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The Europe 2020 Strategy and Skill Mismatch

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Abstract

In a recent study, the European Centre for the Development of Vocational Training (Cedefop) investigated the expected effect on European labour markets of the transition to a high-employment, low-carbon economy. The study extended its previous initiatives in skills forecasting to determine employment under different policy scenarios derived from the Europe 2020 Strategy. This strategy includes the so-called 20-20-20 climate and energy targets, namely,

- a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels;
- a requirement that renewable sources represent 20% of EU final energy consumption;
- a reduction in energy consumption of 20% from projected 2020 levels by improving energy efficiency.

It also includes an employment target whereby 75% of the population aged 20-64 will be employed by 2020.

In its quantitative analysis it employs the E3ME macro-econometric model to determine the effects of transition on the demand for labour by industry. The industry projections are then converted into demand for labour by skill (as represented by occupation and qualification) using employment shares taken from the earlier forecasts.

The implementation of a demand-side policy package like the 2020 Strategy introduces structural pressures into the markets for labour in the sense that it creates tendencies towards excess demands for, or supplies of, skills. If the pressures are not accommodated by supply-side policies (such as training programs), they will tend to emerge as changes in relative wage rates and/or unemployment rates. One purpose of Cedefop's analysis is to reveal the nature of the structural pressures the Strategy releases, and hence kind of training programs that are required. However, its scope is limited because it abstracts from constraints imposed by the available supplies of labour.

In this paper a CGE-style labour market extension MLME to the E3ME model is used to investigate how labour supply considerations affect the skill requirements of the Strategy. Specifically, it investigates the proclivity of the Strategy to produce mismatches between the demand for, and supply of, labour differentiated by occupation. Results are reported and compared for 26 EU countries.

JEL codes: C53, C58, D58, E27, J23, O41

Keywords: Forecasting, CGE models, hybrid models, labour markets, structural imbalances

Contents

1. **Introduction**

In a recent study, the European Centre for the Development of Vocational Training (Cedefop, 2013) investigated the expected effect on European labour markets of the transition to a high-employment, low-carbon economy. The study extended its previous initiatives in skills forecasting (Cedefop, 2010a) to determine employment under different policy scenarios derived from the Europe 2020 Strategy. This strategy includes the so-called 20-20-20 climate and energy targets, namely,

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- a requirement that renewable sources represent 20% of EU final energy consumption;
- a reduction in energy consumption of 20% from projected 2020 levels by improving energy efficiency.

It also includes an employment target whereby 75% of the population aged 20-64 will be employed by 2020.

Cedefop considers that the skill requirements of the transition can be best understood as being driven by structural labour market change. In its quantitative analysis, therefore, it employs the E3ME macro-econometric model[1] to determine the effects of transition on the demand for labour by industry. The industry projections are then converted into demand for labour by skill (as represented by occupation and qualification) using employment shares taken from the Cedefop 2010 forecasts.

The implementation of a demand-side policy package like the 2020 Strategy introduces structural pressures into the markets for labour in the sense that it creates tendencies towards excess demands for, or supplies of, skills. If the pressures are not accommodated by supply-side policies (such as training programs), they will tend to emerge as changes in relative wage rates and/or unemployment rates. One purpose of Cedefop's analysis is to reveal the nature of the structural pressures the Strategy releases, and hence kind of training programs that are required. However, its scope is limited because it abstracts from constraints imposed by the available supplies of labour.

In this paper a CGE-style labour market extension MLME (Meagher et al., 2014a) to the E3ME model is used to investigate how labour supply considerations affect the skill requirements of the Strategy. Specifically, it investigates the proclivity of the Strategy to produce mismatches between the demand for, and supply of, labour differentiated by

[1] The energy-environment-economy model for Europe (E3ME) has been developed by Cambridge Econometrics. A short non-technical description can be found in Cedefop (2013. Annex 4). Further details, including the full technical manual, are available from the E3ME website.

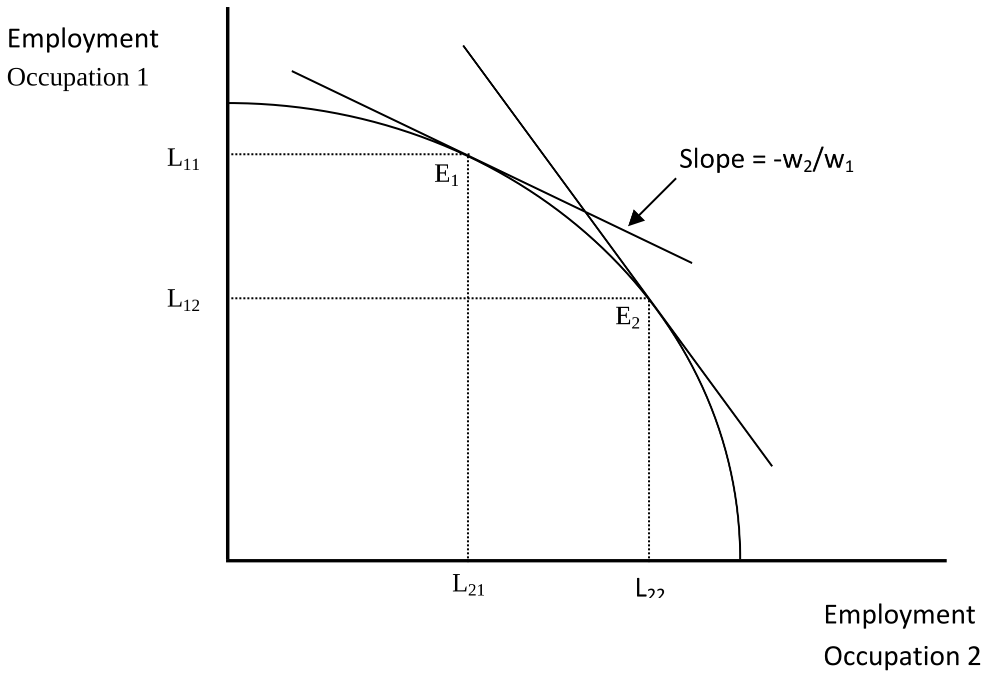
occupation. The remainder of the paper is structured as follows: Section 2 presents an overview of the MLME model. Section 3 describes how the Cedefop demand-side projections are introduced into MLME. Section 4 analyses how the Strategy affects structural pressures in a particular country, with the United Kingdom providing the example. Section 5 presents comparative results for 26 EU countries. Section 6 contains some concluding remarks.

