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CICLO XXXII

TITOLO DELLA TESI

The labour market analysis through a Computable General Equilibrium model.

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General summary

Starting from the second half of 1990s, economic systems have deeply changed both because of the intensifying globalisation and of the massive introduction of digital innovation, as well as of progressive automation. These trends have affected the labour demand composition by skills (OECD, 2010). While the demand for low-skilled (LS) labour shrank (lowering LS wages), high-skilled (HS) labour demand more than offset the increase in HS labour supply by causing the increase in their wages (Oesch, 2010). Empirical evidences seem to confirm the complementarity between HS labour demand and capital, and a substitutability between LS labour demand and capital; however, the determinants of low-skilled unemployment reduction should be investigated at national and sectoral level.

In this framework, the evaluation of digital skills in the labour market is assuming a strategic role. Furthermore, a higher incidence of HS working force - in association with the adoption of ICT technologies - appears to be strongly correlated with a robust, sustainable and equal growth patterns. A particularly relevant aspect of the analysis of this problem consists in the use of Computable General Equilibrium (CGE) models, in order to study the general equilibrium consequences of ICT development.

In this context, as for the Part 1, a Social Accounting Matrix (SAM) of the Italian economy for 2013 has been built in order to study labour demand pattern changes. 12 labour components (the considered dimensions are the following: 3 types of occupations, 3 formal educational attainment levels and 2 levels of digital competences related to "*computer use/not use*" according to the PIAAC definition conveniently modified, in order to stress the aspect related to a complex use of computers and programming) have been distinguished. Based on the SAM, the Chapter 6 updates the MAC18-CGE Model developed by the Department of Economics and Law of the University of Macerata for 2011.

The Chapter 6 evaluates how fiscal policies affect the composition of employment by skill and occupation through changes in prices and quantities. The Chapter defines which measures can contribute to increase the share of the most skilled labour components with a higher digital competence on the total labour demand. In particular, the Chapter investigates the effects of a sectoral policy targeted to support HS digitalised work through a change in the composition of households' private consumption as well as in the composition of investment.

The final demand policy is a way to stimulate the change in productive systems towards more knowledge-intensive products. This policy should be accompanied however by a policy aimed at supporting the change in labour supply through Vocational Education Training (VET) and Life-Long Learning (LLL) programmes.

The CGE model will contribute to find a comprehensive and coherent solution to evaluate the labour demand changes through the disaggregation by activity and the possibility of distinguishing the different labour components. Results seem to confirm the effectiveness of final demand

policies in order to support knowledge-intensive activities, especially in the case of a change in the composition of workforce.

Further results can be obtained by integrating the macro dimension of the SAM - which the CGE models is built on - with the micro dimension of a Tax and Benefit (TB) microsimulation model. In this context, the second part uses the same MAC-18 CGE model, but the aspect of non-perfect competition and of the involuntary unemployment in the labour market is stressed. Furthermore, we have considered the year 2014 and have decomposed the labour input into 24 components (by gender also). Furthermore, the gender gap is addressed, in order to take into account the different behaviour of labour supply by gender. The macro CGE model is integrated with the a microsimulation module allowing accounting households' behaviour, which is differentiated according to the personal income tax breaks currently applied in Italy. The CGE model evaluates how the macroeconomic sectoral shock reverberates on the labour demand and ahead on the employment level. Then, the micro-simulation module shows how the changes in macroeconomic variables affect households' behaviours in terms of labour supply and consumption demand.

The Chapter 8 of the thesis also evaluates the effects of a 1-p.-p. cut in SSC rate by using a dynamic CGE model, where capital and labour supply are endogenous. In particular, labour supply changes both through the population ageing, and the effectiveness of LLL and VET programmes in terms of skill developments. The transition from a static to a dynamic approach implies to consider cuts in SSC rates not only as a short term support for the weak component of the labour market, but as a possibility of maintaining or increasing the know-how owned by the weak component through the learning-by-doing mechanism.

Training programmes carried out by employers could be useful to increase workers' human capital, even though there could be some negative effects (the locking-in effect, the low impact on short term and the substitution effect between trained and not-trained). Results of the simulations generally show small effects at the aggregated level. Real investment plays an important role, especially with the ICT innovation. This latter (in the absence of an increase in the aggregate demand) exerts a negative effects on total employment. However, high-skilled workers seem to be less damaged than low-skilled ones.

Finally, there is an estimation exercise of labour/capital substitution elasticities through an econometric approach by using systems of simultaneous equation. This exercise represents a useful integration of general equilibrium analysis, as substitution elasticities represents strategic parameters for CGE results. This is particularly true in the case of the decomposition of labour in several components.

1 - Introduction

Advanced countries have been hit over the last thirty years by a radical change in the economic paradigm, which has affected employment both in terms of level, and of composition. We can list the main drivers of these changes as follows: *1*) globalisation and *2*) digital innovation and progressive automation.

As for the globalisation, new (and often relevant) countries begun to be integrated in the world's trade flows. In this context, changes in the labour geography (also seen as the Global Value Chains - GVCs) occurred. Moreover, low value added productive phases have been transferred towards countries with a relatively higher amount of (often unskilled) labour. Conversely, high-value added productive phases moved towards countries with a relatively higher amount of capital and skilled work. In this context, Italy is specialised in traditional and low technology productions and its endowment of skilled work is relatively lower than in similar countries.

The second mega-trend is represented by a pervasive ICT innovation both in services, and in manufacturing. In this context, the increase in supply of high-skilled workers is associated with a higher productivity - or GDP growth pattern of the skill-biased technological change (SBTC). The SBTC is a long-term trend and the introduction of digital technologies and of ICT innovations could allow to register its effects. This allowed a progressive automation of production phases, by determining an increase in productivity levels with a consequently higher GDP growth rate.

However, the distribution of advantages has been homogenously distributed neither around the world nor within country's labour markets with increasing job opportunities and higher wages for HS workers, decreasing job opportunities for middle-skilled (MS) workers (with complete loss of labour compensation) and decreasing wages for elementary occupations and sales jobs (whose labour demand has generally maintained the existing levels). In terms of composition of the output, in advanced countries, the share of high-knowledge-intensive services (KISs)) and high-technology manufacturing (HTM) has increased with a reduction in low-knowledge-intensive services (LKISs) and low-technology manufacturing (LTM). In some other countries (especially the European Mediterranean ones) the (even if declining) building sector, as well LKISs have increased their share. At this regard, one has to underline the progressive ageing process, which has been increasing the demand for home assistance and household services.

The SBTC has increased the aggregate level of productivity both via the increased share of ICT-producer activities, and via the increased pervasiveness of ICT investments in all the economic activities. A higher weight of ICT-producing activities or a higher intensity of ICT investments is associated with enhancements in productivity patterns (see Bresnahan *et al.*, 2002). ICT innovation requires an adequate composition of workers' labour supply in terms of skill to unlock its whole effects. Indeed, the positive impact of skills on productivity is achieved only if the increased skilled labour supply matches with the higher demand for skilled work. At this regard, according to OECD, 2003, skills and ICT seem to be complementary with higher wages associated with higher ICT investment. Bartelsman and Doms, 2000 and Doms *et. al.*, 1997 use microdata to assess the existence of a positive relation between the number of advanced technologies used and workers' skills (i.e. above-average skilled workers are probably better able to adopt the latest technologies).

The definition of (digital) skills has been developed in EC, 2016 and OECD, 2016. As for EC definition, components of digital competence is articulated in 5 areas which can be summarised as follows: i) information and data literacy; ii) communication and collaboration; iii) digital content creation; iv) safety; v) problem solving. The distribution of digital competences among workers is not homogeneous with different patterns by age classes. Highly digitally integrated environments allow also improvements in information management, protection and development to resolve conceptual problems. Skill endowment constitutes a relevant factor driving the distribution of advantages of GDP increase due to innovation (Matzat and Sadowski, 2012).

An operational tool to evaluate the level and the diffusion of abilities and skills across the economic systems is given by the survey on the Programme for the International Assessment of Adult Competences (PIAAC) by OECD. OECD, 2013 and 2016 synthesised the results of the PIAAC survey, which identifies three main cognitive skills (that is, literacy, numeracy and problem solving in technology-rich environment). The survey investigates the socio-demographic characteristics linked to skill proficiency (i.e. the educational attainment), as well as the way and the measure how the owned skills are used in the workplace and the way how skills are developed, maintained and/or lost.

ICT seems to have had positively contributed to economic growth and productivity dynamics (OECD, 2003 OECD 2016 and OECD Ministerial Meeting declaration[1]), even though benefits are not homogenously distributed among countries with some countries gaining a higher growth (the US, Canada, the Netherlands and Australia), and some others with lower benefits (France and Italy). More specifically, this can be due to the following factors: *a*) direct costs of ICT; b) costs and implementation barriers related to enabling factors (know-how or qualified personnel); c) risks and uncertainty (administrative burden); d) productive structure (i.e. not all activities benefit in the same way from ICT); e) competition.

ICT seems to favour countries with a more qualified labour endowment, so that increase in Life-Long-Learning (LLL) programmes could be a possible solution (Leahy and Wilson, 2014). The gap between advanced and laggard countries is also registered through the World Economic Forum (WEF) index[2] (WEF, 2017). Indeed, WEF, 2017 shows that Mediterranean countries have

[1] In 2016 Ministerial Meeting declared OECD, that in the framework of digitalisation "*the digital economy is a powerful catalyst for innovation, growth and social prosperity; that our shared vision is to promote a more sustainable and inclusive growth focused on well-being and equality of opportunities, where people are empowered with education, skills and values, and enjoy trust and confidence*". http://www.oecd.org/internet/ministerial/

[2] This index is the result of four sub-indices measuring the formal educational attainment and cognitive skills (i.e. capacity), the skills acquired by employed (i.e. deployment), the increase in skills achievable through further formal

performed below the global average due to a higher rate of (youth) under-employment and unemployment rate. Moreover, these countries show a low labour market participation, a marked segmentation of labour market damaging women and young people, as well as a low quality of up- and re-skilling programmes.

The Chapter 5 contains a survey of the literature about modelling of labour market in CGE models. The paragraph 6.1 reports a survey of the literature about the megatrends of the labour market, confirming that skill developments and economic growth are strictly interwoven. Moreover, it contains a review of policies adopted by many countries to address the challenges of the ICT innovation. In this way, a robust and sustainable economic growth can be achieved only through an increase in the share of skilled work. A particular attention is paid for the value of elasticity coefficient of the labour demand by skill (see Chapter 8). The tool adopted to address this issue is the estimation of the Social Accounting Matrix (SAM) for the Italian Economy in 2013 (see Chapter 2). The SAM developed in the paper is relative to Italy in 2013; moreover labour is disaggregated into occupations and formal/digital skills, where these latter are obtained with answers about the use of computer, internet and simple/advanced programmes at work, as turning out from PIAAC database.

On the base of this SAM the products with the highest content of ICT skills, as well as high-qualified workers, are identified (see Paragraph 6.3). The SAM is also used to update and modify the MAC18 Computable General Equilibrium (CGE) model developed by the Department of Economics and Law of the University of Macerata (see Chapter 3). The model allows representing the relations between the changes in output of activities and the changes of compensation of employees by skill, digitalisation degree and gender in the context of the general equilibrium relations where both prices and quantities can adjust. Paragraph 6.4 will finally report results of the CGE simulations.

The next evolution step of the analysis is given by the integration of the microsimulation model with the macro sector CGE model through a convenient linking procedure (see Chapter 4). The Paragraph 7.2 analyses the literature on Micro-Macro integration. The Paragraph 7.3 addresses the issue of employment subsidies. Results of employment subsidies are summarised in the Paragraph 7.4.

The final part of the document is devoted to the estimation of labour/capital substitution elasticities, as well of elasticities among labour components (Paragraph 8.2) after a detailed literature review (Paragraph 8.1).

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education for young people and upskilling/reskilling programmes for adult population (i.e. development), and the breadth and depth of specialised skills use at work (i.e. the know-how)

2 – The Social Accounting Matrix for skill analysis. Data description.

2.1 - The Social Accounting Matrix for skill analysis.

The Social Accounting Matrix (SAM) represents a useful and efficient tool to analyse the impact of a macroeconomic shock on labour compensation decomposed by formal education attainment, digital skills and gender among industries. Sir Richard Stone elaborated the first SAM in 1960 as the representation of transactions in a socio-economic system (Round, 2003) in relation with the Cambridge Growth Project. Since 1960s, the latter aspects emerged, also thanks to the ILO World Employment Programme (ILO, 1970) in 1970s. Models that are more complete were built in1970s with Iran, Sri Lanka and Swaziland (ILO, 1971, 1973, 1973b and 1976).

The SAM describes all the phases of circular flow of income from its generation in the production process (total output and value added generation), through its allocation in the distributive process (value added by factor, and primary and secondary income distribution) to the use of the disposable income in terms of final demand (Stone, 1985).

The SAM used in this paper is represented in Table 1. The market clearing condition for goods can be described as follows by taking into account both the first row and column:

$$\sum_{j=1}^{m} M_{j,i} + \sum_{ct=1}^{CT} T_{ct,i} + \sum_{rtm=1}^{RTM} m_{rtm,i} + \sum_{row=1}^{ROW} I_{row,i} = \sum_{j=1}^{m} Z_{i,j} + \sum_{s=1}^{S} C_{i,s} + \sum_{row=1}^{ROW} E_{i,row} + \sum_{inv=1}^{INV} I_{i,inv} \text{ (EQ1)},$$

where the supply of (domestic $M_{j,i}$ and imported $I_{row,i}$) goods including product taxes $T_{ct,i}$ and margins $m_{rtm,i}$ equals the intermediate consumption $Z_{i,j}$ and the final demand, as sum of the final consumption $C_{i,s}$, exports $E_{i,row}$ and investments $I_{i,inv}$.

The second constraint is that the value of production is equal to the sum of cost for intermediate consumption, primary factors and for taxes on activity output:

$$\sum_{i=1}^{n} M_{j,i} = \sum_{i=1}^{n} Z_{i,j} + \sum_{l=1}^{L} LC_{l,j} + CR_{.,j} + \sum_{act=1}^{ACT} T_{act,j} \text{ (EQ2)},$$

where the value of output carried out by each activity $M_{j,i}$ is given by the sum of the intermediate consumption $Z_{i,j}$, the cost of primary factors (labour $LC_{l,j}$ and capital $CR_{.,j}$), as well by revenue of production taxes $T_{ot,j}$ (among them there is the tax on productive activity IRAP levied on the remuneration of primary factors).

The third constraint is that the demand for primary factors is equal to the supply of them plus the net inflow from abroad:

$$\sum_{j=1}^{m} LC_{l,j} + \sum_{j=1}^{m} CR_{.,j} = \sum_{si=1}^{SI} LC_{si,l} + \sum_{si=1}^{SI} CR_{si,.} + \sum_{row=1}^{ROW} \Delta LC_{row,l} + \sum_{row=1}^{ROW} \Delta CR_{row,.} \text{ (EQ3)},$$

where the labour and capital demand (respectively, $LC_{l,j}$ and $CR_{.,j}$) is equal to the supply by national institutional sectors (respectively, $LC_{si,l}$ and $CR_{si,.}$) and the rest of the world ($\Delta LC_{row,l}$ and $\Delta CR_{row,.}$). The fourth constraint is given by the equivalence of output taxes levied on activities $T_{ot,j}$ and the taxes received by the institutional sectors (taxes received by national sectors $T_{si,ot}$ and by the rest of the world $\Delta T_{row,ot}$):

$$\sum_{j=1}^{m} T_{ot,j} = \sum_{si=1}^{SI} T_{si,ot} + \sum_{row=1}^{ROW} \Delta T_{row,ot} \quad \text{(EQ4)}.$$

At the same way we can reconstruct the constraint for commodity taxes:

$$\sum_{i=1}^{n} T_{ct,i} = \sum_{si=1}^{SI} T_{si,ct} + \sum_{row=1}^{ROW} \Delta T_{row,ct} \quad \text{(EQ5)}.$$

The next equation is the budget constraint of institutional sectors, where the received income $YD_{si,.}$, in terms of both net income and tax revenues $Rev_{si,.}$, should equal the use of income for final consumption $C_{i,si}$ and savings $S_{inv,si}$:

$$YD_{si,.} = \sum_{l=1}^{L} LC_{si,l} + CR_{si,.} + \sum_{\widetilde{si}=1}^{SI} TR_{si,\widetilde{si}} + \sum_{row=1}^{ROW} \Delta TR_{si,row} - \sum_{it=1}^{IT} T_{it,si} \text{(EQ6')},$$

$$Rev_{si,.} = \sum_{ot=1}^{OT} T_{si,ot} + \sum_{ct=1}^{CT} T_{si,ct} + \sum_{it=1}^{IT} T_{si,it} \text{(EQ6'')},$$

$$YD_{si,.} + Rev_{si,.} = \sum_{i=1}^{n} C_{i,si} + \sum_{inv=1}^{INV} S_{inv,si} \text{ (EQ6''')}.$$

The seventh constraint is given by the equivalence of income taxes paid by institutional sectors and the income taxes received by the institutional sectors:

$$\sum_{si=1}^{SI} T_{it,si} = \sum_{si=1}^{SI} T_{it,si} \quad \text{(EQ7)}.$$

The eighth constraint is that the sum of trade and transport margins $m_{rtm,j}$ by activity is zero:

$$\sum_{j=1}^{m} m_{rtm,j} = 0 \quad \text{(EQ8)}.$$

The last two constraints are about the budget constraint for the rest of the world with the import and the net inflows for primary factors, taxes and transfers as received income and export and the opposite of the current account as income usages:

$$\sum_{i=1}^{n} I_{row,i} + \sum_{l=1}^{L} \Delta LC_{row,l} + \Delta CR_{row,.} + \sum_{ot=1}^{OT} \Delta T_{row,ot} + \sum_{ct=1}^{CT} \Delta T_{row,ct} + \sum_{si=1}^{SI} \Delta TR_{si,row} = \sum_{i=1}^{n} E_{i,row} + \sum_{inv=1}^{INV} S_{inv,row} \quad \text{(EQ9)}.$$

The last constraint is the equivalence of the sum of savings and the investment flows:

$$\sum_{si=1}^{SI} S_{inv,si} + \sum_{row=1}^{ROW} S_{inv,row} = \sum_{i=1}^{n} I_{i,inv} \text{ (EQ10)}.$$

Table 1 - The structure of the SAM

	$com_{1.....i.......n}$	$act_{1.....\cdot j.....m}$	$L_{1.....l......L}$ K	$Out\_Tax_{1.....ot......OT}$	$Com\_Tax_{1.....ct......CT}$	$Inst\_Sect_{1....s....S}$	$Inc\_Tax_{1....it....IT}$	$RTM_{1.......rtm.....RTM}$	ROW	$INV_{1.....inv.....INV}$	**Row total**
$com_{1.....i.......n}$		**Intermediate consumption** **[$Z_{i,j}$]**				**Final consumption** **[$C_{i,s}$]**			**Export** **[$E_{i,row}$]**	**Investments** **[$I_{i,inv}$]**	$q_1...q_i...q_n$
$act_{1.....\cdot j.....m}$	**Make Matrix** **[$M_{j,i}$]**										$x_1...x_j...x_m$
$L_{1.....l......L}$ K		**Labour compensation** **[$LC_{l,j}$] +** **Capital remuneration** **[$CR_{.,j}$]**							**Labour compensation** **[$LC_{l,row}$]** **+** **Capital remuneration** **[$KR_{.,row}$]**		$LC_1...LC.........LC_l$ KR
$Out\_Tax_{1.....ot......OT}$		**Output taxes paid [$T_{ot,j}$]**							**Output taxes paid [$T_{ot,row}$]**		$OT_1...OT_{ot}...OT_{OT}$
$Com\_Tax_{1.....ct......CT}$	**Commodity taxes paid [$T_{ct,i}$]**								**Commodity taxes paid[$T_{ct,row}$]**		$CT_1...CT_{ct}...CT_{CT}$
$Inst\_Sect_{1....s....S}$			**Labour compensation** **[$LC_{si,l}$]** **+** **capital remuneration** **[$CR_{si,.}$]**	**Output taxes received** **[$T_{s,ot}$]**	**Commodity taxes received [$T_{s,ct}$]**	**Secondary transfers** **[$Tr_{s,s}$]**	**Income taxes received** **[$T_{s,it}$]**		**Secondary transfers** **[$Tr_{s,row}$]**		$Y_1.............Y_{s.........}...Y_S$
$Inc\_Tax_{1....it....IT}$						**Income taxes paid** **[$T_{it,s}$]**					$IT_{1..}...Itit....IT_{IT}$
$RTM_{1.......rtm.....RTM}$	**Retail and transport margins** **[$m_{rtm,i}$]**										0..........0.......0
ROW	**Import** **[$I_{.,i}$]**		**Labour compensation** **[$LC_{row,l}$]** **+** **capital remuneration** **[$CR_{row,.}$]**	**Output taxes** **[$T_{row,ot}$]**	**Commodity taxes** **[$T_{row,ct}$]**	**Secondary transfers [$T_{row,s}$]**					Y_{ROW}
$INV_{1.....inv.....INV}$						**Savings [$S_{inv,s}$]**			**Savings** **[$S_{inv,row}$]**		$INV_1...INV_{inv}...INV_{INV}$
Colmun total	$q_1....q_i......q_n$	$x_1....x_j......x_m$	$LC_1...LC_l....LC_L$ KR	$OT_1...OT_{ot}...OT_{OT}$	$CT_1...CT_{ct}...CT_{CT}$	$Y_1......Y_{s...}...Y_S$	$IT_{1..}...Itit.....IT_{IT}$	0.............0.........0	Y_{ROW}	$INV_1...INV_{inv}....INV_{INV}$	

Source: Authors' elaboration.

In the framework described by the previous equations, the SAM could be defined as a comprehensive and coherent representation of the flows of the economy from the income generation, through the allocation of primary income to institutional sectors and the secondary distribution flows, until the final expenditures for consumption and savings (Miller and Blair, 2009). These relations can be used to construct the CGE model by the introduction of prices that in the benchmark are supposed to be equal to the unit.

2.2 – Macro data description

The main data-source of the SAM is the National Accounting Matrix (NAM). In the first paper we have used the matrix relative to 2013 (ISTAT, 2016[3)], differently from the second paper where the 2014 edition has been used ISTAT, 2019[4]).

It provides a general scheme to elaborate the income generation divided in 20 activities and attributes primary incomes by 3 income types (labour compensation, gross operating surplus and mixed income) and 6 institutional sectors (financial and non-financial corporation, public administration, consumer- and producer households and social private institutions). The database provides additional information about the formation and the use of the disposable income.

These data are elaborated using the Input-Output table at purchaser's price with 63 activities for 2013 released by ISTAT, 2016b[5] in the first paper and for 2014 released by ISTAT, 2019b[6] in the second paper. The labour compensation has been disaggregated in the first paper into 12 classes by occupation, educational attainment and ICT skill deriving from PIAAC data. In the second paper, we have added the gender dimension by obtaining 24 components.

The disaggregation of the '*Compensation of employees*' component is made in relation to gender, formal qualification and digital competences. In detail, we have three groups of skills: *i*) no formal qualification up to the primary school diploma, *ii*) high school diploma; and *iii*) university degree (from PIAAC database). Digital competences are divided into '*workers with skills - Skill*' ('*computer use*') and '*No skill - Unskill*' ('*computer no use*'). This latter index is obtained as the weighted average of the use of e-mail (5 per cent), the use of internet to better understand questions related to work (7 per cent), e-commerce and e-government (10 per cent), the use of excel (13.5 per cent), the use of word (17.5 per cent), the use of complex programming (22 per cent) and the use of video-conference and other real-time participation to discussion (25 per cent). For this disaggregation, we have used the data from PIAAC database integrated by EU-SILC.

In particular, occupations are distinguished among high-skilled, medium skilled and low skilled; formal educational attainment is classified between low-educated, medium educated and tertiary educated. Digital competences have been assessed by using PIAAC answers about the use of computers, e-mail and simple/advanced programmes at work. The Table 2 gives a detailed

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[3] See https://www.istat.it/it/archivio/196839 .
[4] See https://www.istat.it/it/archivio/209141 .
[5] See https://www.istat.it/it/archivio/208938 .
[6] See https://www.istat.it/it/archivio/225665.

description of the labour components. The first level of aggregation is represented by gender with components 1-12 are related to the male components and 13-24 to the female one.

Table 2 - Classification of labour factor in the SAM

Index	Sex (1 male; 2 female)	Occupations (1 LS;2 MS; 3 HS)	Skills (1 L. qualification; 2 M. q.; 3 H. q.)	Computer using (0 NO; 1 Yes)	Description
1	1	1	1/2	0	Low occupations with a low-medium educational attainment and not using computers
2	1	1	1/2	1	Low occupations with a low-medium educational attainment and using computers
3	1	1	3	0	Low occupations with an high educational attainment and not using computers
4	1	2	1/2	0	Medium occupations with a low-medium educational attainment not using computers
5	1	2	1_2	1	Medium occupations with a low-medium educational attainment using computers
6	1	2	3	0	Medium occupations with high educational attainment not using computers
7	1	2	3	1	Medium occupations with high educational attainment and using computers
8	1	3	1/2	0	High occupations with low-medium educational attainment and not using computers
9	1	3	1	1	High occupations with low educational attainment and using computers
10	1	3	2	1	High occupations with medium educational attainment and using computers
11	1	3	3	0	High occupations with high educational attainment and not using computers
12	1	3	3	1	High occupations with high educational attainment and using computers
13	2	1	1/2		Low occupations with a low-medium educational attainment and not using computers
14	2	1	1/2	1	Low occupations with a low-medium educational attainment and using computers
15	2	1	3	0	Low occupations with an high educational attainment and not using computers
16	2	2	1/2	0	Medium occupations with a low-medium educational attainment not using computers
17	2	2	1/2	1	Medium occupations with a low-medium educational attainment using computers
18	2	2	3	0	Medium occupations with high educational attainment not using computers
19	2	2	3	1	Medium occupations with high educational attainment and using computers
20	2	3	1/2	0	High occupations with low-medium educational attainment and not using computers
21	2	3	1	1	High occupations with low educational attainment and using computers
22	2	3	2	1	High occupations with medium educational attainment and using computers
23	2	3	3	0	High occupations with high educational attainment and not using computers
24	2	3	3	1	High occupations with high educational attainment and using computers

Source: Own elaborations

A the second level, the leading criterion is given by occupations with components 1-3 for males and 13-15 for females concerning LS occupations, 4-7 and 16-19, respectively for both genders, for HS occupations, as well as 8-12 and 20-24, respectively, for HS occupations. The third level of aggregation allows us to conduct an in-depth analysis of the relationship between formal skills requested by occupations and those owned by workers. More precisely, the components 1-2 and 13-14 could be considered as the occupation/worker combinations characterised by a substantial matching for low skills. The same occurs for medium skills in components 4-5 and 16-17. Moreover, components 11-12 and 23-24 register the condition of perfect matching for high skills. Overkilling (i.e. the condition of workers owning higher skills than those requested by occupations) can be found in components 3 and 15, where HS workers perform LS tasks. The situation is only slightly more favourable in components 6-7 and 18-19, where HS workers performs MS tasks. Undereducation (i.e. the condition of workers owning lower skills than those requested) seems particularly severe in components 9 and 21, where LS workers perform HS occupations. The phenomenon seems less severe in components 8 and 10, and 20 and 22, where MS workers are employed in HS occupations. The fourth dimension is represented by ICT informal skills and offers a hint for the adoption of digital innovation by firms. Components 9, 10 and 12, as well as 21, 23 and 24 include HS occupations using ICT competences and this is particularly relevant for the components 9-10 and 21-22, where MLS workers perform HS occupations. ICT competences are also used in components 5 ant 7, and 17 and 19 for MS skills, as well as 2 and 14 for LS workers.

The primary distribution to institutional sectors has been made by using the original classification of the NAM 2013 and 2014, aggregating producer- and consumer-households, as well as disaggregating the public administration into six sub-sectors (central administration, social insurance bodies, regional, provincial, municipal and other local and central administrations).

A relevant feature in the SAM elaborated in the paper is that labour compensation includes only the gross wages - including employers' SSCs - relative to dependent workers. In this way, independent work (including entrepreneurs, occasional workers, free-lance workers and members of workers' owned companies) is not explicitly considered and its remuneration is included in the mixed income with other components (such as profits). Theoretically, this is not correct, because it determines an understatement of the effective labour input used in production (especially in countries with a high share of independent work). However, prices of independent work are more similar to profit or to remuneration of capital than to prices of dependent work which are determined through the wage bargaining. Therefore, summing-up the remuneration for independent work and capital could be suitable. A three-nested production function has been adopted. In the first nest, we have a Leontief production function aggregating intermediate consumption and the value added. Intermediate commodities are assumed to have fixed share intermediate consumption taken together, so by hypothesising also in this case a Leontief aggregation function. Primary factors capital and labour - which are part of the value added - are aggregated through a CES production function. In the same way, the aggregate labour input has been obtained from the aggregation of each specific labour type. Elasticities between capital and labour as well as among different types of labour have been defined on the base of the international literature.

The coefficient related to the capital/aggregated labour elasticity has been estimated on the base of OECD disaggregate data until 2009 and this could not take into account the consequences of the structural break of the economic crisis. In addition, the elasticity coefficient among labour types could be not suitable for the Italian 2013 condition, as it has been estimated on US data and for faraway periods.

We have to stress that the wage or the capital return rate calculated on the base of the National Account data can show a high heterogeneity degree across activities and this circumstance contradicts the assumption of a full mobility of production factors across activities/firms implied by the perfect competition. Wage- and return differentials could be modelled as exogenous or endogenous. In our model, the production and the cost function are modelled based on the different types of labour compensation and capital remuneration, by hypothesising a factor price equal to one in the benchmark. This implies that in the benchmark wage- and return rate-differentials in terms of physical units of employment and capital are assumed to be different from zero and these differentials are endogenous, as they can change in simulations through factor prices higher/greater than 1.

Table 12.2.1 in Appendix shows the distribution of labour compensation by skill level of occupation and digital competence in 2014. We can see that generally the Italian productive system is characterised averagely by a use of computer and internet at work amounting to 37.5 per cent of labour compensation. About the 70 per cent of labour compensation paid to ICT skilled workers is paid to workers performing high-skilled occupations.

The more intensive activities of use of computers (see Tables 10.2.1 and 10.2.2 in the Appendix) are professional and scientific services (M74-75), programming activities (J62_63), legal and accounting services (M69_70) and insurance services (K65). Conversely, paper industries (C17), accommodation services (I), other personal services (S96) and household services (T) register a low level of ICT competences.

As for the institutional sector, two main changes have been introduced into the NAM 2014. First, the Public Administration sector has been divided into the following six sub-sectors: i) central administration; ii) pension- and social assistance institutions; iii) regional administrations; iv) province- and town-district[7]-level administrations; v) municipal administrations; vi) other administrations. Transfers between public administrations have been obtained by elaborating the data about the current transfers from the SIOPE database released by the Ministry of Economy and Finance and the Bank of Italy [8] and the Public Finance statistics from ISTAT[9].

As for households, we have aggregated the NAM figures for consumer- and producer-households. Then, we have used the IT-SILC data integrated with the Consumer Survey (both released by ISTAT) and with the SHIW survey released by the Bank of Italy. Then the individual taxable income has been calculated and individuals have been classified according the five Personal Income Tax (PIT) brackets in force in Italy (<=15,000 with a gross rate of 23 per cent; 15,001-28,000 with 27 per cent; 28,001-55,000 with 38 per cent; 55,001-75,000 with 41 per cent; >75,000 with 43 per cent). Finally, households have been ranked according to the prevalence of components belonging to each PIT bracket (see households from FAM2-FAM6); a residual category (FAM1) has been identified for households without a precise identification.

As we can observe from the Table 3, the employment in low-skilled occupations is concentrated in the first two PIT brackets FAM2-FAM3 (52/53 per cent for males and 16/26 per cent for females without/with the use of computers at work). On the contrary, employment in high-

[7] Town- districts include medium-large sized towns (such as Rome, Milan and Turin) with the same powers of provinces.
[8] See https://www.siope.it/Siope/ .
[9] See https://www.istat.it/it/archivio/204387 .and https://www.istat.it/it/archivio/finanza+pubblica .

skilled occupations is more concentrated (even though in a lesser extent) in the three richest PIT brackets (FAM4-FAM6) with a cumulated incidence of 21/31 per cent for males and 20/23 per cent for females (respectively, without and with the use of computers at work).

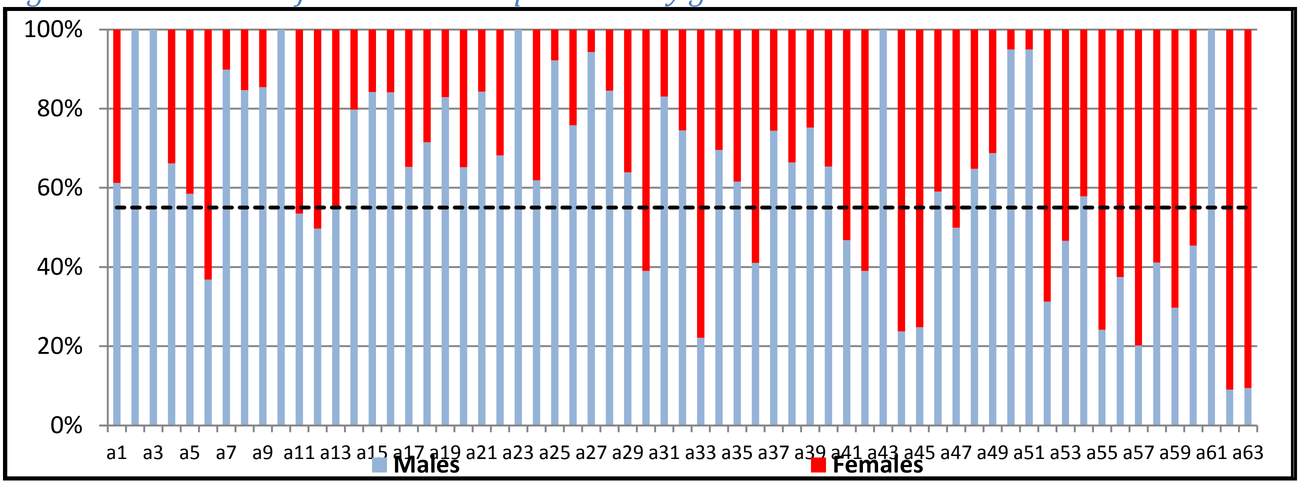
Table 3 - Allocation of the labour compensation by institutional sectors

	Gender	Low-skilled occupations		Medium-skilled occupations		High-skilled occupations		Using computers	High skilled occupations
		Not using com.	Using com.	Not using com.	Using com.	Not using com.	Using com.		
FAM1	Males	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
FAM2		13.04	16.20	9.35	7.33	4.46	6.04	6.94	5.47
FAM3		40.07	36.96	28.10	21.28	11.98	13.46	16.75	12.93
FAM4		16.11	27.81	11.50	16.32	13.41	24.36	22.57	20.43
FAM5		0.00	0.84	0.47	1.77	6.31	6.20	4.79	6.24
FAM6		0.74	0.33	0.35	0.73	1.49	8.22	5.91	5.81
ROW		0.20	0.24	0.14	0.14	0.11	0.17	0.17	0.15
FAM1	Females	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FAM2		12.17	7.47	15.38	11.01	4.96	3.68	5.71	4.14
FAM3		14.02	7.63	24.76	25.78	20.66	14.56	16.93	16.74
FAM4		2.94	2.44	8.97	13.69	31.18	17.40	15.62	22.34
FAM5		0.51	0.00	0.60	1.01	2.72	2.70	2.13	2.71
FAM6		0.10	0.00	0.22	0.78	2.55	3.10	2.35	2.90
ROW		0.09	0.05	0.15	0.15	0.18	0.12	0.12	0.14
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As we can observe from the Figure 1, male employment covers about 55 per cent of labour compensation at the aggregate level (see the dashed line). There is a high heterogeneity by activity with the male employment prevailing in Auxiliary activities to the financial sector (a43), Rental and leasing services (a50), Employment activities (a51), Repair of computers (a61), Repair and installation of machinery/equipment (a23), Water collection, treatment and supply (a25), Construction (a27), Forestry and logging (a2), Fishing (a3) and Manufacture of coke and refined petroleum (a10). Female workers are the majority in Households services (a63) and Other personal services (a62) with a relevant percentage in Education (a55) and in Human health (a56), Real estate services (a44), Legal and accounting activities (a45) and Air transport (a33).

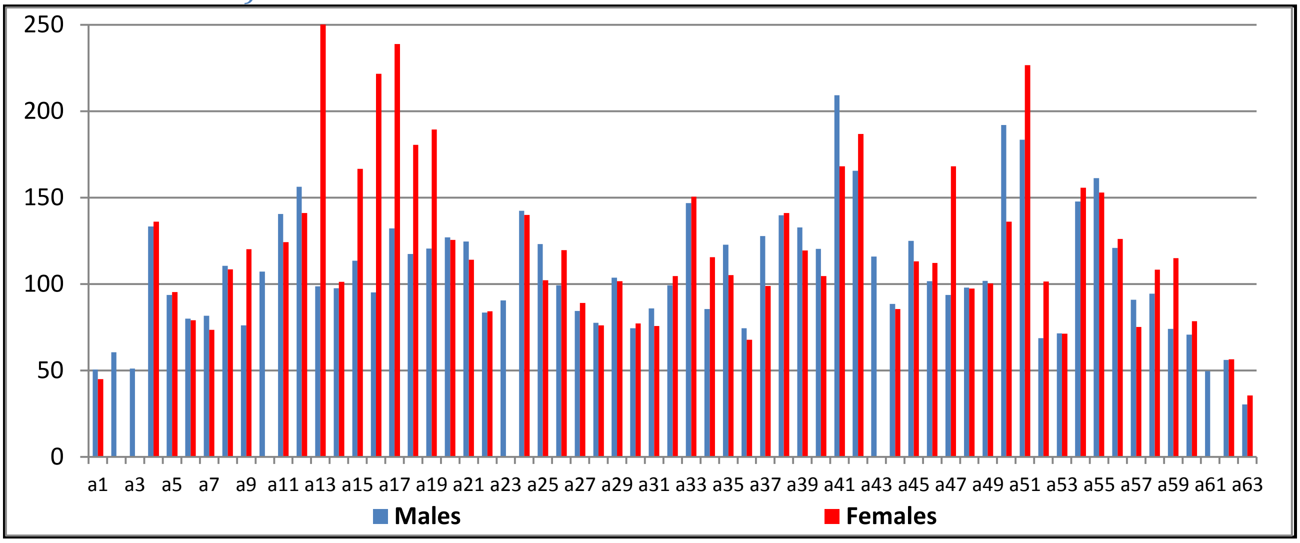
Figure 1 - Allocation of the labour compensation by gender



Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As for the labour compensation (see Figure 2), data confirm the existence of a gender gap amounting to 5.7 p.p.s normalised with respect to the average aggregate hourly labour compensation. We can observe an high heterogeneity among activities: the Manufacture of basic metals (a15) and of metal products (a16) register an high difference between male and female hourly wages, amounting respectively to 61 and 91 p.p.s.; in services there is a difference of 121.0 p.p,s favourable to male workers. Differences are negative and favourable to women in the Manufacture of wood and cork (a7 with -35.9) and of rubber and plastic (a13 with -37.3), as well as in the Rental and leasing activities (a50 with -53.9). In 31 out of 49 activities for which hourly wages are available both for both genders, there is a positive difference favourable for men.

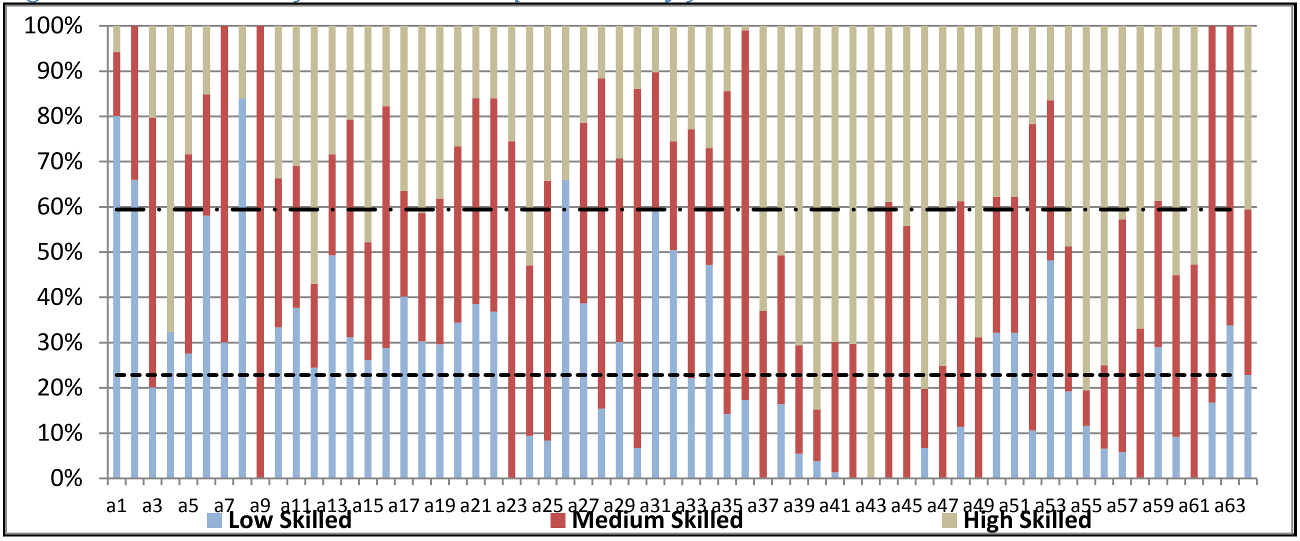
Figure 2 - Average labour compensation per hour worked by gender (index with the aggregate level=100)



Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As for composition by skill (see Figure 3), averagely, LS work covers 22.9 per cent of labour compensation vs.36.5 of MS work and 40.6 per cent of HS work. LS work has a particularly high weight in Agriculture (a1 with 80.1 per cent), Forestry (a2 with 66.0 per cent), Sewage and waste management (a26 with 66 per cent) and Land transport (a31 with 59.4 per cent). Instead, MS work is prevalent in Fishing (a3 with 59.6 per cent), Manufacture of woof and cork products (a7 with 69.9 per cent), Printing (a9 with 100 per cent), Vehicle trade (a28 with 73.0 per cent), Other retail trade (a30 with 79.4 per cent), Postal activities (a35 with 71.3), Accommodation (a36 with 81.6), Travel agency (a52 with 67.7 per cent) and Household services (a63 with 66.2 per cent). Moreover, the labour compensation of HS work is high in Real estate activities (a4 with 67.2 per cent),Manufacture of pharmaceuticals (a12 with 57.0), Electricity and gas (a24 with 53.0 per cent), Publishing activities (a37 with 63.0 per cent), Telecommunications (a39 with 70.6), Computer programming (a40 with 84.8), Financial services (a41 with 69.9), Insurance services (a42 with 70.3), Auxiliary financial services (a43 with 100.0), Architectural and engineering (a46 with 80.2), Scientific research (a47 with 75.1), Other professional services (a49 with 68.8), Education (a55 with 80.6) and Human health (a56 with 75.0).

Figure 3 - Allocation of the labour compensation by formal skill

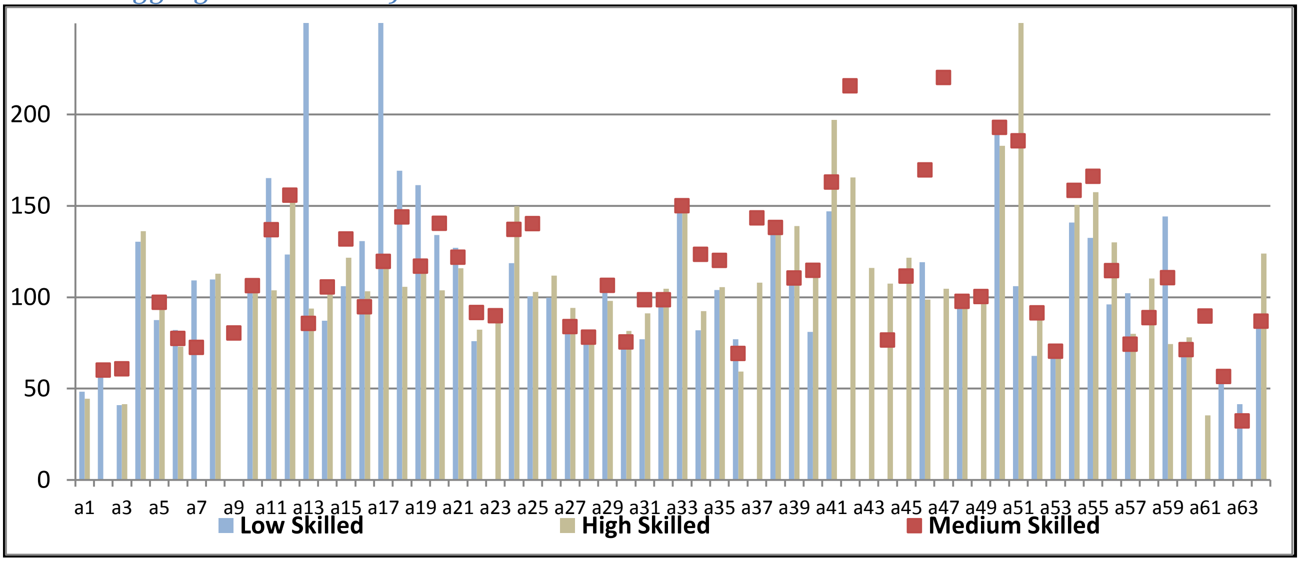


Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

Hourly labour compensations (see Figure 4) follows averagely the expected pattern in terms of values normalised to the average figure. Indeed, LS workers earn a wage equal to 90.5 per cent of the average value vs. 87.0 per cent of MS workers and 124.0 per cent of HS workers, even though no relevant difference emerges averagely between LS and MS work. In Manufacture of basic metals (a15), Manufacture of motor vehicles (a20), Rental and leasing activities (a50), Public Administration (a54) and Education (a55), all components earn an hourly wage higher than the average and MS work seems particularly favoured with a figure amounting respectively to 132.0, 140.5, 193.1, 158.6 and 166.3. In the both activities, HS workers are, respectively at 121.6, 103.9, 183.0, 150.5 and 157.7. Also, Manufacture of coke (a10), Manufacture of chemicals (a11) and Manufacture of pharmaceuticals (a12) generate wages higher than the average and the distribution of wages among components follows the expected pattern (LS wages<MS wages<HS wages) with the exception of a11, where LS workers are particularly favoured (165.3 vs. 137.1 and 103.9 for, respectively, LS and MS workers. Manufacture of electrical equipment (a18) and of machinery and equipment (a19) register an advantage for LS work with a figure amounting respectively to 169.3 and 161.4. MS workers' wages is particularly high at 220.4 for a47.

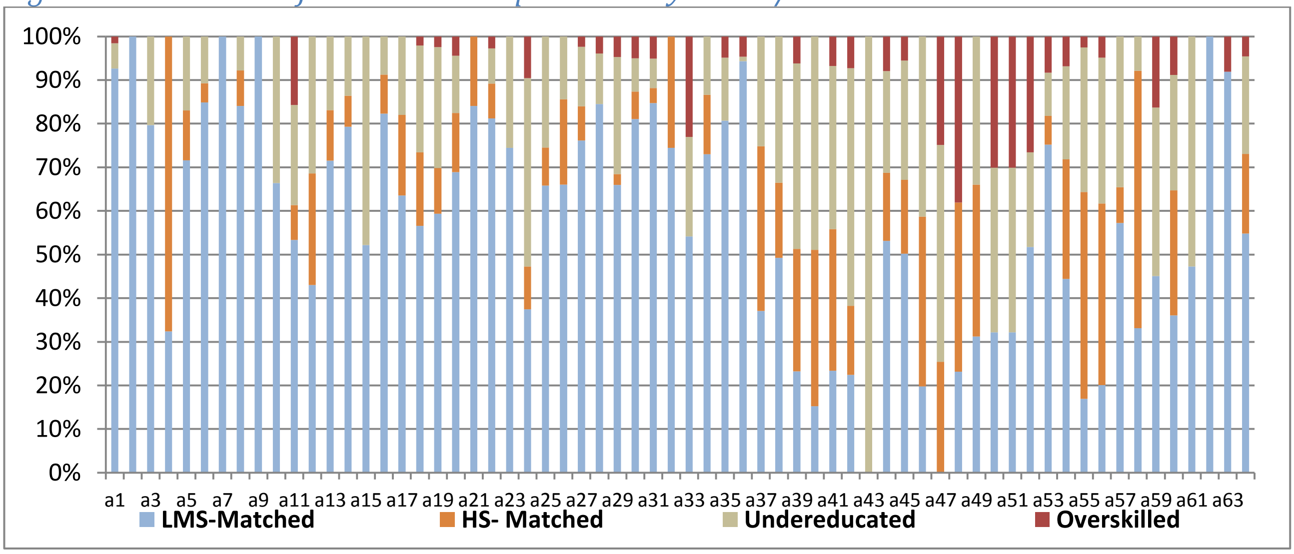
As for the composition by skill (see Figure 5), averagely, perfectly matched work covers 73.0 per cent of labour compensation vs. 27.0 of not-perfectly matched work. 75.1 per cent of matched work is represented by LS work. Indeed, 16.9 per cent of unmatched work is constituted by overskilled work. The activities with the lowest incidence of the matched work are Auxiliary activities to financial services (a43 with 0.0 per cent), Scientific research (a47 with 25.4), Rental and leasing activities (a50) and Employment activities (a51) - both with 32.2 per cent - , Repair services (a61 with 47.3) and Electricity (a24 with 47.2). Computer programming (a40 with 29.8 per cent), Publishing activities (a37 with 37.4), Architectural and engineering (a46 with 33.7), Education (a55 with 26.3), Human health (a56 with 32.6) register particularly low figures for the incidence of LMS matched workers on matched workers. Indeed, the incidence of overskilled workers on unmatched workers is highest in Advertising (a48) and Household services (a63) - both at 100.0 per cent -, Accommodation services (a36 with 82.4), Travel agency (a52 with 55.0 per cent) and Air transport (a33 with 50.2).

Figure 4 - Average labour compensation per hour worked by formal skill (index with the aggregate level=100)



Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

Figure 5 - Allocation of the labour compensation by match/mismatch

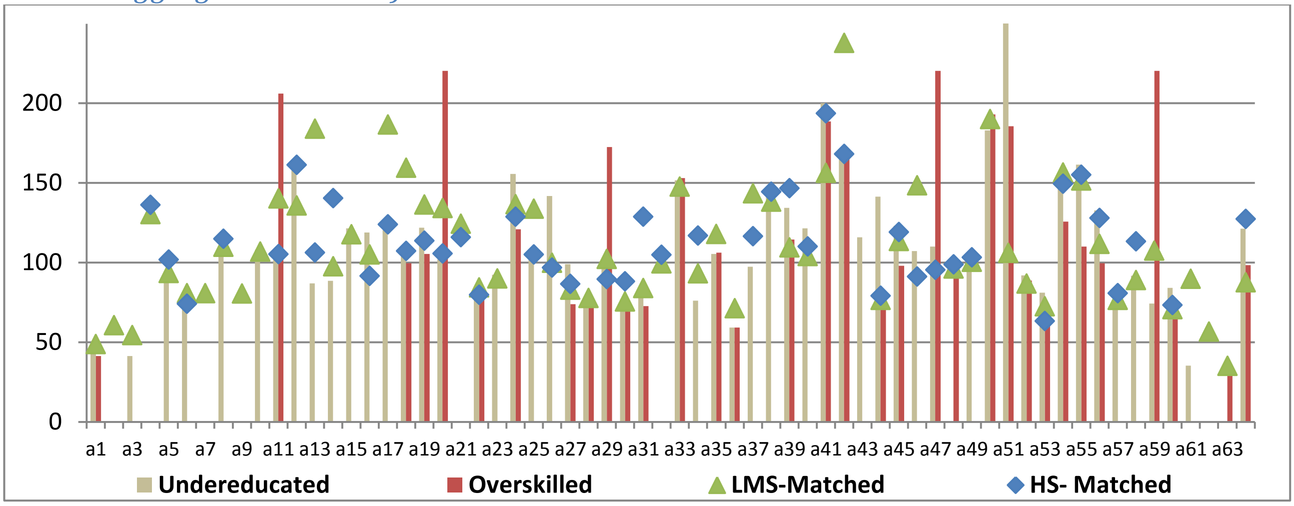


Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As for the hourly labour compensation by skill (see Figure 6), averagely, perfectly LMS matched workers earn the 87.6 per cent of total economy wage and this represents the minimum. Overskilled workers earn 10.9 p.p.s more than LMS workers. Moreover, HS matched workers earn the maximum at 127.3 per cent of the average wage, followed by the undereducated ones (121.4).

The activities with the highest gross wage for all the four mentioned categories are the following: Manufacture of chemicals (a11), of pharmaceuticals (a12) and of motor vehicles (a20), Scientific research (a47) and Sport activities (a59) with particularly high values for overskilled workers; Manufacture of computers (a17), of electrical equipment (a18) and of machinery and equipment (a19), Insurance activities (a42) and Public Administration (a54) with particularly high wages for LMS matched workers; Land transport (a31), Water transport (a32), Warehousing (a34), Telecommunications (a39) with particularly high figures for HM matched workers; Electricity and gas (a24), Sewage and waste management (a26), Employment activities (a51), Education (a55) and Human health (a56), with particularly high values for undereducated workers. Financial services (a41), Legal and accounting services (a45), Other professional activities (a49), Rental and leasing activities (a50),Manufacture of other transport equipment (a21) and of paper products (a8) and Mining and quarrying (a4) register particularly high values without relevant differences among the mentioned components.

