equilibrium (CGE) modelling techniques. This is referred to as the Melbourne Labour Market Extension (MLME).[1] This extension was used in Meagher *et al*. (2013) to explore emerging structural pressures in European labour markets for a small selection of countries based around the main Cedefop skills projections. The MLME has also been used to contribute to the Cedefop/OECD Forum on Green Skills and Innovation for Inclusive Growth, Paris, 14 February, 2014 (see Meagher *et al*.(2014).

The present paper extends and enhances this work, focussing on the measurement and interpretation of skills imbalances and mismatches, especially the role of markets and prices

It includes a general review and assessment of different measures of skills imbalances and mismatches (including those used in the Cedefop work).

[1] Previously it was referred to as the Monash Labour Market Extension as it was developed by the Centre of Policy Studies COPS at Monash University in Melbourne Australia. CoPS has recently moved to Victoria University in Melbourne.

The MLME is updated to use the latest data and classifications adopted in the Cedefop projections work, including revisions based on NACE Rev 2 and ISCO08. It has also been extended to cover all member countries in the European Union and a few additional countries in the periphery.

It present some new results including comparison of the indicators of shortage and labour market pressure with those developed by Kriechel (2013)

Structure of the paper

Following this introductory section, Section 2 provides a brief review of previous research on defining and measuring skills imbalances and mismatches. This includes a conceptual overview, as well as an initial attempt to clarify practical measures that might be used, including links between them and apparently obvious indicators such as vacancies and unemployment.

Section 3 reviews the various indicators of imbalances and mismatches that have been used in practice, including examples from the USA, the UK and Australia.

Section 4 and Section 5 describes the MLME CGE module in detail, including showing how it can be used to develop useful indicators of labour market pressure based on both quantities of labour (employment) and prices of labour (wages).

Section 6 concludes by outlining how the measures of imbalance and mismatch from the MLME can be compared with indicators developed by Kriechel (2013) and finishes with some recommendations for policy makers and suggestions for further work that can be undertaken such as the possible impact of population ageing.

The paper also includes an extensive bibliography plus two Annexes which provide further details of the conceptual framework, the indicators developed in previous research and comparisons between indicators.

2 Defining and measuring skills imbalances and mismatches

Conceptual discussion

Concerns about skill shortages and their impact on the economy have been around for decades (if not centuries!). However, although these terms are in common parlance, and widely and frequently used by policy makers, there is far from a clear consensus on what the term means and how such things should be measured.

Economists have very precise idea about all of this, but the general public, employers and policy makers frequently use the terms much more loosely. This paper attempts to clarify these differences and to set out the ways that skills imbalances and mismatches (and especially shortages) can be measured using outputs from the quantitative projections (as well as other sources).

The most popular way of discussing such issues focuses on the term *Skill Shortages.* The press and media use the term frequently as do policy makers and politicians. On closer inspection defining and measuring such things is not as straightforward as it might at first appear.

Defining Skills

Consider first the problem of defining (and measuring) skills. Different disciplines such as Economics, Sociology and Psychology use the term in different ways. It can encompass the occupation somebody works in, the formal qualification they obtain and (or) the generic skills and competences involved. These include many personal characteristics such as attitude (self or externally assessed). In the Cedefop work, the main focus is on Occupation and Qualification. This reflects the practical difficulties of obtaining consistent measures of skills across all countries other than occupation and qualification.

Defining shortages

When it comes to defining (and measuring) shortages the position is even more complex. Some have dismissed it as an impossible task, but still people (especially policy makers) insist on using the term! The following quotations typical of those who have attempted this task:

- ".. a 'notoriously difficult' task … there is no one 'best way' to do it". (Bosworth 1993:242)
- "no single empirical measure of occupational shortages exists, nor does it appear that one can easily be developed" (US Bureau of Labor Statistics1999:17)
- "labour shortages are not easy to measure" (OECD, 2003: 103)
- "there are no objective measures or direct indications of skill shortages" (Zaidi and Cohen: 2003:1)

Reviews such as those by Lassnigg (2012) highlight the different problems faced by different actors. Public Employment Services are charged with matching short term vacancies with those trying to find jobs. Individuals (both young people entering the labour market and older workers who may have been made redundant face problems of whether or not their skills match what employers are looking for.

At a more macro level governments are concerned with general decisions about how to manage the supply of skills. This includes:

- investment in education and training (which is generally something that governments have some control over via their interventions in public provision of education (both academic and vocational); as well as
- control of immigration (although this is nowadays much less straightforward in Europe with the free movement of labour across national borders.

Interventions relating to training or immigration controls (which focus on numbers) can be contrasted with market adjustments in which prices (in the case of labour, wages) change in response to any imbalances.

Some such as Brown *et al*. (2013) argue that some form of intervention is necessary to achieve national objectives and that reliance on market adjustments is too risky. Many countries are focussing on strategic occupations and skills trying to avoid bottlenecks and achieve broader national objectives (e.g: Singapore).

Thoughts on Modelling & Theory

Annex A sets out some detailed analysis based on a simple economic modelling approach to these matters.

From Figure 2 in Annex A it is clear that Supply (S) = Employment (E) plus unemployment (U) and Demand (D) = Employment (E) plus unfilled Vacancies (V).

$D = E + V$ 1.

$S = E + U$ 2.

A shortage is observed when Demand exceeds Supply

$D - S = V - U$ 3.

From this it is clear that unfilled Vacancies by themselves are NOT a measure of shortages – it is necessary to focus on V-U (or the ratio of V/U).

Further complications arise when one considers the total; demand for labour services or supply of services, as measured in hours of work, as opposed to simply focussing on numbers employed.

A second set of complications arise when the focus moves from just a single measure of labour services to recognising that policy makers are generally concerned with a range of different skills (as measured, for example, by occupation or level of education). In such circumstances it is the relative wage of one occupation or skill level to another that is important.[2]

A final complication is the need to recognise that it is "real" wages that are the appropriate indicator to focus attention on, allowing for general inflation. If wages are rising less rapidly than prices then the real costs to employers of using labour will be falling, and similarly the real value of the income received by those supply those labour services will be declining. Focussing on relative pay will, to some extent, deal with this problem.

When interpreting the results from the CGE modelling work, these thought have the following implications.

When Demand = Supply (D=S) in equilibrium this is typically measured by Employment (observed) when it should be employment plus the natural (non-inflation accelerating) rates of Unemployment and Vacancies ((V/(V+E)) or U/(U+E)), where U=V).

Technical change will be taking place on the demand side. This means that the Demand curve shifts – typically more output can be obtained with the same level of labour input (all else equal), i.e. the Demand curve shifts inwards. For particular skill categories this has been associated in recent years with Skill-biased Technical change (especially linked to information and communications technology), which is tending to favour high as opposed to medium or low skilled workers.

Technical change on the supply side can be interpreted analogously. For example if workers achieve lower utility levels for supplying more hours of work (all else equal) the supply curve shifts inwards (and conversely). This may have similar implications to the classic "backward bending" labour supply curve mentioned in labour economics text books (as people get richer they chose to take more of the growth in real incomes in the form of leisure rather than income, working shorter hours, taking longer holidays and retiring earlier).[3]

The precise shapes of the demand and supply schedules and how they shift over time will determine how the labour market response to economic and other shocks. This highlights the importance of the (implicit) assumptions being made about elasticities of transformation and elasticities of substitution when discussing such matter. If the world is as envisaged by Leontieff, substitution possibilities are limited and there is much less scope for flexibility.

[2] This also raises the issue of "rates of return" to the acquisition of skill, which some commentators argue is a key policy indicator of whether or not investment in skills is at the correct level.
[3] See for example, Bosworth *et al.* (1996).

3 Practical indicators of imbalances

Reviews of practical measures of Skill shortages

As noted above, detailed reviews, such as those by Bosworth (1993) have concluded that measuring shortages is far from straightforward. Nevertheless researchers continue to try to do so!

Despite concluding that it was an impossible tasks, Veneri (1999, went on to identify three main possibilities for useful indicators of occupational shortage:

- **Strong employment growth:** are employment levels in the occupation growing much faster than the average?

- **Relative wage increases:** are wages for the occupation wage increasing faster than the average?

- **Falling or low occupational unemployment rate:** is the occupation's unemployment rate below average or falling relative to the average? (Veneri did not consider vacancies as US LMI at that time did not include general surveys of vacancies

Although this methodology has the advantage of simplicity, the problem with all this is that the kinds of thresholds suggested are essentially arbitrary. Moreover many of these conditions can arise in situations where no shortage exists.

Many other reviews have been undertaken. A selection of these is summarised in Annex B. Drawing together all of the studies cited there, it is possible to conclude that:

- the term "skill shortage" is interpreted in many different ways;
- no indicators provide an unequivocal measure of shortage, the thresholds above which an indicator is deemed to show a "shortage" is arbitrary and different indicators often give conflicting results – all require some element of judgement;]
- no single indicator of "skill shortage exists;
- the most widely utilised indicators of shortage are vacancies (variously defined and recognising their limitations);
- growth in employment and in overtime hours provide complementary evidence;
- changes in relative wages are in principle relevant but in practice observed movement are often difficult to interpret;
- rates of return are also relevant qualifications but in practice they are hard to measure and are backward looking;
- employer views are useful but inevitably biased – they do not provide an independent view of the situation;
- the devil is in the detail, policy makers and others want very detailed indicators but the available data are often inadequate for the purpose

The following summarises the main measures that have been used:

1. External labour market measures (recruitment difficulties)
   - Vacancies
   - Unfilled vacancies
   - Skill shortage vacancies
2. Internal skill gaps (inadequate skills amongst the exiting workforce).

Employer surveys can provide all these, but:

- not always in great occupational detail
- they are also static and marginal
- dependent on employer perceptions

Vacancies provide an indicator of demand less supply but they do not necessarily indicate a shortage. Various different indicators are possible:

- Levels;
- Rates (as a percentage of employment or as a ratio with a related unemployment measure);
- Duration
- Changes over time

Unemployment (supply in excess of demand)

- (different indicators, as for vacancies)

Earnings (relative pay, net of general inflation) – but observed pay changes are often not very informative in contrast to “what if “ scenarios as developed here.

Possible measures of imbalances and skill deficiencies at a pan-European level

Cedefop, with its own Employer Survey and other projects aiming to produce short term indicators, is fishing in the same pool.[4]

The results from the present project, both from Kriechel (2013) and the present paper, attempt to throw some new light in these issues.

[4] See Cedefop (2015). *Work programme 2015.*Luxembourg: Publications Office of the European Union.Cedefop Information series.A for details

4 The MLME CGE module

Outline

Figure 4.1 describes the current Modular approach to skills forecasting used for the Cedefop projections. At its heart is the multi-sectoral macroeconomic model, E3ME. Other modules cover the demand for and supply of Skills. Together Modules 2-7 comprise the so called Warwick Labour Market Extension to E3ME (WLME).

Countries are treated as an integrated system in E3ME model but separately within the WLME extension.