2. The MLME Model: an Overview

MLME describes the operation of 27 occupational labour markets. On the supply side of these markets, the preferences of workers with a particular skill (here represented by qualification) are such that they are indifferent between occupational combinations which lie on the same Constant Elasticity of Transformation (CET) function. Figure 1 presents the idea diagrammatically. The position of the transformation curve is determined by the supply of the skill measured in preference units rather than hours. If the wage rate for occupation 2 increases relative to that for occupation 1, the isorevenue line becomes steeper, and the owners of the skill can increase their income by transforming some of occupation 1 into occupation 2. Hence, they change the occupational mix from E_1 to E_2. In principle, each of the 3 skills (high, medium and low) identified in MLME can be transformed into any of the 27 occupations. However, if none of a particular skill is used in a particular occupation in the base period[2], none of it will be used in that occupation in any of the forecasts.

On the demand side, labour of different occupations can be converted into effective units of industry specific labour according to Constant Elasticity Substitution (CES) functions. In Figure 2, the position of the isoquant is determined by the demand for labour in the industry.

[2] The base period for the simulations reported in here is 2009.



F*igure 1 : Skill Transformations between Occupations*

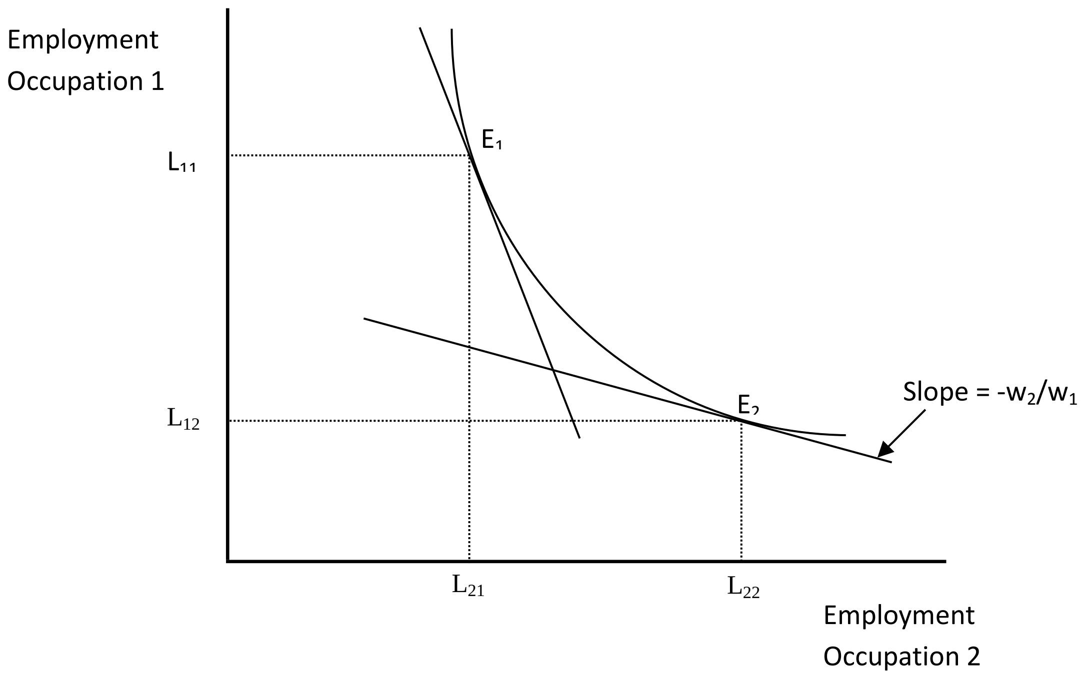


Figure 2: Substitution between Occupations in Industries

If the wage rate for occupation 2 decreases relative to that for occupation 1, the isocost line becomes flatter, and the producers in the industry can reduce their costs by substituting some of occupation 2 for occupation 1. Hence they change the occupational mix from E_1 to E_2. In principle, each of the 41 E3ME industries can employ any of 27 occupations but, as before, 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.

MLME can accommodate different scenarios concerning the operation of the occupational labour markets. If relative wage rates are fixed, the model determines the skill mismatches (expressed in terms of occupations) which pertain at those wage rates. If relative wage rates are flexible, the model determines the wage rate changes required to clear the labour markets and eliminate any skills mismatches. If relative wage rates are sticky, the model determines the residual mismatches after the partial wage adjustment has occurred.

The MLME model has been developed at the Centre of Policy Studies, variously located at Monash and Victoria Universities, Melbourne. It is designed to provide an alternative to the WLME labour market extension (Wilson et al. 2010) used in conjunction with E3ME to derive the Cedefop 2010 forecasts. WLME has been developed at the Institute for Employment Studies, University of Warwick. Like E3ME, WLME relies mainly on time-series econometric techniques. The equations and closure of the MLME model are set out in an appendix.

3. Adapting the MLME model

As well as a baseline, three policy scenarios regarding sustainable energy are considered by Cedefop. They can be described as follows (Cedefop, 2013, p. 34):

- *The Baseline scenario*

The baseline scenario is designed to be consistent with projections derived from the Primes partial equilibrium energy market model published by Directorate-General for Energy (European Commission, 2010). The baseline includes many existing energy and climate policies accounting for about half of the reduction in CO2 emissions from 1990 levels required to meet the 20% emissions target. It is regarded as a business-as-usual case, representing expected outcomes if no further policy is implemented.

- *The Energy target scenario*

Apart from energy-efficiency measures, the policies implemented to reach the emissions and renewables targets are the same as those used by the Primes model to produce the reference case described by the Directorate-General for Energy. Energy efficiency is assumed to be achieved through additional investment. In this scenario, the 2020 targets for reductions in greenhouse gas emissions and uptake of renewables technologies are met; as is the objective of reducing final energy use by 20%.

- *The Energy-target growth scenario*

In this scenario, rates of economic growth are increased (by raising export volumes) to the point where the EU 2020 employment targets are met. It is designed to draw attention to the kind of stimulus that will be required to meet the 2020 targets in the post-recession European environment.