Figure 6 - Average labour compensation per hour worked by match/mismatch (index with the aggregate level=100)

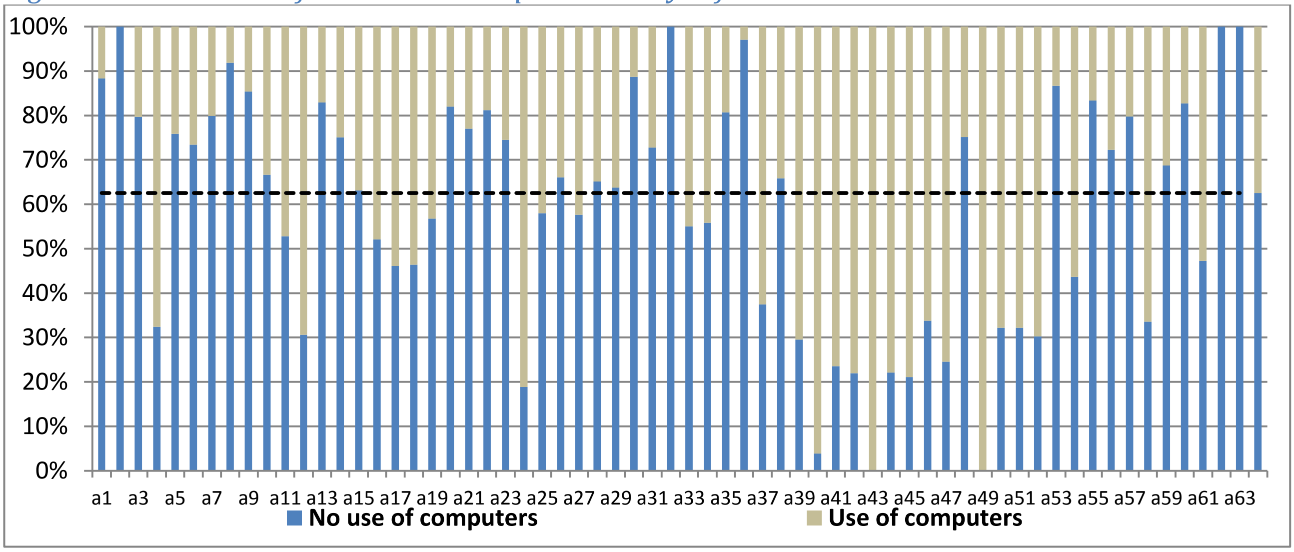


Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As for the composition by informal skills approximated by ICT competences (see Figure 7), averagely, averagely, ICT-intensive workers represent the 37.5 per cent of total labour compensation. There is a high heterogeneity among activities with particularly high figures in Other professional activities, rent and employment services (a4 to a52), Creative services (a58), Telecommunications and (also scientific) professional services (a3 to a47), Publishing (a37), Electricity and gas (a24), Manufacture of pharmaceuticals (a12) and Mining and quarrying (a4) with values higher than 60 per cent.

As for the hourly labour compensation by skill (see Figure 8), averagely, the hourly labour compensation of ICT-intensive workers amounts to 121.9 per cent of the total economy hourly gross wage index with a differential vs, non ICT-intensive workers amounting to 31.6 p.p.s. The differential varies across activities and we can find activities with very low positive differentials or also negative ones.

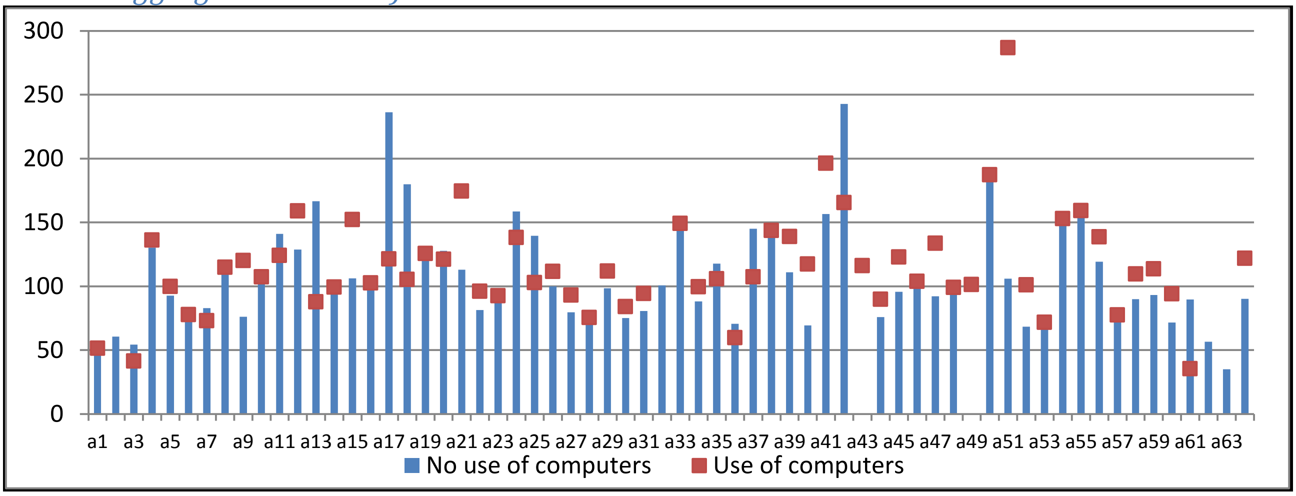
Figure 7 - Allocation of the labour compensation by informal skills



Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

As for the first case we can list the following activities: Agriculture (a1), Mining and quarrying (a4), Manufacture of food and beverages (a5), of paper products (a8), of coke (a10), of other non-metallic mineral products (a14) and of furniture (a22), repair and installation services (a23), Sewage and waste management (a26), Construction (a27), Trade and land transport (a29 to a31), Warehousing (a34), Broadcasting programming (a38), Real estate activities (a44), Advertising (a48) and Security services (a53) and Public Administration and education (a54 and a55).

Figure 8 - Average labour compensation per hour worked by informal skill (index with the aggregate level=100)



Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

Instead, as for the second group, the following activities can be listed: Fishing (a3),Manufacture of textiles (a6), of wood and cork products (a7), of chemicals (a11), of rubber and plastic (a13), of metal, computer and machinery (a16 to a20), Electricity and gas (a24), Water collection (a25), Trade of motor vehicles (a28), Air Transport (a33), Postal, publishing and accommodation services (a35 to a37), Insurance (a42),Architectural and engineering (a46), Employment services (a50) and Repair of computers (a61).

2.3 - Description of microeconomic data

The IT_SILC database contains information about income, as well households. Incomes are reported as net of taxes, so that they should made gross by summing up direct taxes (distinguishing by the beneficiary administration) and subtracting benefits (such as tax deductions from taxes or taxable income). This allows obtaining the disposable income, whose sum has to be equal with national accounts. The use of income and wealth is obtained by linking IT_SILC with SHIW and microdata from consumer survey through an imputation technique, so to obtain the household's consumer propensity and an aggregate one, which should be consistent with microdata. Changes in disposable income determine changes in individual labour supply in terms of hours.

Our microeconomic dataset is based on the 2014 IT-SILC data with income data related to 2014 and labour market statuses related to 2013. The base has then been enriched through matching procedures with the 2014 SHIW survey and the 2013 Consumer survey. This approach allows combining the statistical representativeness of SILC data with the particular attention paid by SHIW to the wealth (even though these data are not representative at regional level and upward biased) and with the detail by COICOP assured by the Consumer Survey.

With particular reference to the disaggregation of consumption by commodity, we have estimated the weights transforming COICOP into the NACE classification through an equation system through a Seemingly Unrelated Regression (SUR) model. This step is very useful, as it allows us to estimate the change in households' consumption patterns after a change at the microeconomic level, originated either from the micro level itself, or as a response to a macroeconomic shock.

Our micro dataset contains 47,136 observations, representing 60,623,518 people. The dataset includes the gross employees' income with a poor and reliable detail by activity, but a rich detail in terms of time (hours/months) worked, type of contract and reasons to work/not work. This allows us to extract from inactive people's pool the potential labour force (PLF) including inactive people not searching for a job, but still available to work. From the dataset we can also obtain reliable (even though not complete) estimation of jobs which people and especially unemployed and PLF inactive are searching for. By combining information about the hour worked, the reasons to work/not work and job expectations, we are able to determine the potential employment and income. The potential employment and income differ from the actual ones because of the amount attributed to involuntary part-time or fixed-term workers, unemployed and PLF members. We can describe all these quantities as an activation margin in case of a positive shock on employment at the macro level.

Labour Force Survey (LFS) micro data provide for a decomposition of population by occupational statuses (employed, unemployed and inactive) and allow analysing detailed aspects of each individual's life, such as gender, age, education, residence and other drivers of choice of individuals. Since 2011, LFS data contain data on wages too. LFS data also allow analysing the emerging skill mismatch if there is match between the formal skills requested to perform a task and those owned by the workers. EUKLEMS provides for a survey report on gender, gender and skills by economic sectors until 2014. Not-formal skills are not available in LFS data. At this regard, we can found information by opportunely combining data on innovation by firms with data on formal education by sectors.

3 - Macro sectoral CGE model description.

3.1 - Description of the static CGE model.

The model used in all the papers is the MAC-18 model od Computable General Equilibrium (CGE), developed by the Department of Economics and Law of the University of Macerata. The main target of the model is to quantify the economic, disaggregate, direct and indirect impacts of fiscal policies and policy reforms on the Italian macroeconomic variables. The main assumption of the CGE models is that there is perfect competition in all markets, so that the constrained maximising choices of households, firms, public administrations and private social institutions determine simultaneously prices and quantities according to policy changes in final demand or in other parameters. In order to make the model more coherent with the actual situation, a wage curve scheme explains wages. The relations among prices and quantities are summarised in Table 4, which is similar to the Table 1, but it distinguishes the endogenous and exogenous variables.

By recalling the EQ1 defined in the explanation of the SAM, the supply of goods Q_i has offered both by domestic firms producing according to a CES production function X_j and by the rest of the world through imports. These latter depend on prices of output by activity pa_j, revenues of taxes on output function of the rate of taxes on output to_i, as well of import function of import prices pmw_i.. The demand of goods comes from the following sources: i) the intermediate consumption from activities depending on the volume of output X_j (hypothesis of a Leontief production function with fixed shares); ii) final demand for households' consumption depending on p_i and the disposable income of households Y_h; iii) the final demand public administration assumed fixed at G_g; iv) investment I according to the price of each good p_i and the aggregate level of saving S; as well as *v*) the rest of world depending on the competitiveness given by $p_i \cdot EXR/P_{ROW}$ (where EXR is the exchange rate and P_{ROW} is the price on international markets under the assumption of exporters being price-takers).

As for the EQ2, the price of output by activity pa_j is defined as a cost function with two nests modelled as a Leontief function as for the aggregation of intermediate goods $B(X_j,pi)$ and of primary factors $VA(X_j,pva_j)$. These latter are modelled as a CES function in the labour compensation and in capital remuneration. In the original version of the model there is only one type of labour compensation, whereas in the revised version the labour compensation is a CES aggregation of 12 (or 24) different types of labour compensation, disaggregated by (gender), occupation, educational attainment and digital competence.

As for the EQ3, the value added generated by activity *j* VA_j is attributed to domestic private institutional sectors *h* as gross market income Yf_h, to the different levels of public administration (Yf_g), as well to the rest of world (Yf_{ROW}). The labour compensation is attributed to households and to the rest of the world, whereas the gross operating surplus (including also mixed income potentially earned by independent workers) is divided among all domestic and foreign institutional sectors.

Table 4– The structure of the MACGEM-IT model

	$com_{1.....i.......n}$	$act_{1.....\cdot j.....m}$	$L_{1.....l......L}$ K	$Out\_Tax_{1.....ot......OT}$	$Com\_Tax_{1.....ct......CT}$	$Inst\_Sect_{1....s....S}$	$Inc\_Tax_{1....it....IT}$	$RTM_{1.......rtm.....RTM}$	ROW	$INV_{1.....inv.....INV}$	**Row total**
$com_{1.....i.......n}$		**$B(X_j,P_i)$**				**$C(Y_h,p_i)$ and G_g**			**$E(P_i,EXR,P_{ROW})$**	**$I(S,p_i)$**	$q_1....q_i....q_n$
$act_{1.....\cdot j.....m}$	**$bi(Q_i, pa_j)$**										$x_1....x_j.....x_m$
$L_{1.....l......L}$ K		**$VA(X_j,pva_j)$**									$LC_1....LC.............LC_L$ KR
$Out\_Tax_{1.....ot......OT}$		**$Ta(X_j, ta_j)$**									$OT_1...OT_{ot}...OT_{OT}$
$Com\_Tax_{1.....ct......CT}$	**$To(Q_i,to_i)$**										$CT_1...CT_{ct}...CT_{CT}$
$Inst\_Sect_{1....s....S}$			**$Yf_h(VA_h)$ and $Yf_g(VA_g)$**	**$Ta(X_j, ta_j)$**	**$To(Q_i, to_i)$**	**$Tr(Yf_h,tr^{tras}_h)$ and $Tr(Yf_g, tr^{tras}_g)$**	**$Ty(yf_h, ty^{inc}_h)$**		**Tr_{ROW}**		$Y_1..............Y_{s.........}...Y_S$
$Inc\_Tax_{1....it....IT}$						**$Ty(Yf_h, ty^{inc}_h)$**					$IT_{1..}...Itit....IT_{IT}$
$RTM_{1.......rtm.....RTM}$											0..........0......0
ROW	**$M(Q_i, Pm_i\ pwm_i)$**		**$Yf_{ROW}(VA_{ROW})$**			**$Tr(Yf_h,tr^{tras}_{ROW})$ and Tr_g^{ROW}**					Y_{ROW}
$INV_{1.....inv.....INV}$						**$S(Yf_h,r)$ and $S(Yf_g,r)$**			**$(+/-)S_{ROW}$**		$INV_1...INV_{inv}....INV_{INV}$
Colmun total	$q_1....q_i......q_n$	$x_1....x_j......x_m$	$LC_1...LC_l....LC_L$ KR	$OT_1...OT_{ot}...OT_{OT}$	$CT_1...CT_{ct}...CT_{CT}$	$Y_1......Y_{s....}...Y_S$	$IT_{1..}...Itit.....IT_{IT}$	0..............0.........0	Y_{ROW}	$INV_1...INV_{inv}....INV_{INV}$	

Source: Authors' elaboration.

As for the equations EQ4 and EQ5, the revenues of taxes on goods and on output by activity (respectively, To and Ta) is obtained as the tax rates to_i and ta_j multiplied by the tax bases (respectively, $p_i \cdot Q_i$ and $pa_j \cdot X_j$). Among the taxes on output by activity, there is the regional tax on productive activities (IRAP), whose base is represented by the sum of labour compensation and of capital remuneration.

As for the EQ6, the model outlines the budget constraint of domestic institutional sectors. As for private institutional sectors, the disposable income Y_h is given by sum of the gross market income Yf_h, increased by the net transfers from other domestic institutional sectors Tr_h, which are partly endogenous, and partly exogenous. Endogenous net transfers flows income are obtained as the product of the transfer rate and the gross market income of paying sectors Yf_h net of direct taxes Ty_h. Instead, the exogenous net transfer flows are obtained with an adjustment based on the expected inflation. Transfers come also from the rest of the world (Tr_{ROW}), assumed exogenously fixed. Income taxes Ty_h - are obtained as the product of the income tax rate ty^{inc}_h by the gross market income Yf_h. As for the domestic public institutional sectors, the disposable income Y_g is obtained as the sum of the revenues from taxes on goods and on output by activities (respectively, To and Ta), as well of income taxes Ty_h, of net transfers from other domestic institutional sectors Tr_h (which are endogenous). Other components are constituted by net transfers from the rest of the world Tr^g_{ROW} assumed as exogenous and by the gross market income Yf_g including only the remuneration of capital owned by public sectors.

As for the rest of the world, the disposable income refers to EQ9, and is given by the sum of import M_{ROW}, the net transfers from private domestic sectors Tr_h. and from domestic public sectors T^gr_{ROW} (assumed exogenous). Import is function of the prices set on international markets pwm_i and of the net gross primary income received by activities Yf_{ROW}. Net transfers from private domestic sectors are endogenous according to the gross market income of paying sectors. The disposable income can be used for final consumption (C_h for households and no-profit institutions, G_g for public sectors and E_{ROW} for the rest of the world) or for saving (respectively, S_h, S_g and S_{ROW}). Consumption expenditure by households is obtained through a maximising choice of the utility. The total consumption of public sectors are assumed as exogenously set.

The last equation of the CGE model is the closure, where the sum of saving decisions by institutional sectors is equal to investment choices $I_{i,inv}$ by goods and type (gross investment and changes of inventories).

3.2 - Description of the dynamic CGE model.

We have also used the MAC18_DYN dynamic CGE model, developed by the University of Macerata - Department of Economics and Law. The model has been conveniently modified, in order to include the distinction of wages and salaries, as well as employers' social security contributions into 24 labour categories defined according gender (male and female), occupations (low, medium and high), formal skills (low, medium and high) and ICT skills (use and not-use of advanced computer programmes).

The model include a very detailed disaggregation with sixty-three activities and commodities, twenty-four labour categories (as before mentioned), 16 institutional sectors (including 6 households types and six Government levels). Households are divided according the five PIT tax brackets actually in force plus an additional class defined by upper limit of EUR 2,840.81 (that is the threshold for the independence from the original households for all components with exclusion of the spouses). The income indicator is defined as the average of gross incomes earned by all the components weighted for the share of household income earned by each member. As for the Public administration, the classification in six categories (Central Government, Security Bodies, Regions, Provinces, Municipalities and other Administration) allows to capture the effects due to secondary transfers between each level of administration. The time horizon in the model is defined in five periods.

The MAC18_DYN model is a recursive and multi-input/output/activity model, based on the law of capital accumulation over time (where the capital accumulated at the beginning of the t-1 time increased by investment flows occurred during the t-1 period and reduced by the depreciation flows occurred in the same t-1 time determine the capital at each t time). As in the static MAC18 mode, the equations are modelled under the assumption of profit and utility maximisation, respectively by activities and by consumers. In MAC18_DYN utility maximisation has been obtained by adopting a disposable income cumulated over the whole time spell according the Ramsey approach (Lau *et al.*2002).

The model adopt a Make-Use approach, so that each activity produces the characterising commodity, as well as the remaining commodities according endogenous shares which are function of relative prices. Each commodity is supplied to the economic system as the sum of imports domestic and of domestic production. Imports are set as function of relative domestic/foreign prices, the foreign inflation rate and the nominal exchange rate (the latter two variables are assumed exogenous) according some convenient substitution elasticities. As for the domestic production, we combine the value added with intermediate consumptions according a Leontief production function. Labour categories and capital contribute to the value-added formation according a CES production function with elasticity of substitution set at 0.52 following to van der Werf, 2007. The composition of intermediate consumption by commodities is function of the activity level for each activity using commodities and of commodity relative prices.

The demand of final consumption by households and non-profit institutions serving households (NPISH) is determined by maximising the intertemporal utility under the constraint of the disposable income earned over the whole analysis horizon. The disposable income is obtained as the sum of primary (labour- and capital-) income, of employers' social security contributions transferred from firms and of active secondary transfers (including income taxes and employees' and employers' social security contributions collected), net of negative transfers (including income taxes and employees' and employers' social security contributions paid). As for transfers, all transfers are endogenously determined with the exception of transfers from Public Administration and Rest of the World. We assume the real consumption of the Public Administration as constant.

The demand for investment is function of saving attributed to each institutional sector. At the same way of import, export also depends on foreign prices and inflation, as well on the nominal exchange rate (all assumed as exogenous) and on domestic prices. In the case of exports, additionally, we take into account the exogenous growth rate of the world demand.

Prices are defined through the market clearing condition expressed by assuming the perfect functioning of markets (i.e. zero profit condition). With reference to the productive factor prices, capital prices are set according the profit maximisation rule to the marginal productivity of each factor, which corresponds to the marginal cost. As for labour, the 24 labour prices are set according to a wage curve decreasing in the unemployment rate (increasing in employment and decreasing in the labour supply): this constitutes a deviation from the profit maximisation rule, but it takes into account the actual conditions of labour markets explainable trough many reasons (as the collective bargaining and the efficiency wages). The labour supply constitutes an exogenous variable growing at an exogenous growth rate corresponding to the stationary status. We partly endogenised the labour supply in two steps. Firstly, we introduce shocks as responses to the changes in individuals' choices determined at the microeconomic level as the consequence of developments of Tax and Benefit system. Second, we outline the evolution of labour supply by labour category over time due to the effect of the training-on-the-job of LS labour under three scenarios (i.e. low, medium and high effectiveness).

The model is closed by introducing some rigidities on prices. Budget constraints of public sector and on exchange rates. As for the Public Administration, the income-, activity- and output taxes are function of endogenous tax bases and determine the gross saving. The consumption of the Public Administration is set in real terms. As for the Rest of the World, in each period, the nominal exchange rates and the gross saving are set exogenously and the real exchange rate is endogenous. The real import demand depends on the relative prices and on domestic income, whereas real exports are fixed. Finally, the investment in the model is determined by the gross saving, even if the saving of the Rest of the World cannot change compared to the benchmark level and the change in the gross saving of the Public Administration is put into a reserve (i.e. '*def*' variable).

We can divide the MAC18_DYN model in 4 bocks. The first block is given by the production block, modelled as a two-nested production function. The first nest is given by the combination of intermediate inputs and primary factors and is modelled as a Leontief function:

$$\mathrm{X}_{\mathrm{a}}^{\mathrm{t}} = \left(\mathrm{alfa}_{\mathrm{a}}^{\mathrm{X}} \cdot {\mathrm{IC}_{\mathrm{a}}^{\mathrm{t}}}^{\rho} + \left(1 - \mathrm{alfa}_{\mathrm{a}}^{\mathrm{X}}\right) \cdot {\mathrm{VA}_{\mathrm{a}}^{\mathrm{t}}}^{\rho}\right)^{\frac{1}{\rho}} \text{ with } \rho\text{->-}\infty \text{ (EQ11);}$$

$$PX_a^t \cdot (1 - \sum_{act=1}^{ACT} ta_a^{act}) = \left(alfa_a^X \cdot PIC_a^{t\frac{\rho}{\rho-1}} + \left(1 - alfa_a^X\right) \cdot PVA_a^{t\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}} \text{ with} \frac{1}{-\rho+1} = \sigma \text{ and } \rho\text{->-}\infty$$

(EQ12).

The physical amount of the composite intermediate consumption and of the composite primary factors can be written in general forms in the following way:

$$IC_a^t = alfa_a^X \cdot X_a^t \cdot (\frac{PX_a^t}{PIC_a^t})^{\frac{1}{-\rho+1}} \text{ (EQ13);}$$

$$VA_a^t = (1 - alfa_a^X) \cdot X_a^t \cdot (\frac{PX_a^t}{PVA_a^t})^{\frac{1}{-\rho+1}} \text{ (EQ14).}$$

At the second nest we have to identify the demand of each intermediate commodity and of each elementary primary factor:

$$IC_{i,a}^t = alfa_{i,a}^{IC} \cdot IC_a^t \cdot (\frac{PIC_a^t}{P_{i,q}^t})^{\frac{1}{-\gamma+1}} \text{ with } \gamma\text{->-}\infty \text{ (EQ15);}$$

$$PIC_a^t = (\sum_{i=1}^{N}(alfa_{i,a}^{IC} \cdot P_{i,q}^{t\ \frac{\gamma}{\gamma-1}}))^{\frac{\gamma-1}{\gamma}} \text{ with } \gamma\text{->-}\infty \text{ (EQ16).}$$

We can express in other terms the composite intermediate consumption and the composite value added as fixed shares of total output and the price of total output as the weighted average of the prices of each single composite good. Each intermediate commodity can be seen as a fixed share of the composite intermediate good and the price of the composite intermediate good can be expressed as the weighted average of the prices of each commodity by its weights (i.e. the share of the nominal expenditure in this commodity on the total nominal expenditure for all intermediate commodities).

A different reasoning should be for the single primary factors: the capital and each category of 24 labour categories.

$$L_{l,a}^t = alfa_{l,a}^{VA} \cdot VA_a^t \cdot (\frac{PVA_a^t}{PL_{l,a}^t})^{\frac{1}{-\varepsilon+1}} \text{ (EQ17);}$$

$$K_a^t = alfa_{K,a}^{VA} \cdot VA_a^t \cdot (\frac{PVA_a^t}{RK_a^t})^{\frac{1}{-\varepsilon+1}} \text{ (EQ18);}$$

$$alfa_{K,a}^{VA} + \sum_{l=1}^{L} alfa_{l,a}^{VA} = 1 \text{ (EQ19);}$$

$$PVA_a^t = (\sum_{l=1}^{L} alfa_{l,a}^{VA} \cdot PL_{l,a}^{t\frac{\varepsilon}{\varepsilon-1}} + alfa_{K,a}^{VA} \cdot RK_a^{t\frac{\varepsilon}{\varepsilon-1}} L_{l,a}^t)^{\frac{\varepsilon-1}{\varepsilon}} \text{ (EQ20).}$$

The model assumes that the labour market is not perfectly competitive, so that there is involuntary unemployment as gap between labour supply by private institutional sectors and the labour demand by activities for each labour category:

$$\mathrm{unr}_l^t = 1 - \frac{\sum_{a=1}^{m} L_{l,a}^t}{\sum_{is=1}^{IS} LS_l^{is,t} \cdot (1+Shock\_LS_l^{micro,t}) \cdot (1+Shock\_LS_l^{training,t})} \quad \text{(EQ21).}$$

A similar equation can be written for the capital, but in this case the perfect competition allows to set the unemployment rate - or better the capacity under-utilisation - as zero:

$$1 = \frac{\sum_{a=1}^{m} K_a^t}{\sum_{is=1}^{IS} KS_l^{is,t}} \quad \text{(EQ22).}$$

The model is based on a MAKE-USE base, in which each activity produces the main commodity and a wide range of secondary products according fixed shares:

$$X_a^t = \sum_{i=1}^{n} alfa_{i,a}^{Q} \cdot Q_i^t. \text{ (EQ23).}$$

Commodity prices are obtained in the market clearing equations, but they are also the results of both domestic and import prices according the Armington (1969) elasticity of substitution:

$$PQ_i^t = \sum_{a=1}^{m} (alfa_{a,i}^{X} \cdot PX_a^t) \text{ (EQ24);}$$

$$PM_i^t = PMW_i^t \cdot \frac{1+Shock_{PM}{}_i^Q}{EXCH_t} \text{ (EQ25);}$$

$$P_{i,q}^t \cdot \left(1 - \sum_{out=1}^{OUT} tq_i^{out}\right) = ((1 - alfa_{i,M}^{Q}) \cdot PQ_i^{t^{1-\sigma_{ARM}}} + alfa_{i,M}^{Q} \cdot PM_i^{t^{1-\sigma_{ARM}}})^{\frac{1}{1-\sigma_{ARM}}} \text{ (EQ26).}$$

The demand for real import is obtained as an increasing function in the total demand for each commodity and in the price competitiveness expressed by the ration between the internal and the import prices:

$$M_i^t = alfa_{i,M}^{Q} \cdot Q_i^t \cdot \left(\frac{P_{i,q}^t}{PM_i^t}\right)^{\sigma_{ARM}} \text{ (EQ27).}$$

The second block of equations of the MAC18_DYN is given by the income formation step, when the gross incomes from primary factors generated during the productive process are attributed to institutional sectors. These incomes constitute the base to calculate income taxes sand passive transfers paid by national private sectors. Employers' social security contributions paid by activities are assigned to the institutional sectors supplying the labour input and are then transferred to Social Security Bodies in the phase of secondary distribution. The Public Administration collects output and activity taxes from the activities and income taxes from the private national sectors. Moreover, the Public Administration uses the positive flows to pay transfers to private sectors and to demand commodities for consumption. The rest of the World includes in the disposable income also the nominal import, whereas we can consider nominal exports as its final consumption.

$$YF_{is}^{t} = unr_{l}^{t} \cdot L^{S}{}_{l}^{is,t} \cdot \left(1 + Shock_{L^{S}}{}_{l}^{micro,t}\right) \cdot \left(1 + Shock_{L^{S}}{}_{l}^{training,t}\right) \cdot PL_{l,a}^{t} + K^{S^{is,t}} \cdot RK_{a}^{t}$$

(EQ28);

$$GDY_{is=PrivNat}^{t} = YF_{is}^{t} \cdot \left(1 - \sum_{inc=1}^{INC} tr_{is}^{inc} - \sum_{iss=1}^{IS} tr_{iss,is}\right) + \sum_{iss=1}^{PrivNat} (tr_{is,iss} \cdot YF_{iss}^{t}) + \sum_{iss=1}^{Pub,RoW} TR_{is,iss}$$

(EQ29);

$$GDY_{is=Pubb}^{t} = YF_{is}^{t} + \sum_{iss=1}^{PrivNat} \sum_{inc=1}^{INC} tr_{iss}^{inc} + \sum_{act=1}^{ACT} ta_{a}^{act} \cdot PX_{a}^{t} \cdot X_{a}^{t} \cdot share_{TACT}{}_{is}^{t} + \sum_{out=1}^{OUT} tq_{i}^{out} \cdot P_{i,q}^{t} \cdot Q_{i}^{t} + \sum_{iss=1}^{PrivNat} (tr_{is,iss} \cdot YF_{iss}^{t}) + \sum_{iss=1}^{RoW} TR_{is,iss} - \sum_{iss=1}^{IS} TR_{iss,is}$$

(EQ30);

$$GDY_{is=RoW}^{t} = PM_{i}^{t} \cdot M_{i}^{t} + YF_{is}^{t} + \sum_{act=1}^{ACT} ta_{a}^{act} \cdot PX_{a}^{t} \cdot X_{a}^{t} \cdot share\_TACT_{is}^{t} + \sum_{iss=1}^{PrivNat} (tr_{is,iss} \cdot YF_{iss}^{t}) + \sum_{iss=1}^{Pubb} TR_{is,iss} - \sum_{iss=1}^{IS} TR_{iss,is};$$

$$pk^{t} = (1 - depr) \cdot pk^{t} + RK_{a}^{t}$$

(EQ31);

$$GDY_{is=PrivNat} = \sum_{t=1}^{T} GDY_{is=PrivNat}^{t} \cdot \left(\frac{1}{1+r}\right)^{t} + K^{S^{is,tfirst}} \cdot pk^{tfirst} - K^{S^{is,T}} \cdot pk^{T} \cdot \left(\frac{1}{1+r}\right)^{T}$$

(EQ32).

RK_{a}^{t} is the return on capital for each time t. Instead, pk^{t} is the price of the stock of capital. The deprecation rate $depr$ is set according the rule of investment in the steady state (see Barro and Sala-i-Martin, 1995):

$$I^{tfirst} = \frac{(d+g) \cdot \sum_{is=1}^{IS} K^{S^{is,tfirst}} \cdot RK_{a}^{tfirst}}{d+r} \quad \text{(EQ33);}$$

$$d = \frac{-I^{tfirst} \cdot r + g \cdot \sum_{is=1}^{IS} K^{S^{is,tfirst}} \cdot RK_{a}^{tfirst}}{I^{tfirst} - \sum_{is=1}^{IS} K^{S^{is,tfirst}} \cdot RK_{a}^{tfirst}} \quad \text{(EQ34).}$$

The final demand by institutional sectors is established through an intertemporal utility maximisation subjected to three constraints:

$$\pounds = \prod_{t=1}^{T} \left(\left(\frac{1}{1+\varphi}\right)^{t} \cdot C_{is}^{t}\right)^{alpha(t)} + \mu 1 \cdot \left(\sum_{i=1}^{n} \sum_{is=1}^{IS} C_{is}^{t} - \sum_{i=1}^{n} Q_{i}^{t} - OTHER_{FINAL_{USES}}\right) + \mu 2 \cdot \left(\sum_{is=1}^{IS} (K^{S^{is,t+1}} - K^{S^{is,t}} \cdot (1 - depr)) - I_{t}\right) + \mu 3 \cdot \left(\sum_{t=1}^{T} \left(\frac{1}{1+\varphi}\right)^{t} \cdot C_{is}^{t} \cdot PC_{is}^{t} - GDY_{is}\right) \quad \text{(E35).}$$

The maximisation process gives the following result:

$$PU_{is} = \prod_{t=1}^{T} \left(\frac{PC_{is}^{t}}{1+\varphi}\right)^{alpha(t)} \quad \text{(EQ36)}$$

$$\text{with } alpha(t) = \frac{\left(\frac{1+g}{1+r}\right)}{\sum_{t=1}^{T}\left(\frac{1+g}{1+r}\right)^{t-1}} \text{ (EQ37);}$$

$$C_{is}^{t} = \frac{U_{is}}{1+r} \cdot \left(\frac{PU_{is}}{PC_{is}^{t} \cdot (1+r)}\right)^{alpha(t)} \text{ (EQ38);}$$

$$PC_{is}^{t} = \left(\sum_{i=1}^{n} (alfa_{i,is}^{Q} \cdot P_{i,q}^{t}{}^{1-\sigma_C})\right)^{\frac{1}{1-\sigma_C}} \text{ (EQ39);}$$

$$PC_{i,is}^{t} = alfa_{i,is}^{Q} \cdot U_{is} \cdot \left(\frac{PC_{is}^{t}}{P_{i,q}^{t}}\right)^{\frac{1}{1-\sigma C}} \text{ (EQ40).}$$

4 - Microsimulation model description.

In order to integrate the CGE macro model illustrated in the Chapter 3, the microsimulation model is used to evaluate the poverty and distributional consequences according three factors: i) how employment and wages are distributed among individuals; ii) how the tax burden is distributed among taxpayers; iii) consumption patterns and preferences in the economy. Furthermore, the microsimulation model is used to evaluate how changes the labour supply by individuals and the consumption demand by households in response to a change, both originated at the micro level in Tax and Benefit system, and originated at the Macro level.

Basically, the microsimulation model represents a calculator of the disposable net income both by individual and by households, by applying to gross income flows the deductions from taxable income and from taxes in force in a given year (or not still in force if we are running a simulation).

Three aspects are to be stressed:

i) the income derived from own-occupied residence and other real estate is estimated through a regression on home characteristics as covariates and it is used to estimate the payment for real estate taxes;

ii) some deductions from income taxes are statistically attributed from an external file with the exception of deduction directly attributable according to characteristics reported in the survey (e.g. the number of children with several age limits and the presence of a not-working spouse);

iii) gross incomes are - separately for dependent work, independent work, pension income and other income, which are derived from a '*lordizzazione*' procedure starting from the net income reported in the survey and applying inversely the Tax and Benefit system on net incomes.

A relevant assumption should be done about the tax evasion, which is different for the different types of incomes. Moreover, we have assumed that incomes reported in the survey include not-registered incomes, which can be obtained as the difference of the income reported in the survey from the income resulting from publicly available data (e.g. data released by the Ministry of Economy and Finance on income taxes by deciles).

The microsimulation model can be used both to run static simulations and behavioural ones. As for the static simulations, a change in the Tax and Benefit system determines a change in net disposable income, whose distributive impact and poverty consequences we can estimate in line with many experiences of the World Bank. Hours offered by individuals in the survey will react to changes in the Tax and Benefit system through behavioural simulations on the basis of a discrete choice model for couple and individuals *a la'* Van Soest with a defined number of working options differentiated by gender (female workers can generally be considered more flexible than male ones).

Furthermore, we could identify the following five analysis stages. Firstly, losses (gains) of employment in contracting (growing) activities are distributed among existing workers in each work category (within the potential workers according the activation margin) based on a score estimated through a (multinomial) LOGIT of employment options[10] run on personal characteristics. Secondly, we estimate the hourly wage earned by LS workers through a regression on personal characteristics and estimates are used to attribute wages to new hires coming from the PLF, in order to calculate the changes in the primary income following the previous phase (wages at the micro level are corrected through general equilibrium variations from CGE layers). Thirdly, the gross operating surplus is adjusted according to changes resulting from the CGE model. Finally, we calculate the new household gross income value, which is used to calculate the tax burden and savings according the changes in tax rates and savings propensity.

Our data contain also information about the consumption by CPA classification, which have been obtained by matching the micro data on personal income in EU-SILC with those of consumption (conveniently modified in order to pass from the COICOP classification to the CPA one) through the SHIW data on total conception and disposable income by household. This allows us also to analyse how change households' consumption by household classes following to a tax or a macro shock and these changes can be applied again to the CGE model as an external shock.

We use a model to estimate the labour supply, which is choses differently by individuals and couples. The consumption demand is obtained as the result of the aggregation of optimal disposable incomes by household, which the observed propensity to consumption is applied to.

As for individuals, the utility function is the following:

$$\mathrm{U_i} = (\alpha_{1,\mathrm{i}} \cdot \mathrm{ydisp_i}^{\gamma} + (1 - \alpha_{1,\mathrm{i}}) \cdot \mathrm{L_i}^{\gamma})^{\frac{1}{\gamma}} \text{ (EQ41)},$$

where $\mathrm{ydisp_i}$ is the individual disposable income (expressed in real terms) and $\mathrm{L_i}$ is the leisure.

The function follows a CES approach, so that:

$$\sigma = \frac{1}{\gamma - 1} \text{ (EQ42)},$$

where σ is the individual elasticity of substitution between disposable income and leisure.

This function in EQ41 is to be maximised under the following constraint:

$$\mathrm{ydisp_i} = \mathrm{wnet_i} \cdot (\mathrm{T} - \mathrm{L_i}) + \overline{\mathrm{Y0_i}} \text{ (EQ43)},$$

where $\mathrm{wnet_i}$ is the wage of individuals net of income taxes and $\overline{\mathrm{Y0_i}}$ is the total amount of other incomes (i.e. self-employment-, pension-, capital-, and other social benefits not included in the net salaries and wages).

[10] If the micro dataset shows a reliable detail in terms of employment by activity, we could consider all the possibility to work in specific activities plus the status of unemployed. Conversely, we should run only a LOGIT model with labour market statuses non related to activity.

By maximising the EQ1 under EQ3 according to the leisure, we obtain the following equation:

$$L_i^* = \frac{\left(\frac{\alpha_i}{1-\alpha_i}\cdot wnet_i\right)^{\sigma}\cdot\left(wnet_i\cdot T+\overline{YO_i}\right)}{1+\left(\frac{\alpha_i}{1-\alpha_i}\right)^{\sigma}\cdot wnet_i^{1+\sigma}} \text{ (EQ44).}$$

Employment and disposable income can be obtained as it follows:

$$l_i^* = \frac{T-\left(\frac{\alpha_i}{1-\alpha_i}\cdot wnet_i\right)^{\sigma}\cdot\overline{YO_i}}{1+\left(\frac{\alpha_i}{1-\alpha_i}\right)^{\sigma}\cdot wnet_i^{1+\sigma}} \text{ (EQ45);}$$

$$ydisp_i^* = \frac{wnet_i\cdot T+\overline{YO_i}}{1+\left(\frac{\alpha_i}{1-\alpha_i}\right)^{\sigma}\cdot wnet_i^{1+\sigma}} \text{ (EQ46).}$$

The parameter α_i is estimated as the actual share of the disposable income earned by the individual and the potential income (given by the sum of the actual income and of the value of leisure at the actual net individual wages). On this base and by using the EQ44, we can obtain the calibration formula for σ:

$$\widehat{\sigma} = \frac{\ln\left(\frac{L_i^*}{\left(wnet_i\cdot T+\overline{YO_i}-L_i^*\cdot wnet_i\right)}\right)}{\ln\left(\frac{\alpha_i}{1-\alpha_i}\cdot wnet_i\right)} \text{ (EQ44'),}$$

which becomes by applying the EQ2:

$$\widehat{\gamma} = \frac{\left(\ln\left(\frac{\alpha_i}{1-\alpha_i}\cdot wnet_i\right)+\ln\left(\frac{L_i^*}{\left(wnet_i\cdot T+\overline{YO_i}-L_i^*\cdot wnet_i\right)}\right)\right)}{\ln\left(\frac{L_i^*}{\left(wnet_i\cdot T+\overline{YO_i}-L_i^*\cdot wnet_i\right)}\right)} \text{(EQ44'').}$$

As for couples the utility function can be written as it follows:

$$U_h = \left(\frac{\alpha_{1h}}{2}\cdot ydisp_{1,h}^{\ \gamma} + \frac{1-\alpha_{1h}}{2}\cdot ydisp_{2,h}^{\ \gamma} + \frac{\alpha_{2h}}{2}\cdot L_{1,h}^{\ \gamma} + \frac{1-\alpha_{2h}}{2}\cdot L_{2,h}^{\ \gamma}\right)^{\frac{1}{\gamma}} \text{ (EQ47).}$$

EQ42 can be used also for couples without changes. As for EQ43, you should substitute the subscript 'i' with '1,h' or '2,h', respectively, for the first and the second component of the couple.

The optimal leisure for the both members of the couple can be written in the following way:

$$L_{1,h}^* = \frac{\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)^{\sigma}\cdot\left(wnet_{1,h}\cdot T+\overline{YO_{1,h}}\right)}{1+\left(\frac{\alpha_{1h}}{\alpha_{2h}}\right)^{\sigma}\cdot wnet_{1,h}^{\ 1+\sigma}} \text{ (EQ48),}$$

$$L_{2,h}^* = \frac{\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)^{\sigma}\cdot\left(wnet_{2,h}\cdot T+\overline{YO_{2,h}}\right)}{1+\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\right)^{\sigma}\cdot wnet_{2,h}^{\ 1+\sigma}} \text{ (EQ48').}$$

The link between the both members pf the couple is given by the ratios $\frac{\alpha_{1h}}{\alpha_{2h}}$ and $\frac{1-\alpha_{1h}}{1-\alpha_{2h}}$, telling us which component (respectively, the first od the second member) has starker preferences for disposable income (higher ratio) or for leisure (lower ratio).

The employment and the disposable income for both members of the couple as it follows:

$$l_{1,h}^{*} = \frac{T-\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)^{\sigma}\cdot\overline{YO_{1,h}}}{1+\left(\frac{\alpha_{1h}}{\alpha_{2h}}\right)^{\sigma}\cdot wnet_{1,h}{}^{1+\sigma}} \text{ (EQ49)},$$

$$l_{2,h}^{*} = \frac{T-\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)^{\sigma}\cdot\overline{YO_{2,h}}}{1+\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\right)^{\sigma}\cdot wnet_{2,h}{}^{1+\sigma}} \text{ (EQ49')},$$

$$ydisp_{1,h}^{*} = \frac{wnet_{1,h}\cdot T+\overline{YO_{1,h}}}{1+\left(\frac{\alpha_{1h}}{\alpha_{2h}}\right)^{\sigma}\cdot wnet_{1,h}{}^{1+\sigma}} \text{ (EQ50)},$$

$$ydisp_{2,h}^{*} = \frac{wnet_{2,h}\cdot T+\overline{YO_{2,h}}}{1+\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\right)^{\sigma}\cdot wnet_{2,h}{}^{1+\sigma}} \text{ (EQ50')}.$$

The parameters α_{1h} and α_{2h} are estimated as the actual share of, respectively, the disposable income earned and the value of leisure of each member of the couple on the total by couple. On this base and by using the EQ44, we can obtain the calibration formula for σ:

$$l_{2,h}^{*} + l_{1,h}^{*} = \frac{T-\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)^{\sigma}\cdot\overline{YO_{2,h}}}{1+\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\right)^{\sigma}\cdot wnet_{2,h}{}^{1+\sigma}} + \frac{T-\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)^{\sigma}\cdot\overline{YO_{1,h}}}{1+\left(\frac{\alpha_{1h}}{\alpha_{2h}}\right)^{\sigma}\cdot wnet_{1,h}{}^{1+\sigma}} \text{ (EQ51)},$$

which gives us the general solution for the couple. However, the equation can be easily solved in this form. We have to adopt the following hypothesis only as a trick to simply the equation:

$$\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)^{\sigma} = \left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)^{\sigma} = Z^{\sigma} \text{ (EQ52)}.$$

By substituting the EQ12 into the EQ11, we can solve according σ:

$$\widehat{\sigma_{1,h}}(i = 1,2) = \frac{\ln\left(L_{1,h}^{*}+L_{2,h}^{*}\right)-\ln\left(wnet_{1,h}\cdot\left(T-L_{1,h}^{*}\right)+\overline{YO_{1,h}}+wnet_{2,h}\cdot\left(T-L_{2,h}^{*}\right)+\overline{YO_{2,h}}\right)}{\ln(z)} \text{ (EQ53)}.$$

By substituting the specific values of Z for both members of the couple as in EQ52, we can obtain:

$$\hat{\sigma} = \frac{\left(\ln\left(L_{1,h}^{*}+L_{2,h}^{*}\right)-\ln\left(wnet_{1,h}\cdot\left(T-L_{1,h}^{*}\right)+\overline{YO_{1,h}}+wnet_{2,h}\cdot\left(T-L_{2,h}^{*}\right)+\overline{YO_{2,h}}\right)\right)}{2}\cdot\left(\frac{1}{\ln\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)}+\frac{1}{\ln\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)}\right) \text{ (EQ53')},$$

where the link between the both members of the couple is given both by the mean of disposable income on the left and by the sum two factors integrating the relative income/leisure shares on the right.

By applying the EQ42, we obtain:

$$\widehat{\gamma} = \frac{\left(1+\frac{\left(\ln\left(L^*_{1,h}+L^*_{2,h}\right)-\ln\left(wnet_{1,h}\cdot\left(T-L^*_{1,h}\right)+\overline{YO_{1,h}}+wnet_{2,h}\cdot\left(T-L^*_{2,h}\right)+\overline{YO_{2,h}}\right)\right)}{2}\cdot\left(\frac{1}{\ln\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)}+\frac{1}{\ln\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)}\right)\right)}{\frac{\left(\ln\left(L^*_{1,h}+L^*_{2,h}\right)-\ln\left(wnet_{1,h}\cdot\left(T-L^*_{1,h}\right)+\overline{YO_{1,h}}+wnet_{2,h}\cdot\left(T-L^*_{2,h}\right)+\overline{YO_{2,h}}\right)\right)}{2}\cdot\left(\frac{1}{\ln\left(\frac{\alpha_{1h}}{\alpha_{2h}}\cdot wnet_{1,h}\right)}+\frac{1}{\ln\left(\frac{1-\alpha_{1h}}{1-\alpha_{2h}}\cdot wnet_{2,h}\right)}\right)} \text{(EQ54).}$$

We have to underline that the Italian tax system is not linear, so that tax aggregates (i.e. tax rates and the fix tax component) change according to the amount of gross wages and of dependent hours worked and on the base of the interaction with the other gross incomes. In the maximisation we set only the optimal number of employees' worked hours, given gross wages, the other gross income (e.g. the self-employed income and the capital income) and the Tax and Benefit system. We run the microsimulation model at the Benchmark Tax and Benefit system at the Benchmark level and set the initial levels of the net average PIT tax rate and of the fix tax component. Then, we run again the microsimulation model at the simulation model and estimate the new tax rate. At the benchmark level, the hours optimal hours worked are equal to the actual level, whereas at the simulation level they could be different according the fix tax component estimated at the benchmark level, the tax rate estimate at the simulation level and the other incomes assumed unchanged. A final step is to check if the new hours worked are coherent with the average tax rate. However, we could assume that in case of small changes in the Tax and Benefit System, as well as in other gross incomes the average tax rate calculated in the simulation stage substantially equals to the actual tax rate following to the hours worked established at the simulation stage.

4.1 - Description of linking mechanism between macro- and micro layer

The Micro-Macro integrated model can be used both in the Top-Down direction than in the bottom-up one. In the former case, a shock originating in the macro context (i.e. the increase in the autonomous final demand and/or the change in its composition) determines a change in the level and in the composition of labour compensation, as well as in the level of prices and wages. By combining the both before mentioned figures, we can obtain the change in the number of employees. At the macro-layer, the increased labour demand generates a greater employment and, therefore, a greater income according to the labour elasticity to wages. The increased income contributes to activate the income circular flow and, finally, a new equilibrium is reached. The macroeconomic layer is solved by assuming maximising responses by institutional sectors and by productive activities. The new macroeconomic situation has to coincide with the microeconomic one, so that the linking variables should vary at the same rate both at the macro- and at the micro level.

Also at the micro layer, there is a maximising behaviour of individuals and households: they have to obtain those combinations of consumption and leisure maximising the welfare function with the constraint that the disposable income depending on the gross labour income, the gross capital and other source income and the Tax and Benefit system. Another constraint is that there is a rationing mechanism preventing unemployed workers from finding a job also at lower wages (i.e. involuntary unemployment and involuntary part-time, as registered in survey questionnaires). We know exactly the preferences about the desired hour worked and type of labour of involuntary unemployed and part-time workers; this information has been used to calculate a margin of potentially supplied hour worked. We divide the changes of labour demand obtained at the macro-economic level among individuals according to scores estimated by LOGIT regressions within the limits of the before estimated hours margins. In this way, we can calculate the primary income of each individual by applying wages changes obtained in the CGE. This allows us to obtain the individual net disposable income by applying the rules of taxes and transfers coming from the Tax and Benefit system. The net disposable income at the household level can be obtained by adding up components' incomes. Each household can adjust his consumption demand both at the aggregate level and at CPA level by applying the estimated consumption propensities to net incomes. The new level of consumption demand can be introduced in the macro-model as shocks in the second round of the simulation. This provides new labour demand patterns and, in this way, we can find an iterative solution until the first and the second layer do not reproduce the same picture of the economy.

Clearly, if the macroeconomic shock on employment is negative, we use the same LOGIT mechanism to estimate employment probability scores and order employed people increasingly according to them. Employed with low employment probabilities are now classified as unemployed until the job loss is fully attributed.

In the context of Bottom-Up approach, we could use a more complex model with equations mimicking the Tax and Benefit institutions. This allows us to analyse changes in some particular aspects of the Tax and Benefit system (i.e. tax credits for children at different ages and for dependent spouses with different labour market conditions). However, in some cases it could be useful to use reduced statically estimated forms, in order to avoid an excessively complex estimation.

After having modelled the existing Tax and Benefit system, we have selected individuals with a flexible labour supply and simulating the responses to successive increases in hour worked on disposable income. Finally, for each individual we will choose the solution giving the highest income as the labour supply. A shock in the Tax and Benefit system changes the optimal solution in terms of hours worked and the difference is the response in terms of the labour supply. The response in terms of labour supply can be evaluated both according the extensive margin (i.e. if participating or not) and the intensive margin (i.e. how many hours to work).

The change in the individuals' behaviour in terms of labour supply pinpoints changes in the level and the composition of consumption by households. The different pattern of consumption choices at micro level constitutes a shock at macro level. This changes equilibrium prices and quantities and determines a new labour demand.

The Micro-Macro equilibrium is achieved if the labour demand is equal or lower than the labour supply established at the micro level under the assumption of the involuntary unemployment and of rationing in the labour market: in other terms, replacing the labour supply with the values determined in the labour demand following the abovementioned LOGIT scores. Conversely, if labour demand is higher than the labour supply, labour supply remains. A new vector of consumption is set at the micro level and is inserted as a shock in the CGE model a new labour demand is estimated. The iterating procedure will finish with a labour demand lower or equal to labour supply.

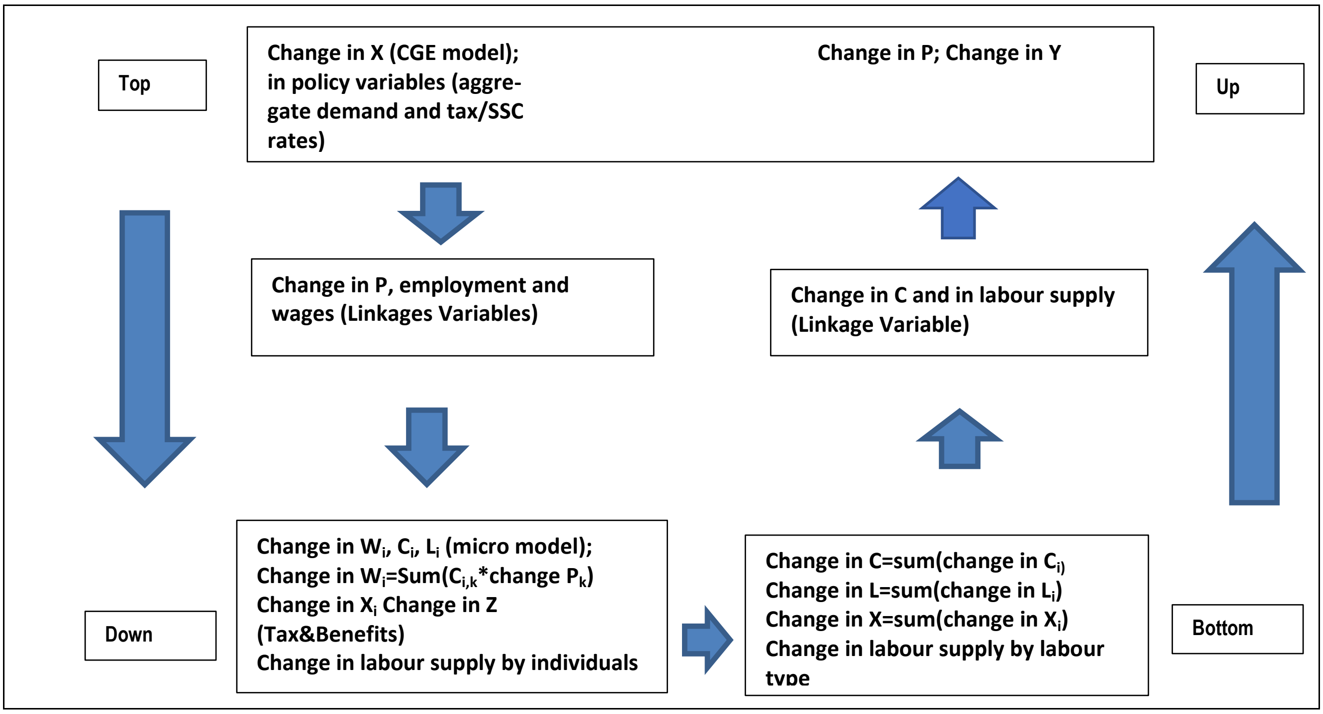
Workers' labour supply depend on several factors: economic and demographic factors, as well as policy shocks. Traditionally, labour supply depends positively on real wage earned on labour market and negatively on reserve salary (which is function of unemployment benefits, as well as past work- and educational background). However, modelling labour supply is different between the case of a single or a married worker, where the former decide their labour supply through a maximisation of their individual welfare function and the latter maximise a joint utility function. Moreover, the presence or the age of children/elderly components makes more difficult (especially for women) to participate to labour market (so the availability of children- and older care services is crucial to labour market participation) and can determine fixed costs affecting the choice of working or working at least a minimum number of hours.