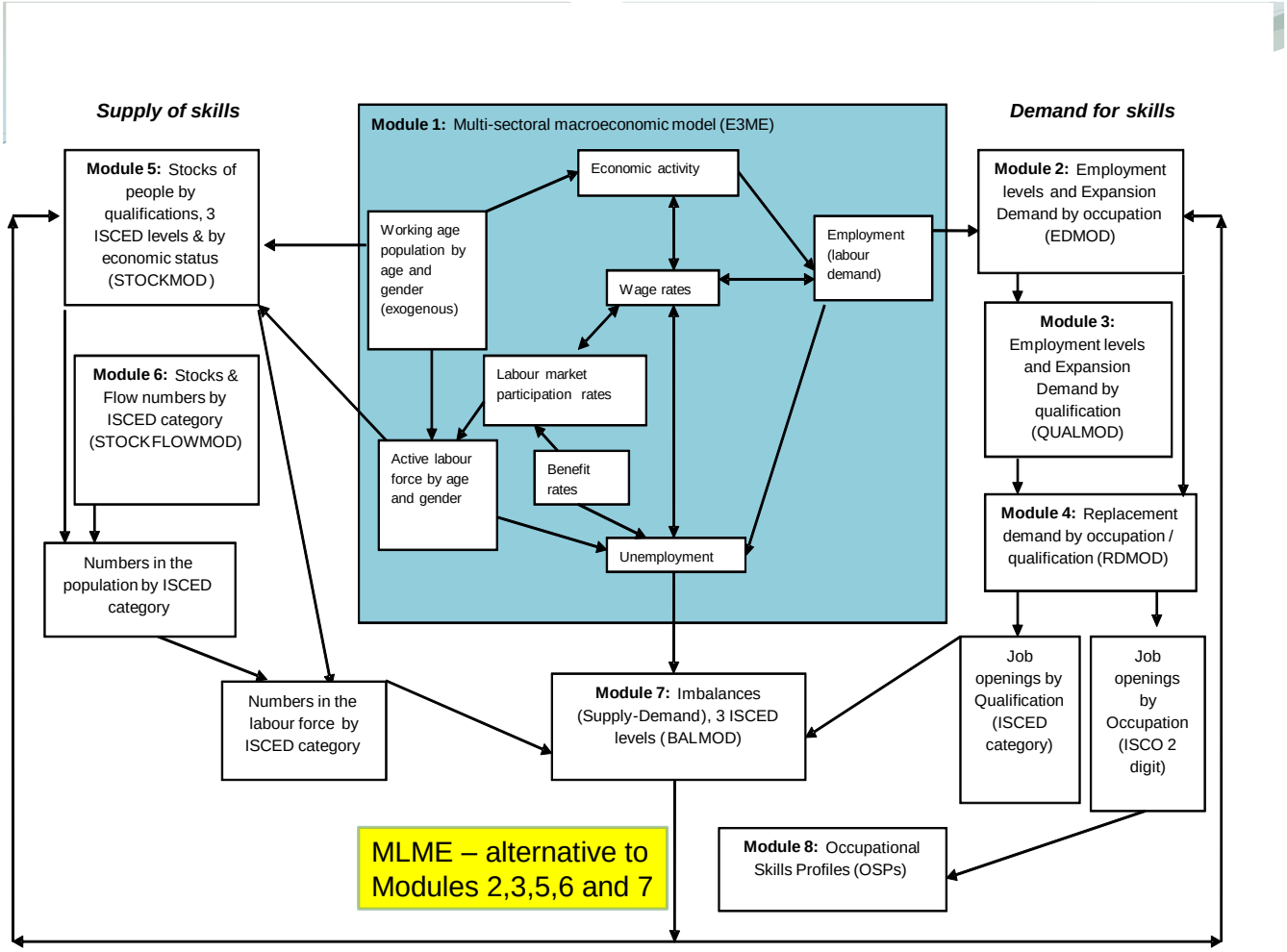
Forecasts of employment by industry are determined by E3ME. Forecasts of employment by occupation and qualification are determined by the WLME extension:

- EDMOD produces forecasts expansion demand by occupation,
- QUALMOD forecasts of demand by qualification,
- STOCKMOD forecasts of labour supply by qualification,
- BALMOD reconciles demand and supply forecasts

The Melbourne Labour Market Extension (MLME) is a computable general equilibrium (CGE) alternative to the econometrically based WLME. It is described in detail in Meagher *et al.* (2012), and applied in Meagher *et al.* (2013) as an initial exploration of the use of CGE methods to help interpret skills imbalances and mismatches. The input data used by the MLME was based on an earlier set of projections, old data, and an older version of occupation classification. Some of its usages have been to explore issues related with greening of the economy and the impact on the demand for skills of measures to mitigate climate change.

The MLME can be seen as an additional module within the framework of the E3ME/WLME models. Figure 4-1 generally illustrates how the various elements work together. At its heart, the E3ME model (module 1) projects labour demand (employment), labour supply (the economically actove work force) and unemployment. These are then used as inputs into the WLME (modules 2-7). The role of the MLME is to shadow the WLME results, while assuming that labour markets are sufficiently flexible and clear through changes to wage levels.

Figure 4-1: Modular Approach: E3ME, WLME & MLME



Objectives of the current model

The purpose of this study is to use the MLME CGE is to assess skills mismatches and imbalances for all EU member states.

Given our previous discussion about the difficulty in assessing skill mismatches and imbalances, the model develops two main indicators that:

(1) measure the relative wage change (WC), given that wages are fully flexible in order to clear labour markets (i.e., supply equals demand);
(2) measure the excess demand (ED) of employment, given that wages are not flexible, i.e., relative wages are fixed to the base year values.

These two indicators provide signals because: (1) an expected rise (fall) in demand for employment –categorized by occupation, industry or skill qualification - should coincide with a rise (fall) in wages; (2) given that wages do not adjust, an expected rise (fall) in demand for employment should coincide with a rise (fall) in the excess demand for employment.

We report results for four countries: Germany, Greece, Netherlands and UK, updated using new data and the latest NACE and ISCO classifications.

The MLME model

Generally speaking, the MLME describes the operation of 27 occupational labour markets (currently based on the 27, 2 digit ISCO88 occupations used in the WLME).[5] On the demand side of these markets, labour of different occupations can be converted into effective units of industry specific labour using a Constant Elasticity Substitution (CES) functions. In principle, each of the 41E3ME industries can employ any of 27 occupations but none of a particular occupation will be used by an industry in a forecast if none of it was used by that industry in the base period.

On the supply side, labour by skill (represented by 3 broad levels of qualification as measured by ISCED) can be converted into labour by occupation according to Constant Elasticity of Transformation (CET) functions. Again, each of the 3 skills identified in WLME can, in principle, be transformed into any of the 27 occupations.

The complete set of equations which makes up the MLME model is set out in Meagher et al. (2012). The main equations in the model to focus on are the following:

Equation T1: Demand for labour of occupation o by industry i, hours

$$d_{io*} = d^{W}_{i**} - \sigma^{S}_{i} \left[p_{o} - \sum_{k=1}^{OCC} SH^{W}_{ik*} \; p_{k} \right] \qquad \text{(all } i \in IND, o \in OCC\text{)}$$

where

d_{io*} is the change in demand for labour of occupation *o* by industry *i*,

d^{W}_{i**} is the change in demand for labour of all occupations by industry *i*,

p_{o} is the change in the hourly wage rate for occupation *o*

SH^{W}_{io*} is the share of occupation *o* in total cost of labour employed in industry *i*

σ^{S}_{i} is the elasticity of substitution between occupations in industry *i*.

The equations in MLME are expressed in terms of percentage changes of the variables. That is, the system computes the percentage changes in the endogenous variables in some period arising from changes ("shocks") to the exogenous variables. The coefficients in the system are shares. Sets, coefficients and parameters are denoted by upper-case or Greek symbols. The convention is adopted that lower-case symbols denote percentage changes in the levels of the variables represented by the corresponding upper case symbols, that is, the notation assumes y=100 (dY/Y). The levels variables Y do not appear in the equations but they will be used in the discussion which follows.

The equation T1 maintains that, if there are no changes in the relative occupational wage rates P_{o} , i.e., if

[5] Note that this model and the corresponding work on the FGB model re based on the previous round of Cedefop forecasts (Wilson et al. (2012) using ISCO88 rather than the new ISCO08 categories.

$$p_o = 0,$$

a one per cent increase in the demand D^W_{i**} for effective units of labour in industry *i* leads to a one per cent increase in the demand D_{io*} for labour of each occupation by the industry. Here, the number of "effective" units is obtained by aggregating the occupational demands measured in hours according to a constant elasticity of substitution function. If, however, the wage rate P_o for occupation *o* rises relative to the average wage rate for the industry, i.e., if

$$p_o > \sum_{k=1}^{OCC} SH^W_{ik*}\, p_k .$$

the demand D_{io*} for occupation *o* will increase less rapidly than D^W_{i**}.. Producers will substitute against occupation *o* in favour of other occupations. If it is difficult to substitute other occupations for occupation *o*, i.e., if the elasticity of substitution σ^S_i is small, the amount by which d^W_{i**} exceeds d_{io*} will also tend to be small. Note that the superscript W attached to the SH^W_{ik*} indicates that wage cost shares are to be used in computing the average wage rate for industry *i*, i.e.,

$$SH^W_{ik*} = P_k\, D_{ik*} \,/ \sum_{o=1}^{OCC} P_o\, D_{io*} .$$

For current purposes, the equation is replaced by:

Equation T1: Demand for labour of occupation o by industry i, hours

$$d_{io*} = d^W_{i**} - \sigma^S_i [\, p_o - \sum_{k=1}^{OCC} SH^W_{ik*}\, p_k] + a^D_o - \sigma^S_i [a^D_o - \sum_{k=1}^{OCC} SH^W_{ik*}\, a^D_k]$$

(all $i \in IND$, $o \in OCC$)

Where:

a^D_o is occupation-*o*-augmenting technical change in production. Note that the treatment of technical change described in this section follows Dixon et al. (1982)

Suppose that the wage rates P_k and the effective demand D^W_{i**} are constant but technical change is taking place. If the change is *o*-augmenting at the rate of one per cent, i.e.,

$$a^D_o = -1$$

and

$$a^D_k = 0$$

for $k \neq o$, then industry *i* 's demand for labour of occupation *o* falls by

$$(1 - \sigma^S_i (1 - SH^W_{io*}))$$

per cent, i.e. by less than one per cent. Thus the *o*-augmenting technical progress induces some substitution in favour of occupation *o* and away from occupation *k* , *k* ≠ *o*. Note that industry *i* 's demand for labour of occupation *k* , *k* ≠ *o*, falls by $\sigma_i^S SH_{io*}{}^W$ percent.

In most applications of MLME, the technical change variables a_k^D are set exogenously and the model determines employment by occupation. However, if employment by occupation is set at the levels forecast by E3ME-WLME and the a_k^D made endogenous, MLME determines the technical change regime $\hat{a}_k^D$, say, implicit in those forecasts. That is, if the a_k^D are set at the levels so determined, MLME will reproduce the WLME forecasts. In the forecasts reported in the next section, a_k^D is always set equal to $\hat{a}_k^D$. Note, however, that technical change which affects the supply of labour, rather than the demand for labour, is not considered here so the specification is not unique.