- *The Energy and employment target scenario*

Here the employment target is met without compromising the climate and energy targets. For this, policy measures will be required to provide incentives for employers to hire more workers and for individuals to supply their labour.

The changes in the demand for labour by industry induced by one or other of the target scenarios, that is, the differences between the target scenario in question and the baseline scenario, are introduced as policy shocks into MLME.

In the Cedefop 2010 forecasts, one of the modules in WLME "balances" the demand for labour by occupation (derived from E3ME) with the supply of labour by occupation (derived from independent projections of employment by qualification). If the balanced E3ME-WLME forecast is interpreted as a market clearing forecast, technical change can be introduced into MLME such that E3ME-MLME reproduces the Cedefop forecasts. This procedure is described in Meagher et al. (2014b). It is these Cedefop 2010 forecasts, forecasts which can be produced by either E3ME-WLME or the market-clearing version of E3ME-MLME, which constitute the baseline for the present analysis. They are similar to, but not the same as, the baseline projections used by Cedefop in its 2013 study.

To simulate the effects a Cedefop target scenario, the changes in the demand for labour by industry induced by the policy (that is, the deviations from the baseline as computed by E3ME) are imposed as shocks to the baseline demand for labour by industry in MLME The aggregate demand for labour and the supply of labour by qualification in each period are assumed to be unaffected by the shocks. Hence, it is actually the changes in the *distribution* of demand across industries due to the policy that constitute the shocks to MLME. In other words, the present simulations focus on changes in the structure, rather than the level, of employment.

Now, according to Cedefop, “the key result from (its quantitative) analysis … is that there is little discernible difference in occupational structure between the baseline and the ‘energy target scenarios’ in 2020” (Cedefop, 2013, p.48). This result is reproduced in the MLME simulations. That is, the shocks due to the *Energy target scenario* and the *Energy-target growth scenario* are so small that they do not induce any significant changes in the market-clearing distribution of labour by occupation. The distribution remains essentially the same as in the baseline. The result originates entirely within E3ME and owes nothing to the MLME model. For that reason, this paper will follow the precedent established in the Cedefop report and focus its attention henceforth on the *Energy and employment target* scenario.

Table 1 shows selected shocks for the *Energy and employment target* scenario as it applies to the United Kingdom. From row 1, the policy is responsible for an increase of 0.636 per cent in the demand for labour by the industry *1 Agriculture etc*. in 2012. The change in demand increases to 4.953 per cent in 2016 and to 8.515 per cent in 2020. On average, demand by the industry increases by 4.124 per cent each year from 2012 to 2020. The policy is introduced in 2012 and does not affect demand in any year before then. From row 42, aggregate demand is also not affected.

Table 2 ranks the industries by the absolute values of their changes in demand in 2020. In a market-clearing MLME simulation, the changes in demand are also the changes in employment. The industry most affected is *17 Electronics* for which employment is projected to increase by 44.65 per cent as a result of the policy. The industry least affected is *9 Manufactured fuels* for which employment changes by only 0.87 per cent. If the sign of the change is taken into account, the ranking in column 5 of Table 2 closely resembles the ranking in column 4 of Table 1. The rankings are not identical because they refer to different periods of time.

Tables 1 and 2 provide a summary of the information that is transferred from E3ME to MLME for the United Kingdom. Based on information of this kind, the MLME simulations extend the Cedefop results for 26 of the 28 member countries of the European Union.

Table 1. Selected Employment Changes by Industry, Energy and Employment Target Scenario, United Kingdom, Per Cent

Code	Industry	(1) 2012	(2) 2016	(3) 2020	(4) Average 2012-20
1	Agriculture etc	0.788	6.221	10.236	5.303
2	Coal	-0.875	-3.406	-6.288	-3.108
3	Oil & Gas etc	-1.699	-6.605	-12.014	-6.025
4	Other Mining	-0.451	-1.768	-3.310	-1.607
5	Food, Drink & Tobacco	-0.540	11.726	20.922	10.953
6	Textiles, Clothing & Leather	2.081	13.650	33.455	15.568
7	Wood & Paper	-0.772	8.634	9.276	6.465
8	Printing & Publishing	-0.609	-2.425	-3.598	-1.988
9	Manufactured Fuels	-1.704	3.229	2.956	1.966
10	Pharmaceuticals	-2.149	-6.045	-6.060	-4.982
11	Chemicals nes	-0.902	-2.259	-4.851	-2.238
12	Rubber & Plastics	0.795	0.022	5.330	1.478
13	Non-Metallic Mineral Products	-0.780	-3.198	-5.475	-2.946
14	Basic Metals	-1.249	-0.769	0.977	0.022
15	Metal Goods	-0.845	-1.396	3.722	0.362
16	Mechanical Engineering	-0.844	4.232	17.729	8.340
17	Electronics	2.809	20.472	25.192	16.914
18	Electrical Eng. & Instruments	0.278	13.278	25.771	16.633
19	Motor Vehicles	-0.362	-1.544	2.777	0.057
20	Other Transport Equipment	-0.975	-3.730	-7.249	-3.389
21	Manufacturing nes	-0.241	0.305	2.619	0.789
22	Electricity	-3.127	-4.190	-2.325	-2.305
23	Gas Supply	-2.577	-6.636	-4.383	-3.733
24	Water Supply	-0.151	-0.584	-1.274	-0.532
25	Construction	-0.656	-1.249	0.923	-0.333
26	Distribution	-0.746	-3.031	-5.723	-2.762
27	Retailing	-0.519	-1.549	-3.922	-1.626
28	Hotels & Catering	-0.731	-0.930	-3.352	-1.061
29	Land Transport etc	0.601	20.926	29.062	16.205
30	Water Transport	-1.079	-2.507	-4.547	-2.203
31	Air Transport	-0.845	9.406	13.196	7.330
32	Communications	-0.858	-3.405	-5.970	-3.110
33	Banking & Finance	-0.768	-2.467	-2.212	-1.719
34	Insurance	-0.930	3.671	-5.246	0.668
35	Computing Services	-1.085	-3.776	-5.411	-2.978
36	Professional Services	-0.449	-1.172	1.936	-0.045
37	Other Business Services	-0.573	2.760	10.457	3.235
38	Public Administration & Defence	1.740	-1.218	-4.341	-1.775
39	Education	1.416	-0.992	-4.012	-1.455
40	Health & Social Work	1.388	-0.966	-4.130	-1.395
41	Miscellaneous Services	-0.836	-3.390	-7.357	-3.109
42	All industries	0.000	0.000	0.000	0.000