Labour supply could be also affected by policy changes, such as the pension reforms (i.e. higher labour supply of older workers); changes in the Tax and Benefit system also could determine an increase/decrease in labour supply. This effect can be induced by decreasing/increasing both the net taxation on wage income (e.g. UK's WTC, US' EITC, child benefits, spouse deductions, as well as changes in marginal rate of taxation and personal tax brackets) and the income during non-work periods (i.e. unemployment benefits and minimum income). Also structural reforms - such as labour market liberalisation (i.e. shift in EPL increasing/decreasing reactivity of labour market to economic cycle) and product market reforms (i.e. reduction of tariffs on imports) - affect labour supply and consumption demand choices.

The type of Micro-Macro integration considered in the paper is the Top-Down/Bottom-Up approach between two levels: an activity- and institutional sector – detailed CGE model and a microsimulation model, linked by a soft link. There is no need to start from the same levels in aggregate variables at the micro- and at the macro level. Indeed, the new Micro-Macro coherence is obtained in terms of relative changes from the starting values. However, convergence is not assured and some other procedures could be useful. At this regard, some authors have also proposed to recalibrate representative household's utility function (i.e. its elasticities) according information from the micro data[11].

The alternative solution to achieve a Micro-Macro integration is the full integration[12], that is to insert directly microdata in our SAMs, so that maximisation rules follow the same program codes both for the CGE quantities and for the MSM data. The advantage is to avoid long iteration processes, but at the cost of losing the heterogeneity by individual and household contained in socio-demographic variables excluded at the macro level. Moreover, the fully integrated approach requires three conditions: a) the existence of explicit expressions for the micro-reactions (e.g. use of the analytical switching probabilities for the LOGIT model)[13]; b) sufficiently simple micro-reaction functions; and c) the presence of a not excessive number of micro units. Moreover, all markets achieve clearance conditions (demand equals supply) and all income balances (expenditure equals income) in an integrated model. Calibration and simulation phases could result too difficult.

Figure 9 - Interaction between macro- and micro level



Source: Authors' elaboration on Bourguignon and Bussolo, 2013[14].

[11] See Rausch and Rutherford, 2010.
[12] See Magnani and Mercenier, 2009.
[13] See Bonin and Schneider, 2006.
[14] See Bourguignon and Bussolo, 2013.

Inconsistency at the level of the individual income balances (income does not equal expenditure plus savings) could be addressed by adjusting data at the level of the individual households or by introducing a residual household[15].

The integrated Micro-Macro approach can be represented in Figure 9. A change in CGE model at the top model (see the following figure) determines changes in prices used as linkage aggregate variables (LAVs). At the micro level, individuals will change labour supply, consumption demand and change in well-being. Generally, the Top-Down approach stops at this stage under the assumption of consistency between aggregate preferences in the CGE models and micro individual consumption preferences. The Bottom-Up approach starts from a change of Tax and Benefit system at micro level. This changes individuals' consumption demand, output, labour supply and well-being. Individual output is aggregated at linkage variable level, so that it is inserted at the macro level. Consequently, this will determine a change in prices and in income at CGE level. Generally, aggregate labour supply is assumed as exogenous.

The linking mechanism between the CGE level is represented by two phases. The first one is the Top-Down approach. The CGE model determines a change in employment and in wages by working category. Whereas the change in wages are directly implemented in the microsimulation model, the changes in employment are applied according a score estimated on the basis of a LOGIT regression (EQ55) by using as the dependent variable the variable attivabili1 (dummy with 0 for workers without margins to increase their hours worked - full-timers and voluntary part-time/temporary workers - and 1 for workers with margins - involuntary part-time and temporary workers, unemployed and inactive people members of the potential labour force [1]). The covariates in the LOGIT model are the gender (1=MALE, 0=FEMALE), the regions where people lives reg (from 1 to 20), the educational attainment (edu=1 for LOW; =2 for MEDIUM; 3 for HIGH), age (from 15 to 75 years old), the number of components $\#_{\text{component}}$ (discrete variable from 0 to 6) and the number of components under three years old $\#_{\text{component}<3}$ (discrete variable from 0 to 5) :

$$\text{PR}(\text{attivabili1} = 1 \,|\text{gender}, \text{reg}, \text{edu}, \text{age}, \#_{\text{component}}\,, \#_{\text{components}<3}) = \frac{1}{1+\exp(-\beta_0 - \beta_1 \cdot \text{gender} - \beta_3 \cdot \text{reg} - \beta_4 \cdot \text{edu} - \beta_5 \cdot \text{age} - \beta_6 \cdot \#_{\text{component}} - \beta_7 \cdot \#_{\text{component}<3}))} \quad \text{(EQ55).}$$

The Table 5 shows the outcomes of the LOGIT regression for the probability of being activated in terms of additional hours worker (i.e. potential>effective), where females and LS workers have higher margins to increase labour supply. The same happens if the number of household components are increased. However, there is the opposite effect for the number of components aged less than three years.

[15] The share of capital income in the household data set is smaller than in the national accounts, so that a residual capital income recipient can be introduced. See Arntz *et al*., 2008.

[1] The Potential Labour Force includes inactive people, which are not searching for a job according the ILO definition, but who would accept to work if a job is offered. In this way, we can capture the component of discouragement, including people who think to not find a work.

Table 5 – LOGIT regression for activation

	LOGIT regression		Marginal effects	
attivabili1=1	Coef.	P>z	dy/dx	P>z
Being women	1.48231	0.00000	0.27351	0.00000
Lombardia	0.06323	0.37600	0.01167	0.37600
TAA	-0.05876	0.54600	-0.01084	0.54600
Veneto	0.06469	0.38900	0.01194	0.38900
FVG	-0.00246	0.97600	-0.00045	0.97600
Liguria	0.33911	0.00000	0.06257	0.00000
Emilia-Romagna	-0.10180	0.19100	-0.01878	0.19100
Toscana	0.12577	0.12000	0.02321	0.12000
Umbria	0.28540	0.00200	0.05266	0.00200
Marche	0.17113	0.03500	0.03158	0.03500
Lazio	0.56907	0.00000	0.10500	0.00000
Abruzzo	0.49742	0.00000	0.09178	0.00000
Molise	0.84453	0.00000	0.15583	0.00000
Campania	1.02072	0.00000	0.18834	0.00000
Puglia	0.83927	0.00000	0.15486	0.00000
Basilicata	0.81687	0.00000	0.15072	0.00000
Calabria	1.31598	0.00000	0.24282	0.00000
Sicilia	1.18173	0.00000	0.21804	0.00000
Sardegna	0.76209	0.00000	0.14062	0.00000
‘*no_titoli_analfabeta*’	1.67321	0.00000	0.30873	0.00000
‘*no_titoli_sa_leggere_scrivere*’	2.71047	0.00000	0.50012	0.00000
‘*elementare*’	2.99398	0.00000	0.55243	0.00000
‘*media_inferiore*’	1.98509	0.00000	0.36628	0.00000
‘*media_superiore_2o3_anni*’	1.45225	0.00000	0.26796	0.00000
‘*media_superiore_4o5_anni*’	1.16267	0.00000	0.21453	0.00000
‘*post_maturita_non_universita*’	1.12608	0.00000	0.20778	0.00000
‘*laurea*’	0.63362	0.01200	0.11691	0.01200
‘*specializzazione_post_laurea*’	0.02832	0.91800	0.00523	0.91800
age	-0.03216	0.00000	-0.00593	0.00000
No. of components of the households	0.11847	0.00000	0.02186	0.00000
No. of components less than 3 years aged of the households	-0.20093	0.00000	-0.03708	0.00000
Constant	-2.16592	0.00000		

Source: Authors’ elaboration on EU-SILC and database.

In our dataset wages are recorded only for employed. However, we have to consider the need to attribute wages to unemployed and inactive people. Therefore, we run an Heckman wage regression separately for males and females.

```
heckman lw educ2 educ3 educ4 educ5 eta${AnnoFiscale} eta2 area5_1 area5_2 area5_3 area5_4 house if male==1 & eligibili_d==1 , select(educ2 educ3 educ4 educ5 eta${AnnoFiscale} eta2 area5_1 area5_2 area5_3 area5_4 house fnly T1 T2 T3 T4 T5 T6 T7) robust
heckman lw educ2 educ3 educ4 educ5 eta${AnnoFiscale} eta2 area5_1 area5_2 area5_3 area5_4 house if female==1 & eligibili_d==1, select(educ2 educ3 educ4 educ5 eta${AnnoFiscale} eta2 area5_1 area5_2 area5_3 area5_4 house fnly T1 T2 T3 T4 T5 T6 T7) robust,
```

where we regress the logarithm of wages (lw) on different educational levels (from educ2 to educ5), the age (eta${AnnoFiscale} or eta13) and the square age (eta2), the territorial area (Nord-West area5_1, Nord-East area5_2, Centre area5_3, South area5_4 and Islands area5_5).

Table 6 – Heckman regression for the attribution of wages to all the sample

Females			Males		
lw	Coef.	P>z	lw	Coef.	P>z
'*media inferiore*'	0.35310	0.00000	'*media inferiore*'	0.26594	0.00000
'*media superiore*'	0.67868	0.00000	'*media superiore*'	0.45642	0.00000
'*laurea*'	0.96915	0.00000	'*laurea*'	0.79640	0.00000
'*Post-laurea*'	1.18598	0.00000	'*Post-laurea*'	1.03483	0.00000
age	0.06394	0.00000	age	0.05692	0.00000
Square age	-0.00059	0.00000	Square age	-0.00052	0.00000
North-West	0.25367	0.00000	North-West	0.20389	0.00000
North-East	0.25707	0.00000	North-East	0.22431	0.00000
Centre	0.11705	0.01100	Centre	0.12402	0.00100
South	-0.08665	0.05100	South	-0.06340	0.12500
Property of princ. res.	0.18578	0.00000	Property of princ. res.	0.13929	0.00000
Constant	-0.16445	0.62500	Constant	0.53039	0.00100
select			**select**		
'*media inferiore*'	0.48699	0.00000	'*media inferiore*'	0.34151	0.00000
'*media superiore*'	0.94528	0.00000	'*media superiore*'	0.67068	0.00000
'*laurea*'	1.20484	0.00000	'*laurea*'	0.81452	0.00000
'*Post-laurea*'	1.37738	0.00000	'*Post-laurea*'	1.23570	0.00000
age	0.12428	0.00000	age	0.14437	0.00000
Square age	-0.00128	0.00000	Square age	-0.00145	0.00000
North-West	0.51576	0.00000	North-West	0.56213	0.00000
North-East	0.58597	0.00000	North-East	0.68242	0.00000
Centre	0.38702	0.00000	Centre	0.42844	0.00000
South	0.01353	0.82000	South	0.05989	0.26000
Property of princ. res.	0.10840	0.00100	Property of princ. res.	0.28465	0.00000
HH non-labour income	-0.00000	0.17100	HH non-labour income	-0.00000	0.00200
HH with children <-1-y	-0.02987	0.73600	HH with children <-1-y	0.49308	0.00000
HH with children 2-y	-0.02059	0.81600	HH with children 2-y	0.56345	0.00000
HH with children 3-y	-0.11381	0.20600	HH with children 3-y	0.43007	0.00000
HH with children 4/6-y	0.00099	0.99100	HH with children 4/6-y	0.15587	0.10200
HH with children 7/11 y	0.05060	0.42100	HH with children 7/11-y	0.39711	0.00000
HH with children 12/15-y	-0.14055	0.00400	HH with children 12/15-y	0.24796	0.00000
HH with children Z=16- y	-0.01333	0.80700	HH with children>= 16- y	0.21587	0.00000
Constant	-3.39269	0.00000	Constant	-3.65166	0.00000
/athrho	0.44794	0.00500	/athrho	-0.00113	0.96800
/lnsigma	-0.27106	0.00000	/lnsigma	-0.33031	0.00000
rho	0.42020		rho	-0.00113	
sigma	0.76257		sigma	0.71870	
lambda	0.32043		lambda	-0.00081	
Wald test of indep. eqns. (rho = 0): chi2(1) = 7.82 Prob > chi2 = 0.0052			Wald test of indep. eqns. (rho = 0): chi2(1) = 0 Prob > chi2 = 0.968		

Source: Authors' elaboration on EU-SILC and database.

Furthermore, the covariates are also the household's non-labour income (fnly) and the property of the principal residence (house), as well as the circumstance that households have children with different ages from 3 years T1 to 16 and more T7. The Table 6 below synthetises the results of the Heckman regression for both females and males.

Wages estimated for not working amount averagely at 10.7 and 15.6 euro per hour worked, respectively for females and males. The gap with the average wage for employed workers amounts to 54.1 and to 43.4 per cent, respectively for females and males.

We try an econometric estimation of the above described equation. This probability is used to order workers accessing to new jobs in the case of employment increase. The following exert shows the way to elaborate the increase in employment. We have to order individuals according a decreasing probability by considering only people with an activation margin (acitivity1=1), so that the new job opportunities will be attributed to workers with higher scores.

```
gen prob_inv=1/probability
browse nquest nord classe probabilty attivabili1
*** INCREASE IN EMPLOYMENT
sort classe attivabili1 prob_inv
* increasing in category(classe) and decreasing in probability/ increasing in the inverse of the probability
bysort classe attivabili1: gen ordinamento=_n
bysort classe: sum ordinamento
```

Table 7 shows the mechanism to apply CGE changes in employment by labour category to the micro dataset, in order to conveniently modify this latter to simulate both changes in labour supply and in labour demand. Individuals ordered by the variable *ordinamento* are eligible to increases in employment established according the CGE model until the difference between the progressive sum of the activation margin and the CGE margin is null. In this case the simulation is run only on workers who have some margins to increase their work effort: that is, involuntary part-time and temporary workers and unemployed, and PLD inactive.

As for the reduction in employment, a score estimated on the basis of a LOGIT regression (EQ56) by using as the dependent variable the variable employed(dummy with 0 for workers without employment and 1 for workers with employment [1])is applied. The covariates in the LOGIT model are the gender (1=MALE, 0=FEMALE), the regions where people lives reg (from 1 to 20), the educational attainment (edu=1 for LOW; =2 for MEDIUM; 3 for HIGH), age (from 15 to 75 years old), the number of components $\#_{\text{component}}$ (discrete variable from 0 to 6) and the number of components under three years old $\#_{\text{component}<3}$ (discrete variable from 0 to 5):

$$\text{PR}(\text{employed} = 1\ |\text{gender}, \text{reg}, \text{edu}, \text{age}, \#_{\text{component}}, \#_{\text{components}<3}) = \frac{1}{1+\exp(-\beta_0 - \beta_1 \cdot \text{gender} - \beta_3 \cdot \text{reg} - \beta_4 \cdot \text{edu} - \beta_5 \cdot \text{age} - \beta_6 \cdot \#_{\text{component}} - \beta_7 \cdot \#_{\text{component}<3}))} \quad \text{(EQ56).}$$

[1] The Potential Labour Force includes inactive people, which are not searching for a job according the ILO definition, but who would accept to work if a job is offered. In this way, we can capture the component of discouragement, including people who think to not find a work.

Table 7 - Mechanism to attribute employment increases determined at the macro level to the micro layer.

		Potential hours worked			Activation margin_Hours worked							
Individual	attivabili1	Labour category 1	……… ……..	Labour category 24	Labour category 1	……… ……..	Labour category 24	Score	Ordinamento	Progressive sum of activation margin	CGE Margin (>0)	Difference of the progressive activation margin from the CGE margin
1	0	>0			0							
.	.	>0			0							
.	.	>0			0							
.	.	>0			0							
n1	0	>0			0							
n1+1	**1**	**>0**			$\mathbf{h_{n1+1}}$			**++**	**1**	**hn1+1**	$\mathbf{Z_1}$	**<0**
.	**.**	**>0**			**.**			**.**	**.**	**.**	$\mathbf{Z_1}$	**<0**
.	**.**	**>0**			**.**			**.**	**.**	**.**	$\mathbf{Z_1}$	**0**
.	.	>0			.			.	.	.	Z_1	>0
n'1	1	>0			$h_{n'1}$			--	max1	hn1+1+.+.+.+hn'1	Z_1	>0
.												
.												
.												
1	0			>0			0					
.	.			>0			0					
.	.			>0			0					
.	.			>0			0					
n24	0			>0			0					
n24+1	**1**			**>0**			$\mathbf{h_{n24+1}}$	**++**	**1**	**hn24+1**	$\mathbf{Z_{24}}$	**<0**
.	**.**			**>0**			**.**	**.**	**.**	**.**	$\mathbf{Z_{24}}$	**<0**
.	**.**			**>0**			**.**	**.**	**.**	**.**	$\mathbf{Z_{24}}$	**0**
.	.			>0			.	.	.	.	Z_{24}	>0
n24	1			>0			$h_{n'24}$	--	max24	hn24+1+.+.+.+hn'24	Z_{24}	>0

Source: our elaboration.

Table 8 – LOGIT regression for employment probability

LOGIT regression			Marginal effects		
Employed (0/1)	Coef.	P>z		dy/dx	P>z
Being women	-1.36158	0.00000	Being women	-0.22197	0.00000
Lombardia	0.03659	0.63900	Lombardia	0.00597	0.63900
TAA	0.38708	0.00100	TAA	0.06310	0.00100
Veneto	-0.00897	0.91200	Veneto	-0.00146	0.91200
FVG	0.17989	0.05400	FVG	0.02933	0.05400
Liguria	-0.11863	0.20900	Liguria	-0.01934	0.20900
Emilia-Romagna	0.25407	0.00300	Emilia-Romagna	0.04142	0.00300
Toscana	-0.07278	0.40700	Toscana	-0.01187	0.40700
Umbria	-0.21158	0.03300	Umbria	-0.03449	0.03300
Marche	-0.09151	0.29700	Marche	-0.01492	0.29700
Lazio	-0.54228	0.00000	Lazio	-0.08840	0.00000
Abruzzo	-0.62457	0.00000	Abruzzo	-0.10182	0.00000
Molise	-0.88156	0.00000	Molise	-0.14371	0.00000
Campania	-1.13188	0.00000	Campania	-0.18452	0.00000
Puglia	-0.89799	0.00000	Puglia	-0.14639	0.00000
Basilicata	-0.97487	0.00000	Basilicata	-0.15892	0.00000
Calabria	-1.31430	0.00000	Calabria	-0.21426	0.00000
Sicilia	-1.25089	0.00000	Sicilia	-0.20392	0.00000
Sardegna	-0.67193	0.00000	Sardegna	-0.10954	0.00000
'*no_titoli_analfabeta*'	-2.11633	0.00000	'*no_titoli_analfabeta*'	-0.34501	0.00000
'*no_titoli_sa_leggere_scrivere'*	-2.73388	0.00000	'*no_titoli_sa_leggere_scrivere'*	-0.44568	0.00000
'*elementare*'	-3.15177	0.00000	'*elementare*'	-0.51381	0.00000
'*media_inferiore*'	-2.21258	0.00000	'*media_inferiore*'	-0.36070	0.00000
'*media_superiore_2o3_anni*'	-1.69960	0.00000	'*media_superiore_2o3_anni*'	-0.27707	0.00000
'*media_superiore_4o5_anni*'	-1.37869	0.00000	'*media_superiore_4o5_anni*'	-0.22476	0.00000
'*pot_maturita_non_universita*'	-1.29637	0.00000	'*pot_maturita_non_universita*'	-0.21134	0.00000
'*laurea*'	-0.62717	0.05300	'*laurea*'	-0.10224	0.05300
'*specializzazione_post_laurea'*	-0.02383	0.94600	'*specializzazione_post_laurea'*	-0.00389	0.94600
age	0.02494	0.00000	age	0.00407	0.00000
No. of HH components	-0.12931	0.00000	No. of HH components	-0.02108	0.00000
No. of HH component (3 years old)	0.19193	0.00000	No. of HH component (3 years old)	0.03129	0.00000
Constant	3.05824	0.00000			

Source: Authors' elaboration on EU-SILC and database.

The Table 8 shows the outcomes of the LOGIT regression for the probability of being employed, where females and LS workers have a lower probability to be employed. The same happens if the number of household components are increased. However, there is the opposite effect for the number of components aged less than three years.

This probability is used to order workers absorbing the loss in employment in the case of employment. The following exert shows the procedure to be applied in the case of the decrease in employment. We have to order individuals according an increasing probability to be employed (employed1=1), so that the loss in job opportunities will be attributed to workers with lower scores. *Probability1* is the probability to be employed., whereas *prob_inv1* is the inverse of this probability.

```
*** DECREASE IN EMPLOYMENT
* Decreasing order of labour category (classe) and increasing in probability to be employed
sort classe employed probabilty1
bysort classe employed: gen ordinamento1=_n if employed==1
browse nquest nord ordinamento ordinamento1 classe probabilty* attivabili1* employed
gsort - employed -classe + probabilty1
bysort classe: sum ordinamento1
bysort employed: sum probabilty1
```

Clearly, we could have an integration of the both methods, if there are labour categories with increases and decreases in employment. In Table 9, we can observe that the loss in jobs is applied to the employed in each labour category, until the CGE margin is fully distributed.

The microsimulation model could be used in the final version of the model in a fully integration approach in the following way. The disposable income of each individual in each household at the starting time 0 (EQ57) can be written as the sum the compensation of employees $w_{h,i}^{0} \cdot HW_{h,i}^{0}$, the income of self-employed $Yaut_{h,i}^{0}$, the income from capital $Ycap_{h,i}^{0}$, the pensions $Ypen_{h,i}^{0}$ and the other incomes $Yothers_{h,i}^{0}$ net of taxes t^{gross} and increased by tax credits $TaxCredit_{h,i}$:

$$Y_{h,i}^{D,0} = \left(w_{h,i}^{0} \cdot HW_{h,i}^{0} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right) \cdot \Big(1 - t^{gross}\big(w_{h,i}^{0} \cdot HW_{h,i}^{0} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\big)\Big) + TaxCredit_{h,i} \quad \text{(EQ57)}.$$

Changes in wages and employment obtained at the first stage in the CGE simulation can be used to construct the new disposable income (EQ57'):

$$Y_{h,i}^{D,CGE} = \left(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right) \cdot \Big(1 - t^{gross}\big(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\big)\Big) + TaxCredit_{h,i} \quad \text{(EQ57')}.$$

Table 9 - Mechanism to attribute employment decreases determined at the macro level to the micro layer.

		Hours worked							
Individual	employed	Labour category 1	……………. .	Labour category 24	Score	Ordinamento	Progressive sum of activation margin	CGE Margin	Difference of the progressive activation margin from the CGE margin
1	**1**	**hw_{n1+1}**			**--**	**1**	**-hwn1+1**	**-Z1**	**>0**
.	**.**	**.**			**.**	**.**	**.**	**-Z1**	**>0**
.	**.**	**.**			**.**	**.**	**.**	**-Z1**	**0**
.	.	.			.	.	.	-Z1	<0
n1	1	$hw_{n'1}$			++	max1	-hwn1+1-.-.-.-hwn'1	-Z1	<0
n1+1	0	>0							
.	.	>0							
.	.	>0							
.	.	>0							
n'1	0	>0							
.									
.									
.									
1	**1**	**hw_{n24+1}**		**>0**	**--**	**1**	**-hwn24+1**	**-Z24**	**>0**
.	**.**	**.**		**>0**	**.**	**.**	**.**	**-Z24**	**>0**
.	**.**	**.**		**>0**	**.**	**.**	**.**	**-Z24**	**0**
.	.	.		>0	.	.	.	-Z24	<0
n24	1	$hw_{n'24}$		>0	++	max1	-hwn24+1-.-.-.-hwn'24	-Z24	<0
n24+1	0	>0		>0					
.	.	>0		>0					
.	.	>0		>0					
.	.	>0		>0					
n24	0	>0		>0					

Source: our elaboration.

gen average_tax_rate=irpefn/ynlor.

Then, we apply the net PIT tax rate (estimated in this way) to the gross wage rate (gross_wage_rate), in order to obtain the net wage rate (net_wage_rate):

gen net_wage_rate=gross_wage_rate*(1-average_tax_rate)..

Capital incomes, self-employment incomes and other incomes are summed up into the residual income (altri_redditi) according the following equation:

gen altri_redditi=ydisp13-yldip*(1-average_tax_rate).

By knowing the amount of potential hours worked by individuals (orelavorate_anno_potenziale), we calculate the leisure (tempo_libero) according the following formula:

gen tempo_libero=(24-8)*365-orelavorate_anno_potenziale.

As for couples, at this stage we follow the same procedure for both the components of the couple.

The utility function used for individuals is a CES utility function increasing in both the net disposable income and the leisure. Clearly, the disposable income and the leisure are negatively correlated and the disposable income is not the effective one, but the potential one (that is, the amount individuals would obtain at the current net wages if they could work for the wanted working hours). In this case we use the (EQ41), by imposing the linear coefficients $\alpha_{1,i}$ and $1-\alpha_{1,i}$ of both disposable income ydisp13 and leisure tempo_libero to 1, in order to estimate the exponential coefficient γ gamma_ind:

gen utility=.
replace utility=(ydisp13^gamma_ind+tempo_libero^gamma_ind)^(1/gamma_ind) if individuo==1 & attivabili2!=..

The parameter gamma_ind is calibrated for each individuals by taking into account the initial level of variables adjusted in order to eliminate the effect of the rationing mechanism:

gen gamma_ind=(-1+ln(ydisp13/tempo_libero)/ln(net_wage_rate))/(ln(ydisp13/tempo_libero)/ln(net_wage_rate)) if individuo==1 & attivabili2!=..

As for couples, the utility function follows the same approach of the individuals, but in this case we have to calibrate two parameters (alfa1 and alfa2), under the assumption that the substitutability coefficient for the both members of couples amounts to -2. By remember the (EQ47), we impose that the linear coefficients of the disposable income of both components of the couple α_{1h} and $1-\alpha_{1h}$, as well as the linear coefficients of leisure of both components of the couple α_{2h} and $1-\alpha_{2h}$ are multiplied by 2. Furthermore, the exponential coefficient γ is set at 0.5:

```
replace utility=(alfa1*ydisp13_1^0.5+(1-alfa1)*ydisp13_2^0.5+alfa2*tempo_libero_1^0.5 + (1-alfa2)*tempo_libero_2^0.5)^(1/0.5) if coppia1==1 & sumapp1==2 & attivabili!=. .
```

The parameters alfa1 and alfa2 are obtained by applying the following procedure on the benchmark variables adjusted in order to eliminate the effect of rationing:

```
gen coef1coppia=ydisp13_1^0.5/net_wage_rate_1/tempo_libero_1^0.5 if coppia1==1 & sumapp1==2 & attivabili!=.
gen coef2coppia=ydisp13_2^0.5/net_wage_rate_2/tempo_libero_2^0.5 if coppia1==1 & sumapp1==2 & attivabili!=.
gen alfa2=(coef2coppia-1)/(coef2coppia-coef1coppia) if coppia1==1 & sumapp1==2 & attivabili!=.
gen alfa1=coef1coppia*(coef2coppia-1)/(coef2coppia-coef1coppia) if coppia1==1 & sumapp1==2 & attivabili!=. .
```

We replicate the benchmark by applying the Tax and Benefit in force at the starting time ("$path\taxsim3_1bis.do"), in order to verify the calibration. Then, we apply the Tax and Benefit system modified according the shock("$path\taxsim3_1bis_rev.do"). In this way, we can estimate the change in the labour supply following to the shock (labsuptot_chg).

This procedure is the same as to maximise the utility function both for individuals and for couples:

$$\mathrm{HW}^*_{h,i} = \mathrm{argmin}\left((\mathrm{YD}^{*,\ \mathrm{CGE,\ PROVISION}}_{h,i}{}^{\mathrm{gamma\_ind}} + \mathrm{tempo\_libero}^{\mathrm{gamma\_ind}})^{\frac{1}{\mathrm{gamma\_ind}}} \right) \text{(EQ60)},$$

$$(HW^*_{h,1}, HW^*_{h,2}) = argmin\left((alpha_1 \cdot \mathrm{YD}^{*,\ \mathrm{CGE,\ PROVISION}}_{h,1}{}^{0.5} + (1-alpha_1)\cdot \mathrm{YD}^{*,\ \mathrm{CGE,\ PROVISION}}_{h,2}{}^{0.5} + alpha_2 \cdot \mathrm{tempo}_{\mathrm{libero}_1}{}^{0.5} + (1-alpha_2)\cdot \mathrm{tempo}_{\mathrm{libero}_2}{}^{0.5})^{\frac{1}{0.5}} \right) \text{(EQ61)}.$$

5- Modelling labour market in CGE models

5.1 - Assumptions on labour market functioning

The CGE model is based on the assumptions of perfect competition and instantaneous adjustments of quantities to price changes, so that the system is structurally in equilibrium and each imbalance is corrected. In the labour market, this implies that there is no involuntary unemployment for each labour type. Each increase in unemployment is only temporary and is promptly reabsorbed through convenient changes in wages.

However, these too unrealistic assumptions of market clearing could also be relaxed, by allowing both involuntary unemployment (at current wages labour supply higher than demand) and vacancies (jobs not covered) without an automatic mechanism narrowing the gap with the equilibrium. In this context, however, representative agents take labour supply decisions by time schedule, labour contract, skill and activity and each household/individual within the same representative household group (RHG) is considered to behave at the same way as the average agent. Therefore, one does not take into account heterogeneity contained in micro-data.

Our CGE model is built on the assumption of the existence of a wage curve with a wage directly depending on the complement of the unemployment rate, because of the labour market imperfection. This curve is explained through the Search-and-Matching model following Phelps, 1997 and Hamermesh, 1993 (see the Appendix 12.6). The partial equilibrium effects of the employment subsidies in terms of wages and employment depends both on the labour demand- and labour supply- elasticities (respectively, $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$). The following matrix (seeTable 10) obtained from the equations (EQ8') and (EQ9') in the Appendix 10.6 show the expected partial equilibrium results of a standard decrease in the labour tax rate by 1 p.p.

Table 10 – Matrix of partial equilibrium effects of an employment subsidy equal to 1 p.p.

		Labour supply elasticity of labour to wages		
		$\boldsymbol{\varepsilon = 0}$	$\boldsymbol{\varepsilon = 1}$	$\boldsymbol{\varepsilon \to \infty}$
Labour demand elasticity of labour to wages	$\boldsymbol{\eta = 0}$	$\boldsymbol{\Delta w_i = 0; \Delta L_i = 0}$	$\boldsymbol{\Delta w_i = 0; \Delta L_i = 0}$	$\boldsymbol{\Delta w_i \to 0; \Delta L_i \to 0}$
	$\boldsymbol{\eta = 1}$	$\boldsymbol{\Delta w_i = +1; \Delta L_i = 0}$	$\boldsymbol{\Delta w_i = +\frac{1}{2}; \Delta L_i = +\frac{1}{2}}$	$\boldsymbol{\Delta w_i \to 0; \Delta L_i \to +1}$
	$\boldsymbol{\eta \to \infty}$	$\boldsymbol{\Delta w_i \to +1; \Delta L_i \to 0}$	$\boldsymbol{\Delta w_i \to +1; \Delta L_i \to +1}$	$\boldsymbol{\Delta w_i \to +1; \Delta L_i \to +\infty}$

Source: our elaboration on Hamermesh, 1993.

The effect of the decrease in the labour tax rate is higher on employment if the labour demand and the labour supply are very reactive to changes in wages, which absorb the whole advantage of the tax. In this case, workers are affected both in terms of an increase both in wages and in employment. Clearly, this is the better case for a labour subsidisation. On the contrary, labour subsidisation is completely ineffective both in terms of employment and of wages if both the labour demand and the labour supply are poorly responsive to wages.

The decrease in labour taxes affects only wages when the labour supply is not responsive to wages and the labour demand has an elasticity equal to the unit or higher. Workers will benefit from wage increases offsetting the decreasing labour taxation borne by employers. Conversely, the employment subsidisation generates only employment increases in the case of a highly reactive labour supply to wages (represented by an horizontal line in the wage/employment space) and an unitary elasticity of the labour demand. In these cases, The employers will hire an increasing number of workers following to a decreasing labour tax.

Finally, the decrease in labour taxes is equally shared between employment and wages in the case of a labour demand tending to be highly responsive to wages (horizontal line) and a labour supply with a unitary elasticity. In the particular case when both labour supply and demand elasticity coefficients are near to 1, the decrease of 1 p.p. in the labour tax rate determines an increase of ½ per cent both in employment, and in wages.

Following Hamermesh, 1993 labour market policies can be classified according three criteria. First, we can distinguish general vs. specific policies, respectively if they are relative to all employees or only to specific components. Second, P- vs. Q-policies can be identified, where the former affect factor prices and the latter on the demand for labour and, in general, productive factors. Third, we can distinguish labour- vs. non-labour vs. employment/hours mix- policies according the kinds of policy tools used (i.e. changes in earned wages of the typical worker vs. changes in prices and amounts of other factors vs. change in the relative price of workers and hours worked and limits to the amount of hours an individual worker can work for).

Payroll taxes and subsidies[16] are general labour P-policies differently from changes in requirements for premium pay for overtime (which are general employment/hours P-policies). Payroll taxes and subsidies can be limited by effective ceilings, as well as requirements for a market-wide minimum wage constitute specific employment/hours P-policies. The same type of policies can be the extension of coverage of employee benefit to part-time workers. P-policies can be combined with Q-policies, such as the changes of migration laws (labour policies) and of standard hour schedule legislation (employment/hours policies). Similar effects can be assigned to training programmes aimed at developing skills and to public sector employment programmes aimed at providing LS workers with higher education through training programmes (also supported through employment subsidies)[17].

Following Phelps, 1997, the employer hires workers at a wage higher than in the perfect competition, in order to maintain them in the firm and assure an effort by them according the productivity wage theory. This wage (the incentive wage) should be lower or equal to the level coherent with the condition of zero-marginal profit (sustainable wage). The incentive wage can be thought also as the minimum wage required to productively perform a task (i.e. the requested

[16] At the same way the capital accelerated depreciation, the investment tax credits and subsidies to develop new sources of energy.

[17] Other Q-policies include mandated minimum labour/output ratios and requirements for minimum staffing day care services and restrictions on hours worked by children are employment-hours (these latter are specific Q-policies).

wage). This minimum wage level is inversely correlated with the labour market unemployment rate. Therefore, the equilibrium in the labour market will be found at unemployment rate, at that the incentive wage is equal to the sustainable one. The incentive wage is negatively correlated with the unemployment rate, so that employers can reduce the former simply by lay off workers. This scheme is applied to each individual labour market segment: i) skilled workers will achieve an higher productivity thanks to the complementarity relation with the capital and, therefore, the equilibrium will be reached at a low unemployment rate and an high wage; ii) LS workers will be damaged by the use of capital because of a substitutability relation with a lower productivity with a new equilibrium at a high unemployment rate and a lower wage level.

5.2 – Labour supply and wage differentials

Labour supply can be modelled with an higher degree of complexity with a lower level of aggregation. At the most aggregated level of a single representative household parameters could be calibrated by implementing empirically plausible labour supply elasticities, differentiating labour supply along the intensive (how many hours to work) and extensive margin (if participate or not), and allocating involuntary unemployment. Many classical CGE models[18] adopt a single representative household, by assuming also a fixed labour supply.

The crucial question about the compatibility between uniform wages and wage differentials is to understand if wages in each component react uniformly or not[19] to economic shocks, so that relative wages remain unchanged or not. If the labour can perfectly move from a type to another one, a uniform labour market will be assured through labour supply adjustments (more by sector than by age, gender or skill). Labour supply components are assumed imperfectly substitutable in labour demands. At the same way, some transitions could be assumed less likely than others: a worker can easier move from formal sector/skilled job to the informal sector/unskilled jobs, than the opposite.

Labour supply of a representative household can be calibrated to a set of two aggregate labour supply elasticities: a) elasticity of working hours with respect to (non-wage) income; and b) elasticity of working hours with respect to the wage. The calibration is performed by determining the parameters of a conventional utility function by comprising material consumption and leisure. Income elasticity of labour supply ($\boldsymbol{\eta_{H,Y}}$) can be plausibly fixed at −0.1 points, so that the ratio between total hours and worked hours is equal to 1.1, by implying 4 leisure hours compared to a 40 hour working week. The elasticity of working hours with respect to the wage is obtained as follows:

$$\boldsymbol{\eta_{H,w} = -\frac{T-H}{H} \cdot (-\sigma \cdot \theta_c - (1-\theta_c) + w \cdot (1-t_m) \cdot T \cdot Y_D)} \quad \text{(EQ62);}$$

[18] See Dervis *et al.*, 1982.
[19] See Fontana and Wood ,2000, Fofana *et al.*, 2003 and Hendy and Zaki, 2010.

by assuming that $\boldsymbol{\eta_{H,w}}$=0.1 and the general elasticity of substitution between the both terms of the utility function $\boldsymbol{\sigma} = \mathbf{1} - \frac{\eta_{H,w}}{\eta_{H,Y}}$ is equal to 2.

In CGE models, labour demand is derived from a production function (nested CES). The distinction of labour supply (e.g. male and female labour, labour of different age categories) does not require a corresponding similar differentiation on the labour demand side, as labour supply can be aggregated by summing either labour raw quantities or labour efficiency-weighted quantities.

The same result could be achieved through a conventional, separable, nested CES function by splitting value added into the contributions of LS labour and an aggregate of HMS labour and capital into the upper-level nest. At a second level, the latter composite production factor is split into HMS labour and capital. Finally, HMS labour is split into MS- and HS labour. The alternative set-up to separable CES could be the non-separable, nested CES (NNCES). This increases the flexibility of the nested CES framework through an extension to more generic forms.

Labour market assumptions are strictly linked to taxation issues. In this regard, Boeters, 2009a analyses how unionised labour markets contribute to establish the optimal degree on progressivity in taxation in the context of the individually optimising choice of hours worked through a two-step procedure according both intensive and the extensive margin, by considering the fixed costs to work. Boeters, 2009a assessed the role of the income tax progressivity as a factor distorting labour supply. As for Italy, the Author found that it was characterised by a relatively lower optimal progressivity with respect to the OECD average driven by a lower labour share, a higher average income tax rate and a lower Unemployment Benefit replacement rate.

A survey on how to model labour market in CGE models is given in Annabi (2013). The characteristics considered are the endogenous labour supply (A), exogenous/endogenous wage differentials (B1/B2), wage bargaining (C), efficiency wages (D) and full employment/involuntary unemployment (E1/E2). The A approach obtains hours worked as the result of worker's utility maximisation constrained to the budget constraint with a consequent backward-bending curve. As for the effect of the trade liberalisation on the wage rate and o labour supply, under the A scenario the reduction in labour supply reduces the downward trend of wages, so decreasing the benefits from liberalisation. Moreover, this result is stronger in the case of higher labour supply elasticity to wages.

5.2 – Labour market imperfections

The presence of labour market imperfections produces the emergence of wage curves, as a downward-sloping curve of wages with respect to (local) unemployment rate. The estimation of the curve is initially due to Blanchflower and Oswald, 1990 and 2005. In the latter paper, the focus was on the US labour market, where efficiency wages contributed to generate such a convex downward-sloping curve. The estimated labour supply elasticity to wage is around -0.1. Devicienti, 2002, De Stefanis and Pica, 2010 and Gucciardi, 2014 tried to estimate the wage curve for Italy. Devicienti, 2002 used WHIP (Worker History Italian Panel) data, an unbalanced panel of randomly selected employees over the period 1995-1999. This paper contains official data on occupation and wages from INPS registers. The main conclusions were:

1. there has been a break in 1993 with the repeal of the automatic cost-of-living allowance and the introduction of two separated (national and decentralised) bargain levels;
2. the top-up wage component shows an elasticity of -0.076 to unemployment contrary to the total wage (only -0.020).

De Stefanis and Pica, 2010 used 1987-2006 SHIW- Bank of Italy data and confirmed the estimation of Blanchflower and Oswald, 2005 for annual wages. Moreover, they found an hours curve (related to top-up wage component) with a negative elasticity of -0.04 to unemployment. Guicciardi, 2014 estimated a 10-20 per cent elasticity for blue-collar workers on 1977-2014 ISTAT and 1977-2008 SHIW data. Including the whole set of control variables, elasticity for blue-collar is -5.1 per cent. White-collars show a coefficient ranging between -9 and -12 per cent. Over the period after 1993, blue-collars show an elasticity of -11 per cent. Employees and teachers register an elasticity ranging between -7 and -11 per cent.

Generally, CGE models are based on the assumption of market clearing. This means labour demand and -supply should be in equilibrium without involuntary unemployment (workers included in the labour force who cannot find a job at the current wage). Under this assumption, not-working members of the LF are voluntary unemployed, requiring wages higher than current level. This description of the labour market is not satisfactory and coherent with the stylised facts characteristic of the labour market.

This means that: i) wages are pro-cyclical; ii) a large proportion of unemployment is involuntary and this cannot depend either on mistaken expectations of the rate of inflation or on monetary growth, or search activity; iii) firms would generally produce more at current wages and are constrained by aggregate demand; iv) a change in nominal demand produces both effects on quantity, and on prices/wages; v) changes of quantities due to changes in aggregate demand tend to persist over time; vi) labour market performances in terms of unemployment rate depend on bargaining structures with the best performances attributable both to highly centralised and to very decentralised wage setting.

In order to make the functioning of CGE models more realistic and respond to the above mentioned 6 stylised facts, some labour market assumption have to be relaxed some assumptions (e.g. perfect competition) and some restrictions (such as imposing rigidities caused by search and matching frictions, labour unions and efficiency wages[20]) should be imposed. This determines the emersion of wage curve[21].

The Search and Matching model is based on Pissadires, 2000[22]. The central assumption is that matching between labour-demand and supply is an uncoordinated, time-consuming and costly

[20] See Shapiro and Stiglitz, 1984.
[21] See Folmer, 2009, Blanchflower and Oswald, 1995, Hutton and Ruocco, 1999, Maisonnave *et al.*, 2009 and Graafland *et al.*, 2001.
[22] Another contribution is Keuschnigg and Keuschnigg, 2004.

process for both employers and employees. The matching is not an easy process because of the existence of heterogeneity in terms of owned and requested skills in both the sides, frictions and information imperfections. In this way, unemployment persists in equilibrium, as some of existing jobs break up during the matching process.

Pissarides (2000) analyses the effects of 4 tools: i) the introduction of a progressive income tax on wages; ii) the introduction of an employment subsidy paid throughout the duration of the job and independent of both worker's skill and the paid wage; iii) an hiring subsidy can also be paid to employers when a worker is hired, as well as firms could also pay a separation tax when the job is deleted; iv) an unemployment benefit could be recognised to unemployed as share of net work-income according to a replacement rate.

An alternative approach to take into account labour market imperfections is relative to bargaining whose results are replicated by efficiency wages in countries with a lower union density. The base text book at this regard is Carlin and Soskice (1990).

As for the wage bargaining, a Price-determined Real Wage (PRW) and a Bargained Real Wage (BRW) should be identified. PRW is obtained as the application of a share inversely proportional to mark-up on the marginal productivity of labour (MPL):

$$\frac{W}{P} = w^{p} = \left(1 - \frac{1}{\varepsilon}\right) \cdot MPL(L^{-}) \qquad \text{(EQ63).}$$

This curve can thought as being flat as the share is pro-cyclical. The mark-up $\frac{1}{\left(1-\frac{1}{\varepsilon}\right)}$ is decreasing. In this way, the elasticity of prices to output $\boldsymbol{\varepsilon}$ is increasing in employment and output, as customers develop a loyalty in a particular firm. Moreover, in imperfect competition, firms can use the excess capacity as an entry barrier.

In a closed economy in the imperfect competition model, the level of unemployment depends on the level of aggregate demand of the economy. In this context, inflation can be interpreted as the result of inconsistency between claims of unions and employers on the real income produced in the economy that is as a deviation from the NAIRU (Non Accelerating Inflation Rate of Unemployment). What characterises the system in equilibrium is the presence of involuntary unemployment.

The literature (see Calmfors and Driffil (1988)) shows that the performance of bargaining systems according to the dimension of centralisation/decentralisation in terms of the natural unemployment rate is not simply an upward linear function of centralisation with the lowest unemployment rate for the firm-level bargaining and the highest one for the country-centralised bargaining. Instead, both the extremes register a low unemployment rate differently from the intermediate case (sectoral bargaining), when the result penalises employment outcomes. In the intermediate case (as in Italy, France, Germany and the United Kingdom) there is a sectoral bargaining without coordination between unions with a lower sectoral elasticity of substitution between products than among firms. Therefore, sectoral unions set wages at a relatively higher level than firm- and coordinated unions, because they are less concerned about the employment consequences of their claims.

A second possible approach is the efficient bargain, when both wages, and employment levels are bargained and determined together by unions and firms according to the relative bargaining power β. This latter parameter is critical and depends on the maximum duration of strike unions and firms can bear. In our case z is the utility obtained by workers during a strike:

$$w^B = z + \beta \cdot \frac{\pi(w^-) - \bar{\pi}}{E(Q(p)} \qquad \text{(EQ64),}$$

where bargained wages seem to be driven both by the outside income and by workers' share of profit per capita.

Efficiency wages seem to be alternative mechanisms to set wages in countries where there is a low union density by drawing down an Efficiency Real Wages (ERW) (Salop,1979) developed the theory of efficiency wages starting from the need for the firm to reduce the costs of turnover :

$$w = \frac{u}{\frac{1}{(\tau \cdot c \cdot \alpha)^{\frac{1}{1-\alpha}}} - 1 + u} \cdot b \qquad \text{(EQ65),}$$

where the wage is set as a mark-up on the unemployment benefit that is directly proportional to the training cost rate and to the sensitiveness of quit rate to difference between w and market-clearing wage. Similar results could be found in Shapiro and Stiglitz,1984.

6- Part 1 - Static Macro approach - Labour demand trends by skill among Industries through a CGE analysis.

6.1 - Introduction

Advanced countries have been hit over the last thirty years from a radical change in the economic paradigm, which has affected employment both in terms of level, and on composition. We can list the main drivers of these changes as it follows: 1) globalisation; 2) digital innovation and progressive automation.

As for the globalisation, new (and often relevant) countries begun to be integrated in the world's trade flows. In this context, changes in the labour geography (also seen as the Global Value Chains - GVCs) occurred. Moreover, low-value added productive phases have been transferred towards countries with a relatively higher amount of (often-unskilled) labour. Conversely, high-value added productive phases moved towards countries with a relatively higher amount of capital and skilled work. In this context, Italy is specialised in traditional and low-technology productions and its endowment of skilled work is relatively low than in similar countries.

The second mega-trend is the pervasive ICT innovation both in services, and in manufacturing. In this context, the increase in supply of HS workers is associated with an higher productivity - or GDP growth pattern of the skill-biased technological change (SBTC) through the introduction of digital technologies and of ICT innovations. This has generally determined an increase in productivity levels with a consequently higher GDP growth rate.

However, the distribution of advantages has not been homogenously distributed around the world and within country's labour markets with increasing job opportunities and higher wages for HS jobs, decreasing job opportunities for middle-skilled workers (with complete loss of labour compensation) and decreasing wages for elementary occupations and sales jobs (whose labour demand should maintain the existing levels). In terms of composition of the output, in advanced countries the share of high-knowledge-intensive services and high-technology manufacture has increased with a reduction in low-knowledge-intensive services and low-technology manufacturing. In the European Mediterranean countries, the building sector, as well low-skill intensive services have increased their share. In addition, demand for older care services is increasing due to the underway ageing process.

The definition of (digital) skills has been developed in EC, 2016 and OECD, 2016. These abilities are related to the interaction, communication and cooperation in digital environment by being aware of cultural and generational diversity. In this way, people can also participate in society through public and private digital services and participatory citizenship. Finally, people can manage their own digital identity and improve their reputation. Moreover, highly digitally integrated environments allow also improvements in information management, protection and development to resolve conceptual problems. Skill endowment constitutes a relevant factor driving the distribution of advantages of GDP increase due to innovation (Matzat and Sadowski, 2012).

An operational tool to evaluate the level and the diffusion of abilities and skills across the economic systems is given by the survey on the Programme for the International Assessment of Adult Competences (PIAAC) done by OECD. OECD, 2013 and 2016 synthesised the results of the PIAAC, which identify three main cognitive skills (that is, literacy, numeracy and problem solving in technology-rich environment). The survey investigates the socio-demographic characteristics linked to skill proficiency (i.e. educational attainment), the way and the measure how the owned skills are used in the workplace and how skills are developed, maintained and/or lost.

ICT can affect the performance of the aggregate economy through two channels. The first is given by the ICT-producing activities. In most OECD countries, they cover only between 4 and 17 per cent of value added and the 6-7 per cent of total employment in the business sector. The second transmission channel is given by the diffusion of ICT technologies to other activities with investments in ICT-products. These latter are included in the range between 5 and 11 per cent in agriculture and in manufacturing, even though more than 30 per cent of IT equipment are concentrated in legal services, business services and wholesale, as well as in education, financial services, health, retail trade, and printing and publishing.

ICT benefits have been not homogenously distributed among countries with some countries gaining an higher growth (i.e. the US, Canada, the Netherlands and Australia), and some others with lower benefits (i.e. France and Italy). WEF, 2017 shows that Mediterranean countries have performed below the global average due to a higher rate of (youth) under-employment and unemployment rate.

The paragraph 6.2 reports a survey of the literature about the megatrends of the labour market, confirming that skill developments and economic growth are strictly interwoven. In this way a robust and sustainable economic growth can be achieved only through an increase in the share of skilled work. The paragraph 6.3 contains a survey of the literature about modelling of labour market in CGE models. The tool adopted to address this issue is the estimation of the Social Accounting Matrix (SAM) for the Italian Economy in 2013. The SAM is relative to Italy in 2013; moreover labour is disaggregated into occupations and formal/digital skills, where these latter are obtained with answers about the use of computer, internet and simple/advanced programmes at work, as turning out from PIAAC database.

On the base of the SAM, we have identified the commodities with the highest content of ICT skills, as well as high-qualified workers (see Paragraph 6.4). The SAM is also used to update and modify the MAC18 Computable General Equilibrium (CGE) model developed by the Department of Economics and Law of the University of Macerata. The model allows representing the relations between the changes in output of activities and the changes of compensation of employees by skills, digitalisation degree and gender in the context of the general equilibrium relations where both prices and quantities can adjust. Paragraph 6.5 will finally report results of the CGE simulations.

6.2 - Megatrends and labour market

Skill trends are closely linked to digitalisation (OECD, 2013b). Some 70 per cent of households and 85/95 per cent of large/medium-sized businesses have access to Internet; moreover, 65 per cent of firms use internet for work. Innovation is more pervasive as is shown by the growing weight of knowledge-intensive sectors (KISs) and high-technology manufacture (HTM). ICT and automation have also spread into traditional sectors, such as agriculture (i.e. the introduction of biotechnology as well the use of robotics and internet for GPS and IT sales).

LS supply in OECD countries is disappointing. Significant sections of the labour force (OECD, 2013a) achieve a low proficiency score in literacy, numeracy and/or in problem solving.[23] Indeed, the percentage of the population without any or not enough high basic skills ranges from 7 per cent in the best performing countries (Netherlands, Norway and Sweden) to 23 per cent in the worst ones (which include Italy, Spain and Portugal). The percentage of adults with a high level of proficiency in problem solving only has a cross-country ranges cross-country of between 3 and 9 per cent. This is confirmed by the lack of digital skills: a large share of the adult population, ranging between 7 and 27 per cent, is unable to use computers. In this context, the Nordic countries and the Netherlands have been more successful than other countries in creating a computer-friendly environment, while Finland and Japan registered a satisfactory performance. Conversely, in Italy and Spain only 5 per cent of the population display the highest level of literacy against 30 per cent with the lowest level of proficiency both in literacy and in numeracy. In these latter countries, the main problem is represented by the high incidence of people who are only able to read short texts with a single piece of information or to process simple counting, sorting and arithmetic operations.