In the next section, we present the skills mismatch indicators in more details. We then report them using new results from the MLME multi-country model.

5 Indicators for skill mismatch using new MLME results

As discussed in Section 3, the main aim of this study is to develop measurements that would indicate structural pressure in the labour market. Figure 5-1(below) illustrates how these indicators are constructed based on the CGE model component. Note, that these indicators apply to all types of employment categorisation (i.e., occupation, industry and skill qualification), but for simplicity are omitted from the following equations.

To understand how these indicators are are constructed from the CGE module, refer to Figure 5-1. The model assumes that labour markets are fully flexible in the medium-to-long run. Starting from point E_0, the labour market clears (e.g., for occupation, industry, or skill), and demand and supply for employment equal L_0, and wage rate are set at W_0.

The CGE module is then projected forward dynamically, and driven by the exogenous inputs that are provided by the E3ME/WLME model components. Recall that these exogenous inputs are based on economic fundamentals from the various European countries, such as demographic/migration changes, economic changes, assumptions to productivity, and others, which are part of the E3ME multi-sector macroeconometric model, and the Warwick labour market extension (WLME).

Assume as an example in Figure 5-1 that the E3ME/WLME project a rise in demand for employment for a certain occupation. Holding all else equal, the CGE module will obtain a new equilibrium point at E_2. At this point, employment rises to L_2, and wage rises to W_2 .

Two indicators can then be developed:

(1) Excess demand (ED): the percentage change in the required supply of labour to establish equilibrium while holding relative wage rate fixed to w_0.

$$ED = 100 \cdot \frac{L_1 - L_0}{L_0} \qquad (1)$$

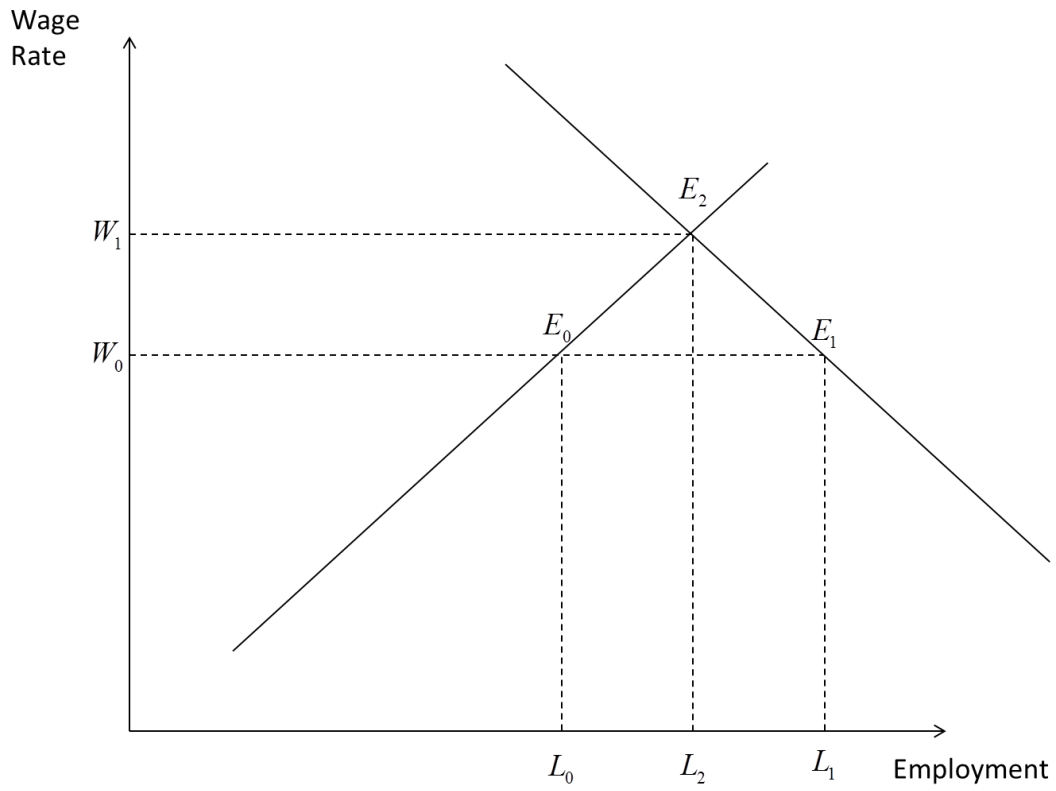
When expressed this way, structural pressure tends to prompt a policy response, such as an increase in training or immigration, which shifts the supply curve to the right. This is the most common form for indicating structural pressures.

(2) **Wage rate change (WC):** the percentage change in the wage rate that is required to establish equilibrium at the new wage rate w_1

$$WC = 100 \cdot \frac{W_1 - W_0}{W_0} \tag{2}$$

This, however, is not the usual way to express structural pressure because most analyses of skill shortages and surpluses do not consider the role of relative wage rates. Hence, the adjustment mechanism associated with the measure, namely, a movement along the supply curve from E_0 to E_1, is more usually identified with *laissez faire* than with a specific policy response. However, policies designed to improve wage flexibility would facilitate the required movement. Furthermore, these two measures usually go hand in hand whereby pressures on demand of certain type of labour will eventually raise the wages of this labour.

Figure 5-1: Supply-Demand Pressures on Wage



Following a change in demand, the medium-to-long run equilibrium would be point E_2. However, in the short-run, structural pressures are determined by the excess Demand which is the distance between E_0 and E_1. Alternatively, market clearance would be achieved when wages rise suffienctly from W_0 to W_1.

The following is an analysis of the measurement results four countries, i.e., Germany, Greece, Netherlands and United Kingdom. Our full model, however, covers all 28 EU member countries plus a few peripheral countries. To facilitate policy makers at the European level to assess labour market pressures at a higher aggregative European level, we are developing additional, broader, definitions of countries, e.g., North EU, South EU, and New Comers to the EU. These will be reported in further work.

Table 5-1 (below) reports the results for excess demand. These results are generated by MLME when relative occupational wage rates are assumed to remain fixed (constant). We furthermore use the new ISCO08 occupation classification codes.

Table 5-1: Excess Demand for labour by occupation (percent of excess demand from base year)*

		Germany		Greece		Netherlands		United Kindgom	
	Occupation ID and Description	Excess	Rank	Excess	Rank	Excess	Rank	Excess	Rank
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	11. Chief executives, senior officials and legislators	3.8	11	-7.1	14	-7.4	15	-72.3	26
2	12. Administrative and commercial managers	14.8	6	-12.4	17	-63.7	25	-53.6	25
3	13,14. Managers in services	-49.6	26	-27.9	25	-1.7	11	28.3	5
4	21. Science and engineering professionals	19.0	5	-20.2	23	-12.1	18	-42.7	22
5	22. Health professionals	-2.7	14	-27.1	24	-33.7	22	-41.2	21
6	23. Teaching professionals	-9.8	21	-19.3	22	-40.8	24	-51.4	23
7	24,25,26. Business and other professionals	21.9	4	-18.2	20	0.9	9	-13.0	15
8	31,35. Science and engineering associate	-7.5	19	-8.7	15	-15.0	19	1.7	12
9	32. Health associate professionals	0.0	12	37.5	4	-7.6	16	301.7	1
10	33. Business and administration associate	-3.1	17	3.4	12	-5.9	14	-7.0	14
11	34. Legal, social, cultural and related associate professionals	48.3	1	150.2	2	12.3	8	149.7	2
12	41,43,44. General office clerks	-19.4	24	-16.3	19	-2.9	12	-52.9	24
13	42. Customer services clerks	42.0	2	10.7	8	31.1	3	5.2	8
14	51,53,54. Personal, care, protective service	9.1	8	9.0	9	20.1	7	4.6	9
15	52. Sales workers	-2.3	13	4.2	11	21.6	6	7.8	7
16	61,62,63. Agricultural workers	11.2	7	7.5	10	-15.4	20	65.2	4
17	71. Building and related trades workers, excluding electricians	-2.7	15	-13.4	18	-1.1	10	-6.4	13
18	72,74. Metal, machinery and electrical trades	-9.1	20	-6.3	13	-8.9	17	-38.5	19
19	73. Handicraft and printing workers	-19.7	25	-43.7	26	-38.8	23	-40.3	20
20	75. Food processing, wood working, garment and other craft and related trades	-16.1	23	-18.2	21	-26.4	21	-22.5	17
21	81. Stationary plant and machine operators	-2.9	16	-8.9	16	21.9	5	12.9	6
22	82. Assemblers	36.1	3	213.7	1	-79.6	26	-24.1	18
23	83. Drivers and mobile plant operators	-15.1	22	19.6	6	-3.0	13	4.0	10
24	91,94,95,96. Cleaners, refuse, street and related sevice occupations	7.6	9	31.0	5	22.1	4	2.6	11
25	92. Agricultural, forestry and fishery labourers	-6.0	18	107.5	3	161.2	1	-19.7	16
26	93. Labourers in mining, construction, manufacturing and transport	5.7	10	11.5	7	39.0	2	146.1	3
27	All	0.0		0.0		0.0		0.0	

Note: Excess Demand is based on the MLME results, and is measured as the percent of the difference between demand and supply in 2020, in persons, from the base year demand in 2009.

We rank the excess demand for each country (e.g., see column 8) to help pin-point more readily the emerging pressures on the labour market. For example, our model finds that by 2020 in the United Kingdom (UK), if no wage adjustments would have occurred between 2009 and 2020, the model results indicate an excess demand for Health associate

professions (row 9) of around 300% relative to base year employment. As suggested previously, this kind of result is often taken as a signal that more training resources should be devoted to increasing the supply for this occupation. In this context, “more resources” means more than the amount already assumed (at least implicitly) to be committed in the E3ME/WLME forecasts. Furthermore, additional supply is provided by specific government policies that would promote certain types of education and training, or through the natural development in the private sector, e.g., by developing private educational facilities (i.e., schools, universities and academies) that recognize these demands and therefore training specific occupations.

More generally, if there were to be a re-allocation of training resources from the occupations with excess supplies in Table 5-1 towards the occupations with excess demands, the employment growth rates in Table 5-1 could have been achieved with a more modest realignment of relative wage rates.[6]

Thus, Table 5-2 (below) further corroborates the model’s expectation about excess demand for *Health associate professions*. Table 5-2 estimates the average annual wage rate required to clear occupational labour markets when relative occupation wages are flexible. For example, for *Health associate professions* (row 9), wages are expected to have the highest rise between 2009 and 2020, relative to other occupations. Figure 5-2, for example, shows the expected wage change for occupations in the UK that rise faster than the national average for occupation, with *Health associate professions* rising fastest. Conversely, Figure 5-3 shows the change in wage for occupations below the national average.

As Figure 5-1 illustrates and described previously, pressures of excess demand (ED) will either push towards an increase in employment supply, which will meet these demands, or alternatively, demand pressures will simply raise the relative wage for these occupations. The true (final) outcome in the medium to long run is something in the middle between the excess demand measure and the wage change measure. We therefore stress that these results are NOT a forecast of the future, but rather indicators that highlight where the expected labour market pressures lie.