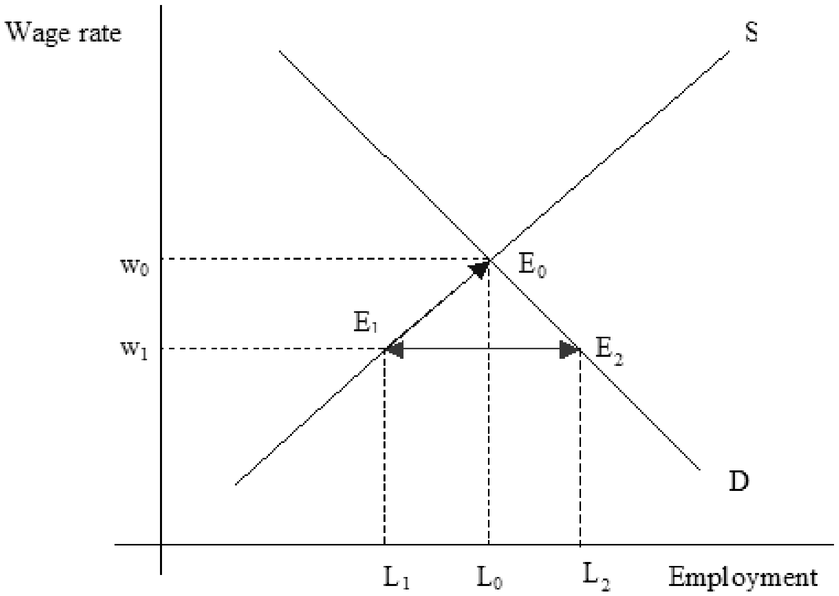
Table 2. Employment by Industry, Energy and Employment Target Scenario, United Kingdom

		(1)	(2)	(3)	(4)	(5)
Code	Industry	Employment Levels (thousands)			Employment Changes	
		2009	2020 Baseline	2020 Target	2020 (per cent)	Rank
1	Agriculture etc	525	479	520	7.78	10
2	Coal	7	5	5	-4.17	26
3	Oil & Gas etc	29	14	12	-4.86	19
4	Other Mining	25	23	21	-5.48	17
5	Food, Drink & Tobacco	362	267	353	23.70	4
6	Textiles, Clothing & Leather	126	91	129	30.26	2
7	Wood & Paper	149	160	171	7.99	8
8	Printing & Publishing	289	279	268	-4.12	28
9	Manufactured Fuels	27	23	24	0.87	41
10	Pharmaceuticals	57	41	39	-3.87	31
11	Chemicals nes	126	111	105	-4.27	24
12	Rubber & Plastics	155	113	122	5.71	16
13	Non-Metallic Mineral Products	115	118	112	-4.80	21
14	Basic Metals	70	46	47	1.22	39
15	Metal Goods	290	246	258	4.45	22
16	Mechanical Engineering	279	306	338	11.47	5
17	Electronics	77	97	132	44.65	1
18	Electrical Eng. & Instruments	221	198	219	9.39	7
19	Motor Vehicles	139	122	126	2.90	35
20	Other Transport Equipment	150	106	96	-6.58	14
21	Manufacturing nes	185	143	148	2.94	34
22	Electricity	74	60	58	-2.52	36
23	Gas Supply	18	14	13	-6.80	12
24	Water Supply	31	30	28	-6.72	13
25	Construction	2063	2101	2122	1.00	40
26	Distribution	1914	1955	1858	-5.08	18
27	Retailing	2780	3110	2993	-4.19	25
28	Hotels & Catering	2003	1957	1894	-3.19	33
29	Land Transport etc	1267	1293	1607	24.85	3
30	Water Transport	20	19	18	-4.41	23
31	Air Transport	94	89	100	10.74	6
32	Communications	488	500	468	-6.52	15
33	Banking & Finance	905	942	920	-2.46	37
34	Insurance	192	159	153	-3.28	32
35	Computing Services	599	636	607	-4.84	20
36	Professional Services	2604	3162	3225	2.43	38
37	Other Business Services	2312	2903	3084	7.80	9
38	Public Administration & Defence	1758	1675	1607	-3.88	30
39	Education	2660	2573	2464	-4.10	29
40	Health & Social Work	3865	3889	3730	-4.12	27
41	Miscellaneous Services	1902	2391	2253	-7.27	11
42	All industries	30972	32464	32464	0.00	

4. Identifying structural pressures

The changes in the distribution of the demand for labour across industries imposed in the *Energy and employment target* scenario will create structural pressures in the markets for labour. In particular, surpluses (excess supplies) and shortages (excess demands) will tend to develop for particular occupations. That is, skill mismatches will tend to occur[3]. To examine how the economy might adjust to these pressures, suppose there is excess demand for labour of a particular occupation at the wage rate w_1, as shown in Figure 3.

Figure 3



Excess Demand for Labor (Skills Shortage)

One measure of the structural pressure on the occupation is given by the percentage change 100 $(L_2-L_1)/L_1$ in the supply of labour required to establish equilibrium at the wage rate w_1. When expressed in this way, structural pressure tends to prompt a policy response, such as an increase in training, which shifts the supply curve to the right. An alternative measure is the percentage change 100 $(w_0-w_1)/w_1$ in the wage rate required to establish

[3] In this paper, skill mismatch refers to differences between the demand for, and supply of, labour belonging to a particular occupation. It does not refer to overskilling (in which the skills of an employed worker are not fully utilised) or underskilling (in which the skills of an employed worker are insufficient for the job in hand).

equilibrium at the wage rate w_0. Structural pressures are not usually expressed in this way 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_1 to E_0, 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. Both types of measure are indicators of the tendency of the policy change to induce skill mismatch and both will be considered in what follows.