The relationship with education is a critical aspect of skill analysis. Generally, skills are positively correlated with formal educational attainment, so that formal education represents the main mechanism through which proficiency is obtained. However, formal education and skills are not perfectly aligned because of the following issues: 1) information processing skills are more weakly correlated with education than numeracy and literacy; and 2) there is a large cross-country heterogeneity of skilled actually owned by comparable formal educational degrees.[24]

Moreover, the share of graduates on total workers - especially in Science, Technology, Engineering, and Mathematics (STEM) (see OECD, 2016b) - is particularly low In Italy, where the percentage of graduates in the 25-64 age group amounts to 18 per cent against 43.5 per cent in the UK and 35 per cent in Spain. The share of STEM graduates amounts to 16 per cent in the UK against only 7 per cent in Italy and 9 per cent in Spain and France. Moreover, a higher heterogeneity of skills for each educational stage makes the matching on the labour market more difficult and costly, and this may be the result of cross-country differences in the effectiveness of expenditure in education.

[23] That is performing multi-step operations to integrate, interpret and synthesise information from complex or lengthy texts involving conditional and/or competing information.

[24] 25-34-year-old Japanese upper secondary graduates have the same numeracy and literacy skills as the Italian graduates in the same age class.

In OECD countries one quarter of workers are professionals or skilled technicians and this is inserted into a process of increasing the weight of highly-educated workers over the 1998-2009 period against a decrease in low- and medium-educated workers (OECD, 2013). However, 200 million adults in OECD countries have a low literacy proficiency and 60 per cent of them lack both numeracy, and literacy. These workers are exposed to a decreasing labour demand as a result of offshoring/outsourcing and automation with consequent job losses and/or wage reductions in the short term. Higher skills imply a lower risk of offshoring/outsourcing along the GVC and enhance job quality with an increasing gap with low skilled workers.

The labour demand in terms of both level and composition (see OECD, 2017g) has changed because of technological changes. Repetitive cognitive and craft skill tasks (i.e. clerical work, bookkeeping, and basic para-legal and reporting jobs) have been increasingly automated. However, this process (i.e. big data, artificial intelligence and ICT) will also involve complex tasks in the near future. These tasks will be increasingly broken down into smaller micro-tasks, many of which could be automated. In the near future, many older workers will retire and this will increase the demand for health- and care-related services requiring specific and advanced skills.

Here we can consider job polarisation and the hollowing-out of the skills content of occupations (see Goos *et al.* 2009 and Fernandez-Macias, 2012). The economic and technological changes under way (see OECD, 2017c) have determined a significant reallocation of employment across activities and occupations and, in this way, skill imbalances with an upward trend of HS and LS workers differently from middle ones. Autor, 2010 explained the current trend of divergence between routine versus non-routine tasks. Globalisation and GVC fragmentation are creating new and better job opportunities and this is also spreading to activities not linked to GVC. However, this exposes the economic system to outsourcing and automation, which are negatively hitting low-level and especially mid-level jobs in OECD countries.

Autor *et al.*, 2016 stressed the role of international integration in GVC as a channel for transmitting positive consequences (in terms of higher wages, higher labour quality and higher productivity), but also higher risks of job losses and wage reduction. This latter effect has been emphasised by Autor *et. al.*, 2015, who focused on the competition from low labour? cost countries. Instead, OECD, 2017 emphasised the opportunities deriving from high-tech imports within OECD countries. Specialisation in high-tech production requires all workers to perform well along a long sequence of tasks, differently from low-tech production, which is characterised by a short sequence of tasks. In this latter case, the low productivity of one worker can be compensated by the high productivity of another worker. Therefore, high-tech production requires a low dispersion of skills for each level of educational attainment. Haugh *et. al.*, 2010 and Timmer *et. al.,* 2016 underlined the slowdown in the fragmentation of activities in 2008, when a process of greater protection of domestic production by substituting imports began.

An important survey of adults' skills was carried out by the OECD in 2016,[25] including a range of information regarding the driving forces of skill development and maintenance such as education, engagement with literacy and numeracy, and ICT. The survey also gathered information and data on how adults use their skills at home, at work and in the wider community. This survey can help us to identify the presence of skill-mismatches in terms of both under-education and overskilling respectively, if a worker's skills are lower or higher than those ones required by the job.

In terms of policy, LLL and VET programmes could help to reduce the mismatch between labour supply and demand, as they contribute to adjusting (both LS and HS) workers' existing competences to the needs of skill-biased technological developments, and thus by reducing unemployment risk in the long run. Moreover, an appropriate investment in these programmes could help to close the gap between low- and high-skilled workers, especially in countries with a reduced participation rate concentrated among high-skilled workers (as in Italy[26]).

According to Italy's National Institute of Statistics (ISTAT, 2017), over the period 2011-2016, employment increased by 403,000 in Italy in qualified professions in retail and services, by 330,000 in scientific professions and professionals, but also in non-qualified occupations (+268,000). Conversely, employment in executive jobs diminished by 106,000. Some 27 out of 221 occupations with over 20,000 employees recorded a cumulative gain of 1.6 million against the loss of 1.0 million in the 24 declining occupations (construction sector and office jobs). Over the period 2011-2016, highly-qualified managerial and technical professions recorded an increase in the weight on total ICT employment from 23 per cent to 31 per cent.

ISTAT, 2018 highlights the most recent trends in labour demand by skill as a consequence of digital innovation. Digital innovation and employment seem to be complementary, as confirmed by a higher increase in labour demand in the most digitally advanced activities than on average in the business sector (respectively, 3.5 per cent against 0.9 per cent in 2017). The increase is higher for firms with 10-49 employees than for other employment classes. Over the period 2015-2016, net hiring amounted to about 290,000 employees (200,000 in 2016), equal to 3.8 per cent of employees. There has been a shift in the composition of workers, with a reduction in managers, professionals and technicians (-16,800 employees) and an increase in plant and machinery operators and elementary occupations (+170,330) and clerks, service workers and shop market sales workers, and skilled agriculture and craft workers (+137,800).

The abovementioned figures are not distributed homogeneously among firms by innovation propensity. In the group of firms more favourable to innovation, HS occupations have increased by 87,874 against a decrease of 14,009 in medium and LS ones . The situation is the opposite for the

[25] The PIAAC (Programme for the International Assessment of Adult Competencies) was created by the OECD to estimate skill endowment (reading, numeracy and problem-solving) of the 16-65 age group in the labour force. It is a biannual survey to assess the skills of the adult population. It involved 24 OECD countries and 166,000 adults in its first edition in 2012.

[26] Countries with low skills use this opportunity less (50 per cent of eligible workers in UK against only 20 per cent in Italy, 32 per cent in France and 35 in Spain) and the probability of participating in these programmes is explained by skill proficiency.

group of firms less favourable to innovation,: -104,670 for HS occupations and +322,156 employees in LMS occupations. The aggregate trend is due to the relatively low weight of activities more favourable to innovation (only 25 per cent of the total net job creation).

The match between labour supply and demand (see OECD, 2017c) has three different effects: i) the unemployment risk for LS workers is higher than for HS workers; ii) labour shortages (i.e. uncovered jobs) could emerge for HS tasks in advanced sectors inserted into the GVC; and iii) misalignments between the skills possessed by employed persons and the skills required for jobs (mismatch). As regards the first point, OECD, 2017c stressed the role of long-term unemployment in the depreciation and obsolescence of skills. A similar effect can also be recorded as a result of inactivity. In a more cross-country integrated context, the position of each country in GVC depends on the supply of skills, so that countries with a LS labour force have to deal with a higher risk of offshoring/outsourcing, without being able to convert to other productions. Moreover, their productivity, and therefore their wages, are low, because low skills constitute an obstacle to introducing productivity-improving technologies and better work organisation practices.

The low signalling power of educational degrees as well as the institutional features of the labour market (EPL and temporary and/or part-time contracts) can explain the skill mismatch, which generally determines economic losses over the middle and the long term because of skills deteriorating badly or not being used over time (see OECD, 2016b). The type of contracts is a driving variable: fixed-term contracts (FTCs) or other temporary contracts, as well as part-time work, generally require a lower use of skills and capital accumulation than open-ended contracts (OECs) except in the UK, as often only long-term and full-time contracts could justify investments in firm-specific skills both by employees, and by employers. Young people and foreign-born workers are disproportionately employed only with temporary and part-time contracts and in jobs requiring lower skills than those possessed by workers. Mismatches are often accompanied both by unemployment, and by vacancies (uncovered jobs demanded by firms). Moreover, FTC or part-time workers have high probabilities to remaining in those statuses with a higher risk of depreciation and obsolescence (OECD, 2014).

Finally, the OECD has undertaken an ambitious work programme on how to achieve a better alignment or skill supply and skill demand by focusing on the following aspects: i) how to collect information on skill needs, cost-effective training and labour market policies for skill-mismatches and shortages; ii) how to support changing skill needs and set up a database of skill needs indicators. In this regard, the OECD created a ‘Skills for Job Database’[27] allowing shortages and surpluses of two-digit ISCO skills to be measured by aggregating five sub-indices (hourly wage growth, employment growth, unemployment rate, hours worked and under-qualification). The OECD (2017g) underlines the fact that in 2016, 14 per cent of Italian students left school without

[27] http://www.oecd.org/els/emp/skills-for-jobs-dataviz.htm.

even achieving the lowest education diploma. Moreover, the mean literacy proficiency score of Italian upper-secondary and tertiary graduates is under the OECD average.

Generally speaking, the shortages of skills, abilities and knowledge in Italy appear to be quite mild compared with other countries; moreover, if they are substantial, they are concentrated in specific technical or quantitative and complex problem-solving domains. Computer science and electronics, clerical knowledge, mathematical engineering, mechanics and technology, as well as design were the areas with the highest shortages of degrees. On the contrary, knowledge of building and construction, public safety and security, or customer- and personal services are the areas showing a surplus.

As for the skills dimension, there are gaps in basic skills such as reading comprehension, writing, active listening and critical thinking. In addition, verbal and quantitative abilities for problem solving are hard to find, differently from endurance and physical strength which has been particularly hit by automation. Shortages of workers with IT and electronics knowledge are experienced in all countries. In Italy, this gap is very marked. In this context, Italy launched the 'Industry 4.0' programme to reinforce ICT skills, which should be combined with the strengthening of quantitative abilities, but also with improved knowledge of physics and engineering and technology.

OECD, 2017h emphasised the role of ICT and automation in determining the patterns of the labour market with excesses of manual and physical skills while creating substantial shortages of non-routine cognitive skills. In particular, there are shortages in cognitive abilities across countries, such as deductive reasoning (i.e. the ability to apply general rules to specific problems), fluency of ideas (i.e. the ability to come up with a number of ideas about a topic) or information ordering (i.e. the ability to arrange things or actions in a certain order or pattern according to a specific rule). It should be stressed that automation has also negatively affected precise control abilities (i.e. the ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions) in mining occupations (especially in Ireland, Finland, Estonia and Sweden).

In Italy, the shortage is higher for non-routine deductive-reasoning skills, which require innovative teaching methods. However, Italy has also a relatively higher demand for routine manual and physical skills, whose surplus is lower than in other comparable countries. This is the product of the Italian specialisation in traditional low- and medium-tech production processes and products. This also shows that the SBTC has not fully affected the Italian economy, but it does also mean that governments should invest more resources to improve cognitive skills to address the consequences of the forthcoming fourth industrial revolution.

The features of SBTC are strongly correlated with the trend of globalisation; as the former constitutes the physical platform capital allocation according to revenue maximisation by maintaining a strong control in company headquarters. In this way, labour markets in different countries have become more interwoven and many developing countries could achieve increases in GDP and productivity. However, this creates more risks for workers (especially in developed countries) of remaining unemployed (for LS workers) and of a greater instability (for HS workers).

OECD, 2017c underlined the dividend gained by countries from participating in GVCs. Over the period 1995-2011, the most integrated countries benefited from an additional annual growth in industry labour productivity. The growth rate ranged from 0.8 percentage points in industries offering the smallest potential for fragmentation of production to 2.2 percentage points in those with the highest potential (also including many high-technology manufacturing industries). These effects are not only limited to directly involved activities, but could also spread to the remaining activities in the presence of an adequate skill supply. According to the OECD, 2017c, currently 30 per cent of OECD countries' exports (40 per cent in manufacturing and 20 per cent in services) originates abroad and one third of jobs in OECD countries' business sectors depend on GVCs. Furthermore, PIAAC data show that small firms, less internationally integrated, are generally less skill-intensive than large ones.

Generally, small firms operate in traditional low-technology sectors, have a low multi-factor productivity (so pay low wages) and require LS employment. In a context characterised by these firms, both the demand for and the supply of skilled work is low with the consequent risk of falling into the low part of GVCs. Moreover, HS work can be used wrongly with a consequent impact on the phenomena of overskilling. in this regard, Italy has an unsatisfactory performance in terms of its percentage of HS workers and it is not specialised in advanced sectors. Therefore, Italy - differently from Finland and Japan - has been recording a stagnant productivity growth over the last 15 years (see OECD, 2017c).

In the context of GVCs, tasks spread across countries according to each country's skill endowment, as we said before. OECD, 2017c assesses the employment shifts from manufacturing to services registered in OECD countries as a factor showing how a country is inserted into GVCs: manufacturing currently employs 11 per cent of workers in France, 13.2 per cent in Spain, and 15.5 per cent in Italy (even though this is in line with EU average). Moreover, a large share of manufacturing employment in Italy and Spain is represented by low-tech manufacturing; finally, in OECD countries, services are polarising between knowledge-Intensive services (KISs, for example in the UK) and personal care and retail services (e.g. in Spain, Italy and France).

The integration of countries into the GVC needs both cognitive skills (including literacy, numeracy and problem solving) and non-cognitive tasks, such as managerial and communication skills, and a readiness to learn (see OECD, 2013). Specialisation in the most technologically advanced tasks requires: a) social and emotional skills (such as managerial, communication and self-organising skills) that can complement cognitive skills with a potential gain on average of 8 per cent more than countries without this combination; b) a close correspondence between formal educational attainment and effective skills; and c) the ability to perform long sequences of tasks with an advantage of 2 per cent compared to countries without it.

However, GVCs expose countries to the risk of offshoring/outsourcing?, but skill-oriented? policies can allow people to adapt their knowledge to new needs. Investment in skills can contribute to protecting workers against job losses and poor job quality, but also to enhancing international competitiveness. Positive examples have been given by Poland and Korea who increased their participation in GVCs in technologically advanced production. Simultaneously, Germany seems to have a population supporting the country's industry specialisation.

In this context, countries should invest resources better and coordinate spending from education and migration policies to employment protection legislation, and align these policies with industry and trade policies. Moreover, the quality of educational systems should be enhanced, in order to make formal qualifications more reliable and help develop cognitive and non-cognitive skills (through a closer collaboration between public and private research centres). Countries can perform well in the GVC by not only increasing the quantity and quality of skills, but also using them better, thereby overcoming the mismatch problem. Therefore, workers' mobility among industries should be supported through a higher flexibility for firms and greater security for workers.

Baldwin, 2016 noted that the impact of GVCs on countries is increasingly pervasive, so the traditional border between activities open and not open to international flows - with, respectively, the choice between higher wages/higher unemployment risks and lower wages/lower unemployment risks - has been disappearing. In the context of international market integration, the role of multinationals in host countries is ambiguous, with a positive effect on job creation, but at the cost of increased uncertainty due to the risk of the international relocation of productive phases. Autor *et al.*, 2016 stressed the importance of politics in better explaining the consequences of the economic and social benefits of GVCs. The authors used the results of the 2002 and 2010 congressional elections and of the 2000, 2008, and 2016 presidential elections, and emphasised the circumstance that Chinese import penetration has been positively correlated with the election of nativist or extremist politicians.

OECD, 2017f reviewed the experience of New Zealand relative to the introduction of digital innovation. New Zealand is a country with a high percentage of MHS workers, also thanks to an efficient education and VET system. The effects of technological change can be seen in the more rapid growth of employment in occupations with high average levels of educational attainment than in others. New Zealand is a country where, starting from the 1960s the incidence of HS occupations has increased with an acceleration from the early 1980s onwards. Bessen (2016) identified the patterns of the U.S., a country very similar to New Zealand in terms of computerisation. He found that polarisation in the US occurred in occupations with below-average computer use, but not in occupations with above-average computer use.

Computerisation has increased the productivity of workers using computers more intensively, and this is positively correlated with the skills possessed. There has been an increase in demand for employees with university degrees even in occupations not normally requiring a university degree where there is a high rate of computerisation. In order to shift to these well-paid occupations, workers need to learn new complementary skills, which are costly to acquire. Computer use is estimated to have accounted for 38-45 per cent of the increase in wage inequality in the US since 1990. In the context of globalisation, repetitive cognitive tasks are easier to outsource than others are.

Fey and Osborne, 2017 estimated the risk that occupations could be automated out of existence over the next couple of decades. Many repetitive tasks have already been automated with subsequent lower employment and wage growth for mid-level skills. ICT investment will involve 47 per cent of current employment in occupations at high risk (with a risk higher than 70 per cent), 19 per cent in occupations with medium risk (with a risk included in the 30-70 per cent range) and 33 per cent in occupations with low risk (with a risk lower than 30 per cent).

Deloitte (2015) showed that occupations with a high susceptibility to automation saw sharp employment declines in the UK between 2010 and 2015, while less exposed jobs experienced rapid growth. NZIER (2015) estimated that 46 per cent of the New Zealand labour force faces a high risk of having their current job automated. Moreover, 75 per cent of labouring jobs have a high risk of being automated.

By adopting a task-based approach, Arntz and Zierahn, (2016) estimated that 34 per cent of US jobs are at risk, that is to say that more than 50 per cent of tasks could be automated with 9 per cent at high risk (more than 70 per cent automatable). The increase in productivity from computerisation can expand demand for employees in an occupation as they are substituted for employees in other occupations benefitting less from computerisation (Bessen, 2016). The tasks performed will evolve from routine towards non-routine tasks requiring higher levels of judgement and social interaction. Many occupations, including currently LS ones, will become more HS.

Government policies (OECD, 2017) should not protect domestic sectors from international competition, as this which is ineffective over the medium term. Instead, a country could design policies to ease firms' reorganisation and enhance productivity, so thereby leading to job creation.

Formal education is not the only source of effective (especially complex problem solving) skills. Work and the social environment are factors that have become increasingly important recently and contribute to explaining the accumulation of human capital. A way to develop skills is given by life-long leaning (LLL) and vocational employment training (VET) programmes, which support both skilled and unskilled workers. Workers can learn to effectively face the higher risk of unemployment and the need to re- and up-skill (that is, protecting existing high skills from deterioration and increasing the level of skills) due to GVC participation and allowing existing competences to be updated to keep pace with the evolution of technology. However, only HS workers participate actively in LLL and VET programmes and the level of participation shows a high cross-country variability (from only about 30 per cent in Italy to 60 per cent in Scandinavian countries)-[28] Policies should be coordinated among countries because of spillover effects. Specific skill policies should be launched in order to promote a better use of skills on the job, also by coordinating educational, migration and employment protection legislation (EPL) policies.

A low share of LS workers is no guarantee against outsourcing, but enables displaced workers to learn the necessary new skills. Only an increase in the proportion of HS workers could help weak countries specialised in more technologically advanced activities without experiencing high unemployment or inactivity. New efforts for the diffusion of education and training ALM policies (PES, LLL) needs. This could help achieve three advantages: i) creating productive gains by participating in GVCs and spreading effects to other firms; ii) protecting workers against negative impacts of GVCs in terms of job losses and quality, with the consequent need for workers to adjust to changes in productive structure; and iii) generating the higher productivity and job creation determined by specialisation in the most technologically advanced manufacturing and high skill-intensive services.

Diminishing human capital via skill deterioration leads to a reduction in growth perspectives with a low and more unequally distributed level of disposable income. Given that non-used skills are higher with temporary contracts and in the event of inactivity, policy makers should facilitate the stabilisation of temporary contracts and hiring of voluntarily inactive people (such as women with children). In addition, tax reforms could help, as tax burdens tends to be higher for LS workers, thereby exposing them to the risk of outsourcing. Finally, enhancing competition could support changes in the productive system towards higher value-added GVC segments.

6.2 - Literature about labour market in CGE models

CGE models (Scrieciu, 2004) are used to estimate the economy-wide impacts on resource allocation and incomes, by taking into account of inter- and intra-industry foreign trade links. These models are based on the traditional neoclassical Walrasian economics, where each operator maximises utility and profit under income or technology constraints. Therefore, we can argue that a CGE model is '*an analytical deterministic integrated system of non-linear equations derived from the economic theory of optimising behaviour of rational economic agents*' solved as a numerical system. However, the results could be biased. First, in general (and CGE models in particular), there is a low capacity of quantitative methods to quantitatively estimate some important aspects that are not quantifiable in monetary terms, such as institutional arrangements, ethical issues and the multi-dimensional developmental needs. Secondly, CGE models are based on the General Equilibrium theory including perfect competition, full employment of resources, perfectly mobile factors of production, as well as complete information about all prices now and in the future (i.e.

[28] Countries with low skills use this opportunity less (50 per cent of eligible workers in UK against only 20 per cent in Italy, 32 per cent in France and 35 in Spain) and the probability of participating in those programmes is explained by skill proficiency.

economic agents are implicitly assumed to have unlimited computational abilities[29]). Thirdly, CGE models are solved through a simultaneous system of equations, so that single specific channels are not identified and parameters are imported from other sources.

Boehringer and Loeschel, 2004 used CGE models as a flexible tool for quantifying the impacts of policy changes or proposals on the three (economic, environment and social) pillars of sustainable development. From this point of view, *"[…] computable general equilibrium models can incorporate several key sustainability (meta-) indicators in a single micro-consistent framework, thereby allowing for a systematic quantitative trade-off analysis between environmental quality, economic performance and income distribution*". The authors developed a standard ('core') CGE multi-sector and multi-region model of trade and environmental or energy policies that employs three primary production factors (labour, capital and fossil fuel resource) and non-energy intermediate inputs.

The treatment of labour markets in CGE models is an important feature for economic analysis. The disaggregation of labour could make it possible to take into account a larger share of heterogeneity across activities by obtaining results also in terms of the composition of labour by skill or by other socio-demographic characteristics. Humphreys (2000) elaborated a CGE model for the South African economy that focused on the labour market to tackle the issue of a high unemployment rate of close to 30 per cent. In order to distinguish between skilled and unskilled workers, the author uses a wage curve by deriving unemployment from wages.

Chitiga *et al.* (2007) disaggregated labour into skilled and unskilled, which are differently distributed among activities and, in particular, among exporting and not-exporting activities in the case of Zimbabwe. The paper used a microsimulation CGE model for Zimbabwe in 1995 to study the impact of trade liberalisation on poverty in Zimbabwe. The model is static in nature and uses a sample of 14,000 households. The results show that liberalisation of external trade would favour export-oriented sectors, and so the unskilled labour factor used intensively in agriculture, mining and services benefits from this policy. On the contrary, skilled labour, which is concentrated in manufacturing sectors, is negatively affected.

Carneiro and Arbache, 2003 assessed the impacts of trade liberalisation on macroeconomic variables and labour market indicators in Brazil using a CGE model. Trade liberalisation seems to contribute to improving economic welfare by means of greater output, lower domestic prices, and higher labour demand (especially for the most skilled workers in the most trade-oriented sectors). More specifically, labour market effects are analysed as a whole regarding the formation of income flows earned by households, firms, governments and the rest of the world. As for labour income, the authors divide the distribution of earnings into eight types of labour and households into nine types according to their composition.

[29] In other words, a factor cannot be employed in two different places, households cannot spend more than they earn, so the society is a waste-free economy.

Pouliakas *et al.*, 2009 estimated the effects of immigration on three small remote EU regions located within Scotland, Greece and Latvia using a regional CGE model. Two migration scenarios are assessed: i) total labour supply is affected; and ii) migration flows are distinguished between several labour skill types. The results indicate significant differences in the extent to which regional economies are affected by immigration (especially of skilled migrants, the so-called 'brain-drain').

One of the most important issues of CGE economic analysis is the study of the impact of labour income taxes. EC, 2015 reviews the literature about this, by focusing on the impact of introducing a single tax rate, instead of the progressive taxation system, and on the impact of fiscal devaluation.

Hodgson and Poot, 2011 made a survey of several key research findings of some 20 projects conducted in New Zealand on the economic impacts of immigration from 2005 to 2010. It concluded that immigration contributed positively to economic growth in New Zealand, without negatively impacting on public finance, wages, and unemployment. Simulations over a 15-year period with a CGE model suggest that even without additional technological change, additional immigration raises GDP per capita, albeit only modestly. The benefits from immigration have been increasingly positive over the last quarter of a century.

Finally, Gibson, 2011 makes a survey of different approaches to the study of the relationship between trade and employment. As for the CGE approach, the author remarked that the projected benefits of liberalising merchandise trade are small, especially for developing countries, and given the limited scope for future reduction, trade liberalisation is unlikely to help reduce poverty significantly. Moreover, the employment effects of liberalisation, even though of fundamental concern to policy-makers, are 'excluded by design' from most CGE models. Models based on more realistic assumptions about market functioning would produce an auditing of winners and losers from trade that would differ from the standard results.

Boeters and Savard, 2011 provided for a detailed study on how labour markets can be modelled in CGE models. In particular, the authors note several circumstances. Firstly, as for involuntary unemployment, one should consider that there are different unemployment rates characterising each labour market segment. Secondly, according to the authors, collective bargaining is only relevant for particular activities, but this introduces the issue of the sectoral labour mobility. Introducing a deviation from the General Equilibrium theory means addressing the questions of education and demographic trend in a dynamic perspective, as well as the issue of labour mobility across regions and activities.

6.3 - First step: simulations from the multi-sectoral model

The analysis will be divided into two steps. The first step is aimed at identifying the products, which mainly contribute to the increase in the percentage of highly formally educated and highly digital skilled workers on labour compensation. For this purpose, we use the average share of highly-educated and highly skilled labour compensation on total compensation by activity (by including only direct effects).

Table 11- Classification of labour factor in the SAM

Index	Occupations (1 LS;2 MS; 3 HS)	Skills (1 L. qualification; 2 M. q.; 3 H. q.)	Computer using (0 NO; 1 Yes)	Description
1	1_1	1_2	0_0	Low occupations with a low-medium educational attainment and not using computers
2	1_1	1_2	1_1	Low occupations with a low-medium educational attainment and using computers
3	1	3	0	Low occupations with an high educational attainment and not using computers
4	2_2	1_2	0_0	Medium occupations with a low-medium educational attainment not using computers
5	2_2	1_2	1_1	Medium occupations with a low-medium educational attainment using computers
6	2	3	0	Medium occupations with high educational attainment not using computers
7	2	3	1	Medium occupations with high educational attainment and using computers
8	3_3	1_2	0_0	High occupations with low-medium educational attainment and not using computers
9	3	1	1	High occupations with low educational attainment and using computers
10	3	2	1	High occupations with medium educational attainment and using computers
11	3	3	0	High occupations with high educational attainment and not using computers
12	3	3	1	High occupations with high educational attainment and using computers

Source: Own elaborations

We have grouped the 12 work categories into 4 macro-categories: HS occupations with the use of computer linked to internet at work (Index 1); high-educated occupations not using computers (Index 2); medium occupations performed by people with tertiary educational attainment and with the use of computers (Index 3); LMS occupations with tertiary educational attainment and without using computers educated (Index 4); LMS occupations performed by workers with medium-low educational attainment (Index 5). Results have been synthesised in Table 12.

Table 12 - Activities by group defined according to skill intensity

Group A	
	Primary activities
RB	Mining and quarrying;
	Manufacturing
R21	Basic pharmaceutical products and pharmaceutical preparations;
R27	Electrical equipment;
R28	Machinery and equipment n.e.c;
	Utilities
R37-39	Sewerage services; sewage sludge, waste collection, treatment and disposal services; materials recovery services and Remediation services and other waste management services;
	Private services
R58	Publishing services;
R59_60	Motion picture, video and television programme production services, sound recording and music publishing and Programming and broadcasting services;
R61	Telecommunications services;
R62_63	Computer programming, consultancy and related services and Information services;
R64	Financial services, except insurance and pension funding;
R65	Insurance, reinsurance and pension funding services, except compulsory social security;
R66	Services auxiliary to financial services and insurance services;
R69_70	Legal and accounting services and Services of head offices; management consulting services;
R71	Architectural and engineering services; technical testing and analysis services;
R72	Scientific research and development services;
R74_75	Other professional, scientific and technical services and Veterinary services;
	Public and social services
RP	Education services;
R86	Human health services;
R90_92	Creative, arts and entertainment services, library, archive, museum and other cultural services and gambling and betting services;
R95	Repair services of computers and personal and household goods.
Other products (Group B) have instead a polarising effect, as they determine an increase both in the incidence of high-skilled ICT-intensive occupations, both in the incidence of medium-low-occupations performed by medium-low educated workers. These products are the following:	

Group B	
	Primary activities
R03	Fish and other fishing products; aquaculture products; support services to fishing;
	Manufacturing
R26	Computer, electronic and optical products;
R33	Repair and installation services of machinery and equipment;
	Utilities
R36	Natural water; water treatment and supply services;
	Private services
R52	Warehousing and support services for transportation;
R53	Postal and courier services;
R78	Employment services;
R80_82	Security and investigation services, Services to buildings and landscape and Office administrative, office support and other business support services;
	Public Administration and social services
R84	Public administration and defence services; compulsory social security services;
R87_88	Residential care services and Social work services without accommodation.
The products with an unambiguous adverse effect on the composition of labour compensation by education and digital competence (i.e. Group C)are the following:	
Group C	
	Primary activities
R01	Products of agriculture, hunting and related services;
R02	Products of forestry, logging and related services;
	Manufacturing
R13_15	Textiles, wearing apparel and leather and related products;
R16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials;
R17	Paper and paper products;
R18	Printing and recording services;
R22	Rubber and plastics products;
R23	Other non-metallic mineral products;
R25	Fabricated metal products, except machinery and equipment;
R30	Other transport equipment;
R31_32	Furniture and Other manufactured goods;
	Construction
RF	Constructions and construction works;
	Private services
R45	Wholesale and retail trade and repair services of motor vehicles and motorcycles;
R46	Wholesale trade services, except of motor vehicles and motorcycles;
R47	Retail trade services, except of motor vehicles and motorcycles;
R49	Land transport services and transport services via pipelines;
RI	Accommodation and food services;
	Public and social services
R94	Services furnished by membership organisations;
R96	Other personal services;
RT	Services of households as employers; undifferentiated goods and services produced by households for own use.

Source: Own elaborations the base of ISTAT, SIOPE and PIAAC data.

As shown in the above-described lists, manufacturing activities are mainly included in the Group C (9 out of 19), than in Group A (only 3/19). Conversely, services register an higher share of activities supporting HS occupations (15/36) than one supporting medium-low skilled occupations (8/36).

In terms of value added (see Table 13.1), the activities producing commodities included in Group A account only for 31 per cent of value added and in 33 per cent of intermediate consumptions; the 56 per cent of intermediate consumption purchased by activities of Group A have been provided by the same activities. These products do not seem to contribute intensively to products included in Group B (32 per cent of specific intermediate consumption) and in Group C (only 21 per cent of specific intermediate consumption). Goods included in Group B cover 14 per cent of total value added and 9 per cent of intermediate consumption; they provide other commodities of Group A (8 per cent) and of Group C (5 per cent) only in a limited way. Goods included in Group C cover about 35 per cent of value added and 29 per cent of intermediate consumption. They contribute to intermediate consumption by commodities of Group A (18 per cent) and of Group B (21 per cent), but the highest contribution is to themselves with a percentage of 40 per cent.

Table 13.1 - Shares of value added and of intermediate consumption by activities

	VA	CI	CI_A	CI_B	CI_C	CI_Other
Group_A	30.53%	32.75%	56.32%	32.28%	21.10%	29.03%
Group_B	13.83%	9.39%	8.17%	25.44%	9.62%	4.91%
Group_C	34.81%	28.17%	17.53%	20.54%	40.36%	21.96%
Other	20.84%	29.70%	17.97%	21.73%	28.92%	44.09%

Source: Authors' calculations on the base of ISTAT, SIOPE and PIAAC data.

Generally, activities with the highest incidence of use of computers at work (Group A) (see Table 13.2) are characterised by a relatively high incidence of exports (about 16 per cent), associated to with a relatively high share of imports on output (17 per cent); this turns out to determine a negative trade balance. The group B shows a negative trade balance amounting to 2.6, resulting from an export propensity amounting to 7 per cent and an import penetration of 9 per cent. Conversely, in the commodities of Group C there is an higher share of export on output (12 per cent) than of import on output (only 8 per cent) with a resulting positive trade balance amounting to 4 per cent of output. These data show that Italy is specialised in commodities produced by activities intensive of low-medium skilled occupations and low-medium educational attainment.

Table 13.2 - Import and exports by commodities

	Import	Export	Output	Import/Output (%)	Export/Output (%)	Trade balance/Output (%)
Group_A	142,342	137,520	848,657	16.77%	16.20%	-0.57%
Group_B	31,852	22,949	344,960	9.23%	6.65%	-2.58%
Group_C	91,319	138,028	1,152,296	7.92%	11.98%	4.05%
Other	147,201	133,191	738,438	19.93%	18.04%	-1.90%

Source: Authors' calculations on the base of ISTAT, SIOPE and PIAAC data.

6.4 - Second step: simulations from the CGE model.

In the second step, we use the CGE model outlined in the Chapter 3. This allows finding a general equilibrium solution, where prices and quantities simultaneously adjust in response to a change in parameters (policy shock) or in the exogenous final demand (demand shock). In this paper, we introduce an exogenous shock in final demand expenditures by commodity whose total value amounts to €10 billion in the Group A commodities. The invariance of aggregate quantities is maintained, so that an equivalent decrease has been attributed to other commodities. The demand shock is divided into different commodities according the shares in the base year, in order to keep the structure of the economy. Two simulations on private households' consumption and investment have been run, in order to study the differential effects of two transmission channels. In the case of the simulation on private consumption, we assume that households receive a grant by the Government to buy HS intensive commodities. In the case of the simulation on investment, the transmission channel is given by increase in disposable income needed to re-establish the macroeconomic savings/investment equilibrium.

As for computational issues, labour factor prices are assumed to be allowed to oscillate in the in a symmetrical range of +/-10 per cent around the reference value of 1. This is due to the need to limit the price reaction to the labour demand shock, given the hypothesis of a fixed labour supply relative to wages. We should introduce a shift in the labour supply, in order to evaluate the additional effect of the demand shock in the presence of a convenient change in labour supply by skill. In other words, a demand policy increasing the demand for HS workers should increase the employment for this work category. However, the increase in wages could reduce the positive effect in terms of employment with a constant labour supply by skill. Only the increase of labour supply by skills through a policy targeted to promote the improvement of the quality of the Italian labour force in terms of tertiary educational attainment could reduce the pressure on wages and so increase the effect in real terms. A dynamic CGE model constitutes the most suitable tool to address such an issue.

Table 14 - Simulation 1: effects on main macroeconomic variables.

	% change from benchmark
GDP	0.70
Imports (goods and services)	0.73
Exports (goods and services)	-0.15
Consumption	1.42
Gross Fixed Investment	0.25
GDP Deflator	0.24
Import Deflator (goods and services)	0.00
Export Deflator (goods and services)	0.15
Consumption Deflator	0.10
Trade balance on GDP_0	1.18
Trade balance on GDP_1	0.99
Real Wage	0.33
Employment	0.42

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

As for the simulation on consumption (see Table 14), there would be an increase in real GDP by 0.7 per cent. Labour demand increase by 0.3 p.p.s less than GDP. Private consumption raises by 1.4 per cent, +1.2 p.p.s than gross fixed investment. Trade balance ratio on GDP decrease by 0.2 p.p.s. Finally, real wages increase by 0.3 per cent.

Table 15 - Simulation 1: aggregate results

Simulation 1 (% changes with the reference)	Quantity	Real wages
Real GDP	0.70	
Labour demand (high-skilled occupations using computers at work) - Index1	-0.17	0.91
Labour demand (high-skilled occupations without using computers at work) - Index2	-0.24	1.18
Labour demand (low-medium-skilled occupations with high educational attainment and with the use of computers at work) - Index3	-0.14	0.58
Labour demand (low-medium-skilled occupations with high educational attainment and without the use of computers at work) - Index4	-0.12	0.46
Labour demand (low-medium-skilled occupations with low-medium educational attainment) - Index5	1.13	-0.39
Labour demand (total)	0.42	0.33

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

The increase in labour demand by 0.4 per cent (see Table 15) is concentrated on perfectly matched low-medium occupations (index5) with an increase by 1.1 per cent. HS occupations (index1 and index2) are instead negatively affected with a decrease by 0.2 per cent. Overskilled LMS skilled occupations (index3 and index4) register a reduction by -0.1 per cent. These effects seem to go in the opposite direction than expected. The explanation is given by the response of real wages to the increased labour demand concentrated in HS occupations. These latter workers benefit from an increase in real wages by 0.9/1.2 per cent with a decrease in perfectly matched LS occupations by 0.4 per cent.

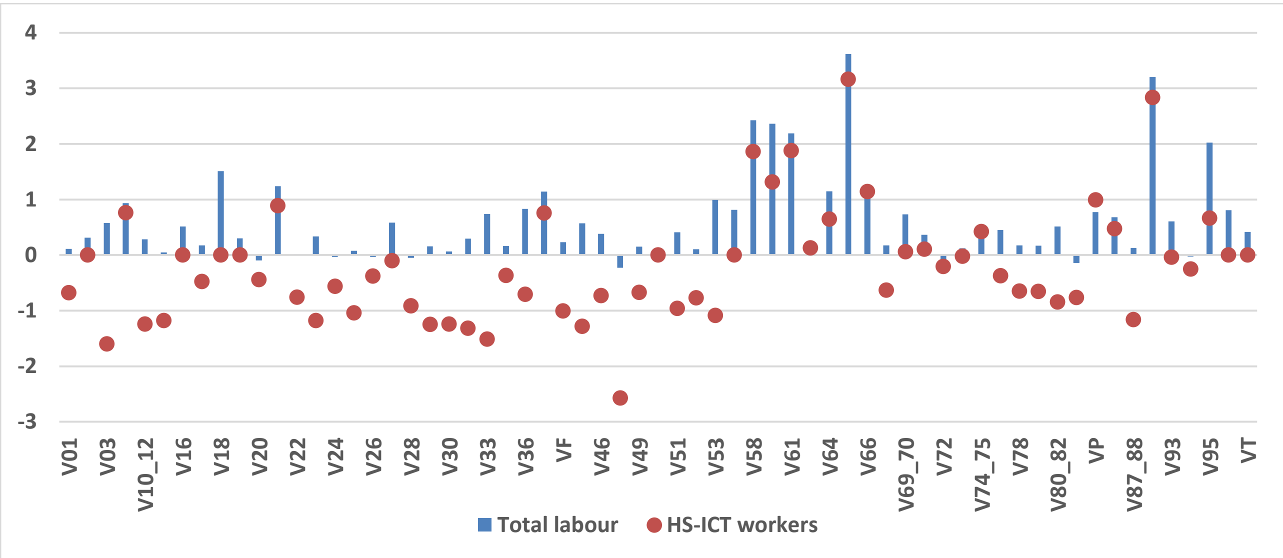
Table 16 and Figure 13 show the disaggregated effects on labour demand by activity. The activities with the highest increase in employment are financial activities, creative activities, publishing and basic pharmaceuticals. In all these activities LS occupations increase more than HS ones. Workers employed in high-skilled ICT-intensive occupations increase by about 3.0 per cent in insurance and creative activities. Figure 14 shows that in manufacturing workers employed in high-skilled ICT-intensive occupations decrease by 1.0 or 2.0 per cent vs. an increase in total labour demand in the range 0.0-1.0 per cent.

Table 16- Simulation 1: aggregate results

	Total labour	Ranking	HS-ICT workers	LS workers
K65 - Insurance, reinsurance and pension funding	3.6	1	3.2	5.6
R90-92 - Creative, arts and entertainment activities;	3.2	2	2.8	4.9
J58 - Publishing activities	2.4	3	1.9	4.4
J59_60 - Motion picture, video	2.4	4	1.3	4.1
J61 - Telecommunications	2.2	5	1.9	4.4
S95 - Repair of computers and personal and household goods	2.0	6	0.7	4.1
C18 - Printing and reproduction of recorded media	1.5	7		1.5
C21 - Basic pharmaceutical	1.2	8	0.9	2.0
K64 - Financial service activities	1.1	9	0.6	3.7
K66 - Finance and insurance auxiliary activities	1.1	10	1.1	

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

Figure 13- Simulation 1: aggregate results



Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

As for the simulation on investment (see Table 17), there would be an increase in real GDP by 0.9 per cent. Labour demand increase by 0.4 p.p.s less than GDP. Private consumption raises by 0.5 per cent vs. +5.2 for gross fixed investment. Trade balance ratio on GDP decrease by 0.2 p.p.s. Finally, real wages increase by 0.5 per cent.

Table 17 - Simulation 2: effects on main macroeconomic variables

	% change from benchmark
GDP	0.88
Imports (goods and services)	0.87
Exports (goods and services)	-0.27
Consumption	0.48
Gross Fixed Investment	5.20
GDP Deflator	0.38
Import Deflator (goods and services)	0.00
Export Deflator (goods and services)	0.27
Consumption Deflator	0.19
Trade balance on GDP_0	1.18
Trade balance on GDP_1	0.95
Real Wage	0.53
Employment	0.45

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

The increase in labour demand by 0.5 per cent (see Table 18) is again concentrated on perfectly matched low-medium occupations (index5) with an increase by 1.3 per cent. Instead, HS occupations (index1 and index2) are negatively affected with a decrease ranging between -0.3 and -0.2 per cent. Overskilled LMS occupations (index3 and index4) register a reduction by -0.2 per cent. These effects seem to go in the opposite direction than expected. The explanation is given by the response of real wages to the increased labour demand concentrated in HS occupations. These latter workers benefit from an increase in real wages by 1.4/1.0 per cent with a decrease in perfectly matched low-skilled occupations by 0.3 per cent.

Table 18 - Simulation 2: aggregate results

Simulation 2 (% changes with the reference)	Quantities	Real wages
Real GDP	0.88	
Labour demand (high-skilled occupations using computers at work) - Index1	-0.27	1.43
Labour demand (high-skilled occupations without using computers at work) - Index2	-0.23	1.03
Labour demand (low-medium-skilled occupations with high educational attainment and with the use of computers at work) - Index3	-0.19	0.74
Labour demand (low-medium-skilled occupations with high educational attainment and without the use of computers at work) - Index4	-0.15	0.53
Labour demand (low-medium-skilled occupations with low-medium educational attainment) - Index5	1.27	-0.27
Labour demand (total)	0.45	0.53

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

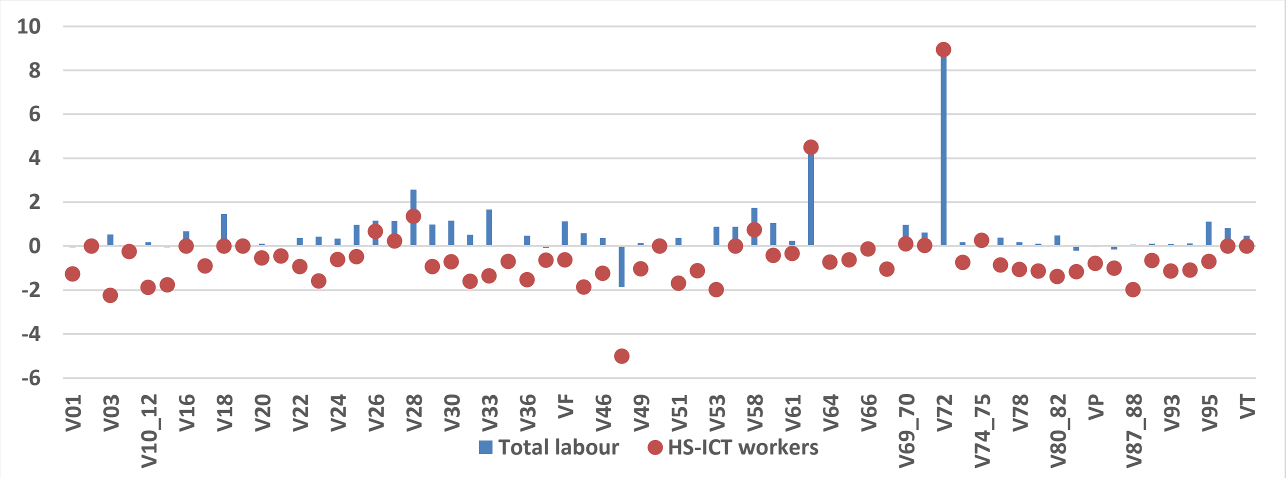
Table 19 and Figure 14 show the disaggregated effects on labour demand by activity. The activities with the highest increase in employment are high-skilled ICT-work intensive activities, such as research and development, computer programming, machinery and publishing. Also in this simulation LS workers increase more than high-skilled ones, by signalling the relevance of complementarity relations between different types of labour and the strength of the substitution effect due to the increase in relative wages of high-skilled workers. Figure 2 shows that in manufacturing workers employed in high-skilled ICT-intensive occupations decrease by 1.0 or 2.0 per cent vs. an increase in total labour demand in the range 0.0-2.0 per cent.

Table 19 - Simulation 2: aggregate results.

	Total labour	Ranking	HS-ICT workers	LS workers
M72 - R&D	9.10	1	8.94	
J62_63 - Computer programming	4.66	2	4.51	6.39
C28 - Machinery and equipment n.e.c.	2.56	3	1.35	3.94
J58 - Publishing activities	1.74	4	0.74	3.92
C33 - Repair and installation of machinery and equipment	1.67	5	-1.35	3.18
C18 - Printing and reproduction of recorded media	1.46	6		1.46
C26 - Computer, electronic and optical products	1.16	7	0.67	1.55
C30 -Otther transport equipment	1.16	8	-0.71	1.65
C27 - Electrical equipment	1.14	9	0.24	2.35
F - Construction	1.13	10	-0.62	2.11

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

Figure 14 - Simulation 2: aggregate results



Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

Table 20 shows that the both simulation have a similar effect on disposable income, which increases by 0.3 per cent. In addition, the distribution among institutional sector is similar with an increase in non-financial corporations, households and non-profit sectors and a negative effect on Public Administration (especially in the simulation on consumption).

Table 20- Effects on disposable income (percentage changes)

	Simulation 1	Simulation 2
Total institutional sectors	0.34	0.32
Non-financial corporations	0.41	0.42
Financial corporations	-0.50	-0.47
Government	-0.29	-0.17
Pension bodies	-0.29	-0.17
Regions	-0.29	-0.17
Provinces	-0.29	-0.17
Municipalities	-0.29	-0.17
Other administrations	-0.29	0.00
Households	0.36	0.34
Non-Profit entities	0.27	0.24

Source: Authors' calculations on the base of ISTAT, SIOPE and EUKELMS data.

In the both simulations, we used the substitution elasticity of labour by skill types of 1.67, according to the international literature. We tried to analyse how our estimations vary with respect to the changes in this parameter. Figures 12.1.1.a-s in the Appendix show the estimation of the percentage change of the variables simulated in the case of a consumption shock (simulation 1) according different elasticity coefficients in the case of increased product demand (Group A) favourable to ICT-intensive HS occupations. Generally, results are not very sensitive to the choice of the parameter except for the extreme values. In particular, estimated results appear to be robust in the range 1.550-3.900. Moreover, results appear to be increasing with respect to substitution elasticity. High skilled workers performing ICT-intensive HS occupations seem to have positive changes only for medium-high values of elasticities. Nonlinearities emerge in the relevant range for ICT-intensive over-skilled workers in LS occupations (L2) at 1.7 and for not ICT-intensive overskilled workers in MS occupations (L6) and for not ICT-intensive perfectly matched workers in HS occupations (L11) at 1.6.

Figures 12.1.2.a-s in the Appendix replicate the previous exercise for the case of investment shock (Simulation 2). In addition, in this case estimations are not very sensitive to the elasticity coefficient, even with effects are increasing in elasticity. Extreme values register outlier values. Also in this simulation, changes in high-skilled workers performing ICT-intensive HS occupations are positive only for medium-high values of elasticities. Non-linearity emerges for tertiary-educated workers performing low-skilled occupations without ICT competences (L3) and tertiary-educated workers performing medium-skilled occupations without ICT competences (L6) at 1.6.

7 - Part 2 – A Micro-Macro integrated approach with a static CGE Model -How incentives for skilled-workers stimulate economic performance and employment levels. Evidence from a CGE analysis.

7.1 - Introduction

Developed countries have been involved since mid-1995 in an extraordinary technological change with the pervasive introduction of ICT innovations. We have already described this phenomenon in Section 6.1. In this section, we start from the main circumstances described above for an in-depth analysis of labour market incentives. The demand for skilled labour is higher compared with that for less skilled workers because of the complementarity between technology and skills in productivity performance (see Bresnahan *et al.*, 2002 and OECD, 2003). As for elementary occupations, employment has not decreased because of the polarisation effect of the ICT revolution. However, the relative decrease in labour demand led to a reduction in wages and a worsening of general working conditions with a marked decline in their labour compensation share.

As emphasised in many studies, the worsening of LS workers' wage and employment prospects has caused a decline in the living standards of poor households with the spread of social problems, such as crime and drug consumption. Moreover, people marginalised from the working sphere have experienced a deterioration in their working abilities, while binding their income prospects to social benefits and subsidies (such as unemployment benefits and poverty scheme benefits).

A possible solution for this problem is to use public resources to finance employment subsidies, in order to ensure satisfactory wages for LS workers. In this regard, the real and deep problem of the ICT revolution for low-skilled workers is not their unemployment or under-employment status in itself, as they could find easily a job if they accepted a reduced wage coherent with the reduced productivity caused by the complementarity relationship between capital and HS work. The true problem is that LS workers should find a job at a satisfactory wage higher than that ensured by the functioning of the neoclassical mechanism of LM equilibrium. In this regard, an employment subsidy could represent a possible solution, as employers could pay LS workers according to their social needs and the latter could obtain a satisfactory take-home gross wage.

Many studies have analysed the effects of employment subsidies through microeconomic and experimental techniques. In the first case, the authors implement a difference-in-difference procedure, in order to find a statistically significant difference in the employment/unemployment rate between the treated and the control group. Both groups are obtained ex post by selecting people with similar socio-demographic characteristics except for the perception of the subsidy. Experimental techniques use a similar approach, but they build ex ante the treatment and the control group. These studies succeed in capturing the effects of socio-demographic covariates, without allowing the effects of the general equilibrium conditions to be included.

In order to solve the abovementioned problem, some authors have linked the study of the macroeconomic level with the microeconomic one. More generally, there are two approaches: i) the integrated approach with the introduction of the microeconomic dimension directly into the macroeconomic model; and ii) a layered approach with two different models linked in three different forms. As for this last method, one can start from a macro shock and observe the consequences at the micro-level (Top-Down) or from a micro shock and observe the consequences at the macro level (Bottom-Up). As a third possibility, one can combine both the Top-Down and Bottom-Up methods.

In this context, an employment subsidy is constituted mainly by a reduction in labour taxes (such as the tax on the productive activities in force in Italy - i.e. IRAP), a deduction of an amount linked to the cost for low-skilled employment from corporate tax, or a cut in employers' SSCs paid for employing/hiring LS workers. Given that the micro-level generally used is represented by a household survey, the shock described above is modelled as a macroeconomic shock on labour demand defined at the macroeconomic level. Conversely, we often use the microeconomic level as a tool to evaluate the distributive and poverty consequences of the macroeconomic changes. Only a few authors have tried to estimate the individual or household-based changes in labour supply and in consumption demand, as factors acting on the macro-level.

In this context, the paper aims to adopt a layered top-down/bottom-up Micro-Macro integrated approach to study the full effects of a cut in employers' social security contributions paid for LS workers in the business sector. The shock is introduced at the macro-level, where there is a CGE model with involuntary unemployment and an upward-sloping wage-employment curve (i.e. a wage curve). We introduce both the hypotheses of an increase in the public deficit - for the whole amount of the manoeuvre - and of a full provision - represented by the increase in PIT rates in the three richest brackets.

The changes at the microeconomic level are given by the changes in wages, in employment and in the PIT brackets (in the event of full provision). These changes determine non-linear effects in terms of net wages because how the Tax and Benefit model functions. This affects the choice of participating in the labour market and the decision on how much to participate through a constrained maximisation of utility calibrated on starting data. Then, we apply the consequent change rates in the aggregated labour supply to the CGE model, in order to obtain a new general equilibrium solution. The process is replicated until the Micro-Macro coherence is obtained again.

We use the MAC-18 model calibrated on the 2014 Italian National Accounting Matrix (NAM)) released by ISTAT in 2018[30] and integrated with 2014 Input-Output tables[31], in order to increase the detail by activity. The Social Accounting Matrix (SAM) is enriched by using administrative and survey data in order to obtain a greater detail by labour type and household. The macro-level is

[30] See https://www.istat.it/it/archivio/209141 .
[31] See https://www.istat.it/it/archivio/225665 .

then linked to micro-data obtained by combining SILC 214 data integrated with other survey data, in order to obtain a clearer and more complete representation of the Italian population.

Section 7.2 reports a survey of the literature on the Micro-Macro integration. Section 7.3 is dedicated to the literature review on employment subsidies with a special focus on international experiences (Section 7.3.1). We report the results of the simulations in Section 7.4.