[6] This statement must be qualified to the extent that neither WLME nor MLME currently specifies the training resources devoted to particular occupations. Supply is only constrained by level of skill. Hence, the method whereby the reallocation could be achieved is not currently determined by either model. This deficiency could be corrected in more detailed future versions.

Table 5-2: Average wage rate required to clear occupational labour markets in 2020 (percent)

		Germany		Greece		Netherlands		United Kindgom	
	Occupation ID and Description	Excess	Rank	Excess	Rank	Excess	Rank	Excess	Rank
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	11. Chief executives, senior officials and legislators	2.8	10	-0.9	17	0.5	17	-9.8	26
2	12. Administrative and commercial managers	4.0	6	-1.2	19	-8.4	25	-5.5	23
3	13,14. Managers in services	-5.9	26	-3.2	23	1.7	11	5.7	5
4	21. Science and engineering professionals	4.8	5	-2.6	22	-0.2	20	-3.7	22
5	22. Health professionals	2.5	12	-3.3	24	-2.6	22	-2.9	20
6	23. Teaching professionals	1.6	16	-3.7	25	-4.8	24	-5.5	24
7	24,25,26. Business and other professionals	5.0	4	-2.2	21	1.2	14	0.4	17
8	31,35. Science and engineering associate professionals	1.3	20	-0.5	16	0.0	18	2.4	13
9	32. Health associate professionals	2.4	13	4.9	7	1.3	13	21.0	1
10	33. Business and administration associate professionals	1.8	14	1.0	12	0.9	16	1.7	15
11	34. Legal, social, cultural and related associate professionals	7.2	1	11.9	3	3.5	8	14.3	3
12	41,43,44. General office clerks	-0.7	25	-1.1	18	1.6	12	-5.8	25
13	42. Customer services clerks	6.2	2	2.7	10	5.7	4	3.5	11
14	51,53,54. Personal, care, protective service	3.2	8	3.0	9	4.9	7	3.7	10
15	52. Sales workers	1.5	17	2.4	11	5.7	3	5.1	7
16	61,62,63. Agricultural workers	3.8	7	5.1	5	0.0	19	10.9	4
17	71. Building and related trades workers, excluding electricians	1.4	18	-0.5	15	2.4	9	2.9	12
18	72,74. Metal, machinery and electrical trades	0.7	21	0.9	13	1.2	15	-2.2	19
19	73. Handicraft and printing workers	-0.6	24	-7.2	26	-4.1	23	-3.2	21
20	75. Food processing, wood working, garment and other craft and related trades	-0.4	23	-1.4	20	-1.2	21	0.8	16
21	81. Stationary plant and machine operators	1.4	19	0.5	14	5.6	5	5.7	6
22	82. Assemblers	5.8	3	19.2	1	-12.4	26	-0.4	18
23	83. Drivers and mobile plant operators	-0.3	22	5.0	6	2.2	10	4.3	8
24	91,94,95,96. Cleaners, refuse, street and related sevice occupations	3.0	9	6.7	4	5.5	6	3.8	9
25	92. Agricultural, forestry and fishery labourers	1.7	15	16.3	2	15.2	1	1.8	14
26	93. Labourers in mining, construction, manufacturing and transport	2.5	11	3.9	8	7.6	2	16.5	2
27	All	2.6		1.9		2.1		4.2	

Figure 5-2: Wage Change, UK Occupations above average

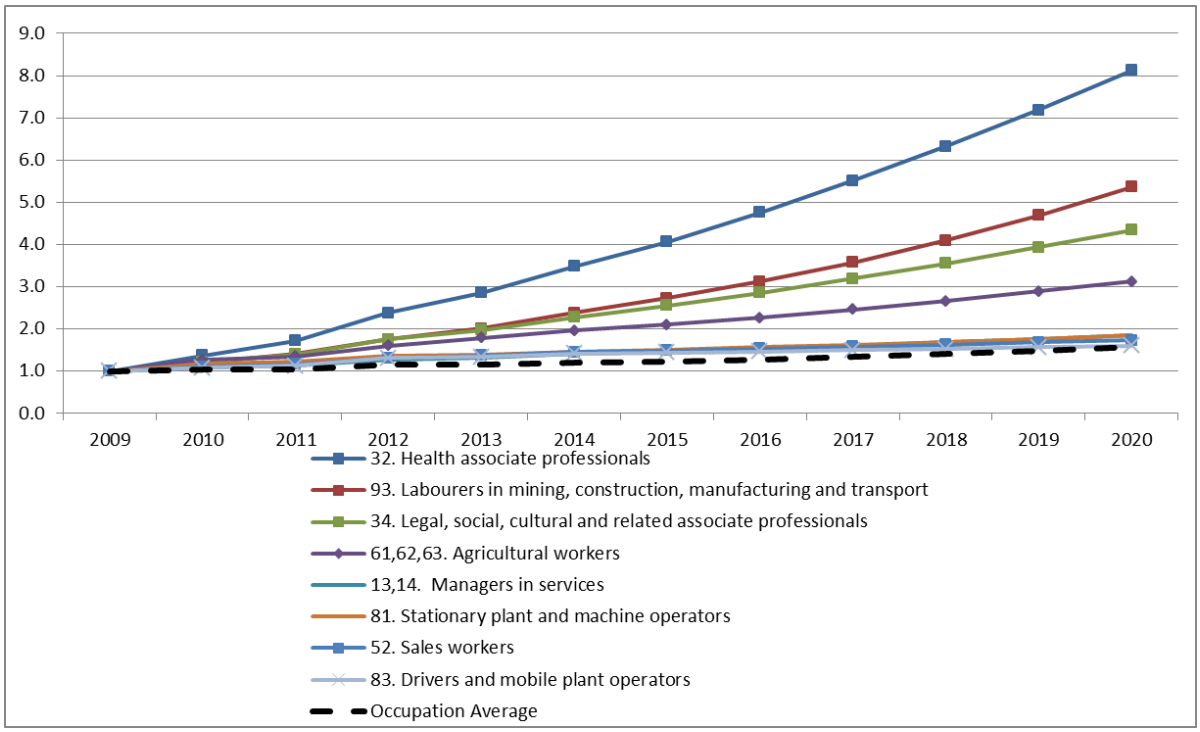
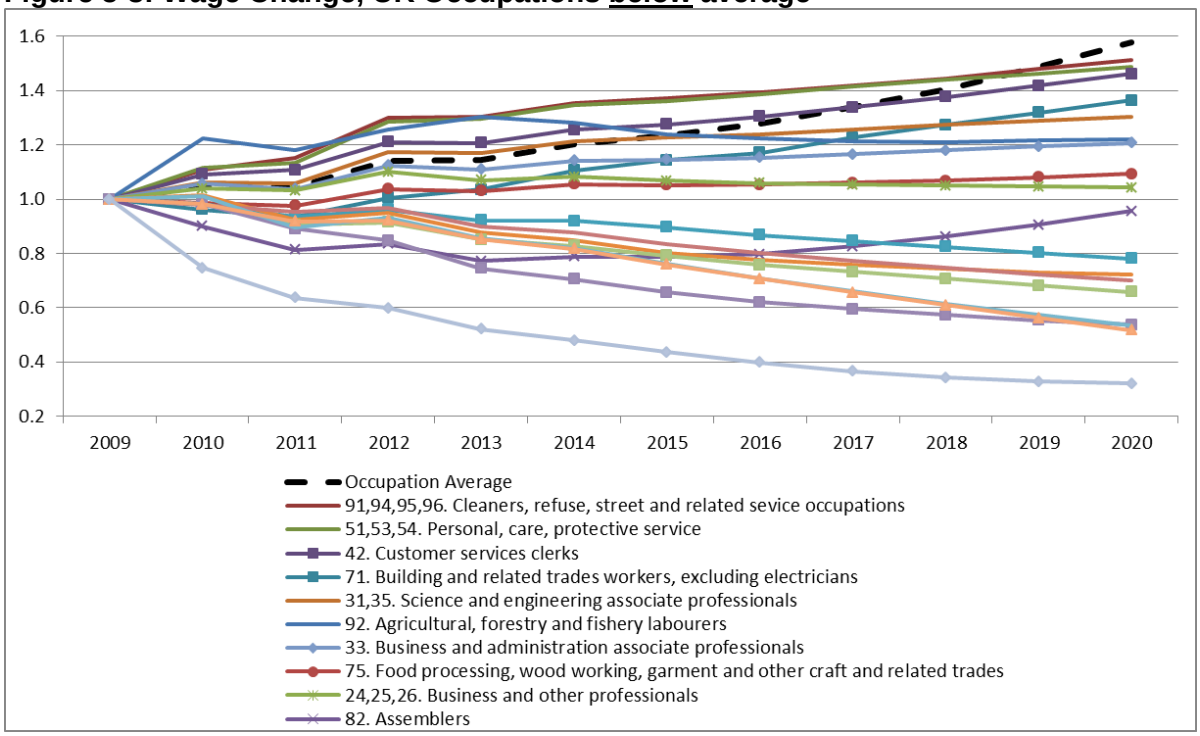


Figure 5-3: Wage Change, UK Occupations below average



5.1 Employment pressures at the industry and skills level

The previous discussion focused on pressures on demand for occupation. As described in the previous section (Section 4), each industry demands various types of occupations using a CES function. Our model, however, can also focus on the supply side of labour by skill,

which is converted into supply of labour by occupation according to a CET function. We therefore can view the expected wage pressures on skills and industry as indicators for build-up of pressures for certain skills and industry employment, as previously discussed in the context of occupation.

Table 5-3 and Table 5-4 report the wage pressures on skills and industries for the four countries, which are indicators for the potential demand pressures for these employment categories.

Table 5-3: Average annual wage rate changes by skill for all occupations, 2009 to 2020 (percent)

Skill	Germany		Greece		Netherlands		United Kingdom	
	Excess	Rank	Excess	Rank	Excess	Rank	Excess	Rank
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Low	2.041	3	3.785	1	3.578	1	6.054	1
Medium	2.272	2	2.263	2	2.549	2	5.437	2
High	3.439	1	-0.423	3	0.831	3	2.172	3
All	2.672		1.909		2.195		4.334	

Table 5-3 (above) is simple to interpret. Its main message is that for three of the four countries (i.e., except for Germany) the model expects an increase in demand for low skilled labourers relative to the others. In Germany, however, the situation is reversed with more high skilled labourers required to fill-in future expected demand for various skill qualifications. The main social-economic reasons that underlie this result cannot be directly analysed here. As previously discussed, the key reasons are driven by the economic forecasts that are projected by the E3ME macro-econometric global model and WLME, which are exogenous inputs for the CGE labour market component (i.e., MLME). Some of these drivers (e.g., for the United Kingdom) include demographic and social trends which supply more High qualified employees that reduce the overall share of the Low qualified. It furthermore could also reflect slower growth in demand for high qualified employees which would put downward pressure on their wages. (In other words, demand growth is not keeping in pace with supply growth of High qualified employees being churned out from universities.) In Germany, the reverse seems to be the case. In future development of this work, we will define additional broader sets (groups) of countries, which will make it easier to see the broader employment development across the EU.

The requirement of specific skills is also reflected in specific demand for employment in the various industries. Table 5-4 reports the wage rate changes by industries for the four countries.