Aggregate employment in the United Kingdom is forecast to be 32464 thousand persons in the year 2020. In Table 2, it was shown how this total is distributed between industries in the baseline scenario (column 2) and in the *Energy and employment target* scenario (column 3). Table 3 shows the corresponding information for employment by occupation when the occupational labour markets clear. The occupation most affected by the policy target is *23 Machine operators and assemblers*. For this occupation, employment increases from 520 thousand persons in the baseline.to 567 thousand in the target scenario. That is, employment increases by 8.94 per cent. The occupation least affected is *13 Office clerks* for which employment increases by only 0.07 per cent. Compared to Table 2, the range of variation is very much reduced. This is because some workers belonging to a particular occupation will be employed in expanding industries and others will be employed in contracting industries.

Now consider the results reported for excess demand in the United Kingdom in Table 4. These results are generated by MLME when relative occupational wage rates are assumed to remain constant. That is, the results correspond to the first of the two measures of structural pressure discussed in the context of Figure 3. According to the baseline scenario, an excess demand equal to 36.84 per cent of base year employment will emerge for the occupation *11 Teaching associate professionals* in 2020 if there is no wage rate adjustment between 2009 and 2020. This excess is larger than that for any other occupation. The largest excess supply is forecast to be 131.90 per cent for the occupation *1 Armed forces*. The effect of the policies associated with the *Energy and employment target* scenario is to reduce the excess demand for *Teaching associate professionals* to 34.83 per cent but to increase the excess supply of *Armed forces* to 134.49 per cent. Generally speaking, the additional changes induced by the policies incorporated in target scenario are modest compared to the changes induced by the economic forces incorporated in the baseline scenario. The generalization is less apposite for occupations for which excess demand is close to zero in the baseline (see occupations *15 Personal and protective service workers*, *17 Skilled agricultural and fishery workers* and *23 Machine operators and assemblers*). With

Table 3. Employment by Occupation, Energy and Employment Target Scenario, United Kingdom.

Code	Occupation	(1)	(2)	(3)	(4)	(5)
		Employment Levels (thousands)			Employment Changes	
		2009	2020 Baseline	2020 Target	2020 (per cent)	Rank
1	Armed Forces	61	31	30	-2.57	11
2	Legislators and senior officials	56	35	34	-1.85	14
3	Corporate managers	3590	3912	3931	0.47	23
4	Managers of small enterprises	1089	1162	1157	-0.45	25
5	Physical, mathematical and engineering science professionals	1169	1144	1158	1.19	16
6	Life science and health professionals	435	566	552	-2.55	12
7	Teaching professionals	1346	1103	1067	-3.28	7
8	Other professionals	1554	1918	1929	0.56	22
9	Physical and engineering science associate professionals	721	762	767	0.68	19
10	Life science and health associate professionals	938	895	871	-2.67	10
11	Teaching associate professionals	203	282	278	-1.34	15
12	Other associate professionals	2219	3217	3202	-0.45	24
13	Office clerks	3139	2634	2636	0.07	27
14	Customer services clerks	941	935	928	-0.68	20
15	Personal and protective services workers	3611	3718	3610	-2.90	8
16	Models, salespersons and demonstrators	1703	1955	1902	-2.71	9
17	Skilled agricultural and fishery workers	384	365	377	3.32	6
18	Extraction and building trades workers	1362	1504	1522	1.17	17
19	Metal, machinery and related trades workers	866	630	635	0.78	18
20	Precision, handicraft, craft printing and related trades workers	123	70	70	0.11	26
21	Other craft and related trades workers	151	117	124	5.55	3
22	Stationary plant and related operators	154	154	157	2.07	13
23	Machine operators and assemblers	556	520	567	8.94	1
24	Drivers and mobile plant operators	1117	1271	1363	7.30	2
25	Sales and services elementary occupations	2309	2225	2210	-0.66	21
26	Agricultural, fishery and related labourers	92	53	56	4.52	4
27	Labourers in mining, construction, manufacturing and transport	1070	1274	1319	3.54	5
28	All occupations	30972	32464	32464	0.00	

Table 4. Excess Demands for Labour by Occupation, United Kingdom, 2020, Relative Wage Rates Fixed

Code	Occupation	(1)	(2)	(3)	(4)
		Baseline		Energy and Employment Target	
		Excess	Rank	Excess	Rank
1	Armed Forces	-131.90	27	-134.49	27
2	Legislators and senior officials	-104.25	26	-106.30	26
3	Corporate managers	-4.61	16	-4.20	15
4	Managers of small enterprises	0.42	12	-0.30	13
5	Physical, mathematical and engineering science professionals	-25.20	18	-24.06	18
6	Life science and health professionals	16.65	6	13.05	6
7	Teaching professionals	-52.07	21	-55.76	22
8	Other professionals	10.22	7	10.92	8
9	Physical and engineering science associate professionals	-6.32	17	-5.59	17
10	Life science and health associate professionals	-26.88	19	-30.09	19
11	Teaching associate professionals	36.84	1	34.83	3
12	Other associate professionals	36.47	2	35.66	2
13	Office clerks	-31.62	20	-31.54	20
14	Customer services clerks	-3.72	15	-4.68	16
15	Personal and protective services workers	-0.23	13	-3.89	14
16	Models, salespersons and demonstrators	20.43	4	16.68	5
17	Skilled agricultural and fishery workers	1.10	11	5.51	12
18	Extraction and building trades workers	6.13	10	7.31	10
19	Metal, machinery and related trades workers	-63.90	23	-63.39	23
20	Precision, handicraft, craft printing and related trades workers	-98.04	25	-98.19	25
21	Other craft and related trades workers	-53.35	22	-46.71	21
22	Stationary plant and related operators	6.20	9	8.66	9
23	Machine operators and assemblers	-0.90	14	11.68	7
24	Drivers and mobile plant operators	16.70	5	27.12	4
25	Sales and services elementary occupations	7.97	8	7.26	11
26	Agricultural, fishery and related labourers	-84.41	24	-79.60	24
27	Labourers in mining, construction, manufacturing and transport	31.71	3	36.92	1
28	All occupations	0.00		0.00	

Note. Excess demands for labour are measured in persons expressed as a percentage of employment in the base year 2009. Negative excess demand signifies excess supply.

these exceptions, the introduction of the target makes little difference to the order of the occupations when they are ranked according to the amount by which demand exceeds supply,

Table 5 shows the changes in occupational wage rates required to clear the markets for labour in the United Kingdom between 2009 and 2020. That is, these results correspond to the second of the two measures of structural pressure. Specifically, the wage rate for the occupation *12 Other associate professionals* would need to increase at an average annual rate of 4.53 per cent per annum in the baseline scenario and 4.30 per cent per annum in the *Energy and employment target* scenario. Again the introduction of the target makes only a minor difference to the magnitudes of the wage rate changes, or to the order of the occupations when they are ranked according to those changes.