7.2- Literature survey on Micro-Macro integration

Colombo,2008 describes the different results between the several approaches to Micro-Macro integration. While the full-integrated approach seems unable to capture all the feedback effects because of programme shortcomings, the Top-Down/Bottom-Up layered approach seems to be the better one. However, the results depend on the variables assumed as linkage variables. Indeed, households' consumption demand appears to be more suitable than households' labour supply.

We can find an example of full-integrated model in Cockburn, 2006 and in Rutherford and Tarr, 2008. They designed two fully integrated Micro-Macro models, with 3,000 or 50,000 households respectively. The micro-model is fully Walrasian, according to a Stone-Geary consumption function.

In the layered approach, two different models, both at the macroeconomic and often sectoral level (in our case a CGE model) and at the microeconomic level (i.e. a microsimulation model), interact with the constraint to re-build the Micro-Macro consistency after the simulation. In this regard, Roy, 1951 and Neal and Rosen, 2000 established a general rule of choice between different tasks in different activities with a sector-specific and individual-based productivity. One of the main shortcomings of Roy's model is that it neglects the household dimension, within which the components of the couple choose their labour supply in order to maximise a joint utility function.

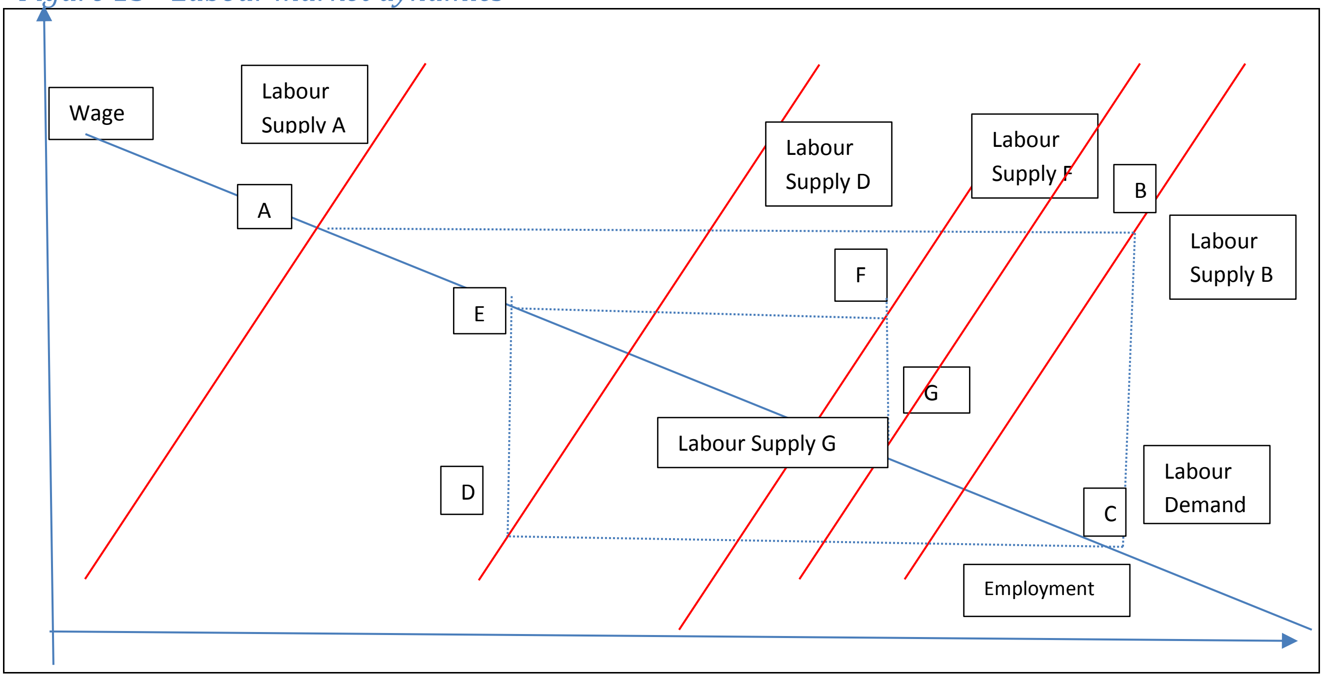
Robilliard *et al.*, 2008 tried to reconcile the employment determination at the macro level with the labour supply decisions at the micro level by studying the consequences of 1998 economic crisis in Indonesia, which produced transitions from the formal to the informal sector and (involuntary) unemployment. At the same way, Bourguignon *et al.*, 2004 and Robillard *et al.*, 2008 connected the employment statuses of household members. This literature models a rationing scheme for accessing the formal sector, and the change in aggregate employment due to a macroeconomic shock is allocated among individuals according to a probability estimated on the basis of household and individual characteristics.

Bourguignon *et. al.*, 2003 described changes in income distribution in Asia and Latin America depending on basic aggregate variables. Other applications were: (for developing countries) *1*) Boccanfuso and Savard, 2007 for Mali; *2*) Ahmed and O' Donoghue, 2008 for Pakistan; 3) Bussolo and Lay, 2006 and 2008 for Brazil and Colombia; and 4) Go *et al.*, 2010 for South Africa. As for developed countries, Peichl and Schaefer, 2009 designed a Micro-Macro approach for Germany. Moreover, Mueller, 2004 replicated the same procedure for Switzerland. Bourguignon and Savard, 2008 developed an integrated macro-micro model. Bourguignon *et al.*, 2004 suggested using panel data on employment and job mobility to calibrate a non-competitive labour market where workers either perform non-preferred jobs or would be employed at current wages; in this context, a combined mechanism of search and sorting by jobs and tasks is designed.

The Micro-Macro integration has also been analysed in a dynamic context by Bussolo *et al.,* 2010, 2011 and 2012 with reference to GIDD, a dynamic integrated model linking the micro- and macro-levels and aimed at defining the counterfactual distribution of income following changes in individual covariates including age, education, endowments, activities and of the market revenues for these endowments. Moreover, technological changes can determine an increase in the coefficients of the individual characteristics; in the same way, changes in direct taxation determine shifts in labour participation.

Peichl and Siegloch, 2011 used an integrated model for labour supply and demand in order to estimate the effects of German labour market reform. This paper does not use a CGE approach, remaining on the micro-level, but it does constitute a useful reference to the results obtained using CGE models. The paper uses an employer-employee linked administrative dataset to estimate a consistent labour demand function. An alternative method for incorporating labour demand effects in labour supply is to link CGE models with labour supply micro data[32] or models integrating demand scale restrictions via probabilities.[33] Figure 15 describes the adjustment mechanism for the labour market in an integrated approach.

Figure 15 - Labour market dynamics



Source: Author's Elaboration on Peichl and Siegloch, 2011.

[32] See Peichl.,2009.
[33] See Blundell *et al.*, 1987.

A policy reform shifts the labour supply curve from A to B. A downward-sloped labour demand curve determines the new equilibrium point (C) according to the wage elasticity. With the new lower net income, labour supply (from B to D) shifts backward. The equilibrium point moves firstly to D and then to E, so as to increase gross wages and therefore net income. The final equilibrium is at G where labour supply and labour demand curve intersect.

Loeffler *et al.*, 2014 noted that micro-estimated labour supply elasticities are lower than macro ones. This may be due to the treatment of wages during the analysis. Wages can be predicted for the full sample or only for non-workers with missing wage information. Another cause of the gap in elasticities between macro and micro-analysis is the assumption of erogeneity between the wage equation and the labour supply decision.

Franz *et al.*, 2007 and Boeters and Feil, 2008 tried to estimate the effects of changes in the universal benefit introduced by the Hartz IV package, which does not support participation to labour market either via a too high initial level or a too high withdrawal rate. The proposed reform consists in the reduction of basic benefits, but also in the decrease in the withdrawal rate. The Authors employed an integrated microsimulation – the Applied General Equilibrium (AGE) model with three imperfect substitute skill labour types (i.e. low-, medium- and high-skilled) modelled in a non-separable nested CES function. As for the demand side, the authors assume a perfectly competitive labour market for HS workers, whereas monopoly trade unions and employers' associations bargain for wages in relation to the other workers. Instead, the labour supply is the result of a maximising procedure for individually defined utility functions. The effect of the measure is specified both on the extensive margin (participating/not participating) and on the intensive margin (worked hours) and is generally higher for low skilled and for single people than for medium skilled and married women.

Boeters and Savard, 2011 reviewed options for taking into account labour market issues in CGE models. Labour could be split according to different criteria. The first to be considered are skills, qualifications or formal education, given the discussion about raising wage differentials and skill-biased technological change.

As for formal education, this split can be found in many CGE models: Dimaranan and Narayanan, 2008, Hertel *et al.*, 2008, Jomini *et al.*, 1994, Boehringer *et al.*, 2005, Boccanfuso and Savard, 2008 and Lejour *et al.*, 2006. A potential advantage of a labour split into the two standard skill types (i.e. LS and HS, with college degree, or a national analogue, such as the demarcation line) is the availability of advanced labour demand estimations. We can draw upon some established literature on the substitution possibilities between LS labour, high skilled labour and capital (e.g. Griliches, 1969, Fallon and Layard, 1975 and Krusell *et al.*, 2000). Loefgren, 2001 uses 4-skill type categories, without any substitution possibilities (the Leontief specification). Maisonnave *et al.*, 2009 have three categories, with a Cobb-Douglas specification. Models that use an empirical specification are Boeters and Feil, 2009 and MIMIC (see Graafland *et al.*, 2001).

Interestingly, in the estimations used for specifying MIMIC, capital-skill complementarity is rejected for the Netherlands.

Relative wages could change according skills and this could determine differential effects on labour markets. The second criterion is given by occupation, which can be considered as a close substitute for skill. Moreover, occupations seem a more stable criterion, because transitions from one occupation to another are less likely than those between skill levels. Data on occupations are internationally available and comparable thanks to the ILO classification and ILO databases. However, there is no clear relationship between skills and occupation (i.e. mismatch), so that a combined occupation-skill segmentation could be useful. Giesecke *et al.*, 2011 made an ambitious classification for the Vietnamese economy, which cross-classifies skills and occupations.

Some other dimensions are the following: 1) full-time and part-time labour (especially for female work), 2) formal and informal labour (especially in developing countries or in countries where there is a large share of undeclared work), 3) rural and urban labour (especially for developing countries) 4) gender (recognising the special role women play for economic development and their role in childcare and in care of elderly), and 5) ethnicity, type of household relationships (couples are characterised by a different labour supply to singles). As for the latter criterion, one could hypothesise that labour supply by the breadwinner is inflexible, differently from other members.

With reference to 1), Hutton and Ruocco, 1999 are concerned with the prevalence of part-time work among women. This motivates them to distinguish between part-time and full-time work as imperfect substitutes in production. They report no estimation results for the elasticity of substitution between these labour types and use a Cobb-Douglas structure in their model. There are some empirical works that try to determine the substitutability between workers and hours (see Hamermesh, 1993), but it has not been used in a CGE context yet.

With reference to 4), the gender decomposition was introduced to the literature by Fontana and Wood, 2000, followed by Fofana *et al.*, 2003, Fontana, 2004, Colombo, 2008 and Hendy and Zaki, 2010. As for other decomposition dimensions, the empirical foundation is a problem. Fontana and Wood, 2000 did not base their specification on empirical estimations, but argue qualitatively for relatively low elasticities to reflect the rigidity of gender roles. As those roles vary greatly across countries and in many cases also over time, deep substitution parameters are not likely to be identified using econometric techniques.

Finally, with reference to 5), Maisonnave *et al.*, 2009 use an ethnic decomposition into African, coloured, Indian and white in a model for the South African economy. In the case of Israel, Flaig *et al.*, 2011 use the ethnic/nationality categories Jewish and non-Jewish, Israeli and non-Israeli, Palestinians and foreigners. In both cases, the substitution elasticities are chosen ad hoc. Maisonnave *et al.,* 2009 assumed that substitution is not possible according to a Leontief specification. Elasticities in Flaig *et al.*, 2011 were set in relation to the GTAP skilled/unskilled substitution elasticity, based on expert judgement.

7.3- Literature survey on employment subsidies

Skill-Biased Technological Change (SBTC) plays a important role in explaining the need for employment subsidies. Phelps, 1997 identified four main channels that can explain the effects of SBTC on employment. The elements underlined by Phelps, 1997 are the lack of learning-to-learning skills of LS workers and the reduction of costs to perform a simple task after the introduction of the ICT innovation. Other aspects are the import substitution of domestic output and the increase in the long-term interest rate since 1980s, which is to be applied to investments in training. As for the lack of learning-to-learning ability, a critical variable for LS employment is represented by training costs needed to bridge the gap between requested and owned skills and is becoming higher than the increase in gross productivity. LS workers not transiting into unemployment and inactivity are concentrated in marginal and low-productivity tasks and industries with lower training costs. Moreover, the import substitution contributes to creating a higher market risk for employers who penalise the hiring of workers without a certified qualification.

In this context, capital incentives (see Phelps and Petrucci, 2000) are not the remedy, as they increase the overall labour demand as a consequence of higher investments in capital, without addressing the true challenge of increasing the labour demand for LS workers in the formal sector (see Phelps, 1997).

The higher wages of LS workers increase their productivity and prevent human skills of low-wage workers from deteriorating over the unemployment - and inactivity period. In this context, a wide and developed welfare system (Phelps, 1997) could be a negative factor because of two circumstances: i) using a significant amount of public resources with the consequent need to levy distorting taxes on productive factors; and ii) maintaining potentially productive people inactive or underutilised.

Burns, 2010 states that effectiveness of wage subsidies could be improved through a structured workplace training to improve the skills of labour market entrants and a targeting on industries more responsive to labour costs. Wage subsidies generally determine a decrease in the relative labour cost of the low-skilled workers versus skilled ones and the effect on the relative labour quantities according to the relative elasticities. The indirect effect due to positive scale effects shifts the iso-production curve upward towards an increase in both LS and MHS employment. Greater investment flows (see also Pollin *et al.*, 2006) and higher work experience gained by people benefitting from the subsidy (see Kingdon and Knight, 2004) contribute positively to labour changes, whereas the substitution of non-subsidised workers with subsidised ones (see also Aislabie, 1980) exerts a negative effects. In Burns, 2010 and also in Go *et al*, 2009 and Pauw and Edwards, 2006, the subsidisation scheme is affected by the churning effect at the end of the subsidisation period.

An interesting final remark can be made with reference to how labour- taxes and subsidies interact with Italy's context conditions. In this regard, Phelps, 2002 - in the context of the strategic 'Italy in Europe' project – noted that unemployment seem to particularly hit LS workers, although it is also not sufficiently low for the more educated workers. There could be several explanations, among them higher financing costs reducing training investments, the relatively higher 'private' and 'social' wealth (where social wealth is given by the entitlement to social benefits under the laws in force) and the increase in pay-roll tax rates and in the income tax rate. In addition, geographical issues play an important role in Italy's poor employment performance. The rent seeking to obtain capital incentives and reducing young people's labour supply in the private business sector due to high possibilities of public employment (see Bonatti, 1996) could determine distortions in, respectively, employers and employees' behaviours.

With reference to employment subsidies, the use of CGE models can allow transversal issues to be captured (see Arndt and Lewis, 2000), relating to the interaction between activities, goods and institutional sectors. We can distinguish two effects: i) the increase in expected profits with consequent higher investment; and ii) the increase in final demand determined by higher employment. Katz, 1998 evaluated the effects of wage subsidies both in the case of a flat supply curve, and in the case of an upward sloping curve.

An important issue regarding wage subsidies is given by the parameter, to which the grant is linked (i.e. the stock of employment or the change in the stock). If we have an employment subsidy, the firm receiving the subsidy does not invest and hire new recruits with the extra-profits deriving from the windfall gains. On the contrary, Heintz and Bowles, 1996 hypothesised the introduction of an explicit constraint on net increases in employment, even though the bargaining process between trade unions and employers could create a bias for increases in wages as in employment.

An important issue in analysing the effects of wage-subsidisation scheme relates to its financing. Phelps, 1994 proposed financing wage subsidies with the savings in welfare expenditures devoted to workers benefitting from the scheme. Heinz and Bowles, 1996 proposed using a tax on capital, which could further increase the price of capital relative to wages after the subsidisations.

Pauw and Leibbrandt, 2011 applied a Macro-Micro model to evaluate the overall effects of the introduction of the minimum wages in South Africa by considering both direct and indirect effects, as well as the impact on increasing job losses and prices. The Macro-Micro integrated model captures both the economy-wide and micro-level distributional effects of the minimum wages. The microsimulation model includes three main components. First, the allocation of aggregate job losses or gains observed for each activity in the CGE model among LS workers according to probabilities estimated by using a multinomial LOGIT on occupational choices (i.e. being employed in each activity and unemployed). Second, workers' wages are adjusted according the endogenous and exogenous wage changes in the CGE model. Third, the household income generation function combines all the different income sources with returns on capital and land (i.e. the gross operating surplus) adjusted to the level established by the CGE model. The authors conclude that LS employment is negatively affected by the introduction of the minimum wage and the negative effect is higher in the presence of a higher substitution elasticity.

Tiberti *et. al.*, 2018 elaborated a procedure to opportunely change microdata by households and individuals in response to an exogenous stimulus from the CGE model. Microdata include social-economic characteristics of individuals, labour market status and labour income, as well as other incomes, taxes and transfers, as well as household spending. Individuals and households choose both labour supply and consumption demand and this choice could be estimated through multinomial LOGIT regressions.

Boehringer and Rutherford, 2007 addressed the issue of Macro-Micro integration in the context of energy policy, by treating market equilibrium problems as mixed complementarity problems (MCP), and relaxing the constraints for equilibrium conditions emerging from the first-order maximisation. This approach can be used through an iterative procedure. The approach adopted in the paper can be extended to other applications, by maintaining wages and prices as fixed in the micro layer and the labour supply and consumption demand in the macro layers (Peichl, 2008).

Peichl, 2008 ran a Macro-Micro analysis to estimate the effects of a flat tax in Germany. This allows both interdependencies on different markets in terms of prices/quantities to be captured, and heterogeneity by households. Such an approach could make it possible to obtain a detailed description of the tax-benefit system.

Similar studies are those of Hutton and Ruocco, 1999 for simulations of tax reforms in Germany, France, Italy and the UK, Soerensen, 2002 using a static model for the analysis of the German tax reform of 2000, Keuschnigg and Dietz, 2003 about the corporate tax reform in Switzerland. Graafland *et al.*, 2001 and Bovenberg, 2003 used the recursive-dynamic model MIMIC to analyse the impact of tax reforms on the Dutch labour market; Boeters *et al.*, 2006 and Boeters *et al.*, 2006b and Boehringer *et al.*, 2005 used a similar approach.

Boeters *et al.*, 2005 used the Bottom-Up approach to calibrate the three representative households of a CGE model and to analyse different reform proposals for the social assistance benefit system in Germany. On the contrary, Arntz *et al.*, 2006 used the recursive Top-Down/Bottom-Up approach to analyse reform proposals designed to encourage the labour supply at the lower end of the wage distribution in Germany. Aaberge *et al.*, 2007 use an integrated Micro-Macro model of Norway to analyse the impact of population ageing on social sustainability with an endogenous labour supply. Rutherford *et al.*, 2005 applied the Macro-Micro approach to the Russian economy, in order to estimate the distributional effects of WTO accession, by using the Russian Household Budget Survey (representing 55,000 households). Finally, Hérault, 2007 used the Top-Down approach to analyse the effect of trade liberalisation on poverty in South Africa. A similar analysis was run in Boeters *et. al.*, 2006b.

Peichl, 2008 adopted a Macro-Miacro integrated model, where the microsimulation model simulates the net household incomes by taking into account working hours choices under a discrete choice approach, and by distinguishing the intensive and the extensive margin according to Blundell and McCurdy, 1999, Van Soest and Das, 2001 and Van Soest *et al.*, 2002. In this way, they estimate the household labour supply, also applying elasticity coefficients obtained in the calibration phase. The microsimulation model gives results in terms of labour supply effects, distributional effects and fiscal effects. By using a similar approach as Peichl, 2008, Peichl, 2009 estimated the loss in tax revenues and the increase in labour supply following to the introduction of a flat tax in Germany. As expected, the benefit of the PIT relief is distributed among the first and (mainly) the richest decile with small gains at the lower end cannot compensate the higher burden for the middle deciles.

Fuest *et al.*, 2007 seems to confirm the previous results for the German economy by using the FiFoSiM microsimulation model. By combining the flat tax with the basic allowance welfare increases, it increase the inequality in income distribution; the reduction in inequality through a higher basic allowance nullifies any gains in terms of efficiency. The paper describes the labour supply module. Fuest *et al.*, 2007 focused particularly on the efficiency effects of the flat tax reform which is the response of labour supply to changes in effective marginal tax rates (EMTRs). With a flat tax, EMTRs for the lowest deciles increases contrary to rates for the highest ones and this can explain that labour supply responses could differ across deciles. The authors applied a discrete choice structural household labour supply model *à la* Van Soest, 1995. The results show an increase in labour supply for single males and females and a reduction for married males, even though the responses of married women are not conclusive, due to the joint-taxation system in force in Germany.

Paulus and Peichl, 2009 proved that the flat tax scheme, by maintaining neutrality with the existing basic allowances improves labour supply incentives, even though it results in higher inequality and polarisation. The highest benefit is found in the Mediterranean countries. The authors used the EUROMOD Tax and Benefit model and only considered short-term static effects. The effects on labour supply depend on the effective marginal and average income tax rates for different groups of taxpayers.

Strauss *et al.,* 2017 used the United Nations' Global Policy model (GPM) to assess the impact of the minimum wage in South Africa. The result is an increase in the labour share with a rise in the consumption expenditure. However, investment reduces slightly due to the decrease in profit share. The GPM model is a demand-driven econometric model differently from a CGE model.

As regards the latter, McLeod, 2015 estimated a negative effect of the minimum wage by using the South African National Treasury's model. The effect is a job loss by 96,000 units (about 1 per cent of employment) and a broad economic deterioration with a reduction in GDP of 3-4 per cent in the short run and 11-15 per cent in the long-run. The same result is obtained in Pauw, 2009 and in Pauw and Leibbrandt, 2012, where LS employment is estimated to decline by 449,000 in the short run and 50,000 in the long run.

Adelzadeh and Alvillar, 2016 used a multi-activity macro-econometric model for South Africa (instead of a CGE model) linked with a full household microsimulation model capturing the dynamic linkage between the economic (also sectoral) growth and the distributional and poverty patterns. The result is an upward shift of the demand curve due to the increased overall disposable income and an outward shift of the supply curve due to an increased productivity. The activity benefitting the most seems to be manufacturing, and the net effect turns out to be positive in 85 per cent of activities. The authors did not adopt the CGE models at the macro level.

Ajwad *et al.*, 2009 analysed the effects of the 2009 economic crisis on Latvian output and employment. They found that the effects were significant but they showed a wide differentiation by activity (i.e. construction, hotels and trade) and by labour type defined by skills (with higher damages for low skilled workers). This problems needs to be addressed by using a macro-micro approach allowing the sectoral and distributional consequences of both the crisis in se and of the remedies for the crisis to be captured.

Mueller, 2004 analysed the effects of participation (also partial) and basic income, as well as low-wage subsidies in the Swiss Tax and Benefit System by using a Macro-Micro integrated model. As emphasised by the author, the integration allows two targets to be achieved simultaneously : i) treating wages as an endogenous variable; and ii) running a detailed analysis of the distribution across households and establishing behavioural rules, so that both labour supply and consumption demand can be considered endogenous. The paper overcomes the limits of the traditional impact analysis, which does not simultaneously considers the effects of both incentives/disincentives due to Tax and Benefit schemes and the need to preserve the public finance equilibrium. The author considers different scenarios with several hypotheses about the provision (VAT rate increases versus. flat income- or additional -income tax rate) and the type of intervention (i.e. basic income, participation income with a participation constraint and low wage subsidies). As a result, the basic income leads to a significant decrease in the aggregate labour supply. The authors also simulates the effects of a participation income, where the monetary benefit is linked to labour market participation.

Pauw and Edwards, 2006 used a CGE model for the South Africa economy to assess the effects of subsidies on semi- and unskilled workers, by finding a significant increase in employment although the financial costs can be high. In South Africa, wage subsidies assume an important role, with a particular reference to the 'Wage Incentive Scheme' launched in 2002[34].

Pauw, 2009 estimated the effects of a subsidy of 11 per cent of the wage on LS workers; the intensity of subsidisation reaches the 25 per cent for workers earning up to 22 per cent of the average[35]. The author uses the Standard General Equilibrium (STAGE) developed by McDonald, 2007 with an infinitively elastic supply of LS workers. In the CGE model, there is no link between

[34] The subsidy is granted to employers as a counterpart of labour taxes and social security contributions paid by them.
[35] The subsidy is modelled as a negative ad valorem tax on wages of targeted workers with a subsidisation of 12.5 per cent of total wage bill in targeted manufacturing sectors and 9.1 per cent in targeted services sectors; the subsidisation rate on total economy equals to 5.2 per cent.

people and households, as employment is only expressed in terms of labour compensation and the number of employed and unemployed people is not explicitly considered.

Pauw and Edwards, 2010 demonstrated that strongly targeted subsidies for semi-skilled and unskilled workers could be useful in the South African case, as it can increase the probability of entering the labour market, acquiring experience and thus reducing the probability of returning to unemployment. However, a targeted subsidy can create stigma-effects, as benefiting workers could be considered too unproductive to be effectively trained and employed. The authors model the subsidy by lowering the wage rate in the firm profit maximisation function, while maintaining unchanged the level of wage earned by the employee.

7.3.1 - International experiences of employment/hiring tax credits

In 1975 in the US was introduced the Earned Income Tax Credit (EITC), which was consequently modified in 1990s and 2000s. Beneficiaries are mainly couples or singles with children differently from low-skilled workers. In particular, this scheme was thought as a tool to reduce the weight of labour taxes and contributions on low-wage workers. The EITC scheme determines negative externalities on wages, whose level before the benefit is reduced. A similar scheme was introduced then In the UK as family tax credits.

In 1977 (see Hamermesh, 1993) the President Carter proposed a 4 per cent credit to employers on their OASDHI taxes with the explicit purpose of attempting to increase labour demand. OASDSHI taxes represent (still today) the payroll taxes including Old Age, Survivors, Disability and Health Insurance (OASDHI)[36]. The rate applied in 2019 for OASDHI amounts to 7.65 per cent of a maximum taxable earnings amounting to yearly $132,900.

In 1977, the United States approved the New Jobs Tax Credit (NJTC) aimed at stimulating employment after the 1973-1975 crisis and establishing a tax credit to employers equal to 50 per cent of the first $4,200 paid to a worker. Each firm could use this tax credit only if the total wage bill increases by 2 per cent y/y up to a tax credit amounting to $100,000 per year. This is a marginal non-categorical P-specific subsidy (see the Section about the simulation design) with a mixture of employment and hiring subsidy. Perloff and Wachter, 1979 (cited in Hamermesh, 1993) showed that firms using the tax credit grew more than the remaining firms (especially SMEs). Bishop, 1981 and O'Neill, 1982 (cited in Hamermesh, 1993) demonstrated that that the tax credit generated 400,00 additional jobs equal to an increase by 0.5 per cent of total employment for a total cost of USD 4.5 blns.

Bishop 1981 evaluated the effects of the NJTC, by adopting relatively low labour supply elasticity coefficients and a labour demand elasticity equal to 0.5 (see Hamermesh, 1993) Only 34 per cent of eligible firms (of which many are large firms) were estimated to know the measure and these firms were estimated to increase employment by 3 per cent with a negative effect in SMEs. However, these estimates can be biased by indigeneity issues.

[36] See https://www.ssa.gov/policy/docs/quickfacts/prog_highlights/RatesLimits2019.pdf .

According to Smith, 2006 the general assessment of the (especially untargeted) schemes is unsatisfactory compared to expectations. The NJTC scheme foresees a total cap per employers, so that large firms are not able to benefit from scale economies by hiring targeted workers; smaller firms register, instead, a lower ability to address the administrative and compliance costs. Moreover, the amount of the subsidy can result insufficient to compensate hiring and training costs of targeted workers perceived too risky (i.e. stigma effects as in Burtless, 1985).

A categorical specific piece-subsidy was established with the Targeted Jobs Tax Credit (TJTC) in 1978. Tax credits were offered to ex-criminals, persons on general assistance, Vietnam veterans and youths working under a cooperative education program. The TJTC was a 2-year scheme with a decreasing subsidisation rate (50 per cent in the first year and 25 per cent in the second one of the gross wage) up to a total amount of $6,000 per employers.

Large firms in the retail and service sectors seemed to use the TJTC scheme. Beneficiaries reached a peak of 622,000 beneficiaries (equal to 0.5 per cent of total employment in the private sector) over a eligible workers amounting to 2.076 mlns people. Disadvantaged youth beneficiaries reached the about 18 percent of eligible disadvantaged youth and the incidence in 1992 reduced to 16 per cent. Notwithstanding to the wide knowledge of the scheme by firms, only few targeted workers found a work with a reduction in hiring probabilities for targeted people vs. control groups in some cases because of a stigma effect. Targeted subsidies could have not fully satisfactory results, and the adoption of earnings ceilings could be more effective.

The same above-mentioned effects was analysed in Burtless, 1985 through a controlled experiment in Dayton in Ohio in 1980-1981. The Author identified a treatment- and a control group with the distribution of vouchers to components of the former group. Results showed a reduction in the employment rate of targeted group with an advantage for the control group.

7.4 - Simulation design and description of results

The wage subsidy has been modelled as a partial reimbursement of the social security contributions granted to employers for low-skilled employees. However, differently from Phelps, 1997, we do not use directly the wage earned, but the gender and the educational level. The subsidy is granted for the stock of low-skilled workers and no for the net hiring. Our solution is exposed to the risk that the effects on employment are limited by the use of the gain from the tax credit as a windfall gain. We assume that competition will eliminate extra-profit. Anyway, our solution has the advantage to avoid ne negative consequences of the increased turnover due to the marginal subsidy. The turnover affects negatively both the public administration, and productivity: it increases administrative difficulties by the Government and reduces the interest of firms and employees to invest in the working relationship.

As for financing, as in Phelps, 1997, we propose two financing sources: *i*) the introduction of a PIT surcharge on the richest three income brackets; *ii*) the reduction in transfers from pension- and social assistance bodies to households relative to unemployment benefits.

Differently from Phelps, 1997, we do not simulate the long-run effects of the intervention due to the increase in wealth (as cumulated savings) by low-wage workers. According the incentive wage theory, this latter factor will reduce the labour supply and, therefore, it decreases employment and increases wages. Such an effect will be captured through a dynamic CGE with a cumulating saving.

Our simulation is the reduction by 1 p.p. of the employers' social security contributions for LS employees (i.e. L1-L4 and L13-L16, all workers employed in low-skilled occupations and workers employed in medium occupation with a low-medium educational attainment and without ICT competences) and in the business sector, excluding agriculture, fishing, the public administration and the social and personal activities (i.e. activities from a4 to a53). The intervention has a cost on public finance amounting to € 1,743.72 million. The financing sources are the following:

- the reduction in transfers from the pension- and social assistance body to households as a consequence of lower unemployment and poverty benefits granted to households due to the better economic conditions for an amount of 39.45 million (equal to 0.01 per cent of payed transfers) (see Table 21);
- the increase in PIT tax rates of the three richest income brackets with a total cost of 1,704.26 million (see Table 22).

Table 21 -Financing source with transfer cut

From	To	% cut of unemployment benefits	Amount of cuts of unemployment benefits (mlns)	Baseline transfers (mln)	% cut of transfers.
EP	FAM1	-1.00%	-0.25	1,836.76	-0.01%
EP	FAM2	-1.00%	-8.97	65,911.02	-0.01%
EP	FAM3	-1.00%	-9.46	69,454.73	-0.01%
EP	FAM4	-1.00%	-20.77	152,529.71	-0.01%
EP	FAM5	0.00%	0.00	52,758.25	0.00%
EP	FAM6	0.00%	0.00	78,989.90	0.00%
			-39.45	421,480.37	-0.01%

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

Table 22 -Financing source with PIT increase

		Base PIT tax rate	Change in PIT tax rate (p.p.s)	Simulated PIT tax rate	Taxable income (mlns)	Higher PIT revenues (mlns)	Baseline PIT revenues (mlns)	% changes in PIT
r1	FAM1	0.77%	0.00%	0.77%	187.68	0	1.45	0.00%
r1	FAM2	6.47%	0.00%	6.47%	124,376.28	0	8048.36	0.00%
r1	FAM3	12.05%	0.04%	12.09%	254,275.41	111.50563	30642.51	0.36%
r1	FAM4	28.90%	0.13%	29.03%	199,362.64	267.36573	57606.66	0.46%
r1	FAM5	58.46%	1.54%	60.00%	35,134.44	540.9176	20539.38	2.63%
r1	FAM6	84.78%	1.48%	86.27%	52,855.04	784.47887	44811.64	1.75%
					666,191.49	1704.2678	161650	1.05%

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

The Table 23 shows the effects of the intervention. In the case of the absence of provision, as shown in the fifth column, the total employment increases by 0.10 per cent with an increase by 0.13/0.15 per cent for low skilled employment and female medium employed. In the case of a full provision, as shown in the seventh column, the increase in employment amounts only to 0.08 per cent with 0.10/0.12 per cent for low skilled employment and female medium employment.

Table 23 –Effects on employments of the intervention

		Baseline level	Results without provision (SIM1)		Results with provision (SIM2a)		Results with provision 2nd step (SIM2b)	
			Level	DIFF%	Level	DIFF%	Level	DIFF%
Group1	Females low-qualified	49,164	49,228	0.13105	49,212	0.09815	49,179	0.03131
Group2	Males low-qualified	76,267	76,378	0.14564	76,358	0.11950	76,242	-0.03270
Group3	Females medium-qualified	82,227	82,335	0.13174	82,309	0.10032	82,276	0.05945
Group4	Males medium-qualified	135,378	135,514	0.10003	135,480	0.07522	135,391	0.00931
Group5	Females high-qualified	77,902	77,945	0.05462	77,930	0.03518	77,937	0.04486
Group6	Males high-qualified	44,587	44,601	0.03220	44,596	0.02009	45,609	2.29312
Total		465,525	466,001	0.10228	465,885	0.07735	466,634	0.23829

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

The changes in employment obtained at the macroeconomic level can be transmitted to the microeconomic level. In the case of absence of provision, this will be mainly aimed at studying distributional and poverty consequences. The case of provision is more interesting, as the provision implies a change in PIT marginal tax rates. As shown in Table 24, we can estimate the new PIT marginal rate by using the distribution of taxable income, amounting to €537 blns of which €216 blns in the richest three richest brackets. The net PIT revenue amounts to €117 blns, of which €65 blns for the richest three brackets. The consistency between the new simulated macro-level and the micro-level is assured by increases by 0.45 p.p.s in the third bracket and 2.05 in the fifth; however the marginal tax rate in the 4th bracket decrease by 0.27 p.p.s.

Table 24- Changes of marginal PIT tax rates

Taxable income brackets	PIT tax rate	Taxable income in Micro-dataset (Euro mlns)	Number of taxpayers (1,000)	Net PIT (Euro mlns)	% change in net PIT as registered after the first stage CGE	Change in gross PIT as estimated at the Micro-level	P.P.s change in PIT marginal tax rate	New PIT tax rate
<=15,000	23.00%	94,423	11,318	8,390	0.00%	0	0.00%	23.00%
15,000< <=28,000	27.00%	226,704	10,902	44,172	0.00%	0	0.00%	27.00%
28,000< <=55,000	38.00%	149,906	4,188	40,499	0.36%	147	0.45%	38.45%
55,000< <=75,000	41.00%	27,311	433	9,353	0.46%	43	-0.27%	40.73%
>75,000	43.00%	38,455	330	15,011	2.63%	304	2.05%	45.05%
Total		536,798	27,171	117,426		495		

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

Table 25- Changes in labour supply after the CGE shocks

L1	-0.11932	FAM1	0.15076
L2	-0.06413	FAM2	0.11263
L3	1.05115	FAM3	0.07140
L4	-0.08608	FAM4	0.26710
L5	-0.04388	FAM5	0.77989
L6	1.83687	FAM6	0.94090
L7	1.93426	ROW	0.00000
L8	-0.02233	Total	0.20350
L9	-0.19419		
L10	0.09039		
L11	2.38219		
L12	2.60964		
L13	0.00437		
L14	0.00540		
L15	0.08443		
L16	0.00780		
L17	0.00983		
L18	0.08303		
L19	0.08021		
L20	0.01013		
L21	-0.00112		
L22	0.01439		
L23	0.08122		
L24	0.08971		
Total	0.20350		

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

The introduction of the new PIT tax rates and the increases in labour incomes (reducing the eligibility for social benefits and so the increase in net disposable income for MLS workers) determine an increase in labour supply by 0.20 per cent concentrated in HS employment and in households more intensive of high-income individuals (see Table 25).

Finally, the insertion of the new labour supply patterns into the macroeconomic CGE level determines, as shown in the ninth column of the Table 23, an increase in employment by 0.24 per cent with an increase in high -skilled employment by 2.29 per cent.

The introduction of the employment subsidy (see Table 26) determines an increase in GDP by 0.08 per cent in the absence of provision (SIM1) with an increase in GDP deflator by 0.19 per cent. The introduction of a full ex-ante provision (SIM2a) nullifies the GDP gain and reduces the GDP deflator increase to only 0.11 per cent. The introduction of a second step due to the microsimulation phase (SIM2b) allows obtaining a growth in GDP by 0.03 per cent with a reduction of the GDP deflator by 0.01 per cent.

As for the international performance, real exports increase by 0.02 per cent in the SIM1 scenario, which amounts to -0.03 per cent in SIM2a scenario. Exports in SIM2b scenario increase by 0.10 per cent due to the increase in labour supply at the microsimulation level. Imports follow a pattern similar to consumption (+0.13 per cent in SIM1 and +0.02 per cent in SIM2a and SIM2b).

Table 26- Percent changes in macroeconomic variables in simulations.

	Percentage change or p.p.s change if (**) without financial provision SIM1	Percentage change or p.p.s change if (**) with financial provision SIM2a	Second stage - Percentage change or p.p.s change if (**) with financial provision SIM2b
Real GDP	0.08%	-0.01%	0.03%
Nominal GDP	0.27%	0.10%	-0.07%
GDP deflator	0.19%	0.11%	-0.10%
Real private consumption	0.17%	0.01%	0.01%
Nominal private consumption	0.29%	0.08%	-0.05%
Private consumption deflator	0.12%	0.07%	-0.05%
Real GFCF	0.00%	0.00%	0.00%
Nominal GFCF	0.00%	-0.06%	-0.24%
GFCF deflator	0.00%	-0.06%	-0.24%
Real Government consumption	0.00%	0.00%	0.00%
Nominal Government consumption	0.33%	0.23%	-0.13%
Government consumption deflator	0.33%	0.23%	-0.13%
Real export	0.02%	-0.03%	0.10%
Nominal export	0.13%	0.02%	0.02%
Export deflator	0.10%	0.05%	-0.08%
Real import	0.13%	0.02%	0.02%
Nominal import	0.13%	0.02%	0.02%
Import deflator	0.00%	0.00%	0.00%
Trade balance on (nominal) GDP	0.00%	0.00%	0.00%
Real Disposable Income - Total	0.16%	0.06%	0.04%
Nominal Disposable Income - Total	0.29%	0.13%	-0.01%

Source: Our Elaborations on MAC-18 integrated by the microsimulation model.

The increase in GDP (see Table 27) is supported by the increase in consumption in SIM1 scenario (+0.17 per cent) with peaks for the FAM2 and FAM3 (respectively, +0.25 and +0.38 per cent). SIM2a and SIM2b scenarios register similar figures for FAM2 and FAM3, but the aggregate increase in consumption amounts only to 0.01 per cent. There is no high heterogeneity of households' consumption deflators among households (see Table 28) with increases by around 0.1 per cent in the case the absence of provision and 0.07 in the case of provision..

Table 27- Percent changes in real household consumptions in simulations.

		Percentage change or p.p.s change if (**) without financial provision SIM1	Percentage change or p.p.s change if (**) with financial provision SIM2a	Second stage - Percentage change or p.p.s change if (**) with financial provision SIM2b
Real private consumption		0.17%	0.01%	0.01%
	FAM1	-0.53%	-0.34%	0.20%
	FAM2	0.25%	0.19%	0.19%
	FAM3	0.38%	0.26%	0.17%
	FAM4	-0.01%	-0.01%	0.00%
	FAM5	-0.04%	-0.67%	-0.59%
	FAM6	-0.09%	-0.58%	-0.49%
	ISP	-0.26%	-0.17%	0.10%

Source: Our Elaborations on MAC-18 integrated by the microsimulation model.

Table 28- Percent changes in deflators of household consumptions in simulations.

	Percentage change or p.p.s change if (**) without financial provision SIM1	Percentage change or p.p.s change if (**) with financial provision SIM2a	Second stage - Percentage change or p.p.s change if (**) with financial provision SIM2b
Private consumption deflator	0.12%	0.07%	-0.05%
FAM1	0.13%	0.08%	-0.05%
FAM2	0.12%	0.07%	-0.06%
FAM3	0.12%	0.07%	-0.05%
FAM4	0.12%	0.07%	-0.05%
FAM5	0.12%	0.07%	-0.05%
FAM6	0.13%	0.08%	-0.05%
ISP	0.25%	0.16%	-0.09%

Source: Our Elaborations on MAC-18 integrated by the microsimulation model.

Table 29- Percent changes in real household net disposable income in simulations.

	Percentage change or p.p.s change if (**) without financial provision SIM1	Percentage change or p.p.s change if (**) with financial provision SIM2a	Second stage - Percentage change or p.p.s change if (**) with financial provision SIM2b
Real Disposable Income - Total	0.16%	0.06%	0.04%
SnF	0.31%	0.02%	-0.01%
SF	0.12%	-0.02%	0.02%
GOV	0.66%	1.28%	1.07%
EP	0.31%	0.84%	1.88%
REG	3.11%	3.25%	1.89%
PROV	0.00%	-0.04%	0.03%
COM	0.06%	0.00%	0.06%
AP	-0.09%	-0.07%	0.05%
FAM1	-0.11%	-0.08%	0.04%
FAM2	0.26%	0.20%	0.18%
FAM3	0.37%	0.25%	0.17%
FAM4	0.07%	-0.02%	0.01%
FAM5	-0.07%	-0.69%	-0.58%
FAM6	-0.12%	-0.60%	-0.47%
ISP	-0.10%	-0.07%	0.05%
ROW	0.01%	-0.05%	0.07%

Source: Our Elaborations on MAC-18 integrated by the microsimulation model.

As for the real disposable income (see Table 29), it increases by 0.16 per cent without provision (SIM1) with peaks for FAM2 and FAM3 (respectively, +0.26 and +0.37 per cent); the two richest households groups register, respectively, only an increase by 0.07 per cent and a decrease of 0.12 per cent. With provision and at the first step (SIM2a), the real disposable income increases only by 0.06 per cent with a slighter worsening for FAM2 and FAM3 (+0.20 and +0.25 per cent) and a greater one for FAM5 and FAM6 (-0.69 and -0.60 per cent, respectively) compared to SIM1 simulation. After having introduced the microsimulation response into the macroeconomic level (SIM2b), the increase in disposable income reduces to 0.04 per cent with slight worsening for

FAM2 and FAM3 (0.18 and 0.17 per cent, respectively) and a slight improvement for FAM5 and FAM6 (-0.58 and -0.47, respectively). As for the public finance, the intervention determines an improvement in Government's accounts (+0.66 per cent in SIM1, +1.28 in SIM2a and +1.07 in SIM2b) and a worsening in the balance of pension and social assistance body (-0.31 per cent, -0.84 and -1.88).

Table 30- Percent changes in labour market variables in simulations.

		Percentage change or p.p.s change if (**) without financial provision SIM1	Percentage change or p.p.s change if (**) with financial provision SIM2a	Second stage - Percentage change or p.p.s change if (**) with financial provision SIM2b
Total employment - Total		0.10%	0.08%	0.24%
	LS	0.15%	0.12%	0.03%
	MHS	0.06%	0.03%	0.44%
Real labour cost per employee - Total		0.31%	0.19%	-0.18%
	LS	0.42%	0.24%	-0.03%
	MHS	0.21%	0.13%	-0.32%
Total real labour cost - Total labour		0.42%	0.26%	0.06%
	LS	0.58%	0.37%	0.00%
	MHS	0.26%	0.17%	0.11%
Total business sector employment		0.19%	0.16%	0.36%
Real business sector labour cost per employee		0.33%	0.15%	-0.30%
Total business sector real labour cost		0.52%	0.32%	0.06%
Real wages -Total		0.57%	0.44%	0.07%
	LS	0.83%	0.69%	0.55%
	MHS	0.32%	0.20%	-0.37%
Real labour compensation -Total		0.67%	0.52%	0.31%
	LS	0.98%	0.82%	0.58%
	MHS	0.38%	0.24%	0.06%

Source: Our Elaborations on MAC-18 integrated by the microsimulation model.

As for the labour market (see Table 30), employment increases by 0.10 per cent in SIM1 with 0.15 per cent for the low-skilled employment. In SIM2a, we obtain similar results, with, respectively, 0.08 and 0.12 per cent. The macro response to micro level changes (SIM2b) determine an increase in employment by 0.24 per cent with a spike for medium-high skilled workers (+0.44 per cent).

Real wages increase by 0.57 per cent in SIM1 scenario with 0.83 per cent for LS workers. With a provision, we obtain an aggregate increase by 0.44 at the first stage (SIM2a) and only 0.07 at the second one (SIM2b). As for LS workers, real wages increase by 0.69 per cent and 0.55 per cent, respectively at the first and the second step. Very interesting is also the case of MHS workers with an increase by 0.20 per cent at the first stage and a decrease by 0.32 per cent at the second stage due to the increase in labour supply.

8 - Part 3 - A CGE evaluation of training programmes for low-skilled workers financed by a social-security contribution cut.

8.1 - Abstract

Over the last two decades, more and more pervasive technological changes have determined a structural shift in employment with a polarisation for HS- and LS workers and the hollowing-out of MS workers. ICT technological changes can indeed be qualified as capital-biased with a resulting increase in the demand for HS workers whose wages and other working conditions improved simultaneously with the increase in their supply. As for LS workers, they were hit by a decrease in their wages and a worsening in other working conditions, even though their job opportunities remained unchanged thanks to the progressive automation of MS occupations. This latter change determined a substantial worsening for these occupations both in terms of working conditions and of job opportunities (with a partial benefit for LS occupations).

In this context, Italy still does not seem fully part of the international trend, even though the economic crisis seemed to accelerate the change in patterns of production and labour demand as shown by ISTAT. Presumably, the process will exert its full effects over the next few years. Therefore, we have decided to study the effects of a comprehensive package of training programmes devoted to LS workers, who benefit from an SSC cut for employers, in order to bridge the gap between a socially acceptable wage and the wage established through the firms' profit maximisation. This policy has the benefit of supporting LS workers' upskilling and reskilling not only in the short term (i.e. by ensuring an income), but also in the medium/long term (i.e. by making them employable in the new ICT context), without hampering technological changes.

The paper aims to assess the effects of such a policy through a dynamic CGE model calibrated on the 2014 Italian social accounting matrix (SAM). The year 2014 is the latest available year for the national accounting matrix (NAM) issued by ISTAT. The use of the CGE model allows us to assess the consequences of a macroeconomic shock in a general equilibrium context, where prices and quantities are simultaneously set substantially under an assumption of utility and profit maximisation. The use of the dynamic model is necessary, as we need to assess the consequences of the changes in labour supply by skill according to different hypotheses on the effectiveness of training activities carried out by employers. Moreover, the dynamic model allows us to study the effects of the ICT innovation modelled both as an increase in the final demand for innovative commodities and as changes in the elasticity of substitution between production factors.

8.2 - Introduction

GDP growth and productivity patterns (see Section 8.3.1) depend on investment in fixed capital, but also on the skills developed by the labour force over time. The economic literature has assessed the role of endogenous growth due to learning-by-doing (see Arrow, 1962 and Nordhaus, 1969a and 1969b). There are two possible approaches to innovation. In the traditional economic models, firms operate on the efficiency frontier, so that improvements can be achieved with outward shifts of the efficiency frontier. The second possible approach is that firms operate below the efficiency curve, so that there is room for endogenous learning to improve the economic performance without exogenous changes in the frontier itself (Mc Call, 2004).

Knowledge can be considered as a positive externality of the production processes of firms (see Stiglitz and Greenwald, 2014). This can explain why the knowledge produced according to private firms' maximisation is lower than the optimal value socially requested with the subsequent need for government intervention. Externality inefficiency depends on the type of skills and on the degree of competition existing in the markets, as outlined in Pigou (1912). Skills can be divided into general versus specific skills. General skills are transferable across firms and activities and they improve the resilience of the labour force with benefits spread over the whole economic system. However, the related costs are borne only by each firm, which are therefore unwilling to produce the production of general skills. Externality inefficiency does not work for specific skills, but the latter are less useful for overall productivity. However, the latter are also less exposed to mobility risk in the context of the integrated economic system (see Stiglitz and Greenwald, 2014).

Training is needed to develop the skills of the labour force in the new context of ICT innovation and of globalisation. Innovation allows productivity and well-being to be increased with the automation of the most tedious and dangerous tasks. However, this exposes LS workers to the risk of displacement and could increase medium-paid (MP) jobs versus the hollowing-out of MS jobs. These risks are recorded by statistical data: in OECD countries there has been a decrease in the share of manufacturing by 20 per cent and an increase in services by 27 per cent over the last two decades; 14 per cent of existing jobs could disappear in the next two decades in OECD countries (see Nedelkoska and Quintini, 2018).

Statistical data in Italy show that 60.2 per cent of firms with 10 or more employees make training activities versus 76 per cent of the OECD average; moreover, there is a gap in training activities between large and small firms that amounts to 36 per cent, the highest among the OECD countries. This seems to confirm the presence of a training quantity lower than the efficient level (under-training). The component most hit by this phenomenon is that of LS workers. However, the literature does not agree on the interpretation of the low participation of LS workers, which is considered either as an efficient outcome of market functioning or as an inefficiency. However, the literature agrees on the circumstance that LS workers need more training programmes to address the challenges of ICT.

The problem of training has been addressed by the economic literature both on the demand and on the supply side. As for the demand side, in perfect competition, workers could obtain training from firms by accepting wages lower than the market levels and this gap covers the cost of the poaching externality (i.e. firms' choice to hire people already trained by other firms, instead of carrying out training activities). In imperfect competition, workers only earn a part of their productivity and this is particularly true for high productivity levels, so that their incentives to train are lower.

On the supply side, instead, firms only provide general training if their service is paid through lower wages. In imperfect competition, firms pay workers only a part of their productivity and this part is decreasing in productivity. Therefore, they should have an incentive to carry out training activities. On the other hand, the turnover possibility after training constitutes a disincentive to training workers because of opportunistic behaviours by other firms. This determines an ambiguous outcome, even though statistical data seem to prove the prevalence of the latter factor over the former (see Brunello and De Paola, 2004). In this regard, an interesting conclusion is that this outcome also depends on the labour market institutions and the same labour market reform can have different results in different contexts.

A strand of the literature on training has focused on the evaluation of the effectiveness of training in the context of active labour market policies. An interesting case study is represented by the 'Hartz' reform in Germany which introduced job-seekers' profiling and competitive mechanisms in the attribution of resources. According to Jacobi and Kluve, 2007, training policies are characterised by two negative effects: i) workers are kept out of the open labour market during training (locking-in effect); and ii) workers might not enjoy a better working position after the training. The effect under ii) can be considered both in the short and the long term, as well as both in terms of a gross impact and a net impact (i.e. not taking and taking into account the substitution effect of untrained workers). The literature is not conclusive, even though many authors do not attribute a sizeable effect to training. Martin and Grubb, 2001 remarked that only targeted interventions could be actually effective.

The economic literature evaluated the training policies through econometric techniques on survey data comparing the employment status before and after the training, both in terms of employment probability and of expected wages. Furthermore, the data do not cover the medium-long run (MLR), so that training cannot be evaluated in the context of the changing labour demand composition due to ICT innovation. Indeed this latter only shows its effects in the long run (LR). One can remark that training could be ineffective as a short-term tool for employability, but it could be effective in the MLR scenario where ICT and globalisation exert their full effects.

We have used the MAC18_DYN CGE dynamic model to assess the general-equilibrium consequences of training programmes associated with SSC cuts (see Section 8.4). In our view, SSC cuts are not only measures to support specific labour market (LM) components, but also tools to promote changes in the labour force coherent with the long-term (LT) trends. In particular, on-the-job training is devoted to LS and we hypothesised three scenarios with different effectiveness levels (low, medium and high). We ran two series of simulations, respectively for high-skilled and low-skilled workers; each series includes six simulations until the inclusion of the interaction of the change in the labour supply and the ICT innovation modelled as the change in HS work intensive commodities.

The CGE model contains a highly detailed decomposition of the labour factor by gender, occupation and formal and ICT skills. Moreover, the institutional sector of households was divided into 6 categories according to the gross income level. The dynamic condition was introduced by assuming the evolution of capital in function of investments and depreciation in the context of the convergence to the steady state. The model runs on 2014 Italian data provided by the National Accounting Matrix (NAM) issued by ISTAT (see ISTAT, 2018) integrated with data from the PIAAC/OECD database, the ITSILC/Consumers Survey by ISTAT and the SIOPE by the Ministry of Economy and the Bank of Italy, respectively with reference to the decomposition of the labour factor, of household flows and of the flows of the Public Administration.