For example in Germany, we expect further wage rise in *Computing Services* (row 35), *Banking and Finance* (row 33), *Oil and Gas* (row 3) and others industries, which require high and medium skills. In the other three countries, we find wage pressures on *Food, Drink & Tobacco* (row 5), *Retailing* (row 27), *Motor Vehicles* (row 19), which require medium to low skills.

Table 5-4: Average Annual Wage Rate Changes by Industry, 2009 to 2020 (percent)

		Germany		Greece		Netherlands		United Kingdom	
Industry ID and Description		Excess	Rank	Excess	Rank	Excess	Rank	Excess	Rank
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Agriculture etc	3.22	7	6.09	3	0.086	19	5.078	2
2	Coal	1.808	33	2.514	11	1.498	4	1.743	21
3	Oil & Gas etc	4.005	3	3.6	9	-1.348	40	4.827	3
4	Other Mining	1.211	40	1.438	19	-1.231	39	1.983	18
5	Food, Drink & Tobacco	1.552	38	-0.11	36	1.635	3	5.744	1
6	Textiles, Clothing & Leather	2.281	24	-1.142	39	0.854	11	2.457	15
7	Wood & Paper	1.412	39	-0.008	34	0.472	16	3.162	9
8	Printing & Publishing	3.06	10	-1.456	40	0.489	15	-0.015	34
9	Manufactured Fuels	2.869	14	1.541	18	-1.152	38	1.439	25
10	Pharmaceuticals	2.969	13	-0.381	37	-0.284	24	1.642	23
11	Chemicals nes	2.515	22	-0.076	35	-0.836	36	1.681	22
12	Rubber & Plastics	2.097	26	1.986	13	0.995	7	2.679	14
13	Non-Metallic Mineral Products	1.816	30	2.576	10	1.06	6	2.989	10
14	Basic Metals	1.814	31	1.259	22	-0.562	30	2.806	11
15	Metal Goods	1.808	32	1.185	23	-0.081	23	1.412	26
16	Mechanical Engineering	2.548	21	6.682	2	0.027	20	1.611	24
17	Electronics	3.147	8	5.739	4	-0.632	34	-0.158	36
18	Electrical Eng. & Instruments	2.744	15	4.356	5	-0.362	26	1.153	27
19	Motor Vehicles	2.646	18	9.03	1	0.011	21	0.531	32
20	Other Transport Equipment	2.985	12	1.165	24	-0.402	27	-0.052	35
21	Manufacturing nes	1.923	27	0.851	26	1.091	5	4.014	7
22	Electricity	2.641	20	0.464	31	-0.61	32	0.667	30
23	Gas Supply	2.641	19	0.472	30	-0.611	33	0.666	31
24	Water Supply	2.414	23	3.646	8	-0.009	22	1.808	20
25	Construction	1.881	29	0.196	33	0.124	18	2.703	13
26	Distribution	1.9	28	1.412	20	0.888	8	2.76	12
27	Retailing	1.613	37	1.822	15	3.208	1	4.457	6
28	Hotels & Catering	2.176	25	1.763	16	2.33	2	4.795	4
29	Land Transport etc	1.071	41	3.731	7	0.86	10	4.546	5
30	Water Transport	1.723	36	0.531	29	-0.963	37	0.868	29
31	Air Transport	3.006	11	1.163	25	0.637	13	2.137	16
32	Communications	1.8	34	0.396	32	0.494	14	-0.325	37
33	Banking & Finance	4.038	2	0.645	27	-0.469	29	-0.768	39
34	Insurance	1.794	35	0.572	28	-0.654	35	-0.326	38
35	Computing Services	4.127	1	-0.908	38	-0.6	31	-1.153	40
36	Professional Services	3.433	5	1.972	14	-0.415	28	1.037	28
37	Other Business Services	3.23	6	2.025	12	0.883	9	1.879	19
38	Public Administration & Defence	2.715	17	1.354	21	-0.362	25	0.422	33
39	Education	2.742	16	-1.976	41	-3.313	41	-1.461	41
40	Health & Social Work	3.082	9	1.638	17	0.245	17	3.428	8
41	Miscellaneous Services	3.754	4	4.334	6	0.835	12	2.093	17
	All	2.629		1.949		0.138		1.822	

6 Conclusions and further work

E3ME /WLME results have been combined with the MLME to reproduce the WLME forecasts and to reveal the structural labour market pressures underling them. “Balance” in the MLME is interpreted to mean that labour markets clear.

The approach has now been extended to cover all countries and to make use of the latest data and classifications.

The measures developed here can be compared with those developed earlier in the project based on the WLME (for example, by Kriechel (2013)). They can also be compared with indicators developed in other Cedefop projects including the Employer Skills Survey and other short-term indicators.

Planned future work will include a detailed comparison of the measures from both the E3ME/WMLE (Kriechel (2013)) and the CGE MLME approaches Meagher *et al* (2013). (both theoretical and conceptual). It will include step by step comparisons between the MLME - CGE and Kriechel *et al* ’s indicators (practical / empirical), both for selected countries (and groups of countries).

Training agencies focus on the education and training mechanisms that respond to emerging shortages and surpluses aiming to promote a workforce that is equipped with the skills needed in jobs in the future.

Emerging mismatches are usually inferred from analyses of the current situation and are usually only qualitative. The measures developed here provide new quantitative insights into future labour market pressures. Judgement about training needs requires a view about wage rate adjustment:

- the skills mismatch approach implicitly assumes relative wage rates are fixed - the entire adjustment must be borne by the training response;
- but if labour markets clear, the entire adjustment can be borne by wages.

In the longer term, changes in wage rates will induce a training response.

Policy should aim to achieve wage differentials that reflect the working conditions attached to different jobs (work intensity, social prestige, etc).

But the “correct” system of “compensating wage differentials” is unknown - by default, the existing system is usually accorded the status of desirability.

Deviations from existing differentials are habitually met with complaints of “skills shortage” with demands that the government provide more training. The role of wage rate adjustment is too often ignored in discussing training

Other possible future work

Indicators such as EC and WC for specific countries, discussed previously, are useful for specific countries. But the large level of detail makes it difficult at an aggregate European level to define and analyse the broader build-up of pressure across Europe. It is therefore proposed to develop higher level aggregates at the European level. For example, Table 6-1

(below) summarises possible definitions for higher aggregate levels, i.e., EU28, North EU, South EU, and New Comers to the EU.

Separating out these countries according to these broad definitions can help to capture differences in their social-economic-historical fundamentals. For example, both Northern and Southern European countries have had a long membership in the EU. This includes a tradition of having a common market for the movement of labour and goods. They are, however, different in their current economic environment and labour law policies. For example, the Southern EU countries are currently highly indebted countries and at risk of default. They also generally have less flexible labour policies compared to Northern EU countries, which is part of their economic malaise (see e.g., Spain). Furthermore, they are considered to have *not* updated their economies sufficiently to the new globalized world.

A third set of countries can be defined - the New Comers to the EU, which have become EU members after 2004. These countries are mainly former Eastern European countries, which have lower income and wages levels compared to the incumbent European countries. These therefore tend to have higher outward labour emigration towards the richer Northern and Southern European countries, and will require some years of adjustment and alignment after entering the European Union.

Table 6-1: Possible definition for North, South, and New Comers Countries in the EU

Country	Joined EU	North (N)	South (S)	New Commers (NC)
1. Belgium	1952	N		
2. Bulgaria	2007			NC
3. Czech Republic	2004			NC
4. Denmark	1973	N		
5. Germany	1952	N		
6. Estonia	2004			NC
7. Ireland	1973		S	
8. Greece	1981		S	
9. Spain	1986		S	
10. France	1952	N		
11. Croatia	2013			NC
12. Italy	1952		S	
13. Cyprus	2004			NC
14. Latvia	2004			NC
15. Lithuania	2004			NC
16. Luxembourg	1952	N		
17. Hungary	2004			NC
18. Malta	2004			NC
19. Netherlands	1952	N		
20. Austria	1995	N		
21. Poland	2004			NC
22. Portugal	1986		S	
23. Romania	2007			NC
24. Slovenia	2004			NC
25. Slovakia	2004			NC
26. Finland	1995	N		
27. Sweden	1995	N		
28. United Kingdom	1973	N		

Finally, future work could also focus on:

- Comparison with the measures developed by Kriechel (2013);
- Treatment of Technical change in the MLME;
- A focus on other policy issues such as Population ageing;
- Development of pan European models, including a focus on cross border flows;
- Other approaches (GAMs/aggregate modelling).

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Annex A: Conceptual Review

Static shortages

This simple example shows the classic demand supply curve cross. The demand for labour services depends on the price (the wage). As the price rises demand is supressed (and conversely). Supply also depends upon the wage, in this case positively (the higher the wage the more labour services are offered.[7] .

In equilibrium Demand = Supply at the equilibrium wage W*. At this point the demand of labour services exactly matches the supply. There are no imbalances or mismatches.

If however wages were reduce to the level W^2 then this would no longer be the case. Now demand would be much higher, but supply would be reduced. There would be a gap between the two of $L^{d2} – L^{s2}$. This represents a shortage.

Assuming the labour market operates freely markets an increase in the wage will increase supply and reduce demand until they are brought back into balance at the point (W*, L*).[8]

Conversely if the wage were set too high (at level W^1) there would be a surplus of labour services on offer of $L^{s1} – L^{d1}$. Pressure on process in this case would be in the opposite direction.

This provides the first possible indicator of a shortage – rising prices (wages). Conversely falling prices (wages) would be indicative of a surplus

In the first situation (demand exceeds supply) one would expect to find high levels of unfilled vacancies whereas in the second case large numbers of unemployed would be observed. This suggests that a second obvious direct measure of shortage would be the number of vacancies (while unemployment would provide a measure of surplus).

In the simple case shown only one or the other can be expected to be observed. In practice vacancies and unemployment are observed simultaneously. The real world is rather more complex than the simple economic text book example would suggest. Imperfect information, lags in labour market adjustment processes and other factors mean that it is the norm that vacancies and unemployment coexist. Moreover the demand and supply schedules are inherently unobservable, and various factors mean that measured unemployment and vacancies are likely to be only part of the gaps shown by $L^{d2} – L^{s2}$ or $L^{s1} – L^{d1}$.

It is in fact employment levels (the result of the outcome of a combination of both supply and demand forces) that is actually observed. By definition this must always reflect the “short” side of the market. If demand exceeds supply, then employment will be closer to measuring the level of supply. Conversely, if supply exceeds demand, employment will reflect the

[7] This ignores the possibility of a “backward bending supply curve which can arise if workers chose to take some of the benefits of a higher wage income in the form of additional leisure.
[8] We abstract here form complications such as real as opposed to nominal wages or relative wages across different occupational categories.

demand for labour. This is sketched out in Figure 2. The observed employment level falls short of both demand and supply curves because of frictions in the labour market. Even in equilibrium there will be some unfilled vacancies, as employers take time to advertise and fill their job openings while at the same time there will always be some minimum unemployment levels as individuals who have quite (voluntarily or otherwise) take a little time to find a new job.