The rankings in Table 5 conform quite closely to those in Table 4 and the two measures of structural pressure are in basic agreement. Note that they should not be expected to conform exactly as, in terms of Figure 3, the excess demands in Table 4 reflect differences between points like E_1 and E_2, whereas the wage rate changes in Table 5 reflect differences between points like E_1 and E_0.

Forecasts of excess demand and supply of the kind reported for the baseline scenario in column 1 of Table 4 are usually taken as evidence of skill mismatch, and hence as a signal that the allocation of training resources implicit in the baseline should be adjusted. If resources were to be reallocated from occupations with excess supply towards occupations with excess demand, the employment growth indicated in column 2 of Table 3 could have been achieved with a more modest realignment of relative wage rates than that shown in column 1 of Table 5. In other words, a decision to reallocate training resources to alleviate skill mismatch is also a decision to engineer relative wage rates so they conform more closely to base year values. In principle, policy should be directed at achieving a system of wage differentials which reflects the working conditions attached to different jobs such as differences in work intensity, the work environment, the risk of injury or social prestige. In practice, the correct system of “compensating wage differentials” is unknown and, by default, the existing system is usually accorded the status of desirability. That is, deviations from existing differentials tend to be met with claims of “skills shortage” and demands that the government provide more training to restore the status quo.

Table 5. Average Annual Wage Rate Changes Required to Clear Occupational Labour Markets between 2009 and 2020, United Kingdom, Per Cent Per Annum

		(1)	(2)	(3)	(4)
Code	Occupation	Baseline		Energy and Employment Target	
		Change	Rank	Change	Rank
1	Armed Forces	-12.63	27	-13.13	27
2	Legislators and senior officials	-10.86	26	-11.30	26
3	Corporate managers	-1.07	16	-1.08	16
4	Managers of small enterprises	0.04	13	-0.02	13
5	Physical, mathematical and engineering science professionals	-3.97	19	-3.92	18
6	Life science and health professionals	1.40	6	0.72	9
7	Teaching professionals	-6.84	22	-7.58	23
8	Other professionals	0.64	9	0.49	12
9	Physical and engineering science associate professionals	-1.74	17	-1.74	17
10	Life science and health associate professionals	-3.73	18	-4.38	20
11	Teaching associate professionals	4.20	3	3.84	4
12	Other associate professionals	4.53	1	4.30	2
13	Office clerks	-4.08	20	-4.14	19
14	Customer services clerks	-0.60	15	-0.70	14
15	Personal and protective services workers	-0.18	14	-0.72	15
16	Models, salespersons and demonstrators	3.30	4	2.82	5
17	Skilled agricultural and fishery workers	0.20	11	0.50	11
18	Extraction and building trades workers	1.03	8	1.23	7
19	Metal, machinery and related trades workers	-7.01	23	-6.86	22
20	Precision, handicraft, craft printing and related trades workers	-9.99	25	-10.05	25
21	Other craft and related trades workers	-5.78	21	-4.75	21
22	Stationary plant and related operators	0.35	10	0.59	10
23	Machine operators and assemblers	0.11	12	1.57	6
24	Drivers and mobile plant operators	2.52	5	4.12	3
25	Sales and services elementary occupations	1.08	7	0.93	8
26	Agricultural, fishery and related labourers	-8.69	24	-8.11	24
27	Labourers in mining, construction, manufacturing and transport	4.47	2	5.23	1
28	All occupations	0.00		0.00	

5. International Comparisons

For purposes of comparing the effects of different scenarios on the markets for labour in different countries, it is necessary to define an aggregate measure of the induced change in structural pressure. For the baseline in the United Kingdom, a weighted sum is taken of the absolute values of the wage rate changes shown in column 1 of Table 5, the weights being 2020 employment shares derived from column 2 of Table 3. The measure will be referred to as the employment-weighted absolute percentage (EWAP) change in the occupational wage rates. The larger the EWAP change, the larger is the overall change in structural pressure for the country. An analogous measure can be defined for the *Energy and employment target* scenario using column 3 of Table 5 and column 3 of Table 3. The results for 26 countries[4].in 2020 are shown in Table 6.

According to the table, the country most affected is Lithuania (row 15) and the country least affected is Malta (row 18). There difference between the EWAP changes for the baseline and *Energy and employment target* scenarios is small for all countries, indicating that the additional structural pressures introduced by the policy target are relatively insignificant compared to those associated with the baseline.

An indication of the sources of the differences in aggregate structural pressure between countries can be obtained by identifying the separate contributions made by each occupation to the EWAP change. The contributions in the baseline scenario are shown for selected countries in Table 7. Consider the results for the United Kingdom in column 1. The ocupation *12 Other associate professionals* makes the largest contribution with 18.86 per cent of the total. To arrive at this figure, note that the occupation provides employment to 3217 thousand of the 32464 thousand persons employed in 2020 (see column 2 of Table 3). That is, it provides 9.91 per cent of total employment. The contribution of the occupation to the EWAP change is obtained by multiplying its market-clearing wage rate change (4.53 per cent from column 1 of Table 5) by its employment share. That is, it contributes (4.53 x 0.0991) or 0.45 per cent to the EWAP change. Since the total EWAP change is 2.38 per cent (see column 1 of Table 6), the occupation's contribution is 18.86 per cent As the sign of its wage rate change in Table 5 is positive, it follows that there is a tendency towards excess demand for workers belonging to the occupation.

[4] Insufficient data are currently available to report results for Croatia (row 11) or Slovenia (row 24).