The results of the simulations (see Section 4) generally seem to prove that both in the LS and the HS simulation, training does not appear to add a significant contribution to the growth in the real GDP determined by the cut in the SSC rates on low-skilled work. As for total employment, the marginal contribution of training is represented by 0.10 p.p.s in both the LS and the HS simulation. If the effects of ICT innovation are taken into account, the effect becomes negative, by showing that the reduction in labour demand due to ICT innovation more than offset the increase due to training. The results seem to confirm the labour-saving content of innovation in the presence of a not perfect capital-labour substitutability and rigidity on the labour market (see Vivarelli, 2013).

8.3 - Literature Review

8.3.1 - Literature Review – Learning-by-doing and human capital

Arrow, 1962 identifies the main features of the 'learning-by-doing' approach, where knowledge grows endogenously over time based on the substitution of new capital units for old ones. Each unit of capital incorporates the whole knowledge and experience accumulated at the time they are built. The main idea is that knowledge and productivity gains come from investment in physical capital, so that experience constitutes an externality with respect to the physical capital and is built up through an endogenous process.

The work of Arrow was analysed in 2014 at a conference held by Columbia University. As a result of that conference,[37] Stiglitz and Greenwald (2014) described the main features of Arrow's reasoning, i.e. that knowledge comes to a lesser extent from the allocation of resources to R&D activity and to a greater extent from a learning progress due to the consequences of production and investment. In modern economies, there has been an improvement in learning processes. There has not been one single main innovation, but a series of organisational innovations. Following Nordhaus (1969), economic development can be seen as a continuous accumulation of small changes in productive processes that are inseparable from investment. This latter can be seen as a knowledge catalyst.

In this context, we can distinguish between the traditional and the new approach to innovation. In the traditional economic models, all firms operate on the efficiency frontier, so that improvements can only be achieved through outward shifts of the efficiency frontier (which is

[37] See the 11th Annual Kenneth J. Arrow Lecture "Market Design in Large Worlds: The Example of Kidney Exchange" https://cgeg.sipa.columbia.edu/summary-11th-annual-kenneth-j-arrow-lecture https://cup.columbia.edu/book/creating-a-learning-society/9780231152143 .

exogenous). On the contrary, according to the new approach, only a small number of firms operate on the efficiency frontier, so that improvements could be achieved by reducing the distance between the best processes on the curve and the processes performed by laggard firms under the curve and this convergence is obtained through learning (see MC Call, 2004).

The approach of Stiglitz and Greenwald, 2014 can also explain the circumstance that the mobility of capital and skilled work in the new globalised and integrated economic system has not greatly affected countries' competitive advantage in some activities. Indeed, the intangible skills relating to behavioural rules among individuals and inside organisations determine advantages in 'learning by doing' and 'learning by learning' abilities. An interesting circumstance in a multi-activity and multi-commodity context is that some abilities related to a specific task in a specific activity can involve a wide number of these latter that use those tasks.

After the seminal work of Arrow, 1962, a strand of economic literature began to analyse the effects of education on GDP. More recently, Marconi and de Grip, 2015 elaborated a general equilibrium model with overlapping generations under the assumption that education increases GDP through the higher ability to learn from work experience in technology-advanced environments.

The human capital for each age and educational category is given by the number of working years weighted by the experience acquired in a technologically advanced environment. The total aggregate human capital is the sum of different groups of human capital by age and education reduced by the share of enrolments on education courses. An econometric approach was used to study the effects of formal education on GDP growth, by showing a negative response in the medium term through diminished working experience, but a positive effect in the long term by accelerating the formation of new working experience.

Albelo and Manresa, 2005 develop an endogenous growth model with human capital accumulation through external and internal learning processes calibrated on the Japanese economy. Experience is modelled as an intentional or internal phenomenon, as it contributes to developing firm-specific, non-transferable skills. The focus of the paper is on the effect of such skills in the transitional period to the steady point.

8.3.2 - Literature Review – Training programmes on the demand- and supply side.

The training problem can be analysed both on the demand- and on the supply side. As for the training demand, the lack of training depends on many factors. Some factors are the lack of motivation and the low quality of training opportunities. The other two reasons for not accessing to training are given by the time and the financial constraints (respectively, for HS and LS workers). As for the supply side, 50 per cent of firms offering training opportunities limit the access to training programmes to only 50 per cent of their employees.

On the supply side, the profit maximisation hypothesis justifies training programmes by employers focused on the most productive workers, by excluding workers with a higher risk of automation. This explains the need to encourage firms to also train workers with a higher risk of displacement and a lower return (also through targeted financial incentives) and to make the training rights portable between firms and employment statuses by breaking the link between the right to training and job tenure and the number of hours worked. Moreover, training expenditures by firms are targeted to only a limited share of employment, by excluding non-standard workers, LS workers, the older workers and the workers most exposed to the automation risk, as well as formal self-employed.

FTC and Temporary Agency workers (see Fialho, Quintini and Vandeweyer, 2019) receive less non-formal training, but more formal training than permanent workers. The reason is that formal training is of a general nature and is less likely to be employer-sponsored. Moreover, temporary workers can use a share of their work income to finance the attendance of formal training courses.

Employers decide not to train because of the following reasons: existing qualifications with sufficient or initial vocational training (apprenticeship); a preference for recruiting instead of training existing employees; the cost of training; the workload of employees having little time to training. Training participation shows a high degree of heterogeneity by activity with the lowest incidence in agriculture, accommodation and food sectors (30 per cent) and the highest in financial and insurance, education and electricity supply sectors (70 per cent of workers in training).

In order to tackle the lack of time, it is necessary to adopt flexible training options (also outside working hours), self-contained learning modules and education and training leave. To tackle financial constraints, free training programmes, and financial incentives to cover direct training costs (i.e. subsidies and tax deductions) or to cover the costs of not working (i.e. wage replacement schemes) are needed.

OECD, 2019b has econometrically estimated the socio-demographic determinants of the participation and the willingness to participate in training programmes in some OECD countries by using a PROBIT regression. The older age group (55-64 years), the risk of automation, and the inclusion of the employers in the private sector show significant and negative effects. Positive and significant effects are instead registered for education. Gender (female=1) and part-time jobs register negative and significant effects on the probability of participating in training programmes, but no significant positive effect on the willingness to participate. Firms with 11-50 employees register a negative and significant effect on the willingness to participate.

8.3.3 - Literature Review - Policy experiences

France adopted the three-year '*Emplois d'avenir*' (i.e. 'Job of the future'), supporting the hiring of low-skilled young unemployed people and covers the 75 per cent of the wage costs (paid at the minimum wage) on condition that a tutor assists new recruits (see Cahuc *et al.,* 2017). Similar measures have been introduced in Greece, Italy ('*Tirocini*' in the Youth Guarantee Scheme) and Belgium too. Closely linked to automation, the Australian Government introduced the Stronger Transition Package in 2018, in order to help workers living in regions hit by structural changes (in UK there is the National Retraining Scheme). A similar measure has also been introduced in

Austria through the Outplacement Labour Foundation (*Arbeitsstiftung*). In Estonia the 'Work and Study Programme' was launched, in order to issue a training card for the employed at high risk of unemployment linked to a training grant for employers wishing to improve the skills of their employees at risk of displacement following the introduction of new technologies (see Estonian Unemployment Insurance Fund, 2019).

On the demand side, France launched the Individual Learning Accounts[38] (ILAs) to provide resources to finance training that is portable from job to job. In this context, some degree of financial participation by employees and employers is foreseen; moreover, there is a trade-off between encouraging the use of ILAs and ensuring good quality training by limiting the list of authorised courses. In Austria, the '*Bildungskonto*' (i.e. training account) has been established for women returning from child-related career breaks, low-income employees over 50 years of age and individuals with only a compulsory education level ad no vocational credentials (i.e. immigrants studying German). A voucher-based scheme seems more effective for HS than for LS workers, less able to autonomously select the right complex training opportunity. The latter require dedicated information and counselling services. Furthermore, restricting vouchers to some workers' categories could reduce the transferable nature of the scheme.

In some cases, employers' associations created institutions aimed at developing new skills for all associated firms. This is the case of the hosiery-manufacturing in Carolina during the 1990s (OECD, 2004). The Hosiery Technological Centre (HTC) was instituted as the centre of a network of community, in order to transfer technological knowledge to the new labour force and to experienced machine technicians and operators .

In Australia in 1990s (see Gospel and Foreman, 2002), the link between productivity and labour remuneration was reinforced, especially for restructuring firms, obliged to finance training arrangements with a mandatory training programme partly financed by a national training fund in turn financed by a payroll tax of 1.5 per cent on firms with more than 8 employees. In the Australian case, a high degree of heterogeneity across activities emerged with peaks in railway transport, power generation and transmission activity, whose commitment is decreasing because of privatisation processes underway in those countries.

Moreover, training programmes are focused on informal skills (especially in small firms), which are often accompanied by ineffective off-the-job training experiences. Training in small firms includes product knowledge sessions and training concerned with the installation, maintenance and repair of specific equipment. As for the second issue, firms channel their expenses into the development of decision-making, teamwork and continuous improvement, not necessarily ensuring an increase in the quality and quantity of training wanted by the Government.

A form of demand-side scheme is provided by the Individual Learning Accounts (ILAs) under the forms of ILA-based saving schemes and of voucher entitlements to training. Under ILA-based

[38] i.e. the French reform '*Loi de 2018 pour la liberte de choisir son avenir professionel*' with the '*Compte Personel de Formation*' (CPF).

saving schemes, individuals save on a regular basis towards payment for periodic training or retraining during their working life. Voucher-type ILAs provide entitlement to access approved training courses at zero or reduced cost (as in Austria, Belgium and Scotland).

As for Italy, OECD, 2019c focused on the effectiveness of Italian training funds.[39]. Training funds in Italy were established during the 2000s and cover about one million firms and 10 million workers with annual financing amounting to €735 million in 2017. Funds are provided through a mandatory contribution of 0.3 per cent of payroll paid by firms. It is to be noted that the rate on payroll amounts to 0.8 per cent in Ireland and up to 2.5 per cent in the United Kingdom. Just after the economic crisis, the Government allocated €433 million to cover its general expenditures.

OECD, 2019c notices some inefficiencies in the use of funds, with a low share used for SMEs, LS workers, low-wage workers and older workers. Moreover, some problems come from the quality of courses provided and from complex administrative procedures to access the Funds. Firms generally allocate training resources to groups with high returns (i.e. HS and young workers), without involving a large share of LS and older workers. OECD proposed several remedies, such as grants to firms with high reimbursement rates (as in Korea), reimbursing for workers' wages during training (as in the Netherlands) and exemption and reduction in contributions paid by SMEs (as foreseen in Malaysia).

8.3.4 - Literature Review - Evaluation of training programmes

Jacobi and Kluve, 2007 evaluate the effects of the reform of PESs and of active policies in the context of the comprehensive labour market's 'Hartz' reform package. As for training, the reform addressed the issue that training had lasted too long, so that participants were kept out of the open labour market (the so-called locking-in effects). Lechner, 2000 and Caliendo *et. al.*, 2003 also proved the existence of zero or even negative post-participation treatment effects.

IZA, DIW and Infas, 2005 compared the performance of the training system before and after the reform, by establishing a severe locking-in effect (due to the worst performance of participants compared to non-participants during and shortly after the course) with presumably positive effects in the medium and long term mainly due to people otherwise remaining unemployed. In any case, the cost-benefit balance remains negative.

Oesch, 2010 used a pooled regression for 21 countries over the period 1991-2008. Investment in active labour market policies seem to contribute to LS workers' employment performance. The indicator is given by the share of active labour market policies on GDP per point of the unemployment rate: Denmark almost tripled this indicator over the period 1990-2000. Visser, 1998 and Nickel and Van Ours, 1999 demonstrated the existence of such an effect also for the Netherlands. As in Bassanini and Duval, 2006 and Martin and Grubb, 2001, employment services and individual case management increased the efficiency of job-search process and training -

[39] Namely the *Fondi Paritetici Interprofessionali per la Formazione Continua.*

associated with wage subsidies - by making workers more attractive for employers and by reducing employees' reservation wages.

OECD, 2004 notes the absence of evidence of returns on training in the context of the OECD Job Strategy. A 10 per cent increase in time spent in training determines an increase in the probability of being active by 0.4 p.p.s and a decrease in the probability of being unemployed by 0.2 p.p.s. In terms of wages, a clear impact of training can be observed for young workers and for highly educated employees. On the contrary, training for older workers and low-educated ones only allows maintaining productivity in line with market wages.

Nickell and Bell, 1996 proves that 10-30 per cent of the increase in the unemployment rate over the 1970-1980 period in G7-countries was due to the skill-biased demand shift. Over the years 1993-2002, jobs typically held by the low-educated workers decreased at a rate ranging from -15.0 per cent in the Czech Republic and to -1.3 per cent in Germany and Austria; in Spain and the Netherlands there was an increase of 1.5 per cent. An additional year in education has been associated in OECD countries with an increase in participation- and employment rates of 1.1 and 1.7 p.p.s, respectively.

According to OECD, 2004, training seems to increase the likelihood of stable income flows. Training premiums are heterogeneous with null figures in Britain and in France and particularly high figures in Portugal and in Italy, where wages increased by 5.0 and 5.6 per cent respectively one year after training.

Ragazzi, 2014 estimates the net impact of vocational training programmes in Piedmont using a Difference-in-Difference approach. The sample is given by the students attending a course one year after the end of the course (for the target group) and students leaving the programmes (for the control group). The average marginal effect of training amounts to 14.5 per cent. However, the deadweight effect proves that most of students attending the programme could also find a job without doing it.

De Koning, 2007 analysed the time series of expenditures in Active Labour Market Policies (ALMPs) by type over the 1991-2003 period in 18 OECD countries with increases in counselling and subsidies for regular jobs, but a decrease in training. On the other hand, OECD, 2004 notices the need to increase training expenditure. Brunello, 2007 does not identify a clear link between the unemployment rate and the training expenditure because of the crowding-out effect except for the case when these policies are targeted to specific groups. Wilson and Hogarth, 2003 explains the reduction in the share of training policies as the result of the lower cost-effectiveness for disadvantaged workers of training compared with shorter term policies focused on job-entry (i.e. job search with sanctions and incentives). Bjoecklund, 1991 and 1994 obtained too uncertain results to allow reliable policy conclusions.

Meager and Evans, 1998 confirms that also in Germany and in Denmark - both characterised by an higher quality and quantity - training and re-training policies often seem to increase employment and earnings only slightly. Robinson, 1995 confirms poor results from training with advantages for placement services and assistance with job search. Lange and Shackleton, 1998 underline conclusions against any type of training or ALMPs other than job search support coupled with benefit incentives and sanctions. During the 1990s, the literature assessed the few or the poor effects of large-scale broad training schemes which were effective only if targeted to specific needs and carried out in real work-places (instead of in classrooms).

Jackman, 1995 analysed the impact of the Job Training Partnership Act (JTPA) targeted to poorly educated workers with a high concentration of expenditure on a relatively small number of beneficiaries. Similar results have been assessed by Auspicos *et. al.*, 1999. The paper mentions the JobCorps programme with large and consistent benefits across a range of employment and social measures and the US Centre for Employment and Training with long-term intensive programmes. No or negative effects were found in Sweden (Bjoerklund, 1991 and 1994 and Forslund and Krueger, 1997) and mixed results in Norway. In Denmark a small statistical impact can be registered with the substantial contribution of programmes that are highly targeted, cost-effective and concentrated in a short period.

O'Connell and Mc Ginnity, 1997 orders the ALMPs according to the market orientation with the highest degree for private-sector placement with a high weight of on-the-job training vs. direct job creation and classroom-based measures. Bryson, 2008 also stressed the role of intensive measures associated with practical work experiences. Payne *et al.*, 1996 assessed that programmes devoted to the long-term unemployed has the highest effect in association with a work placement with private sector employers. Moreover, formal vocational qualification and certified training are important. Calmfors *et al.*, 2002 demonstrates that large-scale ALMP programmes in Scandinavian countries had no high efficiency in matching, whereas partial effects on LM participation were registered even if there were some displacement effects. Instead, there were no effects on wages. Small scale ALMPs should not be used as means to renew UB eligibility.

In the 2000s, more attention was paid in the literature to the build-up of consistent and wide databases. Kluve, 2006 runs a wide-ranging survey of 95 microeconomic papers about 107 ALMP measures in Europe. A significantly higher post-treatment effect emerged for high-skilled workers and women. Among the programmes examined in the paper cited, training shows a medium performance compared with subsidies and incentives. Private-sector incentives programmes, services and sanctions perform significantly better than traditional training. Programmes for adults seemed to perform better than programmes for young people.

De Koning, 2005 surveyed 130 evaluation studies corresponding to 161 measures with positive effectiveness in terms of job entry chances as incentives for job seekers. The absence of any clear conclusions on training and a very poor performance for job creation measures both emerged. Training does not seem a panacea for workers with poor effects for young people and a positive evaluation of training programmes for jobless adults can emerge only in specific group by age or other personal characteristics or according to the nature of training.

De Koning *et. al.*, 2005 confirmed the effectiveness of training programmes for older unemployed adults in the Netherlands. Bryson, 2008 stressed the circumstance that the effectiveness of training programmes cannot be evaluated in the short run and a long-term analysis is needed, as only in this way can we study the accumulation of human capital. However, there are no sufficiently long time series that provide clear and reliable conclusions. Harkman *et al.*, 1996 assessed that there was no clear impact of training programmes in Sweden 6 months after the participation to the scheme; however, effects become positive after 2.5 years on the employment rate (+1.0 p.p.s) and on wages (+1.8 per cent). Payne *et al.*, 1996 evaluated the impact on the employment rate in 3.0 p.p.s 1 year after the measure, 15.0 2 years and 22.0 3 years after participation in the scheme. Holtz *et al.*, 2000 and Kluve, 2006 emphasised the need for long-run impact and assumed a positive long-term effect that more than offset the short-term negative locking-in effect.

According to Gelderblom and De Koning, 1996 long-term effects are negligible. Hujer *et al.*, 2001 examined the German training programmes for the unemployed and showed that they do not determine significant better Labour market outcomes. Fitzenberger and Frey, 2000 focused on training in East Germany and arrived to a similar conclusion with locking-in effects not offset in the long-term. The same results can be found for the German experience in Lechner, 2000. This strand of the literature was partially changed by Bergeman *et al.*, 2004, who focused on East Germany and reached a less clear conclusion in terms of the cost and benefit balance and based on different interventions. The problems linked to training can be seen in the lack of labour demand and in the increase in unemployment due to the same training (i.e. locking-in effect). However, training could be effective if the HS deficiency is not addressed through programmes run by firms. Larsson, 2003 analysed the Swedish youth training programme and reached a negative conclusion about its effectiveness in the short-term with a small positive effect in the long-term.

The results underlined in the previous literature review could have justified the choice to reduce resources devoted to training, with benefits for job-brokering, job-search support and advice and guidance services and training expenditures provided by the Governments. The traditional training approach for a large pool of unemployed persons only seemed to function as a transitory remedy for unemployment. Only smaller-scale measures focused on particular groups and skills and linked to real work experience seem to have a positive impact. A greater effect could be achieved in association with other ALMPs. Some other polices seem to be cost-effective, such as counselling and job-search programmes (Martin and Grubb, 2001) and incentives for self-employment and for hiring subsidies, even though such measures seem to be weakened by the dead-weight and substitution effects.

The main problems in the assessment of labour market measures are the following: i) many evaluations are relative to Canada and US, where there is a precise obligation to assess the effects of the programmes differently from many European countries; ii) many labour market policies are not enough stable to allow a robust and reliable evaluation of the effects and the assessment is relative to specific programmes whose differential effect is difficult to be captured from available data; iii) many analyses are focused on the short run effects without taking into account the long-term consequences; iv) some dimensions (i.e. the social impact and the scale of programmes) are overlooked.

From Martin and Grubb, 2001 it emerges that: i) on-the-job training programmes seem to favour women re-entrants and single mother with a dubious effect on prime-age men. In this regard, these measures should meet labour market needs and, in particular, there should be a strong link with local employers. On the contrary, one should also take into account the increase in the risk of displacement; and ii) subsidies to employment seem to favour long-term unemployed persons and women re-entrants, but require a careful targeting and adequate controls, by taking into account the trade-off with the take-up by employers. The literature confirm the presence of a low net increase in employment because of high substitution- and dead-weight effects that can account for 90 per cent. With a tight targeting to the unemployed and a close monitoring of employer behaviour the net employment could reach 20-30 per cent, even though this could discourage the adhesion of firms in the measure. Moreover, targeted workers could gain worse employment and earnings prospects than non-targeted ones (i.e. stigma effects).

. Small firms are not usually interested in assessing the returns of training expenditure because of a low ownership of results. Instead, large firms tend to treat the vocational training expenditure as an annual budget decision without any detailed evaluation of its returns. In this regard, UK's and Australian firms seem to show a decreasing interest in training because of the following elements: i) the required level of skills; ii) a lack of incentives; iii) other productive priorities; iv) a tendency to hire already trained workers; and v) the lack of knowledge about the skill programmes. Remedies could be the introduction of a formal accreditation of training programme and a less burdensome administrative procedure in the context of a territorial community dimension with the commitment of both private and public entities. Another important policy is the reduction in net costs of training (especially for SMEs), as envisaged in Muehlemann *et al.*, 2005 on data from the Swiss Federal Statistical Office including 3,362 firms through a Probit-Poisson log-normal model.

8.3.5 - Literature Review - Training costs and competition

An important issue is proving if and how firms provide for on-the-job training programmes and how much of the related costs they bear. Pigou, 1912 argued that in perfectly competitive markets firms have no incentives to invest in general employees' skills, but only in specific skills. However, only general skills allow an effective improvement in employees' knowledge and, therefore, in productivity levels at the aggregate or sectoral level.[40]. Bellett, 1998 emphasises the divergence in the objectives pursued by the Government and by firms and related to training programmes: maintaining and developing, as well as making workforce skills more resilient versus securing the highest returns on training expenditure depending on firm's size, activity and location.

[40] Berrett and o'Connell, 2001 proves that productivity is function of general competences rather than specific ones.

In 1964, Becker, reached a different conclusion by arguing that in perfectly competitive markets the employees themselves are interested in developing their general skills. Therefore, employees will pay for training either through direct fees, or through reduced wages. In this way, on-the-job training programmes would only be limited by the credit constraints needed to help workers to bridge the gap between the existing situation with low wages and productivity and the new condition with higher wages and productivity. Specific skills are developed autonomously by firms, as these skills could not be used by other employers. This theoretical approach constituted the guidelines for policies adopted from the 1960s to the1980s, promoting apprenticeship contracts with a reduced wage for apprentices.

Acemoglu and Pischke, 1999 advocated for a partial correction of Becker, 1964: i) specific skills have a relevant content of general skills and there are only few skills related to technologies or practices solely used by the specific firm; ii) under-training by employees is not only the consequence of credit constraints due to financial markets imperfections, but also of labour market imperfections (as unionisation and wage bargaining, efficiency wages and asymmetric information), which squeeze wages below productivity; iii) the same labour market imperfections could justify investments in general training by employers, who can gain the difference between the after-training productivity and wages; iv) the labour market institutions matter and interact with training decisions through the channel of turnover.

As for point iii), the compressed wage structure (characterising the imperfect labour market) could make it profitable for other employers to acquire workers already trained by other employers (the so-called ‘poaching’ phenomenon). In this regard, Loewenstein and Spletzer, 1998 proves that the after-training wages offered by the current employer are lower than the wages offered by other employers, even though wages are lower than productivity. Moreover Brunello and De Paola, 2004 estanlishes that: a) firms provide and pay for general training; b) the provision of skills encourages labour turnover by employees especially in dense industrial areas with a strong industrial specialisation[41]. In the market, the maximisation process can lead to the circumstance that low-skilled workers could receive a lower efficient level of training. A significant and positive relationship between the employer-provided training and the turnover seems to exist with only one case of a negative and significant coefficient (i.e. training strengthens the work relationship).

Furthermore, according to Bardeleben *et al.*, 1995 large German firms bear a positive net variable cost by employing apprentices. A similar scheme was also established in US with the temporary help firm, where a firms hires trainees temporarily at a lower wage and offers them on-the-job training and courses (Krueger, 1993 and Autor *et al.*, 1998). Contra, Bishop, 1996 and Barron *et. al.*, 1997 prove that employees do no bear a wage cut for training, as employers do for (also general) training.

[41] Even though, in these areas there could be positive pooling externalities due to the accumulation and the strengthening of innovation.

As for point iv), we should note that firing costs work differently in the US and in the German labour market. In the former country, workers do not learn industry-specific skills during apprenticeships, so that high firing costs will block workers in low-value work relationships. In the US, the low wage compression makes the perfect competition hypothesis more probable. In Germany, instead, the presence of imperfect competition conditions makes it profitable to develop firm-specific skills for employees and so a tight labour market regulation allows apprentices to enter a long-lasting skill-intensive work experience (see Acemoglu and Pischke, 1998b and 1998c).

OECD, 2003 calls for co-financing schemes (joint financing by employers, employees and governments), in order to minimise the deadweight losses from training, due to the difference between the marginal expected benefits and costs. 'Train and Pay' levy/grant schemes overpay the increase in training investment. A co-financing scheme by employees and employers would allow controls on training quality to be introduced and would limit the cost for the public budget. A good solution could be training consortia pooling together resources from different firms. In Korea joint training SMEs centres of competences were established in 2001. These elements reduce employers' market power and the results in training negotiations in terms of quality and coverage of training programmes (see Bjornavold, 2003 and OECD, , in order to reflect the skill needs of partners enterprises and guarantee the portability and the standardisation 2003b). The Government could increase training supply incentives by firms by introducing corporate tax deductions financed through a specific corporate levy and covering less the total costs of training.

8.4 - Description of results

We have run two series of simulations: i) one is focused on LS workers (LS_Sim), ii) the other is focused on HS workers (HS_Sim). LS workers are considered workers included in L1-to-L4 (males) and L13-to-L16 (females) labour types. HS workers are considered workers belong to L9-to-L12 (males) and L21-to-L24 (females) labour types.

Preliminary, we shall underline that the model evaluates the financing of the effects of the decrease in Employers' Social Security Contribution rates both in the context of the CGE model, and by using a micro-simulation model. From the CGE point of view, the increase in marginal PIT rates of the four richest households types (FAM3 to FAM6) determines - under an hypothesis of utility maximisation by both individuals and couples - a reduction in hours worked and an increase in leisure by individuals. As for couples, effects are more complex, as in this case, the maximisation of the combined utility is considered, probably with the increase in the marginal tax rate and the reduction in hours worked by the bread-winner and a partial balance by second-earners.

The chapter takes into account the learning-on job-hypothesis. In this context, the decrease in SSC rate for LS workers should not be seen a mere assistance measure for this work category disadvantaged by the ICT-SBTC. A the same time, this is not only a measure to delay the implementation of the ICT innovation. Conversely, a SSC rate reduction represents a measure that actually increases resource productivity. Indeed, granting SSC cuts for LS workers is analysed as a tool to improve their skill, in order to maintain workers with an substitution risk due to automation linked to the employment. The expected effect of LS workers' recruitment is that they acquire the new cognitive and soft skills needed to improve their employment status by one degree: i) from workers not using computers at work to workers using computer at work (from L1 to L2 for LS workers, from L4 to L5 for MS workers and from L3 to L6 for HS workers employed in LS occupations); ii) from MLS workers using computer at work to HS workers using computers (from L2 to L3); iii) the transition from LS- to MS occupations for HS workers (from L3 to L6).

It is critical how to identify the pool of LS unemployed eligible for the training. We assume in the paper that this pool is the result of the difference between the LS employment obtained in the case of the simulation of the SSC rate for LS workers and the level obtained through the reduction in the case of the reduction in SSC rate of HS workers. The rationale of this choice is that the LS employment levels obtained in the both simulations in response to a similar shock and financed in a similar manner can produce outcomes representing the extremes of a confidence interval around the baseline. This can mimic the consequences of ICT innovation.

Moreover, the paper attempts to model the ICT innovation as a general process increasing the productivity of capital and of the high-skilled work on the supply side and increased the demand for commodities highly intensive in high-skilled work on the demand side.

As for the supply, the CES production function used in the model has been modified by multiplying the physical quantities by a coefficient greater than 1 according the following formula:

$$Y = [\alpha_K{}^{1-\Upsilon} \cdot (\beta_K \cdot K)^{\Upsilon} + \alpha_{LS}{}^{1-\Upsilon} \cdot (L_{LS})^{\Upsilon} + \alpha_{MS}{}^{1-\Upsilon} \cdot (L_{MS})^{\Upsilon} + \alpha_{HS}{}^{1-\Upsilon} \cdot (\beta_{HS} \cdot L_{HS})^{\Upsilon}]^{\frac{1}{\Upsilon}} \text{ (EQ66);}$$

where the output Y is a CES production function with elasticity of substitution $\frac{1}{\Upsilon-1}$. The productive factors are the following: the capital and the three labour types L_{LS}, L_{MS} and L_{HS} for, respectively LS, MS and HS workers.

By maximising the profit function taking into account (EQ47) and substituting equations in the cost function, we obtain the equation of the minimum cost:

$$p = [\ \alpha_K \cdot (r/\beta_K)^{\frac{\Upsilon}{\Upsilon-1}} + \ \alpha_{LS} \cdot (w_{LS}/\beta_{LS})^{\frac{\Upsilon}{\Upsilon-1}} + \alpha_{MS} \ \cdot (w_{MS}/\beta_{MS})^{\frac{\Upsilon}{\Upsilon-1}} + \alpha_{HS} \ \cdot (w_{HS}/\beta_{HS})^{\frac{\Upsilon}{\Upsilon-1}}]^{\frac{\Upsilon-1}{\Upsilon}}$$

(EQ68),

where the unitary price of the output p is given by a CES function both of the cost of capital r and of wages by work type w_{LS}, w_{MS} and w_{HS}.

As shown in the two previous equations, the introduction of the coefficients β_K and β_{HS} increases the output quantity and decreases the output prices other things being equal.

As for the demand side, commodities have been ordered according the relative content of HS work and the first 20 commodities out of 63 have been considered with an incidence of HS work of 34.8 per cent and more (see Table 31).

Table 31 - Content in skill of commodities

		LOW	MEDIUM	HIGH	ORD	HIGH_ dummy
CPA_A01 - Products of agriculture, hunting and related services	g1	0.78515	0.18337	0.03147	52	0
CPA_A02 - Products of forestry, logging and related services	g2	0.65986	0.34014	0.00000	53	0
CPA_A03 - Fish and other fishing products; aquaculture products; support services to fishing	g3	0.40379	0.59621	0.00000	54	0
CPA_B - Mining and quarrying	g4	0.32376	0.00000	0.67624	2	1
CPA_C10-12 - Food, beverages and tobacco products	g5	0.30906	0.50746	0.18348	29	0
CPA_C13-15 - Textiles, wearing apparel, leather and related products	g6	0.62419	0.31029	0.06552	50	0
CPA_C16 - Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	g7	0.30080	0.69920	0.00000	55	0
CPA_C17 - Paper and paper products	g8	0.84045	0.07840	0.08116	47	0
CPA_C18 - Printing and recording services	g9	0.00000	1.00000	0.00000	56	0
CPA_C19 - Coke and refined petroleum products	g10	0.33350	0.66650	0.00000	57	0
CPA_C20 - Chemicals and chemical products	g11	0.45054	0.39018	0.15928	33	0
CPA_C21 - Basic pharmaceutical products and pharmaceutical preparations	g12	0.24443	0.37276	0.38280	16	1
CPA_C22 - Rubber and plastic products	g13	0.49304	0.39184	0.11513	42	0
CPA_C23 - Other non-metallic mineral products	g14	0.31161	0.61672	0.07166	49	0
CPA_C24 - Basic metals	g15	0.26155	0.58067	0.15779	34	0
CPA_C25 - Fabricated metal products, except machinery and equip.	g16	0.28818	0.62206	0.08976	45	0
CPA_C26 - Computer, electronic and optical products	g17	0.40161	0.41341	0.18498	28	0
CPA_C27 - Electrical equipment	g18	0.28163	0.48641	0.23196	26	0
CPA_C28 - Machinery and equipment n.e.c.	g19	0.29596	0.57549	0.12856	38	0
CPA_C29 - Motor vehicles, trailers and semi-trailers	g20	0.34423	0.52005	0.13572	36	0
CPA_C30 - Other transport equipment	g21	0.38547	0.45497	0.15956	32	0
CPA_C31_32 - Furniture and other manufactured goods	g22	0.39512	0.49679	0.10809	43	0
CPA_C33 - Repair and installation services of machinery and equip.	g23	0.00000	1.00000	0.00000	58	0
CPA_D - Electricity, gas, steam and air conditioning	g24	0.09401	0.66298	0.24302	25	0
CPA_E36 - Natural water; water treatment and supply services	g25	0.08353	0.82924	0.08723	46	0
CPA_E37-39 - Sewerage services; sewage sludge; waste collection, treatment and disposal services; materials recovery services; remediation services and other waste management services	g26	0.66001	0.09519	0.24480	24	0
CPA_F - Constructions and construction works	g27	0.38712	0.48658	0.12631	39	0
CPA_G45 - Wholesale and retail trade and repair services of motor vehicles and motorcycles	g28	0.19339	0.69085	0.11576	41	0
CPA_G46 - Wholesale trade services, except of motor vehicles and motorcycles	g29	0.32546	0.55069	0.12385	40	0
CPA_G47 - Retail trade services, except of motor vehicles and motorc.	g30	0.08599	0.78157	0.13245	37	0
CPA_H49 - Land transport services and transport services via pipelines	g31	0.61032	0.28666	0.10302	44	0
CPA_H50 - Water transport services	g32	0.50433	0.24042	0.25525	23	0
CPA_H51 - Air transport services	g33	0.22113	0.32013	0.45874	10	1
CPA_H52 - Warehousing and support services for transportation	g34	0.47155	0.34704	0.18141	31	0
CPA_H53 - Postal and courier services	g35	0.14244	0.85756	0.00000	59	0
CPA_I - Accommodation and food services	g36	0.16490	0.79762	0.03748	51	0
CPA_J58 - Publishing services	g37	0.00000	0.62209	0.37791	17	1
CPA_J59_60 - Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services	g38	0.16437	0.49422	0.34141	21	1
CPA_J61 - Telecommunications services	g39	0.05480	0.54097	0.40423	14	1
CPA_J62_63 - Computer programming, consultancy and related services; Information services	g40	0.07717	0.48770	0.43513	12	1
CPA_K64 - Financial services, except insurance and pension funding	g41	0.03970	0.46142	0.49887	6	1
CPA_K65 - Insurance, reinsurance and pension funding services, except compulsory social security	g42	0.00000	0.53339	0.46661	8	1
CPA_K66 - Services auxiliary to financial services and insurance services	g43	0.00000	1.00000	0.00000	60	0
CPA_L68B - Real estate services excluding imputed rents	g44	0.00000	0.68984	0.31016	22	1
CPA_M69_70 - Legal and accounting services; services of head offices; management consultancy services	g45	0.00000	0.52974	0.47026	7	1
CPA_M71 - Architectural and engineering services; technical testing and analysis services	g46	0.13712	0.47383	0.38906	15	1
CPA_M72 - Scientific research and development services	g47	0.00000	0.49444	0.50556	5	1

CPA_M73 - Advertising and market research services	g48	0.11410	0.11761	0.76829	1	1
CPA_M74_75 - Other professional, scientific and technical services and veterinary services	g49	0.00000	0.65164	0.34836	20	1
CPA_N77 - Rental and leasing services	g50	0.32161	0.32718	0.35122	18	1
CPA_N78 - Employment services	g51	0.32161	0.32718	0.35122	19	1
CPA_N79 - Travel agency, tour operator and other reservation services and related services	g52	0.10583	0.68586	0.20830	27	0
CPA_N80-82 - Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services	g53	0.48453	0.33210	0.18337	30	0
CPA_O - Public administration and defence services; compulsory social security services	g54	0.17934	0.41067	0.41000	13	1
CPA_P - Education services	g55	0.33385	0.14258	0.52357	4	1
CPA_Q86 - Human health services	g56	0.25788	0.28464	0.45748	11	1
CPA_Q87_88 - Residential care services; social work services without accommodation	g57	0.26305	0.59592	0.14103	35	0
CPA_R90-92 - Creative, arts, entertainment, library, archive, museum, other cultural services; gambling and betting services	g58	0.00000	0.33117	0.66883	3	1
CPA_R93 - Sporting services and amusement and recreation services	g59	0.37870	0.62130	0.00000	61	0
CPA_S94 - Services furnished by membership organisations	g60	0.09172	0.44679	0.46149	9	1
CPA_S95 - Repair services of computers and personal and household goods	g61	0.00000	1.00000	0.00000	62	0
CPA_S96 - Other personal services	g62	0.16748	0.83252	0.00000	63	0
CPA_T - Services of households as employers; undifferentiated goods and services produced by households for own use	g63	0.28198	0.63717	0.08085	48	0
TOT		**0.26944**	**0.46744**	**0.26312**		

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

The parameters of module of ICT technological change have been calibrated in the way to assure an invariant GDP with a mere substitution effect from LS- and MS skilled workers to HS work and capital.

Each series includes 6 different simulations defined by the following shocks:

a. the decrease by 1 percentage point in the employers' SSC rates financed through a partial decrease in social transfers for unemployment benefits (only at a less extent) and an increase in the marginal PIT tax rates levied on the FAM4-to-FAM6 household categories with a PIT tax base of households' earning components amounting to €26,000 and more per year (SIM1LS or SIM1HS, according if LS or HS workers are involved);
b. the decrease in labour supply generated at the micro-economic level as the response of individuals/couples to the new Tax-and-Benefit system determined by the increase in the marginal PIT tax rates (SIM2LS or SIM2HS);
c. the change of the composition of labour supply by work type, by assuming a low effectiveness of the training programme with a success rate of 10 per cent of the eligible pool (SIMTRAIN_LE_LS or SIMTRAIN_LE_HS);
d. the change of the composition of labour supply by work type, by assuming a medium effectiveness of the training programme with a success rate of 50 per cent of the eligible pool (SIMTRAIN_LS or SIMTRAIN_HS);
e. the change of the composition of labour supply by work type by assuming an high effectiveness of the training programme with a success rate of 90 per cent of the eligible pool (SIMTRAIN_HE_LS or SIMTRAIN_HE_HS);

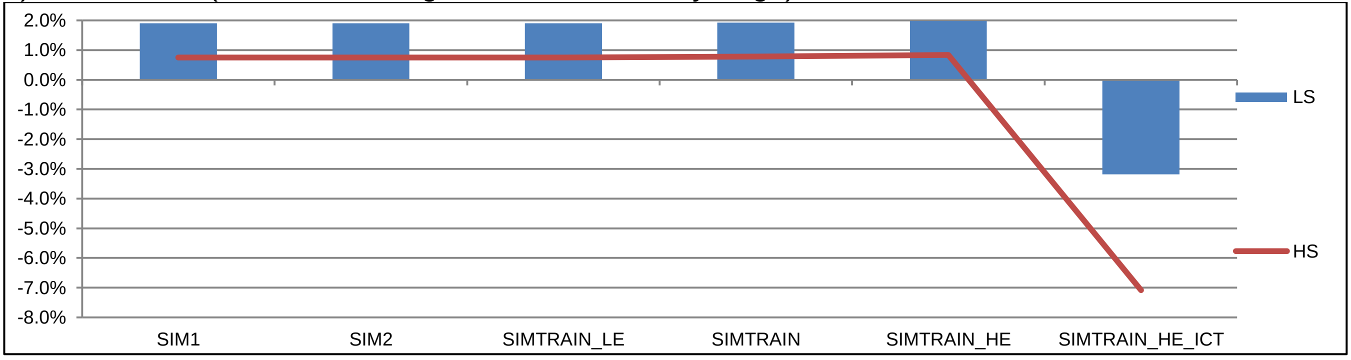
f. the introduction of the ICT development modelled as the increase in the final demand for the commodities highly intensive in HS employment (SIMTRAIN_HE_ICT_LS or SIMTRAIN_HE_ICT_HS).

Figures 16-a)-d) show the effects of the simulations on social security contributions. As for employment, as approximated by the gross labour income at base year' wage, we register at the fifth year of simulation an increase by 2.0 per cent in the case of the reduction of SSC rate for LS workers (SIM1LS_LS), which drops to -3.2 per cent if the effects of ICT innovation are taken into account (SIMTRAIN_HE_ICT_LS). This confirms that ICT innovation is capital-biased, by affecting negatively employment and increasing productivity levels. The corresponding figures for the cases of the HS simulation are 1.0 in SIM1LS_HS and -7.1 per cent in SIMTRAIN_HE_ICT_HS. As for this latter simulation, the effect on LS employment is higher with the HS than on the LS simulation. The cut on LS workers' SSC rates contributes to limit the effects of ICT innovation, which are exacerbated in the case of the cut of HS workers' SSC rates. LS workers constitute still a relevant component in the Italian employment structure (see Figure 14-a).

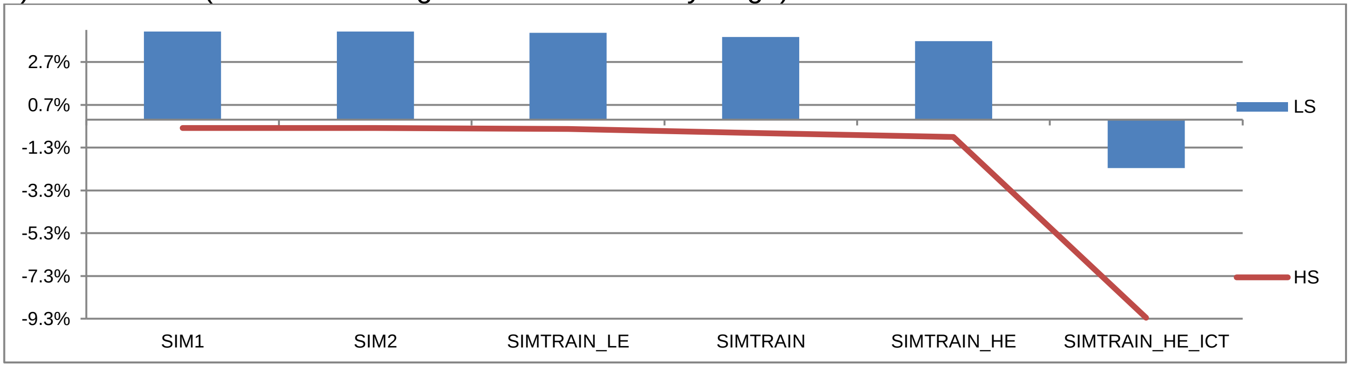
As for LS employment, we register an increase by 3.8 per cent in the case of the reduction of SSC rate for LS workers (SIM1LS_LS), which decreases to 3.3 per cent in the case of the HS performing training policy (SIMTRAIN_HE_LS) and -2.3 per cent if the effects of ICT innovation are taken into account (SIMTRAIN_HE_ICT_LS). As the HS simulation, LS employment increases by 0.1 per cent in SIM1LS_HS with an invariance in the case of SIMTRAIN_LE_HS; it registers a reduction by 0.6 per cent. The decrease in LS employment achieves the level of 9.3 per cent , which confirms what before described.

Figure 16 - Percentage changes in simulation vs. benchmark trend for LS, MS and HS workers.

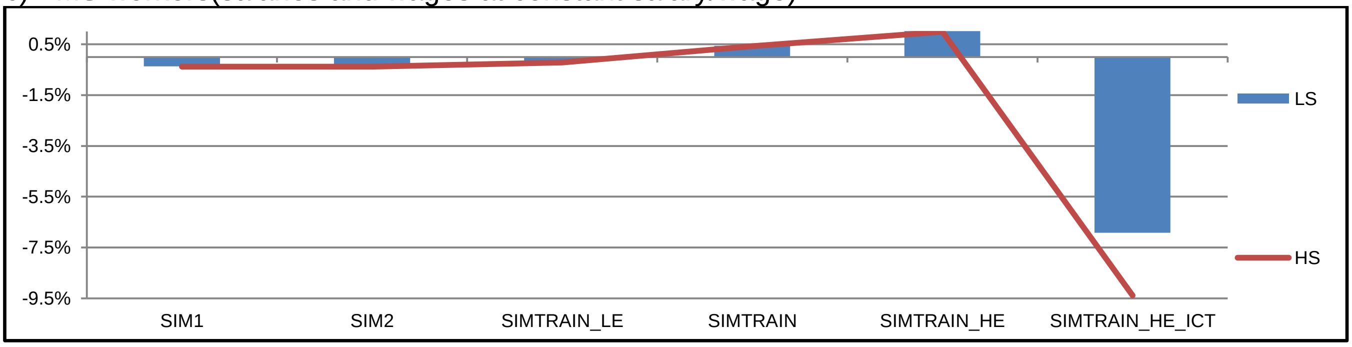
a) - All workers (salaries and wages at constant salary/wage)



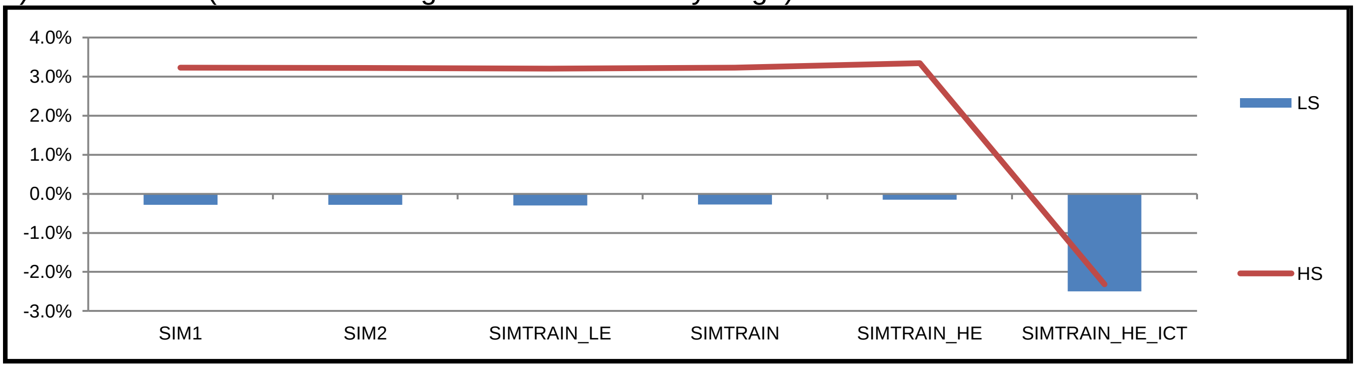
b) - LS workers(salaries and wages at constant salary/wage)



c) - MS workers(salaries and wages at constant salary/wage)



d) - HS workers(salaries and wages at constant salary/wage)



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

MS employment (see Figure 14-c)) we register an increase by 0.1 per cent in the case of the reduction of SSC rate for LS (SIM1LS_LS), which increases to 1.3 per cent in the case of the HS performing training policy (SIMTRAIN_HE_LS). The effect achieves -6.9 per cent is also the effects of ICT innovation SIMTRAIN_HE_ICT_LS) are taken into account. The HS simulation does not change the before described pattern, with the exception of ICT effects (-9.4 per cent). MS work increases in consequence of the training, as a share of LS workers acquires new skills and reaches MS workers. The ICT innovation shows a negative differential effect on MS workers amounting to -2.5 p.p.s.

As for HS employment, we register an increase by 3.0 per cent in the case of the reduction of SSC rate for HS workers (SIM1LS_HS), which remains unchanged in the case of the high-performing training policy (SIMTRAIN_HE_HS) and drops -2.3 per cent if the effects of ICT innovation are taken into account (SIMTRAIN_HE_ICT_LS). The corresponding figures for the cases of the LS simulation are 0.2 in SIM1LS_LS, 0.3 in SIMTRAIN_HE_LS and -2.5 per cent in SIMTRAIN_HE_ICT_LS (see Figure 14-d). Two circumstances emerge: i) ICT innovation affects negatively HS employment less than MLS ones; ii) the combined effect of HS SSC rate cut ICT innovation is not relevantly different of that one of LS SSC rate cut and innovation.

The LS simulation (SIM1LS) (see Table 32) determines an increase in GDP by 0.1 per cent in the case of the decrease in employers' social security contributions by 1.0 p.p. for LS workers with and without the changes in labour supply (as a consequence of the microeconomic response in SIM2LS). The upskilling of LS workers with a low effectiveness (SIMTRAIN_HE_LS) does not add a significant amount at the fifth time of simulation. The ICT innovation (SIMTRAIN_HE_ICT_LS) adds 12.1 p.p.s of growth.

Table 32 – Percentage changes in macroeconomic variables in simulations.

	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Real GDP	0.15	0.15	0.15	0.16	0.17	12.28	0.09	0.09	0.09	0.10	0.12	12.28
Nominal GDP	0.15	0.15	0.14	0.16	0.25	-1.62	0.23	0.23	0.22	0.23	0.32	-1.62
GDP deflator	0.00	0.00	-0.01	-0.00	0.07	-12.38	0.14	0.14	0.12	0.13	0.20	-12.38
Real private consumption	-0.03	-0.03	-0.04	-0.04	-0.04	0.34	-0.03	-0.03	-0.04	-0.04	-0.04	0.34
Nominal private consumption	-0.45	-0.45	-0.46	-0.45	-0.38	-10.38	-0.36	-0.36	-0.37	-0.35	-0.29	-10.38
Private consumption deflator	-0.42	-0.42	-0.42	-0.40	-0.33	-10.68	-0.32	-0.32	-0.33	-0.31	-0.24	-10.68
Real GFCF	-0.02	-0.02	-0.04	0.08	0.38	45.52	-0.06	-0.06	-0.08	0.02	0.30	45.52
Nominal GFCF	-0.74	-0.74	-0.78	-0.68	-0.34	30.19	-0.59	-0.59	-0.63	-0.55	-0.23	30.19
GFCF deflator	-0.72	-0.72	-0.74	-0.76	-0.71	-10.53	-0.53	-0.53	-0.55	-0.57	-0.53	-10.53
Real Government consumption	4.60	4.60	4.60	4.60	4.60	6.50	4.62	4.62	4.62	4.62	4.62	6.50
Nominal Government consumption	4.53	4.53	4.51	4.50	4.55	-6.43	4.47	4.47	4.45	4.44	4.49	-6.43
Government consumption deflator	-0.07	-0.07	-0.08	-0.09	-0.04	-12.14	-0.15	-0.15	-0.16	-0.17	-0.13	-12.14
Real export	0.61	0.61	0.62	0.61	0.55	8.76	0.40	0.40	0.41	0.40	0.35	8.76
Nominal export	-0.00	-0.00	-0.00	-0.00	-0.00	0.12	-0.00	-0.00	-0.00	-0.00	-0.00	0.12
Export deflator	-0.61	-0.61	-0.61	-0.61	-0.55	-7.94	-0.40	-0.40	-0.41	-0.40	-0.35	-7.94
Real import	-0.11	-0.11	-0.12	-0.09	0.03	-0.41	-0.11	-0.11	-0.13	-0.10	0.01	-0.41
Nominal import	-0.11	-0.11	-0.12	-0.09	0.03	-0.41	-0.11	-0.11	-0.13	-0.10	0.01	-0.41
Import deflator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trade balance on (nominal)GDP	0.03	0.03	0.03	0.03	-0.00	0.13	0.03	0.03	0.04	0.03	0.00	0.13

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

The HS simulation (SIM1HS) determines an increase in GDP by 0.1 per cent in the case of the decrease in employers' social security contributions by 1 p.p. for LS workers with and without the changes in labour supply (because of the microeconomic response in SIM2HS). The upskilling of LS workers with an high effectiveness (SIMTRAIN_HE_HS) does not add a significant amount at the fifth time of simulation. The ICT innovation (SIMTRAIN_HE_ICT_HS) adds still 12.2 p.p.s. This implies that the conjunction of the cut in employers' SSCs for HS workers does not relevantly strengthen the effects of ICT innovation in terms of GDP.

The figures relative to the real GDP growth are explained by the trend of prices. As for the GDP deflator, the low-effective training in the case of LS simulation (SIMTRAIN_LE_LS) maintain it unchanged with an increase by 0.1 per cent in the case of high-effective training (SIMTRAIN_HE_LS); and a decrease by 12.4 per cent the ICT innovation (SIMTRAIN_HE_ICT_LS). As for the HS simulation, the GDP deflator increases by 0.1 per cent in all simulation with the exception of the high-effective training (SIMTRAIN_LE_HS) with 0.2. By taking into account innovation (SIMTRAIN_HE_ICT_HS), the deflator decreases still by 12.4 per cent.

The relatively low growth in GDP is also the consequence of the substantial invariance decrease real private consumption. ICT innovation adds about 0.3 p.p.s in both the LS- and HS simulations (SIMTRAIN_HE_ICT_HS and SIMTRAIN_HE_ICT_HS, respectively). The consumption deflator shows a reduction by 0.4 per cent in the case of LS simulation; ICT innovation adds 10.0 p.p.s compared to the simulation SIMTRAIN_HE_LS. In the case of HS simulation the consumption deflator decreases by 0.3 per cent, which becomes -0.2 in SIMTRAIN_LE_HS. The ICT innovation contribution achieves 10.1 p.p.s.