Thus even if wages are well above the equilibrium level (W^1) one would expect to observed a few unfilled vacancies (but much more unemployment). While at the wage W^2, although demand greatly exceeds supply there will still be a small amount on unemployment as a result of normal labour market turnover.

This implies an observable relationship between vacancies and unemployment as sketched out in Figure 3. This is known as the Beveridge curve. It suggests any attempt to measure and observe labour (or skill) shortages or surpluses needs to focus on both Vacancies and Unemployment.

In practice, it is impossible to observe the demand and supply curves directly and measure therefore the notional levels of vacancies and unemployment implied by the diagrams. Not all vacancies are notified because employers may feel it is not worth doing so, while not all those looking for work will feel it worthwhile registering this officially. The practical measures available therefore often fall short of the theoretical concepts (for further discussion see Section 3).

The discussion so far has focussed on a static situation. In practice, the position is generally much more fluid and dynamic. Demand and supply curves are not fixed in time and space but shift around in response to various external shocks from (for example) the economy or demographic factors.

This is illustrated in Figure 4. In this example demand is shifting in response to (say) a surge in economic growth resulting in extra demand for this particular type of labour (as shown by the outward shifting demand curves from D_0 to D_1 and then D_2. Starting from the equilibrium position (W*, L*) this results in an opening gap of unfilled vacancies which will be filled as wages rise and more people are encouraged to enter the market (a shift up the supply schedule from e_0 (W*, L*) to e_1 and then e_2).

This reinforces the previous idea that rising wage levels can be used as an indicator of shortage. However, it also highlights that it is important to consider the dynamics. Consider a situation in which wages are initially at level W^0 well below the equilibrium level needed to balance the market at e_0. There is a substantial shortfall. Demand then shifts out from D_0 to D_1 and D_2, with wages responding, rising from W^0 , W^1 and W^2 (but insufficiently to restore full equilibrium at e_2). In this example the observed Demand – Supply gap (vacancies) actually declines. This is because wages and supply (the movement along the supply curve)) are responding faster than the demand schedule is moving out. It emphasises that it important to consider both shifts of the demand and supply schedules as well as movements along them.

It also highlights that the observed signals may be apparently conflicting unless it is possible to recognise and separate these shifts and movements. For example if one considers the

reverse of the situation just described with demand curves shifting inwards from D_2 to D_1 and then D_0

It would be possible to observe falling wages despite a widening gap between demand and supply if wages fall faster than necessary to balance supply and demand.

It all depends on the pace of change of the position of the demand and supply schedules and of wage levels.

Another important consideration is that there may be big differences between the short-run and long run schedules. Consider Figure 5. Beginning from an equilibrium position such as e_0, consider what happens if there is an outward shift of the demand curve from D^0 to D^1. At the current wage there will be a large gap (shortage) of $L^{d1} – L^{d0}$. If supply is in elastic in the short-run then effectively the supply schedule is an fact a vertical line. Wages will be driven up to W^{1s}. (which in the long run would encourage a big increase in supply to L^{s1}). As supply responds the wage would fall until eventually a new equilibrium is restored at e_1.

Figure 1: Static Shortages (and Surpluses)