Table 6. Employment Weighted Absolute Percentage Change in Market-Clearing Occupational Wage Rates, 2009 to 2020

Code	Occupation	(1)	(2)	(4)	(5)
		Baseline		Energy and Employment Target	
		EWAP change	Rank	EWAP change	Rank
1	Belgium	2.93	8	3.17	6
2	Bulgaria	2.39	17	2.13	21
3	Czech Republic	2.00	23	1.86	23
4	Denmark	2.71	12	2.72	12
5	Germany	1.84	24	1.80	24
6	Estonia	4.80	2	4.49	2
7	Ireland	3.16	5	3.10	8
8	Greece	3.11	6	3.17	5
9	Spain	2.54	15	2.65	15
10	France	2.06	22	2.05	22
11	Croatia				
12	Italy	3.31	4	3.40	4
13	Cyprus	2.58	14	2.65	14
14	Latvia	3.71	3	3.59	3
15	Lithuania	5.03	1	4.88	1
16	Luxembourg	2.75	11	2.81	11
17	Hungary	2.45	16	2.44	19
18	Malta	1.15	26	1.17	26
19	Netherlands	2.25	20	2.27	20
20	Austria	2.90	9	3.01	9
21	Poland	1.44	25	1.42	25
22	Portugal	2.18	21	2.55	16
23	Romania	2.94	7	3.13	7
24	Slovenia				
25	Slovakia	2.34	19	2.51	18
26	Finland	2.71	13	2.65	13
27	Sweden	2.82	10	2.88	10
28	United Kingdom	2.38	18	2.54	17

The remaining columns of Table 7 show the contributions for Lithuania and Malta (which, as already noted, experience the most structural pressure and the least, respectively), and for Finland (which experiences an average amount). The United Kingdom is the only one of the four for which the occupation *12 Other associate professionals* contributes more than 10 per cent of the total change. Indeed, only one occupation, namely 1*3 Office clerks,* contributes more than 10 per cent for more than one country. Generally speaking, then, the pattern of structural pressure associated with the Baseline scenario is quite specific to each of the countries shown. .

6. Concluding Remarks

The simulations presented in this paper indicate (and, at least at the level of aggregation considered, indicate decisively) that any occupational skill mismatches associated with the introduction of the Europe 2020 Strategy are likely to be small compared to mismatches associated with the baseline scenario. This conclusion holds *a fortiori* for the 20-20-20 climate and energy targets where the implications for skill mismatch are negligible. It derives primarily from the simulations using the E3ME model reported in Cedefop (2013) and owes little to the MLME labour market extension. It implies that policies directed at skill mismatch should be driven by developments expected to occur under business-as-usual conditions, and should not be particularly influenced by the 2020 Strategy. It is significant, not only because the E3ME model locates the effects of the Strategy within an economy-wide context, but also because the model has been specifically designed to address the environmental concerns embodied in the Strategy[5]. In another context, it is worth noting that the conclusion is broadly supportive of the assessment advanced by Cedefop in previous bottom-up, case-study work on green skills:

> "Fundamentally, the bulk of jobs – whether classed as 'new green jobs', existing occupations which require greening skills, or those requiring 'retraining' – already possess a base of highly relevant skills and simply require a 'topping-up' of their competences." (Cedefop, 2010, p.9)

While the main policy conclusion is already present in the Cedefop E3ME analysis, the top-down E3ME-MLME methodology makes its contribution by allowing important additional

[5] See European Commission (2011) for further details.

information to be elicited from the pre-existing study. In particular,

- it allows the relationships between
    - the structural pressures introduced into the markets for labour by the baseline and other scenarios,
    - the emergence of skill mismatches (as represented by excess demand for, or supplies of, labour belonging to different occupations), and
    - the emergence of changes in relative occupational wage rates

  to be investigated;

- it allows the amounts of structural pressure introduced in various EU countries to be compared using the employment-weighted absolute percentage change in relative occupational wage rates; and
- it allows the sources of the structural pressures in different countries to be compared in terms of the contributions made by various occupations to EWAP change.

All of this information can serve to better inform the decisions of European policy makers when allocating training resources to avoid skill mismatch.

Table 7. Contributions to EWAP Changes, Baseline Scenario, 2009 to 2020

Code	Occupation	(1) United Kingdom	(2) Lithuania	(3) Finland	(4) Malta
1	Armed Forces	0.51	0.45	1.10	0.34
2	Legislators and senior officials	0.49	2.46	2.30	0.11
3	Corporate managers	5.40	2.69	4.19	0.75
4	Managers of small enterprises	0.05	0.18	1.75	7.17
5	Physical, mathematical and engineering science professionals	5.88	3.75	3.54	5.15
6	Life science and health professionals	1.03	2.24	1.25	0.67
7	Teaching professionals	9.76	6.10	6.81	0.43
8	Other professionals	1.58	1.72	2.63	2.75
9	Physical and engineering science associate professionals	1.72	2.01	4.16	5.32
10	Life science and health associate professionals	4.32	3.21	1.77	0.01
11	Teaching associate professionals	1.53	0.89	0.07	3.21
12	Other associate professionals	18.86	1.26	6.53	2.11
13	Office clerks	13.90	4.67	10.58	2.00
14	Customer services clerks	0.72	1.64	1.71	5.44
15	Personal and protective services workers	0.88	3.36	11.77	0.01
16	Models, salespersons and demonstrators	8.36	7.72	9.68	1.36
17	Skilled agricultural and fishery workers	0.09	10.81	7.96	2.49
18	Extraction and building trades workers	2.00	6.34	4.76	2.54
19	Metal, machinery and related trades workers	5.73	8.38	3.84	10.83
20	Precision, handicraft, craft printing and related trades workers	0.92	0.28	0.91	0.56
21	Other craft and related trades workers	0.88	6.99	0.04	1.02
22	Stationary plant and related operators	0.07	0.93	1.04	1.48
23	Machine operators and assemblers	0.08	1.69	0.75	11.20
24	Drivers and mobile plant operators	4.15	10.09	8.25	7.57
25	Sales and services elementary occupations	3.11	4.79	2.32	21.77
26	Agricultural, fishery and related labourers	0.60	2.25	0.09	0.03
27	Labourers in mining, construction, manufacturing and transport	7.37	3.10	0.21	3.68
28	All occupations	100.00	100.00	100.00	100.00

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APPENDIX: The MLME labour market extension to the E3ME model

The equations and notation for MLME are listed in Tables 1 to 5. The computations are performed with a system of equations that is linear in percentage changes of the variables. That is, the system computes the percentage changes in the endogenous variables in some period t 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. Variables denoting amounts of labour or wage rates carry three subscripts which refer in strict order to industry, occupation and skill. If one of these subscripts is inoperative for a particular variable, it is replaced with an asterisk.