As for real investment, it is not changed following to the LS simulation without and with the micro-response, and reaches 0.1 per cent in the case of low-effective training. Increases in the effectiveness of training determines an increase by 0.3 per cent . In the case of HS simulation, the real investment demand decreases by 0.1 per cent, which becomes null in the case of low-effective training. The increase in effectiveness of training determines an increase by 0.3 p.p.s. In the case of ICT innovation real investment increases by 45.5 per cent in both the LS- and HS simulations, by showing the capital-bias of such an innovation substituting employment. The real Government expenditure increases in all scenario by 4.6 per cent with additional 1.9 p.p.s due to ICT innovation.

The real export increases by 0.6 per cent in the case of decrease in SSC contribution for LS workers SIM1LS, and becomes 5.1 in SIMTRAIN_HE_ICT_LS. In the HS simulation the increase in export due to lower SSC rates in SIM1HS amounts to 0.4 per cent, which increases to 5.1 in SIMTRAIN_HE_HS. Real and nominal imports decrease by 0.1 per cent in all the simulation without ICT, which has a marginal contribution amounting to 0.4. Therefore, the balance of trade on GDP does not change substantially, with an improvement by 0.1 p.p.s due to ICT.

We could also analyse the effects on the real private consumption by households and non-profit organisations (NPISH) (see Table 33). In the case of the cut of SSC rate of LS workers the benefit in increasing up to FAM2 to FAM5 by reaching an increase by 6.1 per cent, reduced to 6.0 for FAM1 and FAM6 (SIM1LS).

Table 33 - Percentage changes in real consumption by household type and NPISH in simulations.

Real private consumption	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
FAM1	5.97	5.97	5.96	5.96	5.96	6.37	5.96	5.96	5.96	5.95	5.95	6.37
FAM2	6.08	6.08	6.07	6.07	6.07	6.47	6.08	6.08	6.07	6.07	6.07	6.47
FAM3	6.08	6.08	6.08	6.07	6.07	6.47	6.08	6.08	6.08	6.07	6.07	6.47
FAM4	6.07	6.07	6.07	6.06	6.06	6.47	6.07	6.07	6.07	6.06	6.06	6.46
FAM5	6.08	6.08	6.07	6.07	6.07	6.49	6.08	6.08	6.07	6.07	6.07	6.47
FAM6	6.02	6.02	6.02	6.01	6.01	6.43	6.02	6.02	6.02	6.01	6.01	6.42
NPISH	5.24	5.24	5.24	5.23	5.23	6.17	5.25	5.25	5.24	5.24	5.24	6.32

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

In terms of deflator of private consumption (see Table 34), there is a low heterogeneity by household type. In the LS simulation the deflator decreases by -0.4 per cent (-0.3 in the HS simulation) until the low-effective training is taken into account. The high-effective training determines a positive contribution by 0.1 p.p.s. Moreover, the ICT determines a decrease in deflators by 6.8 per cent, which becomes -10.7 per cent in the HS simulation.

Table 34 - Percentage changes in the deflator of private consumption by household type and NPISH in simulations.

Deflator of private consumption	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
FAM1	-0.44	-0.44	-0.44	-0.42	-0.36	-6.71	-0.31	-0.31	-0.32	-0.31	-0.24	-10.57
FAM2	-0.43	-0.42	-0.43	-0.41	-0.34	-6.77	-0.32	-0.32	-0.33	-0.31	-0.25	-10.68
FAM3	-0.42	-0.42	-0.43	-0.40	-0.34	-6.77	-0.32	-0.32	-0.33	-0.31	-0.25	-10.67
FAM4	-0.41	-0.41	-0.42	-0.39	-0.32	-6.78	-0.32	-0.32	-0.33	-0.31	-0.24	-10.68
FAM5	-0.41	-0.41	-0.42	-0.39	-0.32	-6.81	-0.32	-0.32	-0.32	-0.30	-0.24	-10.73
FAM6	-0.42	-0.42	-0.43	-0.40	-0.33	-6.73	-0.32	-0.32	-0.33	-0.31	-0.24	-10.62
NPISH	-0.35	-0.35	-0.35	-0.33	-0.26	-7.37	0.18	-0.28	-0.29	-0.27	-0.20	-11.72

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Total employment (expressed in term of wages and salaries at constant wages) (see Table 35) increases by 1.9 per cent in the case of LS simulation at the 5th time span in SIM1LS. The training seems to be effective only in case of high effectiveness by adding 0.1 p.p.s in SIMTRAIN_HE_LS, whereas the marginal contribution of ICT innovation is negative by -5.2 p.p.s in SIMTRAIN_HE_ICT_LS. The HS simulation starts from an increase by +0.8 per cent and ICT (SIMTRAIN_HE_HS) contributes marginally by -7.9 p.p.s, by showing that the substitution effect of LS workers with HS workers due to HS workers' SSC rate cut does not benefit the Italian aggregate employment level. The real labour cost per employee decreases by 1.2 per cent in the case of SSC cut in SSC simulation and by -0.5 in HS simulation. ICT innovation contributes to a further reduction in the real labour cost per employee by 6.9 p.p.s in the LS simulation in SIMTRAIN_HE_ICT_LS and by 11.8 p.p.s in the HS simulation in SIMTRAIN_HE_ICT_HS. It underlines two issues: i) the ICT innovation determines generally an increase in labour productivity, by combining lower work inputs with higher capital ones; ii) a SSC policy focused on HS workers accelerates the trend due to innovation compared to a LS focused policy.

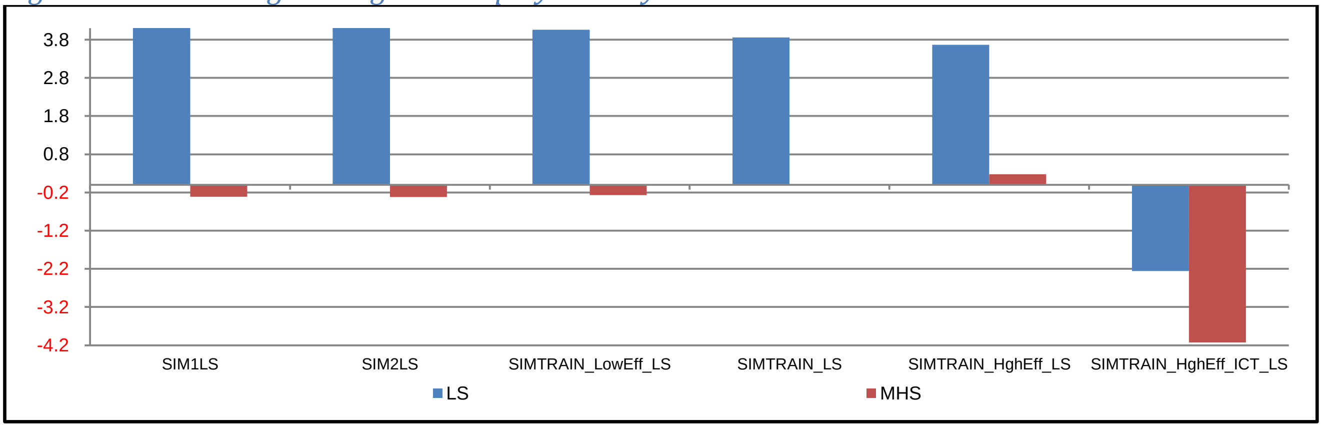
Table 35 - Percentage changes in employment and labour-cost variables in simulations.

	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Total employment	1.91	1.91	1.91	1.93	1.98	-3.19	0.75	0.75	0.75	0.78	0.83	-7.08
Real labour cost per employee	-1.17	-1.17	-1.17	-1.16	-1.15	5.66	-0.47	-0.47	-0.47	-0.47	-0.46	11.35
Total real labour cost	0.72	0.72	0.71	0.74	0.81	2.30	0.28	0.28	0.28	0.30	0.37	3.46
Total business sector employment	3.07	3.07	3.06	3.09	3.16	-2.38	1.30	1.30	1.30	1.34	1.41	-6.15
Real business sector labour cost per employee	-1.93	-1.93	-1.94	-1.91	-1.81	-1.83	-0.97	-0.97	-0.99	-0.97	-0.89	-0.68
Total business sector real labour cost	1.08	1.08	1.06	1.12	1.29	-4.17	0.31	0.31	0.30	0.35	0.51	-6.79
Real wages	-1.17	-1.17	-1.17	-1.17	-1.15	5.67	-0.47	-0.47	-0.47	-0.48	-0.46	11.37
Real labour compensation	0.72	0.72	0.71	0.74	0.81	2.30	0.28	0.28	0.28	0.30	0.37	3.48

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

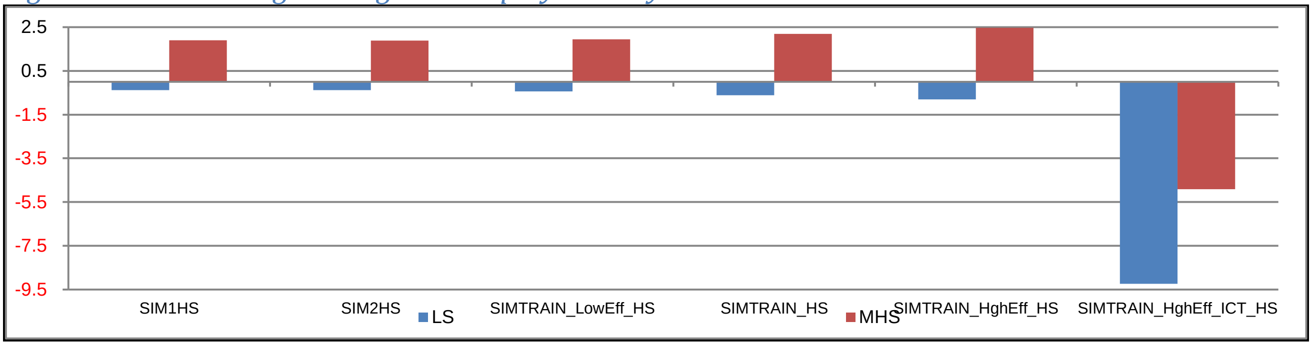
One of the expected main effects of the cut of employers' SSC rate for LS workers is the increase in the share of these latter on total employment. This (see Figure 17) seems to be confirmed by results with an increase by 4.1 per cent. The high-effective training (-3.7 per cent, the change in LS employment) does not seem to significantly contribute to LS employment differently from ICT innovation (-6.0 p.p.s, its marginal contribution), which changes the composition of labour demand by skill against the target workers. On the contrary, MHS workers diminishes by 0.3 per cent in the case of the cut in SSC tax rate, which becomes +0.3 in the case of the high-effective training. In this case, ICT innovation registers a negative marginal effect by -4.5 p.p.s, which is 1.5 p.p.s lower than the case of LS employment.

Figure 17- Percentage changes in employment by skill in LS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Figure 18 - Percentage changes in employment by skill in HS simulation.



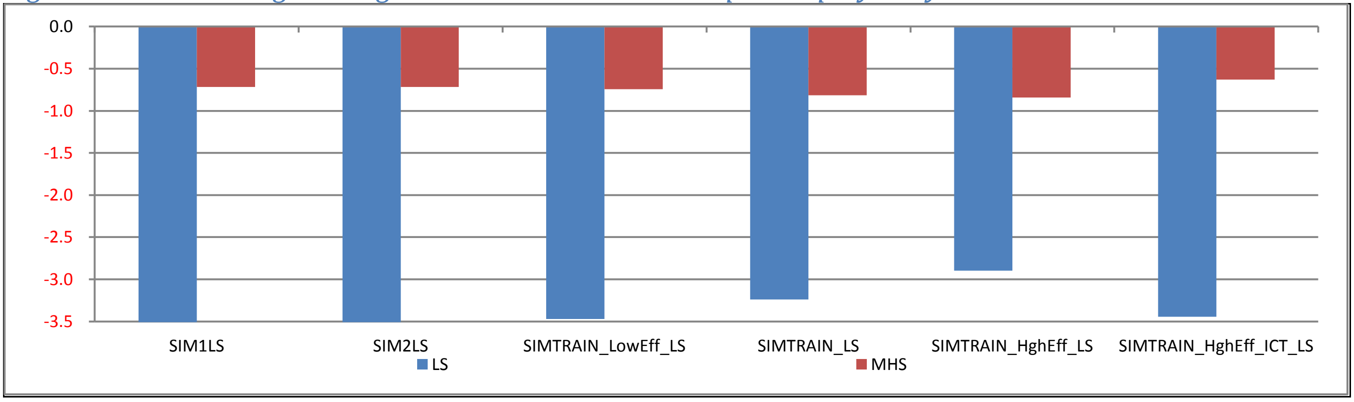
Source: Own simulations on ISTAT, EUKLEMS and SILC data.

The HS simulation (see Figure 18) is more advantageous for HS workers with an increase in employment by 1.9 per cent, which becomes 2.5 in the case of the high-effective training. On the contrary, LS workers are negatively affected with changes, respectively, amounting to -0.4 and -0.8 per cent. The ICT innovation determines a change by -9.2 per cent for LS workers and -4.9 for MHS workers, which implies a marginal effect of -8.4 p.p.s for LS workers and of -7.4 for MHS workers. Also in this case, the ICT innovation confirms its favour for MHS employment vs. LS workers, even though the interaction with the SSC manoeuvre seems to be higher in the case of LS- than of HS simulation.

The remaining expected main effect is represented by the decrease in the real labour cost per employee. A decrease by 3.5 per cent (see Figure 19) is determined without the macro response to the micro change in labour supply, which becomes -2.9 per cent after having considered the effects of training. In the ICT innovation (-3.5 per cent) the initial change is recovered. On the contrary, MHS workers' real labour cost per employee decreases by 0.7 per cent in the case of the simple cut in SSC tax rate, which becomes -0.8 with high-effective training. An increase by 0.2 p.p.s is achieved through the ICT innovation.

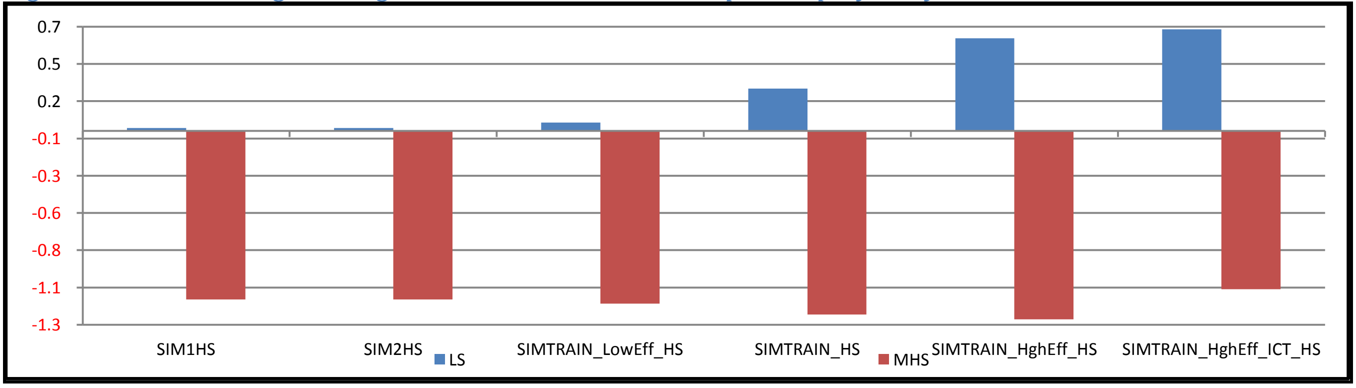
The HS simulation (see Figure 20) is more advantageous for HS workers with a decrease in the real labour cost per employee by 1.1 per cent, which becomes -1.3 for the high-effective training. The ICT innovation determines an increase by 0.2 p.p.s. On the contrary, LS workers are relevantly affected only in the case of high-effective training (+0.6 per cent). Moreover, the ICT innovation adds other 0.1 p.p.s.

Figure 19 - Percentage changes in the real labour cost per employee by skill in LS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

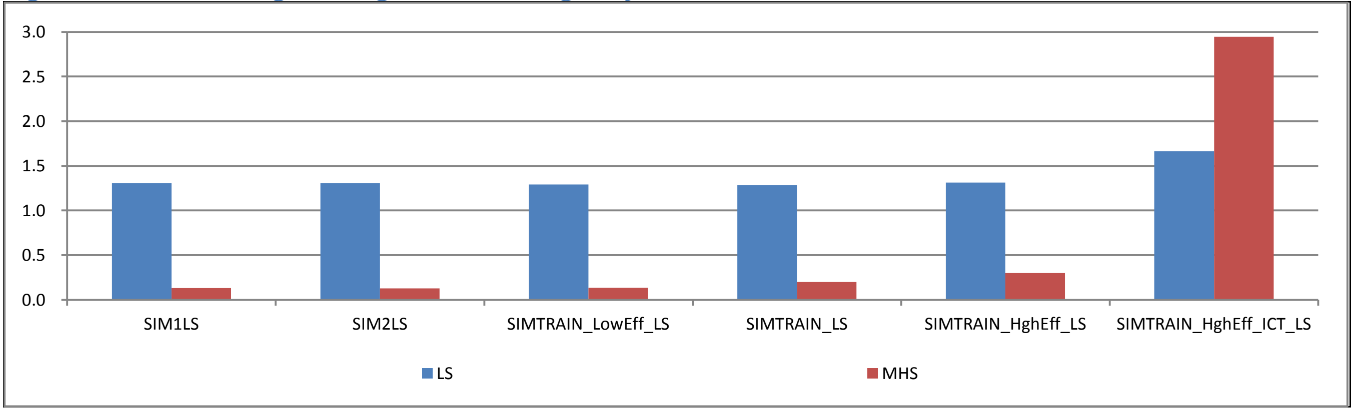
Figure 20 - Percentage changes in the real labour cost per employee by skill in MHS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

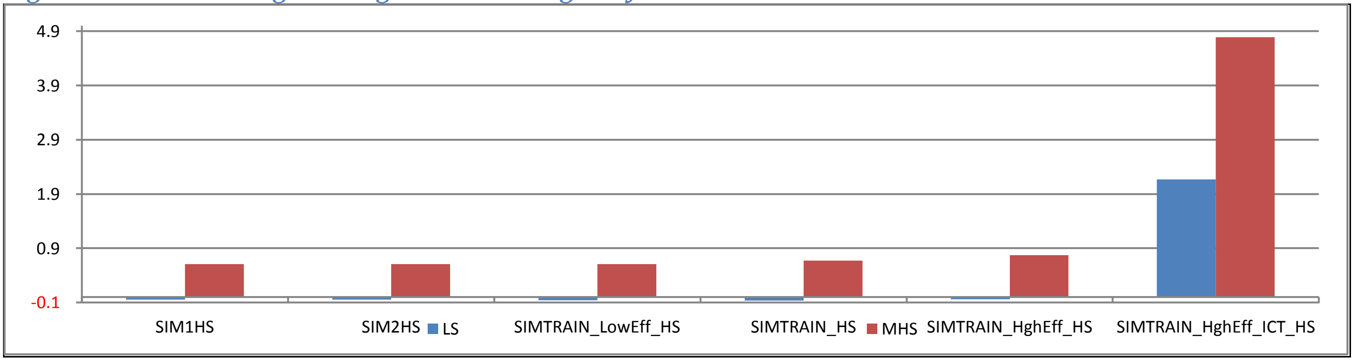
The above-outlined explanation can be confirmed by the changes in real wages resulting from the next two figures. In the LS simulation (see Figure 21) wages of LS- and MHS skilled workers grow with the high-effective training by, respectively, 1.3 and 0.3 per cent , which become 1.7 and 3.0 with ICT Innovation. Moreover, in the case of HS simulation (see Figure 22) data seem to register a similar pattern, even though effects are amplified: 0.0 and +0.8 per cent for, respectively, LS and MHS workers with the high-effective training; 2.2 and 4.8 per cent with the ICT innovation.

Figure 21 - Percentage changes in real wages by skill in LS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Figure 22 - Percentage changes in real wages by skill in HS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 36 – Percentage changes in employment by labour category in LS simulation.

Employment	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS
1	4.73	4.74	4.57	3.98	-1.50	3.42
2	4.74	4.74	5.78	8.92	0.95	11.13
3	1.90	1.90	2.42	4.21	-3.42	5.68
4	4.89	4.89	4.75	4.30	-1.26	3.91
5	-0.39	-0.40	0.13	1.93	-5.45	3.39
6	-0.69	-0.69	-0.66	-0.44	-6.88	-0.12
7	-0.83	-0.83	-0.84	-0.79	-7.93	-0.64
8	-0.30	-0.30	-0.31	-0.28	-6.68	-0.16
9	-0.38	-0.38	-0.39	-0.34	-2.54	-0.17
10	-0.36	-0.36	-0.38	-0.34	-2.12	-0.19
11	-0.21	-0.21	-0.22	-0.19	-2.55	-0.09
12	-0.19	-0.19	-0.21	-0.18	-1.80	-0.06
13	3.05	3.05	2.98	2.80	-2.78	2.68
14	4.96	4.96	6.05	8.91	-1.03	10.64
15	0.86	0.86	0.88	1.00	-3.89	1.18
16	3.23	3.22	3.16	2.98	-4.28	2.87
17	-0.43	-0.43	-0.01	1.49	-6.73	2.73
18	-0.56	-0.56	-0.55	-0.42	-7.84	-0.21
19	-0.24	-0.24	-0.25	-0.20	-7.11	-0.05
20	-0.23	-0.23	-0.24	-0.21	-7.95	-0.14
21	-0.64	-0.64	-0.65	-0.60	-4.19	-0.44
22	-0.32	-0.32	-0.34	-0.31	-2.79	-0.18
23	-0.18	-0.19	-0.20	-0.18	-3.02	-0.11
24	-0.32	-0.32	-0.34	-0.33	-3.05	-0.23

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

In LS simulation (see Table 36), the highest increase in employment with the only cut in SSC rates is obtained for LMS workers both performing low and medium no ICT-intensive occupations (L1 and L4) with, respectively, +4.7 per cent, around +4.9 per cent and low ICT-intensive occupations (L2) with +4.7 per cent. As for females, the highest increases are registered for L13 and L14 corresponding to L1 and L2 (with changes respectively amounting to +3.1 and +5.0 per cent) and L16 corresponding to L14 (+3.2 per cent). Instead, the highest decreases can be found for males in HS workers performing medium both ICT-intensive and ICT intensive occupations L7 and L6 (respectively, -0.8 and in -0.7 per cent) and for females in the corresponding categories L21 and L18 (-0.6 per cent in both cases).

As for the high-effective training,: all components are negative with particularly high decreases for ICT-intensive and not ICT-intensive medium occupations performed by high-skilled (L6 and L7 for males and L17 and L18 for females) and for high-skilled not ICT-intensive occupations performed by low-medium skilled workers (L8 and L19, respectively for males and females) with figures ranging between -7.0/-8.0 per cent.

In HS simulation (see Table 37) the highest increase in employment with the only cut in SSC rates is obtained for MLS workers performing HS and ICT-intensive occupations (respectively, L9 with +5.0 per cent and L10 with +4.6 per cent). As for females, L21 and L22 categories corresponding to, respectively, L9 and L10 increase by+6.0 and +4.2 per cent. On the contrary, the highest decreases can be found for males in HS workers performing medium ICT-intensive occupations (L7) with -0.9 and in LMS workers performing LS-no ICT-intensive occupations (L1), as well as for MLS workers performing medium not ICT-intensive occupations (L4) with -0.6 and for females in the L19 and L14 categories corresponding to L7 and L1 (-0.7 and -0.6 per cent).

Table 37- Percentage changes in employment by labour category in HS simulation.

Employment	SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS
1	-0.41	-0.41	-0.57	-1.11	-1.62	-8.93
2	-0.14	-0.14	0.82	3.70	5.72	0.43
3	-0.22	-0.22	0.28	2.00	3.39	-6.97
4	-0.36	-0.36	-0.48	-0.90	-1.26	-8.22
5	-0.29	-0.29	0.24	2.04	3.50	-5.40
6	-0.32	-0.32	-0.29	-0.08	0.24	-7.06
7	-0.86	-0.86	-0.87	-0.82	-0.68	-12.21
8	-0.35	-0.35	-0.36	-0.33	-0.22	-8.57
9	4.97	4.97	4.95	5.00	5.17	0.86
10	4.55	4.55	4.54	4.57	4.72	0.27
11	1.48	1.48	1.47	1.50	1.59	-4.95
12	3.85	3.84	3.82	3.85	3.97	0.46
13	-0.33	-0.33	-0.40	-0.57	-0.69	-9.41
14	-0.63	-0.63	0.34	2.91	4.46	-9.46
15	-0.26	-0.26	-0.24	-0.13	0.04	-7.75
16	-0.43	-0.43	-0.49	-0.66	-0.76	-12.10
17	-0.49	-0.49	-0.06	1.43	2.67	-9.12
18	-0.48	-0.48	-0.47	-0.35	-0.14	-11.92
19	-0.66	-0.66	-0.67	-0.63	-0.49	-9.16
20	-0.22	-0.21	-0.22	-0.21	-0.13	-12.58
21	6.01	6.01	5.99	6.04	6.20	-2.91
22	4.21	4.21	4.19	4.21	4.34	-1.48
23	0.26	0.25	0.24	0.25	0.32	-7.63
24	2.53	2.53	2.51	2.51	2.62	-4.77

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

The pattern remains unchanged for the simulations taking into account the macro response to micro labour supply changes. By taking into account the macro changes of labour supply due to (low-, medium- and high-effective) training, also MLS workers performing MLS ICT-intensive occupations (respectively, L2 and L5 with +5.7 and +3.5 p.p.s) and HS workers performing LS occupations (L3 with +3.4 p.p.s) for males, as well as the categories L14 and, partially, L17 corresponding to L2 and L5 (with +4.5 and +2.7 p.p.s) for females have positive changes. As for females, L15 corresponding to L3 registers an invariant change.

A third pattern can be identified with the ICT innovation, where all categories register positive changes with the exception of LMS workers performing high ICT-intensive occupations L9 and L10 (respectively, +0.9 p.p.s and +0.3), as well as 0.5 p.p.s in HS occupations with high educational attainment and with ICT competences (L12) for males.

Similar results can be obtained also by grouping the 24 work categories into 6 groups (see Table 38). Males include the groups 2, 4 and 6 and females the groups 1, 3 and 5. The LS simulation shows an increase in employment by 3.8 per cent in LS males (Group 2), which arrives to 3.5 per cent with the HE training (SIMTRAIN_HE_LS) and -2.2 with ICT innovation (SIMTRAIN_HE_ICT_LS). As for LS females (Group 1) the respective values are +1.8, +1.8 and -4.8 per cent. As for MS males (Group 4), the SSCs rate cut determines an increase in employment by 3.5, which becomes -2.4 per cent in the case of the ICT innovation. As for MS females (Group 3), it starts from 2.3 per cent and arrives to 2.6 and 5.0, respectively with training and ICT innovation. As for HS males (Group 6), the SSCs rate cut determines a decrease in employment by -0.2, which becomes null in the case of training and -2.2 per cent in the case of the ICT innovation. As for HS females (Group 5), it starts from -0.3 per cent, becomes -0.1 per cent and arrives to -3.3 with ICT innovation.

Table 38 – Percentage changes in employment by labour group

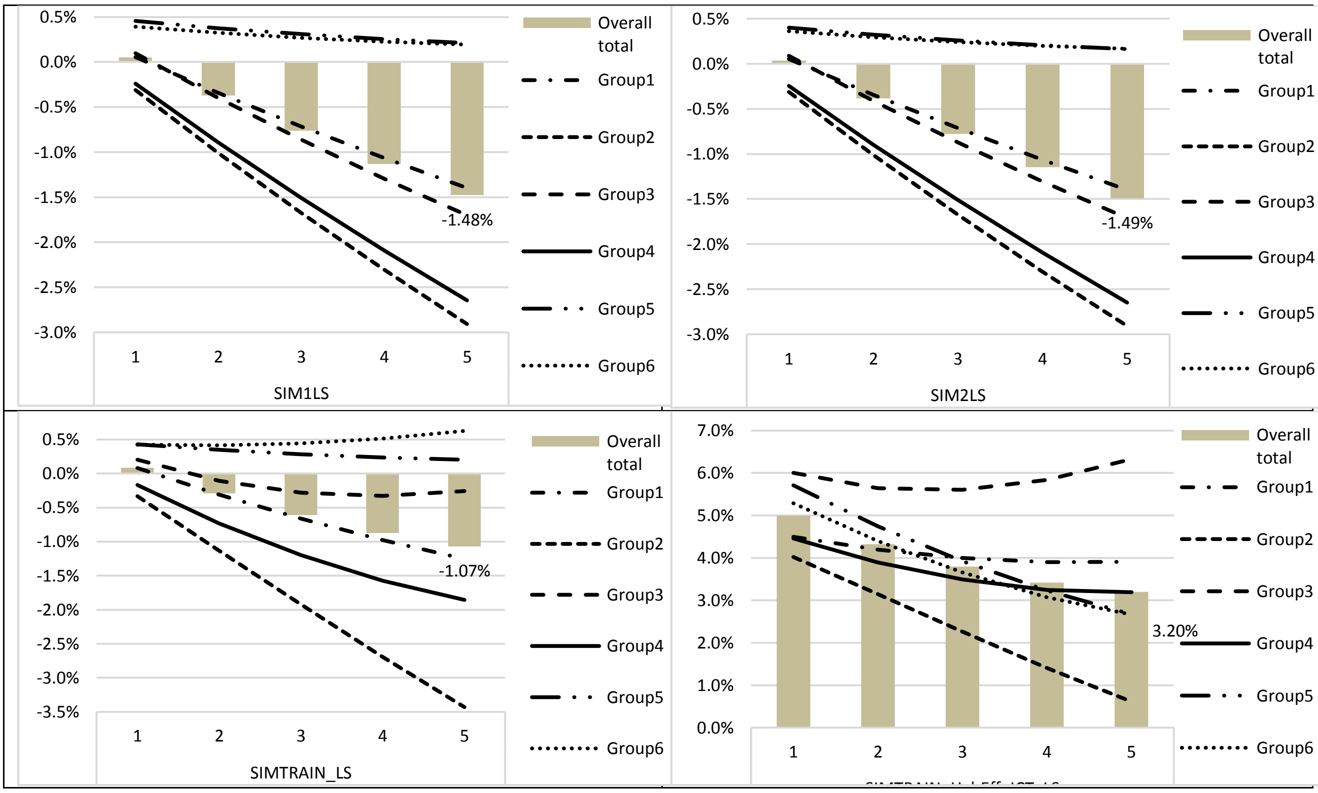
LS Simulation	Gender (M/F/TOT)	Skills (LS/MS/HS/TOT)	SIM1LS	SIM2LS	SIMTRAIN _LE_LS	SIMTRAIN _LS	SIMTRAIN _HE_LS	SIMTRAIN _HE_ICT_LS
1	F	LS	1.81	1.81	1.81	1.81	1.83	-4.77
2	M	LS	3.82	3.82	3.80	3.69	3.53	-2.20
3	F	MS	2.26	2.26	2.29	2.43	2.59	-4.95
4	M	MS	3.47	3.47	3.47	3.48	3.48	-2.42
5	F	HS	-0.26	-0.27	-0.28	-0.25	-0.14	-3.28
6	M	HS	-0.24	-0.24	-0.25	-0.16	0.01	-2.21
	TOT	TOT	1.91	1.91	1.91	1.93	1.98	-3.19
HS Simulation	**Gender (M/F/TOT)**	**Skills (LS/MS/HS/TOT)**	**SIM1LS**	**SIM2LS**	**SIMTRAIN _LE_LS**	**SIMTRAIN _LS**	**SIMTRAIN _HE_LS**	**SIMTRAIN _HE_ICT_LS**
1	F	LS	-0.30	-0.30	-0.30	-0.31	-0.29	-10.67
2	M	LS	-0.37	-0.37	-0.39	-0.49	-0.64	-7.94
3	F	MS	-0.41	-0.41	-0.38	-0.23	-0.07	-11.25
4	M	MS	-0.24	-0.24	-0.23	-0.19	-0.18	-7.66
5	F	HS	2.12	2.12	2.10	2.12	2.23	-5.13
6	M	HS	3.74	3.73	3.73	3.80	3.97	-0.62
	TOT	TOT	0.75	0.75	0.75	0.78	0.83	-7.08

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

In the HS simulation, low-qualified males (Group 2) register a decrease in employment by -0.4 per cent, which arrives to -0.6 per cent with the high-effective training (SIMTRAIN_HE_HS) and -7.9 with ICT innovation (SIMTRAIN_HE_ICT_HS). As for lower qualified females (Group 1) the respective values are -0.3, -0.3 and -10.7 per cent. As for medium qualified males (Group 4), the SSCs rate cut determines a decrease in employment by 0.2, which remains unchanged in the case of training by achieving -7.7 per cent in the case of the ICT innovation. As for medium-qualified females (Group 3), it starts from -0.4 per cent and arrives to -0.1 and -11.3, respectively with training and ICT innovation. As for high qualified males (Group 6), the SSCs rate cut determines an increase in employment by +3.7 per cent, which becomes +4.0 in the case of training and -0.6 in the case of the ICT innovation. As for high-qualified females (Group 5), it starts from +2.2 per cent, which achieves +2.1 with training until it arrives to -5.1 with ICT innovation.

We could examine the outcomes of the LS simulation in terms of unemployment rates (see Figure 23). The average unemployment rate decreases in the case of the change in SSC rates by 1.5 p.p.s, mainly due to all components with the exception of high-skilled female and male components (respectively, Group 5 and 6). The Micro-Macro integration (SIM2LS) does not change a lot the previous described pattern. With a medium-effective training (SIMTRAIN_LS) the average unemployment rate decreases by 1.1 p.p.s with a particular contribution by low-qualified workers (Groups 1 and 2) and medium qualified males (Group 4).

Figure 23 - Changes in p.p.s in unemployment rates by labour group in LS simulation.

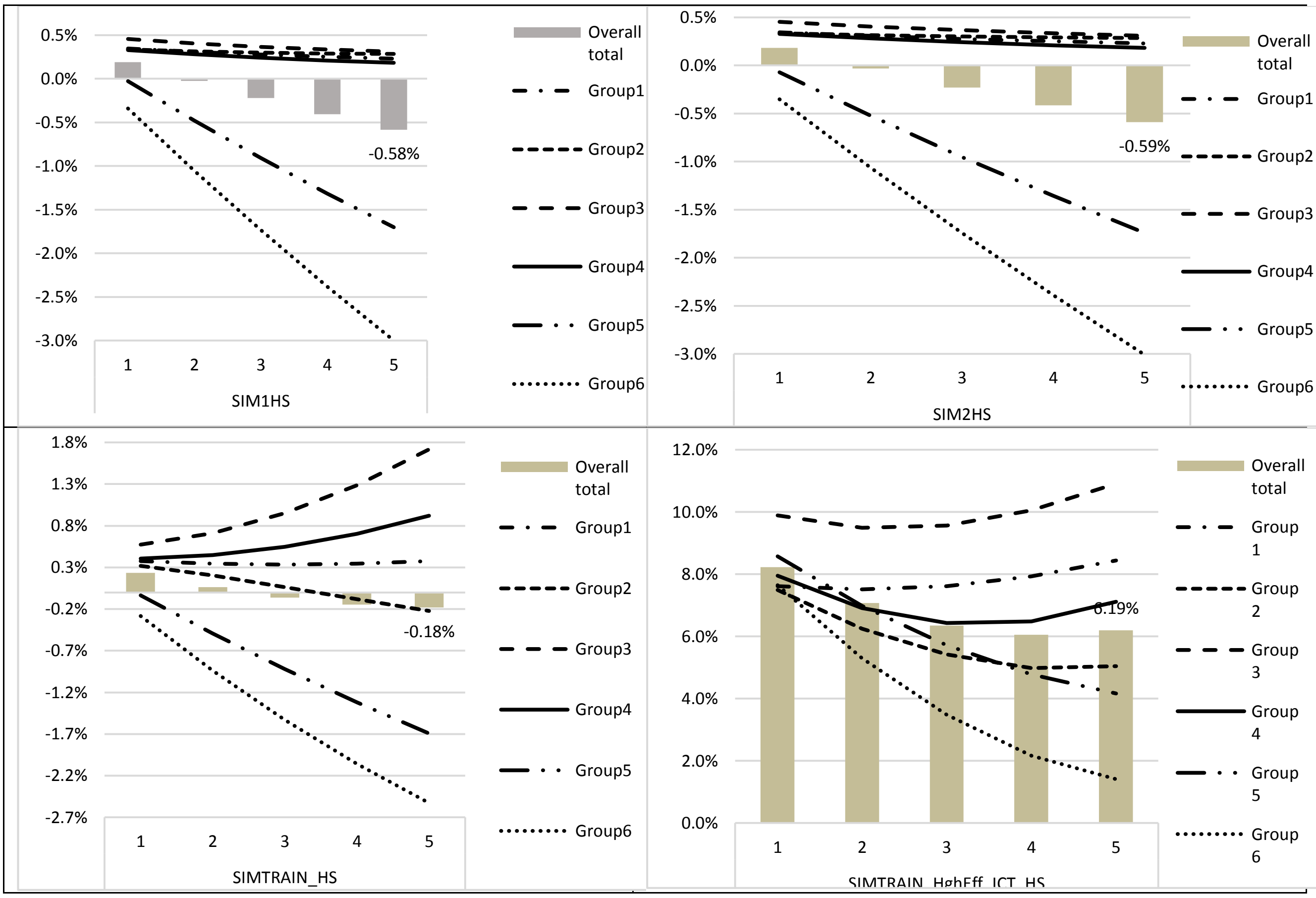


Source: Own simulations on ISTAT, EUKLEMS and SILC data.

The introduction of the ICT innovation (SIMTRAIN_HE_ICT_LS) registers an increase by 3.2 p.p.s in the aggregate unemployment rate due to the before described adverse trend in employment and to its substitution with capital. Gender dimension seems to be a good explanatory variable to distinguish components above and below the average with female LS, MS and HS workers registering performances along the average. As for males, only the high-qualified component (Group 6) follows the average path, while low-qualified workers and, at a higher extent, medium-qualified workers are characterised by a worse performance.

In the HS simulation (see Figure 24), the average outcome in terms of unemployment rates are less positive with a decrease by only 0.6 p.p.s in the simulation with only the decrease in SSC rate (SIM1HS). This figure includes the reduction of -2.5 for male high-qualified workers (Group 6) and -1.7 p.p.s for high-qualified females (Group 5). Medium-qualified males (Group 4) register an increase by 0.9 p.p.s, whereas low-qualified males (Group 2) decrease by -0.2. Medium-qualified female workers (Group 3) increase by 1.7 p.p.s. The introduction of the ICT innovation (SIMTRAIN_HE_ICT_HS) determines an increase in the aggregate unemployment rate by 6.2 p.p.s with the a better performance for high-qualified males and females.

Figure 24 - Changes in p.p.s in unemployment rates by labour group in HS simulation.

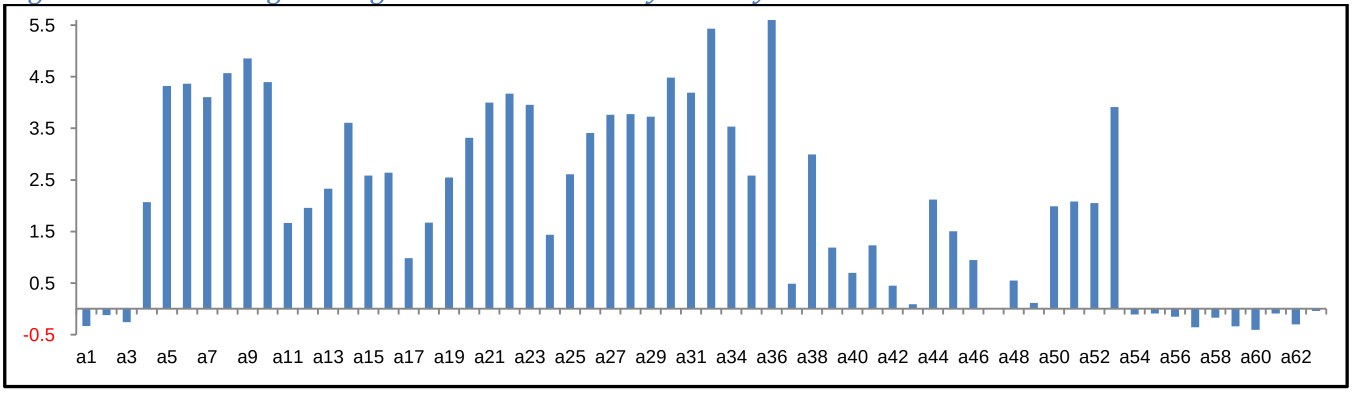


Source: Own simulations on ISTAT, EUKLEMS and SILC data.

We could build the distribution by activity of the LS-Simulation results in terms of hours worked (see Figure 25). Manufacturing of food, textiles, wood and paper (a5-a9), manufacturing of transport vehicles, furniture and repair/installation of machinery (a20-a23) and utilities, trade services, accommodation and transport services (a25-a36) achieve growth rates around 4.0 per cent. Hikes are registered for accommodation and food service activities a36 (+5.6 per cent) and water transport (a32 with +5.4), followed by printing and reproduction of recorded media (a9 with +4.9). Decreases are register for agriculture and fishing (a1-a3) and public and personal services (a54-a63) with a minimum for other personal services (a60 with -0.4 per cent).

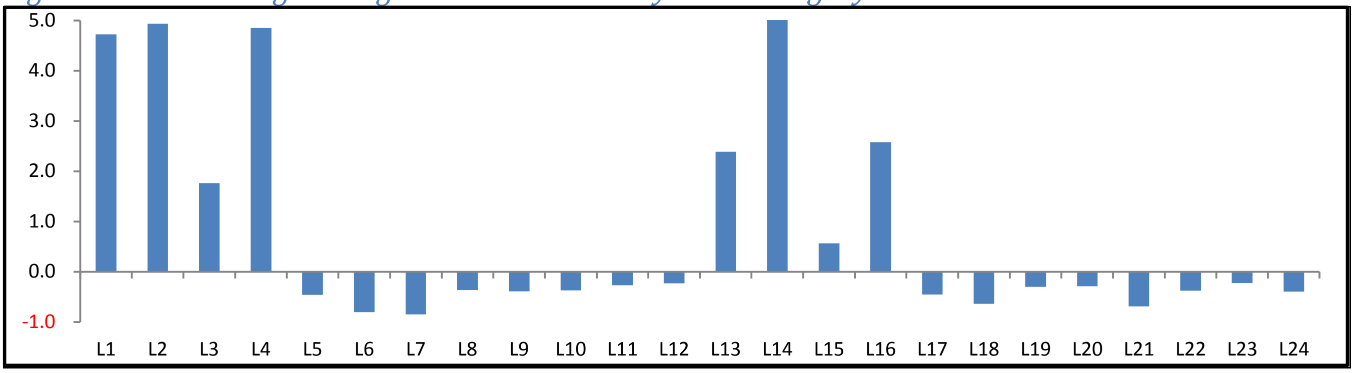
In terms of work categories (see Figure 26), workers performing low occupations (L1-L3 and L13-L15, respectively for males and females) and LMS workers performing medium not ICT-intensive occupations (L4 and L16) register positive and significant changes. HS workers performing MS occupations (with ICT- content for males - L7 - and without it for females -L18) appear to be the most negatively affected; as for females, also LS workers performing high ICT-intensive occupations (L21) decrease.

Figure 25- Percentage changes in hour worked by activity in LS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

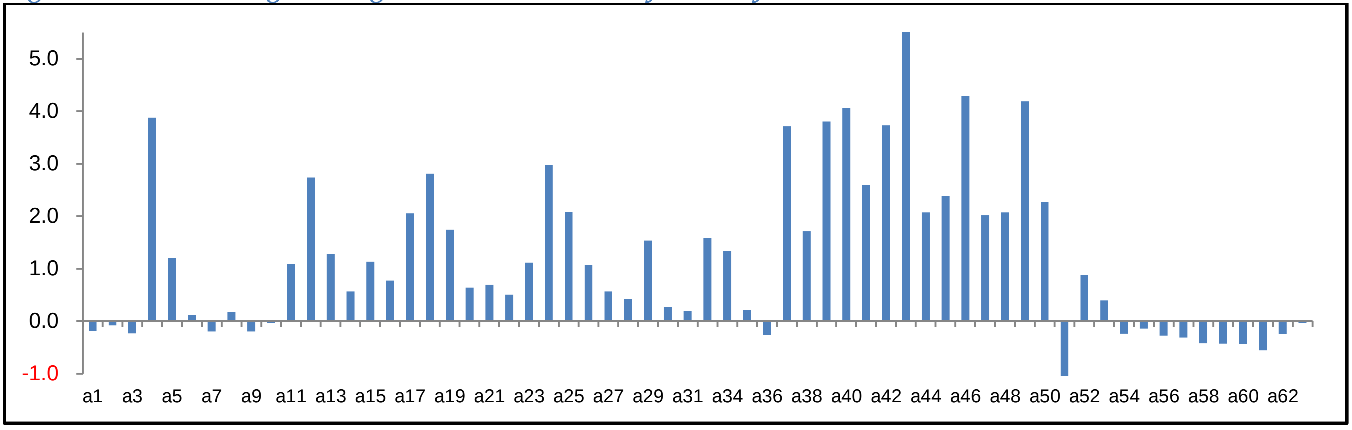
Figure 26 - Percentage changes in hour worked by work category in LS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

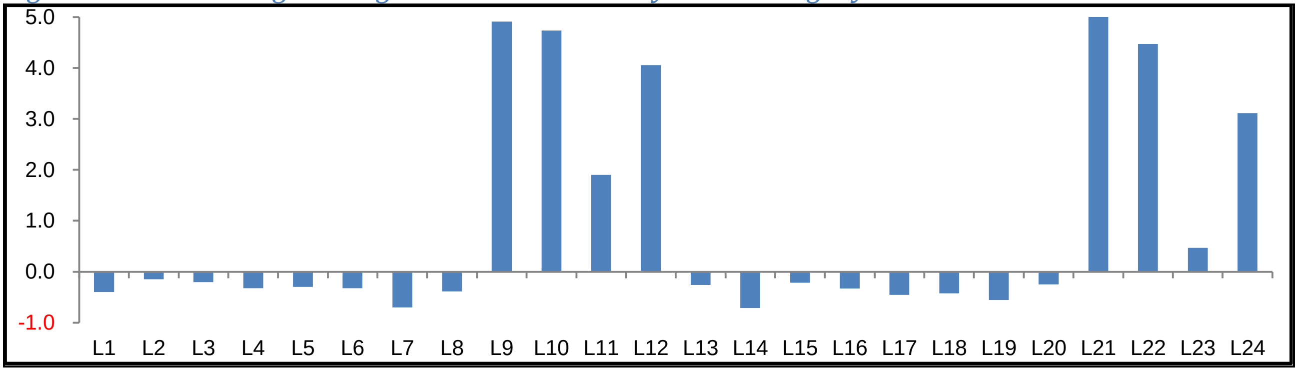
As for the HS simulation (see Figure 27), services with the exclusion of trade, transport and accommodation (from a37 to a50) gain a higher benefit with a peak of 5.5 per cent for activities auxiliary to financial and insurance-services (a43). Also publishing activities (a37), computer programming (a40), telecommunications (a39), architectural and engineering services (a46) and other scientific and technical activities (a49) show relatively high changes. In terms of labour categories (see Figure 28), the most positively affected workers performing HS occupations with the exception LMS skilled workers employed in not ICT-intensive occupations (L9-L12 and L21-L24, respectively for males and females). The simulation appears to be more balanced in terms of gender with an increase by +4.9 per cent for LS males performing high ICT-intensive occupations (L9) vs. +6.1 for the corresponding category for females (L21).

Figure 27- Percentage changes in hour worked by activity in HS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

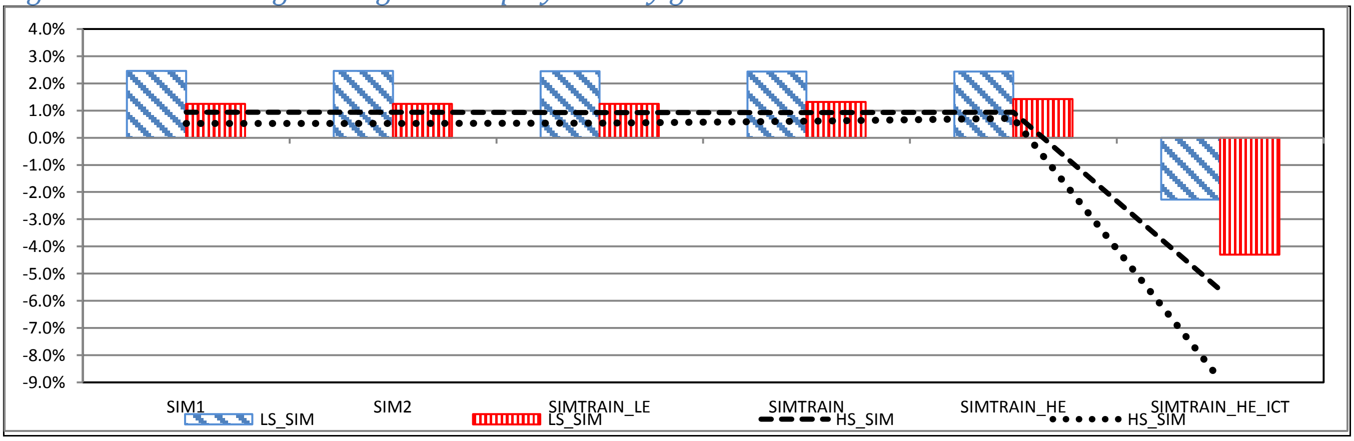
Figure 28 - Percentage changes in hour worked by work category in HS simulation.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

As for the gender gap (see Figure 29), we can observe that the LS simulation (see bars of histograms) seems to favour the male component with a change by 2.4 per cent for male workers vs. +1.2 per cent for females in the simulations with only changes in SSC rates (SIM1LS). The gap is partly recovered by consider also the high-effective training (SIMTRAIN_HE_LS), when it achieves 1.0 p.p.s vs. the starting figure of 1.2. The ICT innovation (SIMTRAIN_HE_ICT_LS) penalises female work with a reduction amounting to -4.3 per cent, vs -2.3 per cent (the gender gap amounts to 2.0 p.p.s). In HS simulation (see lines) the gender gap is lower, even though the gap becomes relatively high in the case of the ICT innovation.

Figure 29 - Percentage changes in employment by gender in LS- and HS simulations.



Source: Own simulations on ISTAT, EUKLEMS and SILC data.

9- Part4 - Elasticity estimation

In the context of CGE models a particular relevance is to be recognised to the question of the substitution elasticities, as regards both the capital/labour substitution, and the labour substitution by skill. The values of elasticities are relevant by determining the results of our simulations. We have used values assessed in literature. They are generally reliable, but basis data are often not-updated and involve country-specific aspects. This constitutes the main reason to verify the figures assessed by the literature for the Italian updated economic situation.

In our CGE model, we have used elasticities derived from the economic literature. In particular, as for the labour/capital elasticity, we have used the figure estimated in Van der Werf, 2007. The author estimated three different structures ((KL)E, (KE)L and K(EL)) on data covering 12 OECD countries[42] with industry details[43] over the 1978-1996 period from the IEA Energy Balances and from the OECD International Sectoral Database. The (KL)E seems to be the best fitting to data. However, for most countries/industries the hypothesis that all three inputs can put into one single nest can be rejected. The Cobb Douglas hypothesis is rejected. Moreover, there are evidences of factor-specific technological change. The Author proved that the best fitting nested structure is (KL)E on the base of the R^2.

As for the elasticity among the different types of labour, the CGE model has adopted the figure showed in Krussel *et al*., 2000. In particular, the authors found that the relative quantity of skilled labour has increased substantially, and the skill premium has grown significantly since 1980. The elasticity between unskilled and skilled labour is set at 1.67, while the elasticity of substitution between skilled labour and capital is set at 0.67. These estimations are compatible the micro literature: Johnson, 1967 established a value of 1.5; Hamermesh, 1993 established a rage of elasticity containing 0.67.

We use a two-level CES production function for the value added. The value added (see EQ49) can be written as a CES production function in the capital (K_j) and labour ($hlav_j$) with two distribution parameters (α and $(1-\alpha)$), an elasticity parameter γ and three possible technological variables (δ_j, $\delta_j^K$and δ_j^L). In our estimation, we consider the capital stock net of buildings (in order to keep only the most substitutable component) and employees' hours worked.

We maximise the production function with respect to the capital and the three labour types (HS, MS and LS). In this way, we obtain four first-order conditions (see EQ69-72), which constitute an equation system. This is important, as it makes possible to estimate parameters through a SUR (Seemingly Unrelated Regressions) under convenient assumptions on coefficients. In order to eliminate autocorrelation, we introduce also an autoregressive term of order 1.