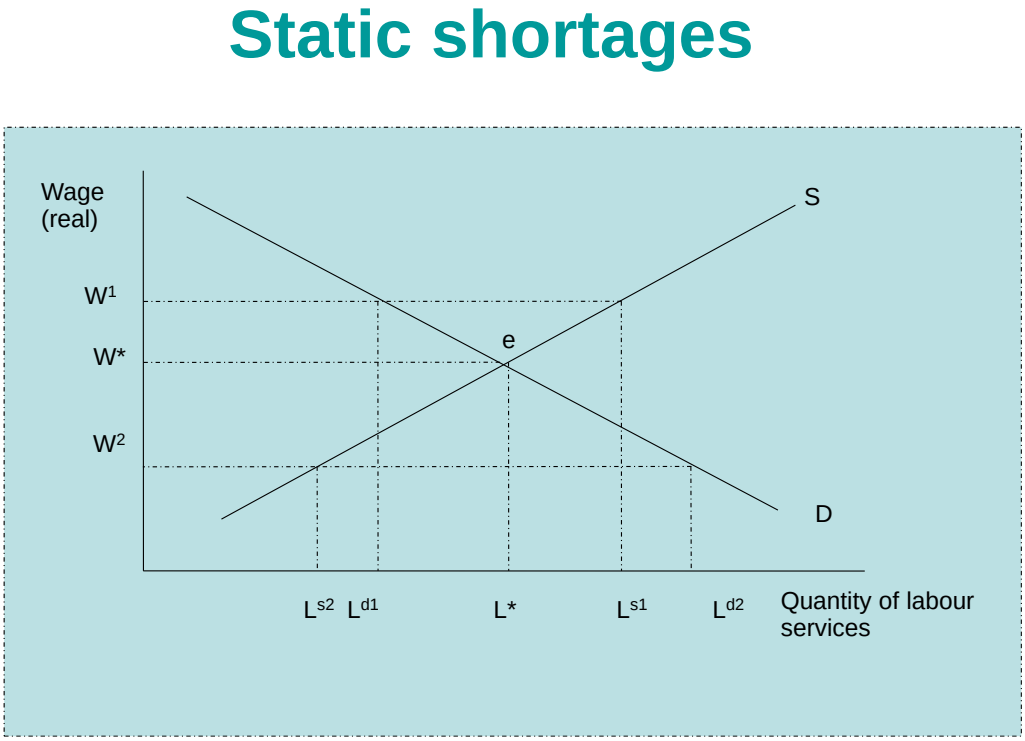


Figure 2: Frictional unemployment and vacancies

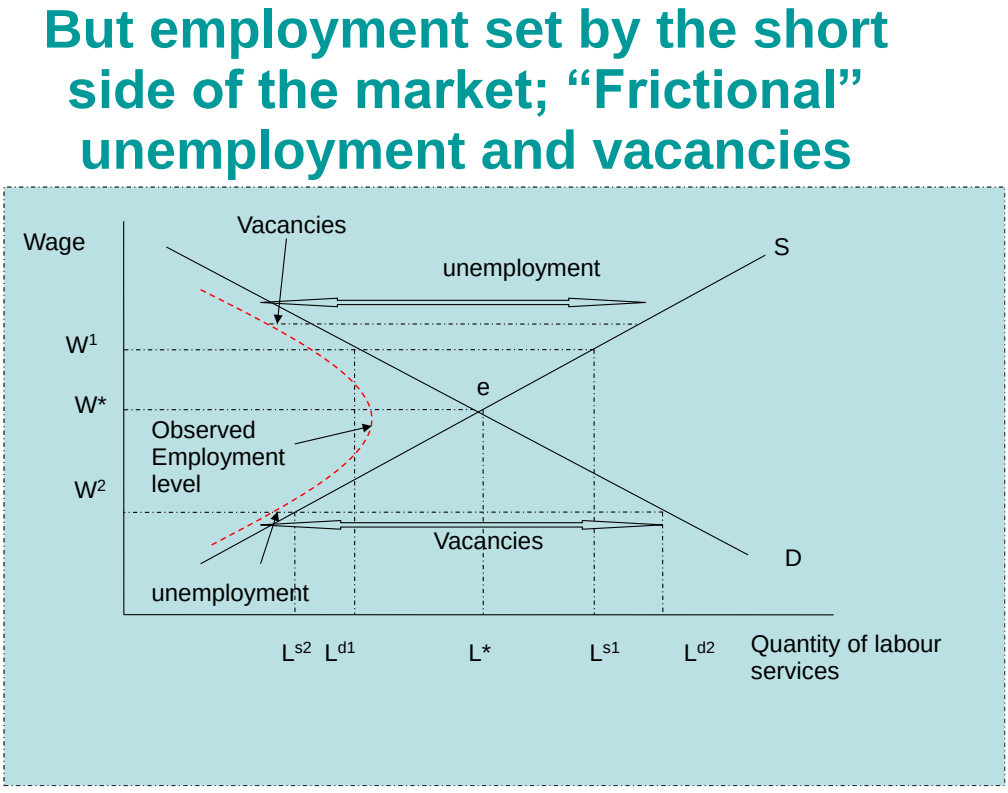


Figure 3: Frictional unemployment and vacancies – the Beveridge curve

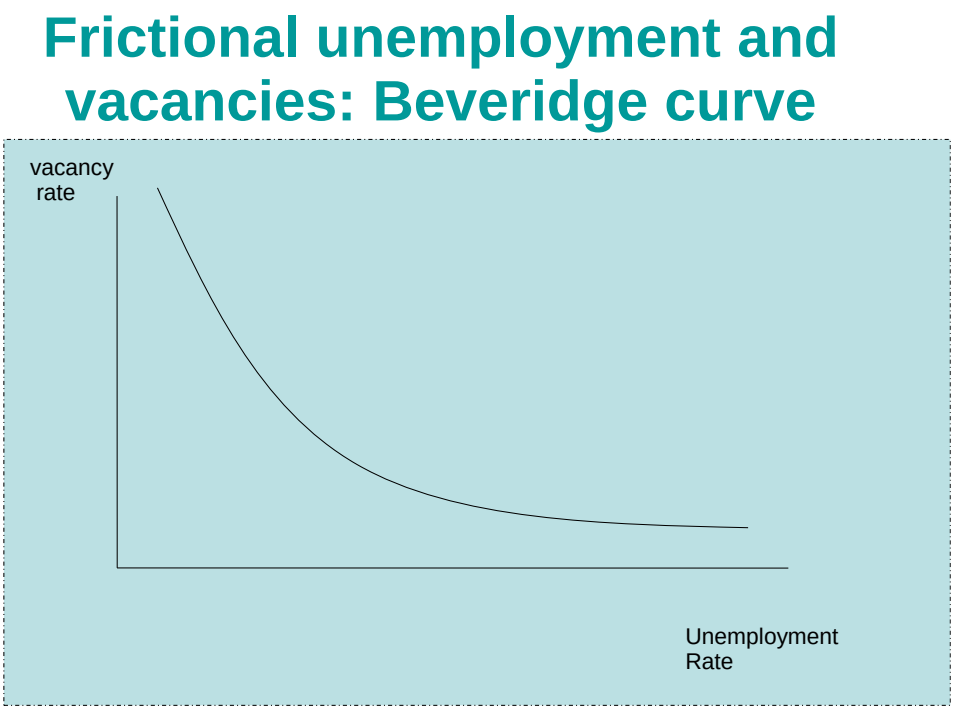


Figure 4: Dynamic shortages

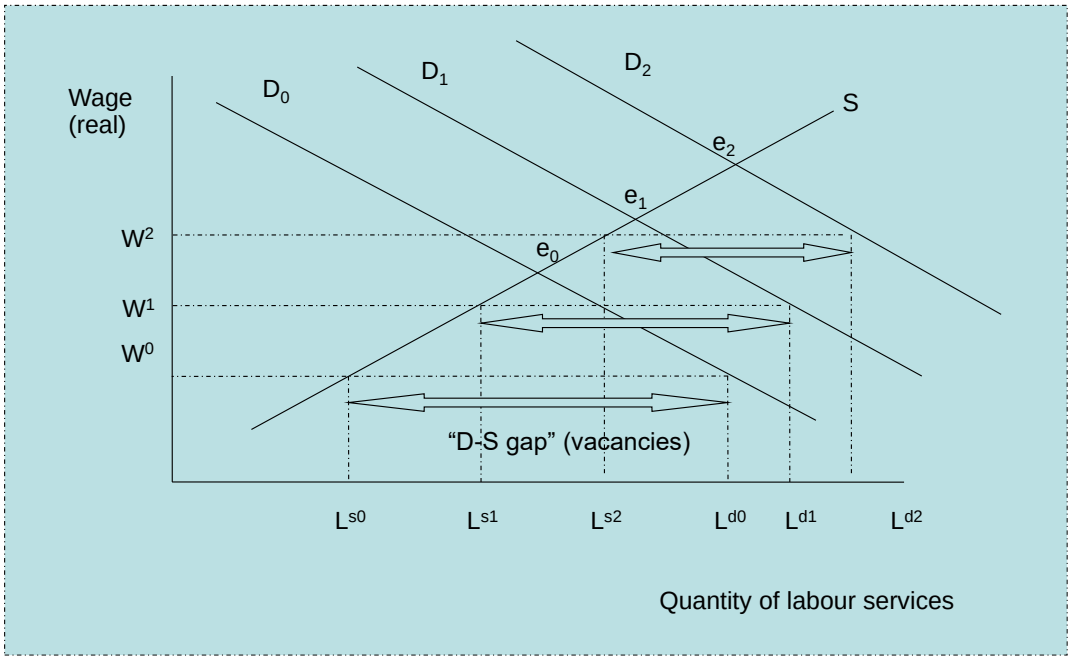
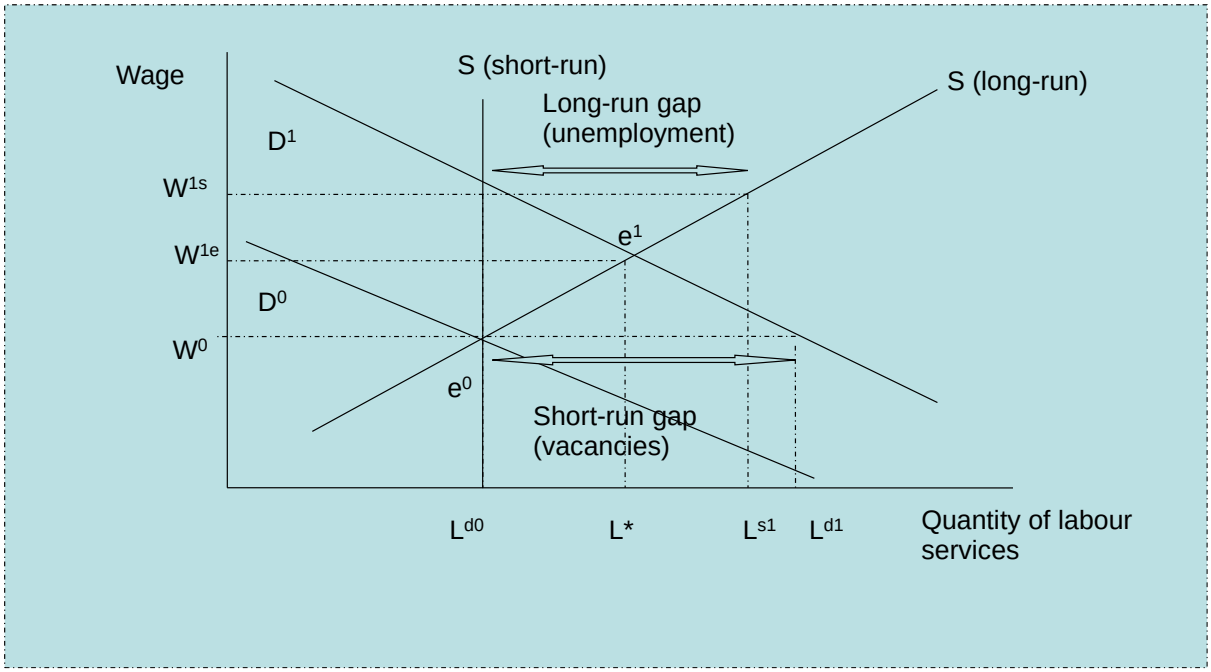


Figure 5: Short and long run supply responses



Annex B: Practical Indicators of Skill Shortages

This annex provides a review of some of the many studies that have explored the issue of the measurement of skill shortages. It focuses especially on experiences in the UK and Australia where there has been considerable effort on this front. The motivation is to set the measures being developed in the CGE modelling work into a broader context. The conceptual review in Annex A highlights the role of changes in "prices" (wages) as well as unfilled vacancies. However, it also illustrates that this is not as simple as it might at first appear.

As noted in Section 2 of the main paper a number of detailed and in depth reviews, such as those by Bosworth (1993) have concluded that measuring shortages is far from straightforward.

For example Veneri (1999) concludes that it was an impossible tasks ("no single empirical measure of occupational shortages exists, nor does it appear that one can easily be developed". Despite that the demand for practical measures cannot be ignored, so the author then proceeds to identify three main possibilities for useful indicators of occupational shortage (focussing on changes over time and using readily available US data). These were:

- **Strong employment growth:** are employment levels in the occupation growing much faster than the average? (Veneri suggested a rate at least 50 per cent faster than the average should be regarded as significant).

- **Relative wage increases:** are wages for the occupation wage increasing faster than the average? (In this case Veneri suggested a threshold of at least 30 per cent faster than average to warrant concern).

- **Falling or low occupational unemployment rate:** Is the occupation's unemployment rate below average or falling relative to the average? (Here Veneri suggests the rate should be at least 30 per cent *below* the average to be of significance).[9]

Although the methodology has the advantage of simplicity, the problem with all this is that the kinds of thresholds suggested are essentially arbitrary. Moreover many of these conditions can arise in situations where no shortage exists.

Green, Machin and Wilkinson (1998, p167) argue that 'in a substantial number of cases, the term "skills shortage" appears to mean for employers something wider or different from "hard-to-fill vacancy"'. The UK Employer Skill Survey (ESS), which was initiated in 1999 (Hogarth *et al.* 2000), was part of a programme of research aimed at measuring the extent causes and implications of skill deficiencies in the UK economy. The ESS distinguished a range of different measures. These attempted to make a distinction between normal labour market operations (vacancies that are filled in a "normal" period of time) and more significant skill deficiencies. The latter included general problems of recruitment in the external labour market (hard to fill vacancies), so called skill shortage vacancies (HTF vacancies attributable to skill shortages based on supplementary questions posed to employers) and internal skill

[9] Veneri did not consider vacancies as US LMI at that time did not include general surveys of vacancies.

gaps (problems with the skills held by the existing workforce). Overall, there is a strong emphasis in the ESS on vacancies as potential measures of skills imbalance.
A number of these indicators were taken up by the UK Commission for Employment and Skills (UKCES), which is currently responsible for commissioning and publishing the latest version of the ESS. A number of them are have also been used by the UK Migration Advisory Committee (MAC) in preparing its Skill Shortage Occupation List (SOL).

The current UK Employer Skills Survey (ESS) is a very large survey of employers' skill needs, including questions about skills utilisation, and investment. It has been conducted every couple of years on a broadly similar basis since 1999.[10] Data are collected data via telephone interviews from some 80-90,000 employers, representative of the UK employer population in terms of size, sector, and region.

The results from the UK ESS are now available for over a decade. They tend to indicate that many problems are ephemeral and marginal (Wilson (2009a and b)):

- Vacancies are generally only modest in scale, typically just 2-3 per cent of UK firms report some vacancies; equivalent to 2-3 per cent of total UK employment.

- Hard to fill (HTF) vacancies (taking more than a few weeks to fill) are even more modest, suggesting that the market is generally quite responsive to employer demands (although in recent years this is also indicative of lack of aggregate demand and an overall excess supply of labour following the financial crisis of 2008..

- There is some evidence that HTF vacancies have an impact on business in some cases loss of business to competitors.

- Using supplementary questions, the UK ESS also distinguishes HTF vacancies attributable to skill-shortages. These are referred to as "skill shortage vacancies" (SSVs). According to the responses of the employers surveyed these are due to deficiencies in the skills, qualifications, or experience of job applicants.

- Examination of changes over time suggests that in many cases the problematic areas come and go which is what one might expect if markets take a while to adjust.

- The areas of persistent problems tend to be in the public sector where employers are unwilling or unable to pay market rates.

- Results from ESS also highlight the problems of what are referred to as internal skill gaps amongst the existing workforce. Such "skill gaps" (where existing workers are not fully proficient in their jobs) are much more frequent than SSVs (affecting 10-15% of UK establishments compared to 2-5%).

- Patterns of vary across occupations: SSVs are most frequent and intense (i.e. as a proportion of all vacancies) for skilled trades; skill gaps are reported most frequently for sales and customer service occupations, and for elementary occupations.

In exploiting that data from the UK ESS various indicators have been developed which highlight the frequency, intensity and scale of skill deficiencies. These range from general indicators of recruitment difficulties, such as vacancy fill rates to complex combinations of employer responses to questions about the proximate causes of the problems they perceive.

[10] For a critical appraisal see Wilson (2009).

As noted above, the Migration Advisory Committee (MAC)[11] is one of the main users of data from ESS as part of its work in monitoring skill needs and making recommendations to the government about whether it is sensible to allow inward migration to meet skills shortages. To this end, since 2008, it has prepared a regular Shortage Occupation List (SOL). In MAC (2008), the first SOL was published and it has been regular updated ever since. Its work programme has included a number of reviews of the concept and measurement of skill shortages.

Greig, Glancey, and Wilson (2008) were commissioned by the MAC to review its proposed approach critically. They concluded that there was no single widely accepted measure of skill shortage and that a "suite" of indicators is needed. They also concurred with the MAC's view that it is necessary to combine "top-down" quantitative, macroeconomic evidence (based on national and official data sources), with "bottom-up", often more qualitative microeconomic evidence drawn from employer surveys and other sources. Frontier Economics (2009) conducted a similar review after the MAC had published its first SOL Tables 1 and 2 summarises some of the main features of these and other reviews.

In a more recent review the MAC (2010) contracts the very detailed concepts of skill gaps, recruitment difficulties, and hard-to-fill vacancies adopted in ESS, with a broader taxonomy focussing on more general policy concerns. This distinguishes four main types of skill shortage:

- Cyclical—dependent on the point in the business cycle;
- Structural—due to a lack of necessary skills in the workforce;
- Due to constraints on public spending (where wages are sticky and unresponsive);
- Due to global talent shortages (reflecting a worldwide rather than national shortage).

Despite these distinctions the MAC has adhered to its preferred set of "top down indicators". These are summarised in Table 3. According to the MAC (2013), to fully assess labour and skill shortages it is necessary to look at various price indicators (wages), as well as volumes (vacancies, employment and unemployment) and employer perceptions of shortage. In their first report (MAC, 2008) they identified a total of 12 indicators of labour shortage for top-down analysis. These indicators fell into four broad categories:

- E - employer-based indicators (e.g. reports of shortage or skill deficiencies);
- P - price-based indicators (e.g. earnings growth, rates of return);
- V - volume-based indicators (e.g. employment or unemployment); and
- I - other indicators of imbalance based on administrative data (e.g. vacancy duration or vacancy/unemployment ratios).