Table 1. Equations

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

$$d_{io*} = d^{E}_{i**} - \sigma^{S}_{i} [\, p_{*o*} - \sum_{k=1}^{OCC} SH^{W}_{ik*}\, p_{*k*}] + a^{D}_{*o*} - \sigma^{S}_{i} [\, a^{D}_{*o*} - \sum_{k=1}^{OCC} SH^{W}_{ik*}\, a^{D}_{*k*}]$$

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

Equation T2: Demand for labour of all occupations by industry *i*, hours

$$d^{H}_{i**} = \sum_{o=1}^{OCC} SH^{DI}_{io*}\, d_{io*} \qquad \text{(all } i \in IND\text{)}$$

Equation T3: Demand for labour of occupation *o* by all industries, hours

$$d^{H}_{*o*} = \sum_{i=1}^{IND} SH^{DO}_{io*}\, d_{io*} \qquad \text{(all } o \in OCC\text{)}$$

… continued

Table 1 (continued)

Equation T4: Supply of labour by skill *s* to occupation *o*, hours

$$s_{*os} = s^{E}_{**s} + \sigma^{T}_{s} [\, p_{*o*} - \sum_{k=1}^{OCC} SH^{W}_{*ks}\ p_{*k*} \,] - a^{S}_{*o*} - \sigma^{T}_{s} [\, a^{S}_{*o*} - \sum_{k=1}^{OCC} SH^{W}_{*ks}\ a^{S}_{*k*} \,]$$

(all $o \in OCC$, $s \in SKL$)

Equation T5: Supply of labour to all occupations by skill *s*, hours

$$s^{H}_{**s} = \sum_{o=1}^{OCC} SH^{SS}_{*os}\ s_{*os}$$

(all $s \in SKL$)

Equation T6: Supply of labour to occupation *o* by all skills, hours

$$s^{H}_{*o*} = \sum_{s=1}^{SKL} SH^{SO}_{*os}\ s_{*os}$$

(all $o \in OCC$)

Equation T7: Market clearing for labour of occupation *o*, hours

$$d^{H}_{*o*} = s^{H}_{*o*}$$

(all $o \in OCC$)

Equation T8: Average hourly wage rate

$$p_{***} = \sum_{o=1}^{OCC} SH^{DI}_{*o*}\ p_{*o*}$$

Equation T9: Flexible handling of labour supply by workers with skill *s*, hours

$$s^{H}_{**s} = \overline{s}^{H}_{**s} + f\_s^{H}_{***}$$

(all $s \in SKL$)

Table 2. Variables

Name	Description	
d_{io*}	Demand for labour of occupation *o* by industry *i*, hours	(all $i \in IND$, $o \in OCC$)
d^{E}_{i**}	Demand for labour of all occupations by industry *i*, effective units	(all $i \in IND$)
d^{H}_{i**}	Demand for labour of all occupations by industry *i*, hours	(all $i \in IND$)
d^{H}_{*o*}	Demand for labour of occupation *o* by all industries, hours	(all $o \in OCC$)
s_{*os}	Supply of labour to occupation *o* by skill *s*, hours	(all $o \in OCC$, $s \in SKL$)
s^{E}_{**s}	Supply of labour to all occupations by skill *s*, preference units	(all $s \in SKL$)
s^{H}_{**s}	Supply of labour to all occupations by skill *s*, hours	(all $s \in SKL$)
s^{H}_{*o*}	Supply of labour to occupation *o* by all skills, hours	(all $o \in OCC$)
p_{*o*}	Hourly wage rate for labour of occupation *o*	(all $o \in OCC$)
p_{***}	Average hourly wage rate	
$\overline{s}^{H}_{**s}$	Exogenous supply of labour to all occupations *o* by skill *s*, hours	(all $s \in SKL$)
$f\_s^{H}_{***}$	Wage shift variable	
a^{D}_{*o*}	Occupation-*o*-augmenting technical change in production	(all $o \in OCC$)
a^{S}_{*o*}	Occupation-o-increasing technical change in labour supply	(all $o \in OCC$)

Table 3. Sets

Name	Description	Number of Elements
IND	Industries	41
OCC	Occupations	27
SKL	Skills	3

Table 4. Coefficients and parameters

Name	Description	
σ_i^S	Elasticity of substitution between occupations in industry *i*	(all $i \in IND$)
σ_s^T	Elasticity of transformation between occupations for skill *s*	(all $s \in SKL$)
SH_{io*}^{W}	Share of occupation *o* in cost of labour in industry *i*	(all $i \in IND$, $o \in OCC$)
SH_{io*}^{DI}	Share of occupation *o* in demand for labour by industry *i*	(all $i \in IND$, $o \in OCC$)
SH_{io*}^{DO}	Share of industry *i* in demand for labour of occupation *o*	(all $i \in IND$, $o \in OCC$)
SH_{*os}^{W}	Share of occupation *o* in income from labour of skill *s*	(all $o \in OCC$, $s \in SKL$)
SH_{*os}^{SS}	Share of occupation *o* in supply of labour of skill *s*	(all $o \in OCC$, $s \in SKL$)
SH_{*os}^{SO}	Share of skill *s* in supply of labour of occupation *o*	(all $o \in OCC$, $s \in SKL$)
SH_{*o*}^{DI}	Share of occupation *o* in total demand for labour	(all $o \in OCC$)

Table 5. Exogenous variables in typical closure

Name	Description	
d^H_{i**}	Demand for labour of all occupations by industry *i*, hours	(all $i \in IND$)
p_{***}	Average hourly wage rate	
$\overline{s}^H_{**s}$	Exogenous supply of labour to all occupations *o* by skill *s*, hours	(all $s \in SKL$)
$f\_s^H_{***}$	Wage shift variable	
a^D_{*o*}	Occupation-*o*-augmenting technical change in production	(all $o \in OCC$)
a^S_{*o*}	Occupation-o-increasing technical change in labour supply	(all $o \in OCC$)