These have subsequently been refined slightly as summarised in Table 3.

The MAC emphasises the important of what it describes as combining top down analysis using macro level mainly official data and bottom up analysis based on a more qualitative assessment of things on the ground. These elements are "dovetailed" together to reach an overall assessment. A second point emphasise is the important of thresholds when reaching a judgement about whether or not a shortage exists. There is therefore a considerable amount of judgement and subjectivity involved.

[11] The MAC is a non-statutory authority, operating under the auspices of the UK Border Agency. The MAC advises the UK government on migration issues, including whether skills shortages warrant inward migration.

Table 1: Indicators of labour or skill shortage

Study	Indicators			
	Employment (E)	Pay (W)	Gaps (V, U)	Other
Veneri (1999)	ΔE	ΔW	ΔU [12]	
Zurn *et al*. (2002),	ΔE	ΔW	ΔV, ΔU	Overtime hours
		RoR?		
SSDA / LSC (ECISD, c 2000)	ΔE	ΔW	ΔV, ΔU	Overtime hours
			Refinements , V/U ratios, Durations, etc SSV hard to fill V skill gaps,	
Shah and Burke (2005)	ΔE	ΔW	ΔV, ΔU	Overtime hours
Greig, Glancey, and Wilson (2008) for MAC	ΔE	ΔW	ΔV, ΔU	Overtime hours
Frontier Economics (2009) for MAC	ΔE	ΔW	ΔV, ΔU	Overtime hours
		RoR		
Richardson (2009)	ΔE	ΔW	ΔV, ΔU	Overtime hours
Holt *et al* (2010) for UKCES	ΔE	ΔW	ΔV, ΔU	Overtime hours
NILS (2013)	ΔE	ΔW	ΔV, ΔU	Overtime hours
I				

[12] US LMI at that time did not include a general survey of vacancies.

Table 2: Issues with indicators

Indicator	Issues
Vacancies	**Rationale:** The most commonly used indicator of skill shortage - a proxy for Demand less Supply. **Limitations:** Rarely comprehensive (many vacancies are not notified) Many official vacancy series (for example, as published by Public Employment Services) account for only a small proportion of the workforce (often excluding higher skill groups). Reported; vacancies can persist for many reasons other than a skill shortage (for example, poor working conditions and low pay). Employers have an incentive to exaggerate skill shortages to encourage the state to intervene and bear the costs of training. **Refinements:** Often used as an absolute measure vacancies are probably best expressed in relative terms as a proportion of employment or compared with unemployment. Vacancy duration and vacancy fill rates are also used. Distinctions can be made between all reported vacancies; hard-to-fill vacancies (HTVs); and skill shortage vacancies (SSVs).
Wages	**Rationale: P**ositive changes in pay may indicate a tightening of the labour market **Limitations:** Wages change for many other reasons (not least general inflation). Even when skill shortages do exist employers may be reluctant to raise wages and adjustments often occur instead in non-wage elements of the work package. **Refinements:** Change over time or wage relativities; rates of return
Unemployment	**Rationale:** The most commonly used indicator of a surplus **Limitations:** unemployment can coexist with vacancies; it can fall for reasons unconnected to skill shortages (for example a general upturn in the economy). Occupational unemployment rates typically relate to a person's last paid job, not to the kinds of jobs for which they are currently searching. **Refinements:** can be combined with vacancy information
Employment/hours	**Rationale:** increases in employment or average hours worked for a particular occupation is a signal of rising demand (and therefore an indirect indicator of possible skill shortages).' (Other indicators such as overtime working, recruitment intensity, and labour turnover turnover can also provide useful signals). **Limitations:** Employment and hours may rise for many reasons and neither are definite indicators of a shortage. **Refinements:** Forward looking and "what-if" scenarios estimates as presented in this paper.

Table 3: The MAC's 12 top-down indicators of shortage (SOC 4 digit level)

Code	Indicator	Source	Threshold used
	Employer perceptions		
E1	Skill-shortage vacancies/total vacancies	NESS	yes
E2	Skill-shortage vacancies/hard-to-fill vacancies	NESS	yes
E3	Skill-shortage vacancies/employment	NESS	yes
	Price based measures		
P1	Percentage change of median real pay (1 yr)	ASHE	yes
P2	Percentage change of median real pay (3 yrs)	ASHE	yes
P3	Rate of return to occupation	LFS	No
	"Volume" based indicators		
V1	Percentage change of claimant count (1 yr)	JCP	yes
V2	Percentage change of employment level (1 yr)	LFS	yes
V3	Percentage change of median paid hours worked (3 yr)	ASHE	yes
V4	Change in new hires (1 yr)	LFS	yes
	Other indicators (based on administrative data)		
I1	Change in median vacancy duration (1 yr)	JCP	yes
I2	Vacancies / claimant count	JCP	yes

Source: Modified from (MAC, 2013).
Notes: NESS – National Employer Skills Survey; ASHE Annual Survey of Hours and Earnings; LFS Labour Force Survey JCP Job Centre Plus (Public Employment Service).

Zurn *et al*. (2002), in a study of the health sector, outline a number of potentially useful indicators, many of which have more general applicability. They include:

Employment indicators: amongst which (rather confusingly) they include vacancies, occupational unemployment rates, and labour turnover as well as, employment growth.

Regarding Vacancies, Zurn *et al*. (2002) focus on the mean vacancy rate by occupation, or the three-month vacancy rate (representing hard to fill vacancies).They emphasise it is the change and not the level that matters. They note that employers may not bother to advertise for the positions they think will be hard to fill. There are also a more general concern that often vacancies reported to Public Employment Services represent only a very partial coverage of all vacancies

Employment growth is suggested as a possible indicator of shortage. Relatively rapid growth in employment in an occupation could indicate a looming shortage or some kind of correction to a previous shortage (but as noted in Section 2 it may indicate many other things).

Labour turnover is easily measured and its rate is another potential indicator of problems. High wastage imposes cost which are both direct (recruitment) and indirect (lower staff morale or lower productivity). But labour turnover does not necessarily imply poor job quality or skills mismatch.

Activity indicators: measuring the state of (economic) activity including overtime work

Price indicators: such as rising relative wages or increasing rates of return on educational investment

Relative wages may change for reasons unrelated to skills imbalances, such as changing regulations, union bargaining, and monopsony power of employers.

Rate of return have been suggested by some as a measure of labour market pressure. If rates of return are above average this does suggest an imbalance of demand over supply and conversely. However, it is reliant on historical data on patterns of wages by age. It is therefore essentially backward looking. It's use to guide policy is therefore a bit like driving forward just using the rear view mirror!

Rates of return can be calculated by estimating the costs of investment in education and skills relative to the expected higher financial returns achievable as a result of that investment. However this requires quite complex calculations (it is not a simple statistic to produce but requires econometric or similar analysis).

Shah and Burke (2005) argue that for economists, skill shortages occur when there is an insufficient supply of appropriately qualified workers available under existing market conditions. This is often associated with hard to fill vacancies, but they argue it is appropriate to consider a much wider range of indicators. They discuss four main groups of indicators:

1. **Occupational Vacancy (V) rates**, although they emphasise that these include normal labour market turnover as workers move between jobs, both within and across occupations.

2. **Occupational unemployment (U) rates,** the main problem highlighted here is that such information is essential backward looking being based on the worker's last occupation.

3. **Combinations of 1. and 2 (V- U or V/U),** focusing on the ratio measure which they argue is easier to produce and interpret at the aggregate labour market level than at a more detailed occupation level.

4. **Wage differentials,** which includes both current wage differentials as well as changes over time. They also recognise that wages may change for other reasons than simple to reduce a skill shortage (not least general inflation).

Shah and Burke (2005) describe a range of other possible indicators of labour market pressure, including:

- intensity of work (average weekly hours or overtime)
- economic activity levels (GDP)
- employment levels and changes therein
- flows of new entrants and leavers
- levels of immigration and emigration

Richardson (2009) identifies vacancies as a particularly useful indicator, noting however that a general problem with such indicators is that they rely heavily on employers' perceptions. This is of concern to policy makers since employers may have an incentive to exaggerate skill shortages to encourage the state to intervene and bear the costs training that they are not prepared to shoulder. Richardson also suggests that recruitment agencies can be consulted although it is not clear that their views are any less prejudiced.

She also mentions a similar range of indicators of labour market pressure, including:

- Rising wages
- Low unemployment rates
- Increasing use of overtime
- Increasing use of temporary workers
- Improving terms of employment
- Low rates of redundancy or dismissal and high rates of quits
- Falling levels of qualifications or experience required
- Increasing use of 'non-traditional' workers (e.g: older people, migrants atypical gender mix)

However, Richardson (2009) recommends restricting the set of indicators to "avoid mixed signals that do not lead to clear policy responses, and to reduce the reliance on lower-quality data". However, this assumes that there is a clear narrative to be discerned. Often the indicators tell a very mixed story which may be just what is to be expected if markets are operating efficiently and any mismatches are ephemeral!

A more recent review conducted by NILS (Mavoratas, *et al*. 2013) draws all this together. Based on their review, and drawing together all of the other studies cited above it is possible to conclude that:

- the term "skill shortage" is interpreted in many different ways;
- no indicators provide an unequivocal measure of shortage, the thresholds above which an indicator is deemed to show a "shortage" is arbitrary and different indicators often give conflicting results – all require some element of judgement;]
- no single indicator of "skill shortage exists;
- the most widely utilised indicators of shortage are vacancies (variously defined and recognising their limitations);
- growth in employment and in overtime hours provide complementary evidence;
- changes in relative wages are in principle relevant but in practice observed movement are often difficult to interpret;
- rates of return are also relevant qualifications but in practice they are hard to measure and are backward looking;
- employer views are useful but inevitably biased – they do not provide an independent view of the situation;
- the devil is in the detail, policy makers and others want very detailed indicators but the available data are often inadequate for the purpose

NILS (2013) recommends four sets of indicators of skills imbalance which can be constructed using widely available and robust Australian data. Their proposed indicators focus on:

1. The state of the labour market;
2. The recruitment experience (employer perceptions);
3. The education experience (student responses); and
4. Labour market entrants.

The state of the labour market focuses on aggregate indicators that measure aspects of the general economic environment that are thought to be linked to skills imbalances. Analogous more specific occupational information is also included, if and when available.

The recruitment experience focuses on the experience and perceptions of employers who are active in the labour market (as well as those of workers who are looking for jobs).

The education experience focuses on the student response to skills imbalances, including how their choices are being influenced by labour market signals.

Labour market entrants focuses on the outcomes and experiences of new and recent labour market entrants, including graduates from universities and the VET system, as well as new immigrants arriving with employer-sponsored skilled visas.

In practice, the final set of indicators include the usual suspects such as hard to fill vacancies, unemployment rates, wages, and changes in the level of employment and utilisation of labour/skills in the jobs concerned.