[42] I.E. Belgium, Canada, Denmark, Finland, France, United Kingdom, Italy, the Netherlands, Norway, Sweden, the US and West-Germany.
[43] I.E. basic metal products, construction, food & tobacco, textiles & leather, non-metallic minerals, transportation equipment, and the paper, pulp & printing industry.

$$\ln\left(\frac{VA_j}{K_j}\right) = \frac{1}{1-\rho}\cdot\ln\left(\frac{\frac{r_j^K}{p_j^{vA}}}{1-\alpha_j}\right) - \frac{\rho}{1-\rho}\cdot\left(\ln(A_j)+\ln(AK_j)\right) \text{ (EQ69);}$$

$$\ln\left(\frac{VA_j}{hlav_j^{low}}\right) = \frac{\rho-\varepsilon}{1-\rho}\cdot\ln\left(\frac{hlav_j^{low}}{hlav_j}\right) + \frac{1}{1-\rho}\cdot\ln\left(\frac{\frac{w_j^{low}}{p_j^{vA}}}{\beta_j^{low}}\right) - \frac{1}{1-\rho}\cdot\left(\rho\cdot\ln(A_j)+\varepsilon\cdot\ln(B_j)+\varepsilon\cdot\ln(AEL_j)\right) \text{ (EQ70);}$$

$$\ln\left(\frac{VA_j}{hlav_j^{medium}}\right) = \frac{\rho-\varepsilon}{1-\rho}\cdot\ln\left(\frac{hlav_j^{medium}}{hlav_j}\right) + \frac{1}{1-\rho}\cdot\ln\left(\frac{\frac{w_j^{medium}}{p_j^{vA}}}{\beta_j^{medium}}\right) - \frac{1}{1-\rho}\cdot\left(\rho\cdot\ln(A_j)+\varepsilon\cdot\ln(B_j)+\varepsilon\cdot\ln(AEM_j)\right) \text{ (EQ71);}$$

$$\ln\left(\frac{VA_j}{hlav_j^{high}}\right) = \frac{\rho-\varepsilon}{1-\rho}\cdot\ln\left(\frac{hlav_j^{high}}{hlav_j}\right) + \frac{1}{1-\rho}\cdot\ln\left(\frac{\frac{w_j^{high}}{p_j^{vA}}}{\beta_j^{high}}\right) - \frac{1}{1-\rho}\cdot\left(\rho\cdot\ln(A_j)+\varepsilon\cdot\ln(B_j)+\varepsilon\cdot\ln(AEH_j)\right) \text{ (EQ72).}$$

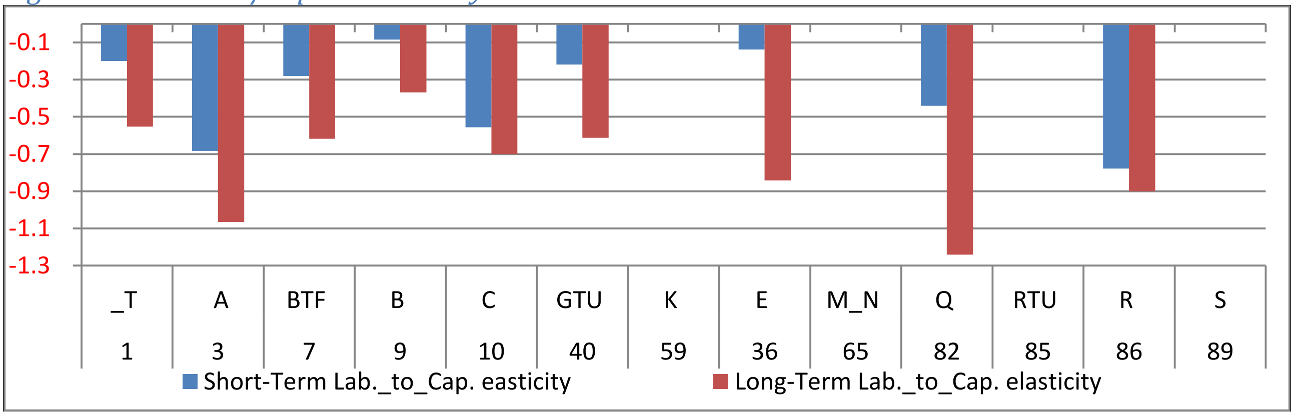
The previous equations have been estimated on a dataset containing time series by activity on the Italian economy from I.STAT over the period 1995-2017. Data are relative to total output, valued added, labour compensation, net taxes on production, investments and net capital stock (neo of or including construction), as well to employment. Employment is expressed in terms of hours worked distinguished in dependent and in in independent ones. Data by ISTAT are distinguished in 93 activities, of which 65 at the highest level of disaggregation and 28 at different level of aggregation.

The wage and the price of capital is obtained by dividing respective nominal remuneration flows according NAs (compensation of employees and gross operating surplus/mixed, income respectively) by the physical flows in terms of production factors. At this regard, two issues are to be underlined: i) the net taxes on production included in the value added are attributed to primary factors according convenient rates; ii) the aggregates of the NAs are revised when we pass from the dependent work to the total work. Indeed, we move the remuneration of independent work, which can be considered as sum of profits and management wages. This latter component, not related to the capital input, is approximated by applying the gross wages calculated for the dependent work to the quantity of independent labour factor. Note that in our SAMs the labour factor is given only by the dependent work, but this could underestimate the contribution of labour to production, especially in countries, such as Italy, where independent work is particularly high.

As for the elasticity of substitution of labour by skill, we identify three components according to formal skills (i.e. low, medium and high skills). However, this distinction is not included in NAs, and therefore we need to integrate NAs aggregated with external estimates. In our case, we have used the WIOD and EU-KLEMS estimates of the shares by skill, both in terms of compensation of employees and in terms of hours worked. The detail by activity in both the WIOD and the EU-KEMS databases have a poorer detail by activity and were different each other. Moreover, the time span of the both analyses were different: 1998-2009 for WIOD and 2009-2015 for EU-KLEMS.

In the total economy (see Figure 30) the estimated short-term capital-labour elasticity amounts to -0.20, which becomes -0.55 in the long run. In Agriculture (A) the both factors seem to be more reactive to their relative prices with -0.68 and -1.06, respectively in the short and in the long term. Conversely, Mining (B) shows lower values (-0.10 and -0.37). Manufacturing seems to be characterised by a relatively lower elasticity with -0.65 in the long run for the manufacture of transport equipment (.C29_30). Utilities related to water treatment and collection (E) register a long-run capital/labour elasticity amounting to -0.84. Generally, elasticity seems to be relatively higher in services with -5.06 for advertising and marketing research activities (M73T75).

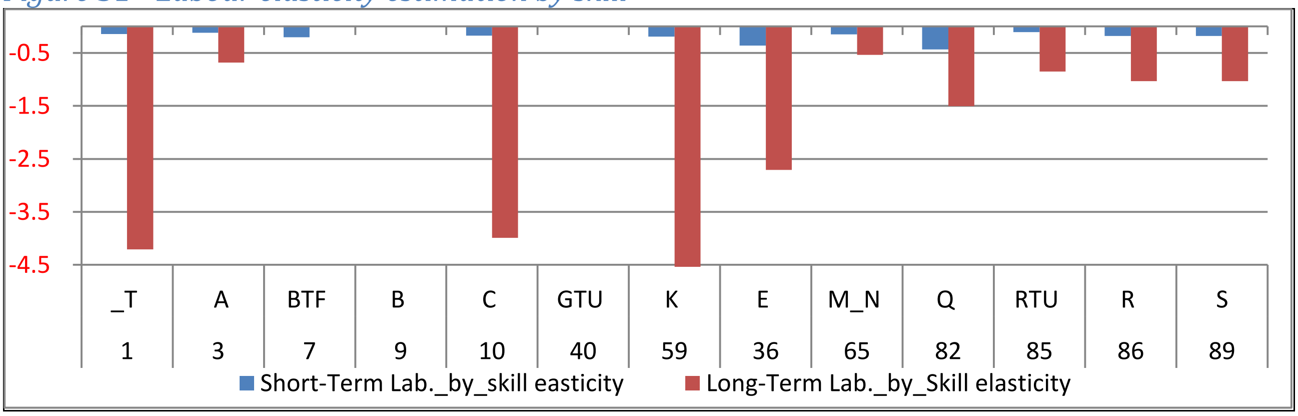
Figure 30 - Labour/capital elasticity estimation



Source: Our Estimations on ISTAT,EUKLEMS and WIOD data.

As for the labour elasticity by skill, the Figure 31 synthesises the results about the labour elasticity of substitution by skill both on the short and on the long run. The value estimated on aggregate data on total economy amounts to 0.14 in the short run and to 4.21 in long run. Agriculture (A with -0.68) seems to register a lower long-term substitutability by skill. On the contrary the elasticity is particularly high in Financial and insurance activities (K). Information and communication (J) and Human health and social work activities (Q) register elasticity coefficients around -1.50.

Figure 31 - Labour elasticity estimation by skill



Source: Our Estimations on ISTAT,EUKLEMS and WIOD data.

10- General conclusion

The thesis has analysed the incidence of both formal and digital skills on the dependent labour compensation within a SAM scheme for the Italian economy in 2013 and in 2014. In this way 12 (24) labour components according (gender) occupations, educational attainment and the use of ICT innovation have been identified. Furthermore, the thesis has evaluated the economic impact of the skill-biased technological change (SBTC) in terms of the increase in final demand on the composition of the labour compensation through a CGE model. Final demand is expressed as commodities produced by activities, both as primary, and as by-products. Commodities have been classified on the basis of skill content according to share of labour by skill on output by activity. In this way, we have obtained three groups: *i*) commodities with an high content of workers employed in HS ICT-intensive occupations (Group A); *ii*) commodities with an high content of both workers employed in HS and LMS occupations (Group B); *iii*) commodities benefitting mainly workers performing LMS occupations (Group C). Then, the General Equilibrium effects of an increase in final demand for commodities included in each group have been evaluated through the CGE model.

The products more intensive of HS workers belong more to business services (e.g. publishing and telecommunications, finance, R&D, computer programming, as well as professional activities) and Public Administration (i.e. education services, health and creative and entertainment services) than to manufacturing (i.e. pharmaceuticals, computers, machinery and electrical equipment). Services have a lower weight in group B (i.e. postal services, employment services, and membership organisations) and in group C (i.e. retail trade services). At this regard, Italy is characterised by the low share of high knowledge-intensive services. Furthermore, a policy favouring digital skills should rely heavily on the Public Administration, which is both a strength and a weakness point. As for the former aspects, policy-makers could use a tool directly affecting employment composition by skills (i.e. through administrative reforms, the introduction of e-government and the promotion of digital development). However, actions by the public sector could be limited through an important financial constraint, by reducing the ability to play an effective role.

Some manufacturing activities are included in Group B and Group C (i.e. furniture and other manufactured goods, repair and installation services of machinery and equipment, textiles and other transport equipment). Manufacturing represents the core of the Italian productive structure and accounts for high shares of the Italian exports; commodities included in the Group C seem to be more opened to the international trade and to contribute more to trade surplus. However, this seems to impact not favourably on the employment composition by skill. Another commodity which plays a relevant role in Italy is construction and this is highly intensive of LS work.

The first part of the thesis is relative to digital innovation and of globalisation. These both aspects are strictly linked, as globalisation has been supported by the reduction of costs, as well the higher possibilities to relocate the tasks across all countries according to comparative advantages. Generally, globalisation and knowledge-based technological development have determined relevant changes in the composition of the labour demand with a polarisation between HS and digitalised occupations and LS and not digitalised ones.

As for globalisation, the position of each country in the labour geography (the so called Global Value Chain - GVC) is different according to the availability of an adequate labour supply by skill. Moreover, economic growth and productivity trends of each country are not equal for all tasks. Indeed, in the new labour geography, countries specialised in more value-added intensive tasks also have a better performance than countries specialised in less value added-intensive ones.

As consequences of the above developed analysis, we can point out the following issues:

a) laggard countries should support digitally advanced investments in order to help the transition towards the ICT innovation, both by enhancing the development and the growth of advanced industries (characterised by a comparatively higher productivity), and by helping the spread of new technologies to other ML-technology activities. In this regard, for example, the Italian '*Impresa* 4.0' plan could be useful;

b) the policy outlined in the previous point creates a probably higher and different labour demand with a beneficial effect for HS workers (with higher job opportunities, higher wages and higher job security) and LS occupation (with stagnant job opportunities and stagnant or decreasing wages and job security). The new demand patterns require the creation of an adequate labour supply. In this regard, educational policies should be enhanced both in terms of resources devoted to them and of their quality in terms of cognitive and non-cognitive skills acquired. Actions should be carried out to avoid the formation of large population components with poor job conditions and high unemployment risks;

c) resources should be devoted also to enhance the Life Long Learning (LLL) and the Vocational Education and Training (VET) for the adult population. In particular, the European Mediterranean countries would obtain the highest benefit from this action, as they could bridge the gap with the Scandinavian countries in terms of digital skills owned by the older population. In this regard, a better coordination between ALMPs and PLMSs could help to reconcile social equality aspects and the participation to GVCs.

The second part of the thesis evaluates the impact of employment subsidies on the composition of labour compensation by gender, occupation and skill. This could be a tool to partially compensate the negative consequences of SBTC on LS workers. In this way, Governments could concentrate available resources to offer more high-quality job opportunities to LS workers. Traditionally, the first answer of Western governments to this problem has been to increase social assistance spending for marginalised workers and grant incentives to capital and investments. The first remedy is aimed at supporting the welfare conditions of poorer households which are more intensive of LS workers, involuntary part-timers and temporary workers. Nevertheless, this circumstance does not address the challenge of decreases in participation to the labour market, both in terms of human capital deterioration, and of an higher crime and drug consumption incidence.

On the other hand, Governments granted capital incentives to support investment and, so, increase the labour demand. However, the increase in employment constitutes only a by-product of the measure and is not targeted on LS workers, which are mainly disadvantaged in the SBTC through substitutability with capital.

In this context, the better solution seems to be to grant employment subsidies to firms as a tax credit for the social security contributions paid for LS workers. This allows to supporting LS employment at a sufficiently high wage, without damaging firms' profitability conditions. One could anchor the tax credit either to the stock of employment or to net/gross hiring flows. The paper has adopted the first approach under the assumption that possible windfall profits linked to subsidies are eliminated by the market competition. The second approach implies both administrative problems by the Government and opportunistic firms' behaviours, as well as a lower productivity due to lower investment in training linked to the higher turnover.

The second part of the thesis adopts a Micro-Macro integration approach by using a CGE model at the macroeconomic level and a microsimulation model at the micro level. This procedure allows, as shown in the literature, to combining the General Equilibrium evaluation - and therefore a simultaneous and instantaneous adjustment of prices and quantities - with the utility maximisation process by individuals and couples. In this process, we take into account the whole heterogeneity reported in surveys. In this context, the microsimulation model could be used for two aims: i) to only assess distributive and poverty consequences of macro- or microeconomic shocks; ii) to actively interact with the macro-level in order to define Micro-Macro consistent prices and quantities. We adopt this latter approach with a CGE model calibrated on the 2014 SAM for Italy with the labour factor decomposed by gender, occupation and skill into 24 components.

We find that an employment subsidy has a significant positive effect on GDP only in the absence of provision. With a provision the effect on GDP is substantially zero. However, the measure seems to achieve the main target to support LS employment. The microsimulation analysis and the following second-round CGE assessment stress the critical role played by the Tax and Benefit system, which could penalise HS workers decreasing their hours worked.

The third part of the thesis addresses the same item of the second part in a dynamic context, where capital and labour supply are endogenous. Capital varies step by step according to the accumulation of net investment flows year-by-year. On the other hand, labour supply changes both through the population ageing, and the effectiveness of LLL and VET programmes in terms of skill developments. One could also imagine a gradual reabsorption of the skill mismatch, that is the distance between skills requested by jobs and those ones owned by workers. As highlighted by many OECD papers, an higher supply of HS workers and their better allocation across jobs can constitute the solution for a robust and sustainable economic growth.

Theoretically, skills determine an increase in the sectoral and aggregate productivity through the learning-by-doing mechanism. Inactivity and unemployment depreciate human capital, which is, instead, increasing during employment. Also training is expected to improve employees' working conditions, both in terms of employment probabilities and of wages. However, the literature does not confirm relevantly this assumption because of the presence of three main effects: i) the locking-in effect related to employment losses faced by trainees during the training period; ii) the low impact on short term trainees' working conditions; iii) the substitution effect with recruitments of trained workers instead of not-trained ones.

However, the literature is limited to US, Canada and, only partly, to Germany and the Scandinavian countries. Moreover, the econometric evaluation can only estimate the short-run effects, as few datasets contain long time series. Therefore, the econometric estimation cannot take into account the long-term evolution of the economic systems due to the ICT innovation.

The lack of a long-term evaluation justifies the use of the CGE model MAC18_DYN, modified in three aspects: i) detailed decomposition of the labour factor; ii) detailed decomposition of flows toward and from households; iii) the introduction of an imperfect competition on the labour market by modelling a wage curve with wages increasing in employment. The dynamic CGE model allows us to finding a General Equilibrium solution over a convenient time span in the context of an endogenous capital supply with a convergence path to the steady state. Labour supply is assumed exogenous, but training affects it according to three different effectiveness scenarios. ICT is modelled as the change in knowledge-intensive commodities.

The shock introduced in the model is the cut of 1 p.p. in employer' s SSC rates for LS and HS workers, respectively, in the LS- and HS simulation. Results of the simulations generally confirm that training does not affect significantly the real GDP growth in the simulation scenario compared with the benchmark. Real consumption remains unchanged following to training and increases only slightly following to the ICT innovation in the LS/HS simulation. The SSC intervention and the training programme determine a slightly negative effect on real investment and only the ICT innovation seems to strengthen it. External trade to GDP worsens slightly because of training, but losses are more than fully recovered with the ICT innovation, due to the satisfactory performance of real exports and the reduction in imports. This is also attributable to the lower import propensity in knowledge-intensive commodities than in the remaining ones. The increase in real investment with the ICT innovation determines an increase in the capital stock of the economy according the rule of capital accumulation over time. This determines an increase in productivity, as shown by the rise in the real GDP.

As for the labour market, the before outlined framework imply both a higher real wage (also because of lower deflators), and a lower aggregated employment level. This is one of the outcomes envisaged by the economic literature for innovation (i.e. labour-saving innovation vs. job creation hypothesis). However, HS labour demand registers lower reductions than MS and, partly, LS one. The cut in SSC rates seems to produce some positive effects on overall employment with a composition which is the direct consequence of the supported component (LS- and HS workers, respectively, in the LS- and HS simulation). Also the distribution of effects by activity change in both the simulations with an advantage for manufacturing in the LS-simulation and for knowledge-intensive services in the HS-simulation. In this context, training programmes appear to exert a positive effect by achieving an up-grading of employment by skill. This confirms the double dividend which can be associated with the cut in SSC rates. Indeed, such a measure could determine both a short-run benefit - in terms of lower unemployment for workers highly exposed to the risk of displacement, social marginalisation and skill deterioration - and a medium-long term benefit - due to up-skilling processes developed because of the learning-by-doing process. Clearly, cuts in SSC rates can only limit the negative consequences of ICT innovation in terms of total labour demand, and only a simultaneous increase in the aggregate demand could achieve the target of an higher employment.

Finally, the thesis tries to estimate econometrically the substitution elasticities between labour and capital, as well as among different types of labour. As shown in the literature, results of the CGE simulations could be sensitive to the value of substitution elasticities. The CGE model used in our simulations adopts the estimate in van der Werf, 2007 for labour/capital substitution and in Krusell *et al.*, 2000 for substation between different labour types. However these estimates have two main disadvantages: *i*) they refers to data which do not take into account the consequences of the 2008-2014 economic crisis; *ii*) the peculiarity of the Italian productive system could be neglected; *iii*) the elasticity of substitution by labour types should consider the characteristics of labour markets by country according to the regulation and the wage bargaining procedures.

A large heterogeneity across activities emerges from the analysis and the average value amounts to 0.5235 in the long-run specification and to 0.2078 in the short-run specification (vs. 0.5218 in van der Werf, 2007) for the labour/capital elasticity. The elasticity of substitution between labour types amounts to 4.1569 and 0.1456, respectively inr the long and the short run (vs. 1.67 in Krusell *et al.*, 2000). We can see that, as expected, substitutability increases over the time. Furthermore, the value of labour/capital elasticity appears coherent with the latest Italian data, differently from the substitutability among labour types. In this latter regard, in-depth analyses should be done, in order to ascertain the causes of the difference (i.e. the different Italian context or the structural break of the 2008-2014 economic crisis).

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12 - Appendix

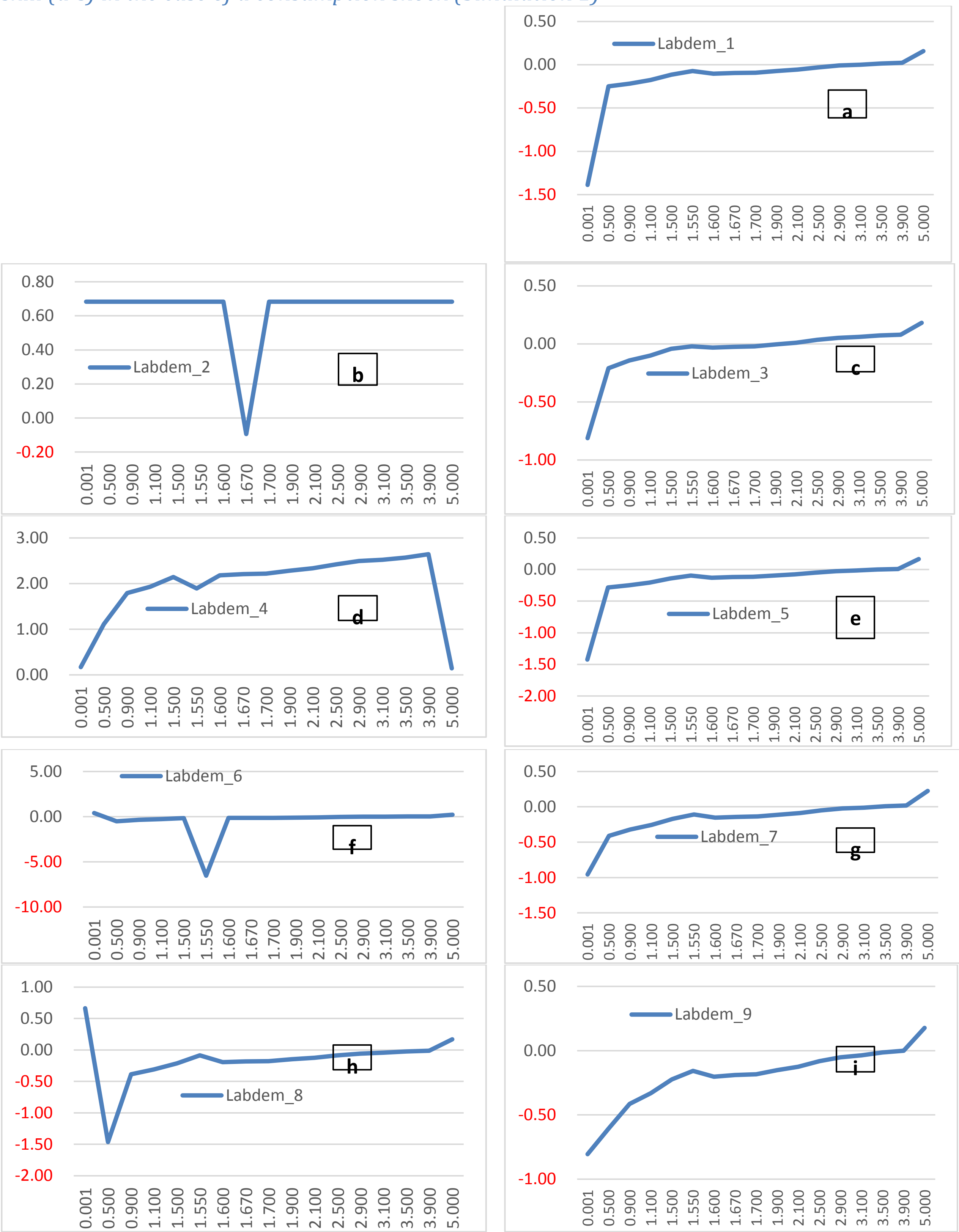
12.1 - Appendix 1 – Tables and figures of Part 1

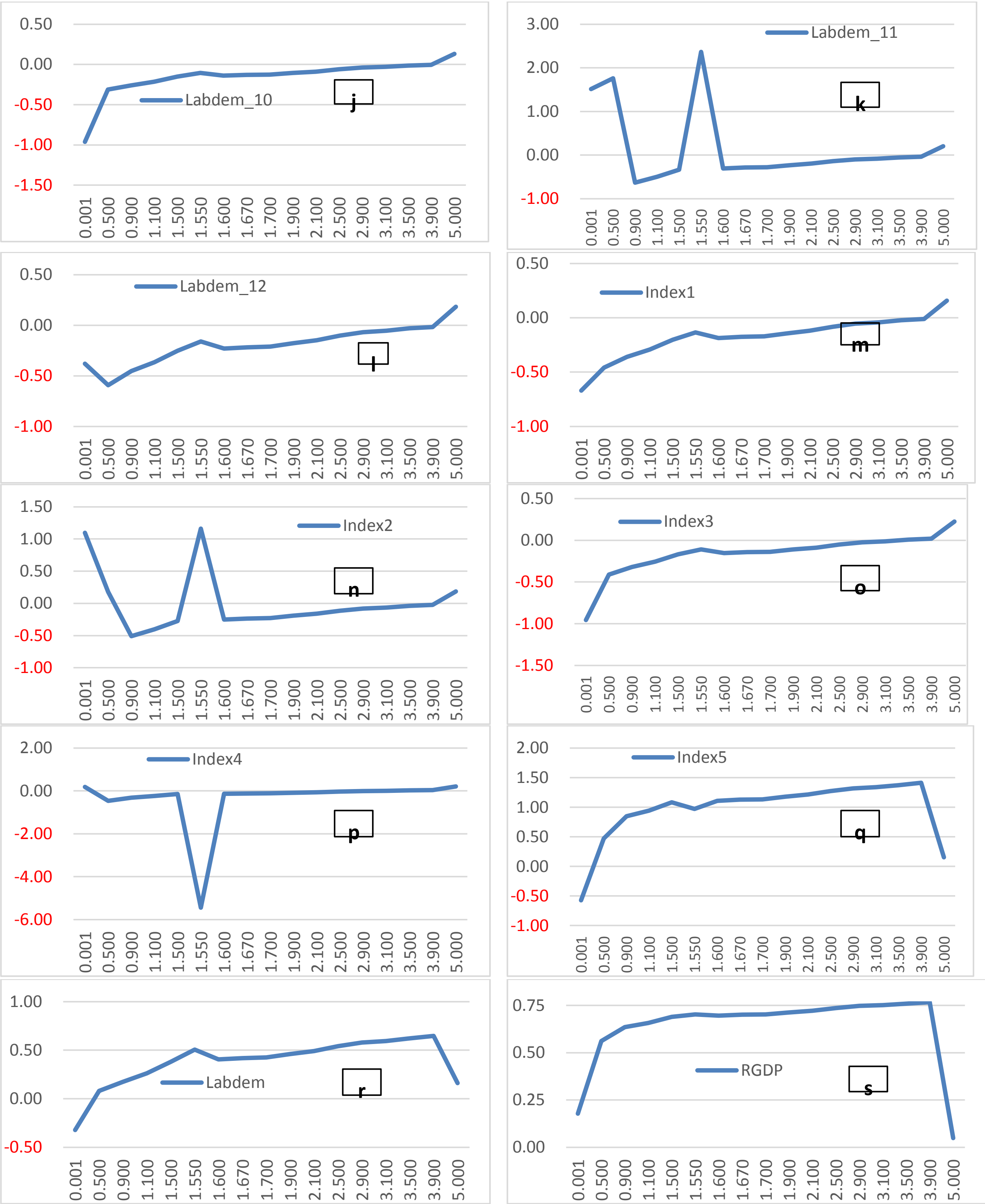
Table 12.1.1 - Distribution of labour compensation share by skill and activity

Activities	Low-skilled occupations		Medium-skilled occupations		High-skilled occupations		Using computers	High skilled occupations
	Not using com.	Using com.	Not using com.	Using com.	Not using com.	Using com.		
1	44.2%	0.0%	29.9%	16.7%	7.9%	1.2%	18.0%	9.2%
2	78.5%	0.0%	21.5%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0.0%	0.0%	85.5%	0.0%	0.0%	14.5%	14.5%	14.5%
4	19.7%	0.0%	0.0%	0.0%	0.0%	80.3%	80.3%	80.3%
5	19.3%	0.0%	41.5%	0.0%	4.7%	34.4%	34.4%	39.2%
6	32.2%	15.2%	21.0%	5.9%	13.1%	12.6%	33.6%	25.7%
7	11.8%	0.0%	52.4%	27.8%	8.0%	0.0%	27.8%	8.0%
8	75.0%	0.0%	0.0%	0.0%	10.6%	14.4%	14.4%	25.0%
9	0.0%	0.0%	85.9%	14.1%	0.0%	0.0%	14.1%	0.0%
10	0.0%	0.0%	43.4%	0.0%	56.6%	0.0%	0.0%	56.6%
11	25.2%	0.0%	0.0%	32.9%	18.2%	23.7%	56.6%	41.9%
12	16.5%	0.0%	4.8%	10.4%	0.0%	68.2%	78.7%	68.2%
13	32.8%	0.0%	15.2%	6.0%	23.6%	22.5%	28.5%	46.1%
14	23.2%	0.0%	37.3%	8.9%	5.6%	24.9%	33.8%	30.5%
15	20.1%	0.0%	12.8%	10.1%	24.7%	32.3%	42.4%	57.0%
16	17.6%	0.0%	22.6%	30.1%	3.5%	26.2%	56.3%	29.7%
17	26.7%	0.0%	0.0%	18.7%	5.9%	48.7%	67.4%	54.6%
18	17.3%	0.0%	13.8%	12.0%	0.0%	57.0%	68.9%	57.0%
19	15.4%	0.0%	19.5%	9.9%	5.8%	49.3%	59.2%	55.2%
20	24.1%	0.0%	34.1%	4.6%	15.8%	21.5%	26.1%	37.3%
21	28.9%	0.0%	26.0%	13.8%	19.4%	11.9%	25.7%	31.3%
22	20.7%	0.0%	34.2%	4.3%	9.9%	30.8%	35.1%	40.8%
23	0.0%	0.0%	57.6%	3.6%	12.0%	26.9%	30.5%	38.8%
24	3.1%	0.0%	11.1%	20.1%	5.5%	60.2%	80.3%	65.6%
25	6.5%	0.0%	42.1%	6.8%	0.0%	44.7%	51.4%	44.7%
26	44.2%	3.5%	0.0%	0.0%	6.1%	46.3%	49.8%	52.4%
27	13.0%	0.0%	32.9%	15.3%	9.5%	29.3%	44.6%	38.8%
28	6.8%	2.6%	58.2%	14.5%	0.0%	17.9%	35.0%	17.9%
29	19.9%	0.0%	25.1%	7.7%	6.8%	40.6%	48.3%	47.4%
30	4.3%	0.0%	70.4%	3.1%	14.4%	7.7%	10.9%	22.1%
31	51.4%	3.8%	12.6%	16.6%	5.6%	10.0%	30.4%	15.6%
32	24.7%	0.0%	25.8%	0.0%	49.5%	0.0%	0.0%	49.5%
33	0.0%	0.0%	64.1%	0.0%	0.0%	35.9%	35.9%	35.9%
34	28.0%	6.1%	15.4%	8.5%	0.0%	42.0%	56.6%	42.0%
35	12.1%	0.0%	58.5%	10.3%	6.1%	13.1%	23.4%	19.2%
36	12.0%	0.0%	70.7%	2.7%	13.6%	1.0%	3.7%	14.6%
37	0.0%	0.0%	12.9%	7.3%	17.3%	62.5%	69.8%	79.8%
38	11.4%	0.0%	27.3%	0.0%	17.8%	43.5%	43.5%	61.3%
39	0.0%	0.0%	11.5%	4.0%	12.4%	72.1%	76.1%	84.4%
40	0.0%	0.0%	2.1%	5.8%	0.0%	92.0%	97.9%	92.0%
41	0.0%	0.0%	14.3%	7.3%	2.9%	75.4%	82.7%	78.3%
42	0.0%	0.0%	9.5%	3.5%	0.0%	87.0%	90.5%	87.0%
43	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%
44	0.0%	0.0%	8.5%	16.0%	0.0%	75.5%	91.5%	75.5%
45	0.0%	0.0%	7.2%	13.4%	1.2%	78.3%	91.7%	79.5%
46	0.0%	0.0%	2.0%	0.0%	8.8%	89.2%	89.2%	98.0%
47	0.0%	0.0%	0.0%	0.0%	27.6%	72.4%	72.4%	100.0%
48	3.6%	0.0%	17.7%	11.6%	27.5%	39.7%	51.2%	67.2%
49	0.0%	0.0%	0.0%	7.9%	0.0%	92.1%	100.0%	92.1%
50	8.1%	0.0%	17.0%	47.8%	0.0%	27.1%	74.9%	27.1%
51	8.1%	0.0%	17.0%	47.8%	0.0%	27.1%	74.9%	27.1%
52	5.0%	0.0%	20.4%	40.1%	0.0%	34.6%	74.7%	34.6%
53	34.5%	0.0%	36.8%	0.0%	5.3%	23.4%	23.4%	28.7%
54	2.2%	0.0%	17.6%	11.6%	11.5%	57.2%	68.8%	68.7%
55	5.8%	0.0%	3.7%	0.7%	72.8%	17.1%	17.7%	89.8%
56	2.8%	0.0%	9.1%	2.5%	49.9%	35.7%	38.2%	85.6%
57	4.0%	0.0%	38.6%	3.2%	30.8%	23.4%	26.6%	54.2%
58	0.0%	0.0%	12.2%	7.4%	18.8%	61.5%	68.9%	80.3%
59	7.7%	0.0%	9.9%	18.0%	35.0%	29.3%	47.4%	64.3%
60	5.4%	0.0%	18.4%	6.1%	54.7%	15.5%	21.6%	70.1%
61	10.4%	0.0%	50.2%	0.0%	21.2%	18.2%	18.2%	39.4%
62	15.5%	0.0%	71.0%	1.8%	6.0%	5.7%	7.5%	11.7%
63	31.1%	0.0%	68.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Tot. econ.	12.4%	0.5%	26.1%	8.1%	16.5%	36.4%	45.0%	52.8%

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

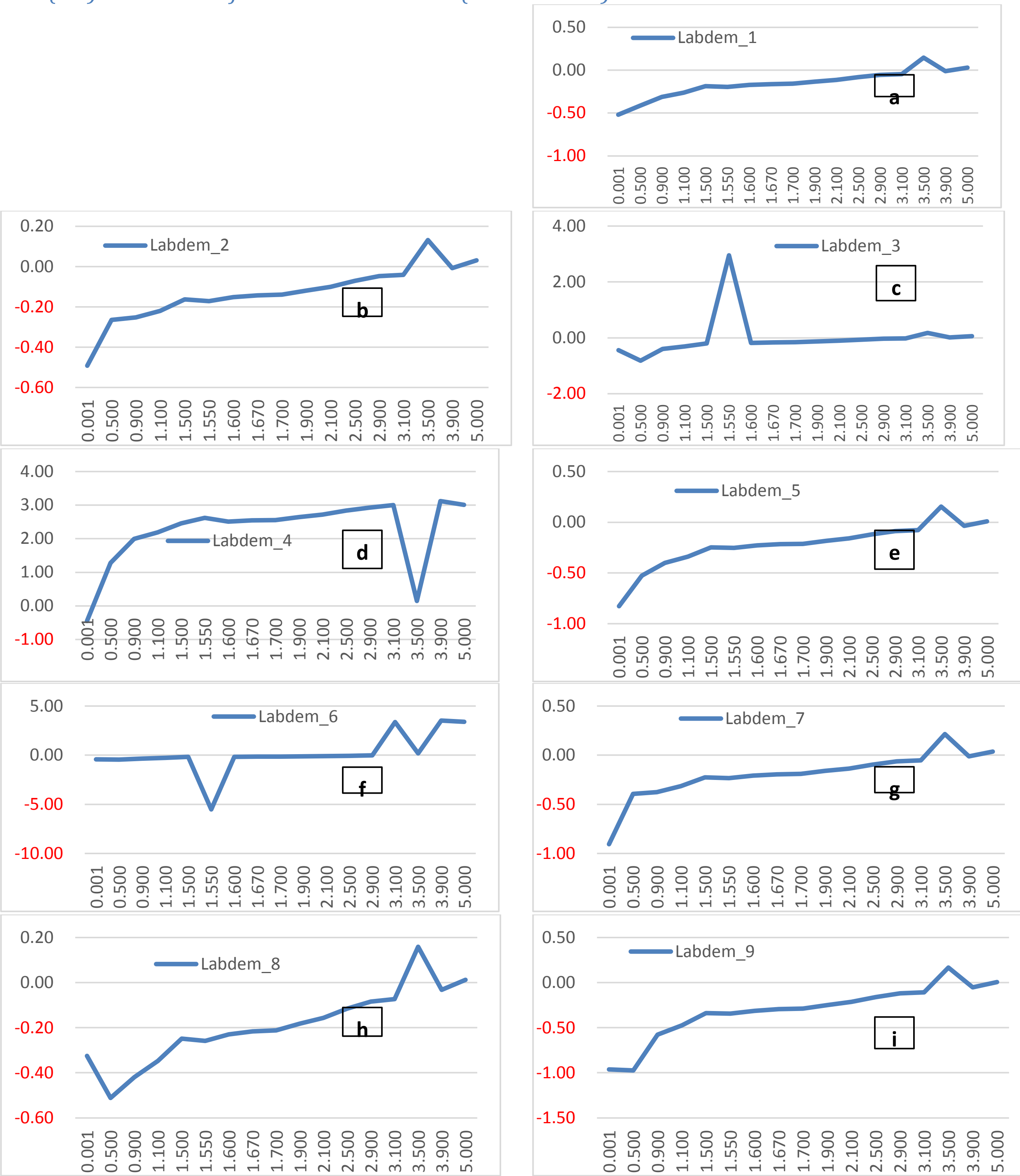
Figure 12.1.1 - Robustness check: percentage changes of RGDP and labour demand (in aggregated terms and by components) according to different values of substitution elasticity by skill (a-s) in the case of a consumption shock (Simulation 1)

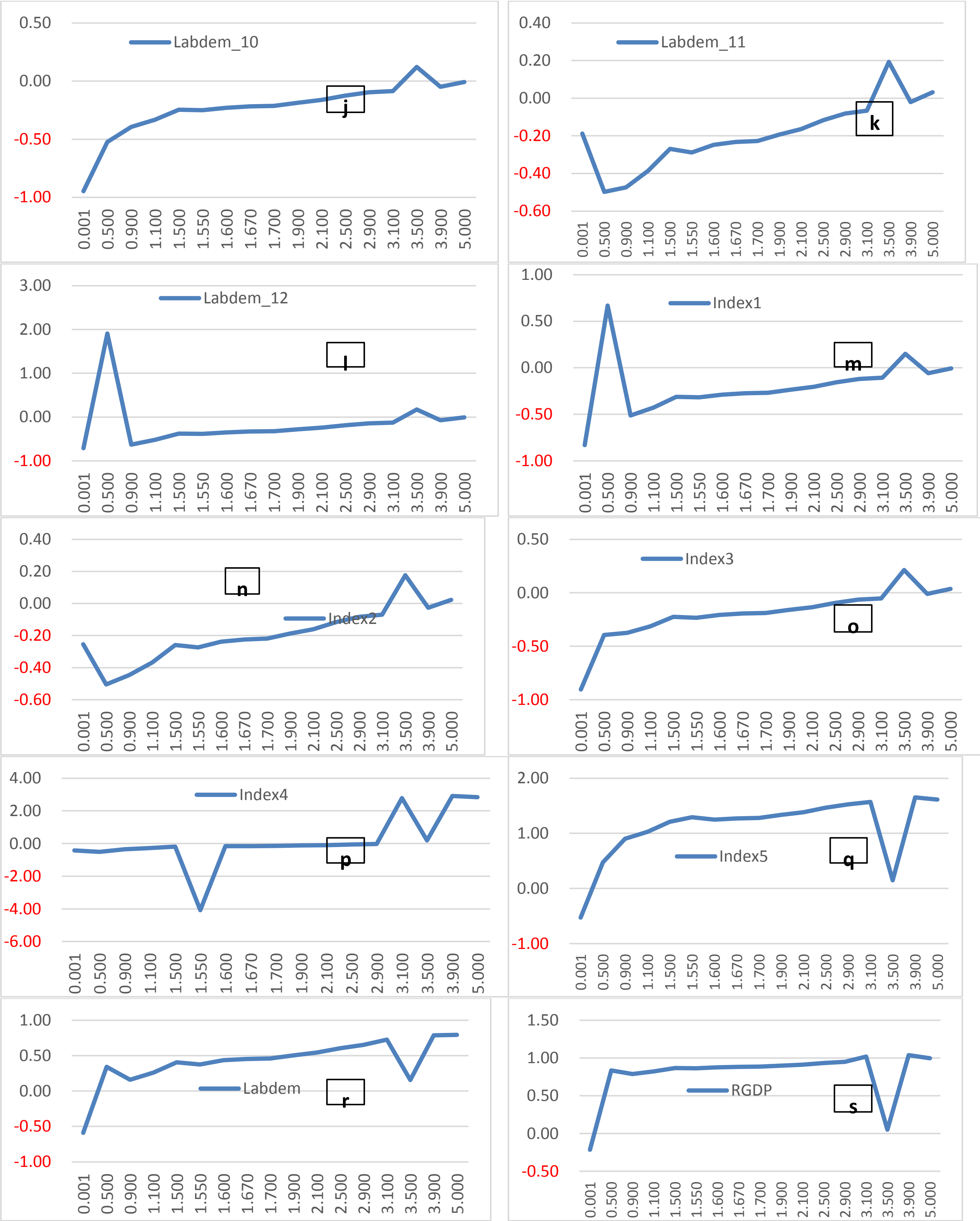




Source: Authors' calculations on the base of ISTAT, SIOPE and PIAAC data.

Figure 12.1.2 - Robustness check: percentage changes of RGDP and labour demand (in aggregated terms and by components) according to different values of substitution elasticity by skill (a-s) in the case of an investment shock (Simulation 2)





Source: Authors' calculations on the base of ISTAT, SIOPE and PIAAC data.

12.2 Appendix 2– Tables and figures of Part 2

Table 12.2.1 - Percentage distribution of labour compensation share by skill and activity

	Low-skilled occupations		Medium-skilled occupations		High-skilled occupations		Using computers	High skilled occupations
Activities	Not using com.	Using com.	Not using com.	Using com.	Not using com.	Using com.		
A01	76.77	3.32	7.34	6.75	4.25	1.58	11.64	5.83
A02	65.99	0.00	34.01	0.00	0.00	0.00	0.00	0.00
A03	20.08	0.00	59.62	0.00	0.00	20.30	20.30	20.30
B	32.38	0.00	0.00	0.00	0.00	67.62	67.62	67.62
C10-12	27.57	0.00	44.06	0.00	4.26	24.11	24.11	28.37
C13-15	42.29	15.78	22.53	4.27	8.59	6.55	26.60	15.14
C16	30.08	0.00	49.81	20.11	0.00	0.00	20.11	0.00
C17	84.04	0.00	0.00	0.00	7.84	8.12	8.12	15.96
C18	0.00	0.00	85.38	14.62	0.00	0.00	14.62	0.00
C19	0.00	33.35	33.01	0.00	33.64	0.00	33.35	33.64
C20	37.73	0.00	0.00	31.28	15.06	15.93	47.21	30.98
C21	24.44	0.00	6.18	12.38	0.00	56.99	69.38	56.99
C22	49.30	0.00	16.67	5.59	16.94	11.50	17.09	28.44
C23	31.16	0.00	39.39	8.71	4.50	16.24	24.95	20.74
C24	26.15	0.00	15.54	10.49	21.40	26.42	36.91	47.82
C25	28.82	0.00	23.23	30.23	0.00	17.72	47.95	17.72
C26	40.16	0.00	0.00	23.37	5.96	30.51	53.88	36.47
C27	30.28	0.00	16.10	12.29	0.00	41.34	53.63	41.34
C28	29.63	0.00	22.24	9.92	4.90	33.30	43.22	38.20
C29	34.42	0.00	34.47	4.43	13.11	13.57	18.00	26.68
C30	38.55	0.00	30.61	14.89	7.88	8.07	22.96	15.96
C31_32	36.84	0.00	41.71	5.37	2.66	13.42	18.79	16.08
C33	0.00	0.00	74.49	0.00	0.00	25.51	25.51	25.51
D	4.70	4.70	14.13	23.47	0.00	53.00	81.17	53.00
E36	8.35	0.00	49.61	7.82	0.00	34.21	42.03	34.21
E37-39	61.34	4.66	0.00	0.00	4.74	29.26	33.92	34.00
F	22.09	16.59	29.47	10.40	6.08	15.38	42.37	21.45
G45	11.58	3.86	53.55	19.45	0.00	11.56	34.87	11.56
G46	30.11	0.00	31.16	9.42	2.45	26.85	36.27	29.31
G47	6.09	0.62	74.43	4.97	8.17	5.72	11.31	13.89
H49	56.07	3.36	13.37	16.94	3.30	6.95	27.26	10.25
H50	50.43	0.00	24.04	0.00	25.53	0.00	0.00	25.53
H51	0.00	22.11	55.05	0.00	0.00	22.84	44.95	22.84
H52	38.44	8.71	17.40	8.44	0.00	27.00	44.15	27.00
H53	14.24	0.00	61.62	9.68	4.79	9.66	19.34	14.45
I	17.35	0.00	78.70	2.94	1.00	0.00	2.94	1.00
J58	0.00	0.00	24.48	12.57	13.00	49.95	62.52	62.95
J59_60	16.44	0.00	32.84	0.00	16.58	34.14	34.14	50.72
J61	5.48	0.00	17.99	5.97	6.07	64.49	70.46	70.56
J62_63	0.00	3.82	3.88	7.52	0.00	84.77	96.12	84.77
K64	1.31	0.00	19.58	9.24	2.66	67.21	76.44	69.87
K65	0.00	0.00	21.98	7.72	0.00	70.30	78.02	70.30
K66	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00
L68	0.00	0.00	22.13	38.95	0.00	38.93	77.87	38.93
M69_70	0.00	0.00	21.08	34.70	0.00	44.22	78.92	44.22
M71	0.00	6.71	13.08	0.00	20.71	59.51	66.21	80.22
M72	0.00	0.00	0.00	24.89	24.55	50.56	75.45	75.11
M73	11.41	0.00	38.09	11.76	25.62	13.12	24.88	38.74
M74_75	0.00	0.00	0.00	31.23	0.00	68.77	100.00	68.77
N77	32.16	0.00	0.00	30.08	0.00	37.76	67.84	37.76
N78	32.16	0.00	0.00	30.08	0.00	37.76	67.84	37.76
N79	10.58	0.00	19.64	48.08	0.00	21.70	69.77	21.70
N80-82	48.18	0.00	35.32	0.00	3.19	13.31	13.31	16.50
O	15.34	3.90	19.79	12.24	8.48	40.24	56.38	48.72
P	11.58	0.00	5.32	2.54	66.46	14.10	16.64	80.56
Q86	6.61	0.00	14.24	4.13	51.40	23.61	27.75	75.01
Q87_88	5.79	0.00	47.35	4.06	26.62	16.18	20.23	42.80
R90-92	0.00	0.00	16.39	16.72	17.15	49.74	66.46	66.88
R93	28.97	0.00	16.08	16.31	23.71	14.93	31.25	38.65
S94	9.17	0.00	27.12	8.59	46.40	8.72	17.31	55.12
S95	0.00	0.00	47.25	0.00	0.00	52.75	52.75	52.75
S96	16.75	0.00	83.25	0.00	0.00	0.00	0.00	0.00
T	33.80	0.00	66.20	0.00	0.00	0.00	0.00	0.00
Total	**20.69**	**2.16**	**27.29**	**9.25**	**14.54**	**26.07**	**37.48**	**40.61**

Source: Authors' calculation on ISTAT data (National Accounts) and PIAAC and EU-SILC data.

12.3 Appendix 3– Tables and figures of Part 3

Table 12.3.1 - Classification of activities in ESA-2010

nr	Name of the activities	Istat code
a1	Crop and animal production, hunting and related service activities	A01
a2	Forestry and logging	A02
a3	Fishing and aquaculture	A03
a4	Mining and quarrying	B
a5	Manufacture of food products; beverages and tobacco products	C10-12
aa6	Manufacture of textiles, wearing apparel, leather and related products	C13-15
a7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw	C16
a8	Manufacture of paper and paper products	C17
a9	Printing and reproduction of recorded media	C18
a10	Manufacture of coke and refined petroleum products	C19
a11	Manufacture of chemicals and chemical products	C20
a12	Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21
a13	Manufacture of rubber and plastic products	C22
a14	Manufacture of other non-metallic mineral products	C23
a15	Manufacture of basic metals	C24
a16	Manufacture of fabricated metal products, except machinery and equipment	C25
a17	Manufacture of computer, electronic and optical products	C26
a18	Manufacture of electrical equipment	C27
a19	Manufacture of machinery and equipment n.e.c.	C28
a20	Manufacture of motor vehicles, trailers and semi-trailers	C29
a21	Manufacture of other transport equipment	C30
a22	Manufacture of furniture; other manufacturing	C31_32
a23	Repair and installation of machinery and equipment	C33
a24	Electricity, gas, steam and air conditioning supply	D
a25	Water collection, treatment and supply	E36
a26	Sewerage, waste management, remediation activities	E37-39
a27	Construction	F
a28	Wholesale and retail trade and repair of motor vehicles and motorcycles	G45
a29	Wholesale trade, except of motor vehicles and motorcycles	G46
a30	Retail trade, except of motor vehicles and motorcycles	G47
a31	Land transport and transport via pipelines	H49
a32	Water transport	H50
a33	Air transport	H51
a34	Warehousing and support activities for transportation	H52
a35	Postal and courier activities	H53
a36	Accommodation and food service activities	I
a37	Publishing activities	J58
a38	Motion picture, video, television programme production; programming and broadcasting activities	J59_60
a39	Telecommunications	J61
a40	Computer programming, consultancy, and information service activities	J62_63
a41	Financial service activities, except insurance and pension funding	K64
a42	Insurance, reinsurance and pension funding, except compulsory social security	K65
a43	Activities auxiliary to financial services and insurance activities	K66
a44	Real estate activities excluding imputed rents and imputed rents of owner-occupied dwellings	L68
a45	Legal and accounting activities; activities of head offices; management consultancy activities	M69_70
a46	Architectural and engineering activities; technical testing and analysis	M71
a47	Scientific research and development	M72
a48	Advertising and market research	M73
a49	Other professional, scientific and technical activities; veterinary activities	M74_75
a50	Rental and leasing activities	N77
a51	Employment activities	N78
a52	Travel agency, tour operator reservation service and related activities	N79
a53	Security and investigation, service and landscape, office administrative and support activities	N80-82
a54	Public administration and defence; compulsory social security	O
a55	Education	P
a56	Human health activities	Q86
a57	Residential care activities and social work activities without accommodation	Q87_88
a58	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling activities	R90-92
a59	Sports activities and amusement and recreation activities	R93
a60	Activities of membership organisations	S94
a61	Repair of computers and personal and household goods	S95
a62	Other personal service activities	S96
a63	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	T

Source: Own elaborations

Table 12.3.2 - Classification of labour by skill level in the SAM

Index	Sex (1 male; 2 female)	Description	Labour group	
L1	1	Low occupations with a low-medium educational attainment and without ICT competences	Group2	Low-qualified male employment
L2	1	Low occupations with a low-medium educational attainment and with ICT competences	Group2	Low-qualified male employment
L3	1	Low occupations with an high educational attainment and with/without ICT competences	Group6	High-qualified male employment
L4	1	Medium occupations with a low-medium educational attainment and without ICT competences	Group4	Medium-qualified male employment
L5	1	Medium occupations with a low-medium educational attainment and with ICT competences	Group4	Medium-qualified male employment
L6	1	Medium occupations with high educational attainment and without ICT competences	Group6	High-qualified male employment
L7	1	Medium occupations with high educational attainment and with ICT competences	Group4	Medium-qualified male employment
L8	1	High occupations with low-medium educational attainment and without ICT competences	Group2	Low-qualified male employment
L9	1	High occupations with low educational attainment and with ICT competences	Group4	Medium-qualified male employment
L10	1	High occupations with medium educational attainment and with ICT competences	Group6	High-qualified male employment
L11	1	High occupations with high educational attainment and without ICT competences	Group6	High-qualified male employment
L12	1	High occupations with high educational attainment and with ICT competences	Group6	High-qualified male employment
L13	2	Low occupations with a low-medium educational attainment and without ICT competences	Group1	Low-qualified female employment
L14	2	Low occupations with a low-medium educational attainment and with ICT competences	Group1	Low-qualified female employment
L15	2	Low occupations with an high educational attainment and with/without ICT competences	Group5	High-qualified female employment
L16	2	Medium occupations with a low-medium educational attainment and without ICT competences	Group3	Medium-qualified female employment
L17	2	Medium occupations with a low-medium educational attainment and with ICT competences	Group3	Medium-qualified female employment
L18	2	Medium occupations with high educational attainment and without ICT competences	Group5	High-qualified female employment
L19	2	Medium occupations with high educational attainment and with ICT competences	Group3	Medium-qualified female employment
L20	2	High occupations with low-medium educational attainment and without ICT competences	Group1	Low-qualified female employment
L21	2	High occupations with low educational attainment and with ICT competences	Group3	Medium-qualified female employment
L22	2	High occupations with medium educational attainment and with ICT competences	Group5	High-qualified female employment
L23	2	High occupations with high educational attainment and without ICT competences	Group5	High-qualified female employment
L24	2	High occupations with high educational attainment and with ICT competences	Group5	High-qualified female employment

Source: Own elaborations

Table 12.3.3 - Percentage changes in macroeconomic variables due to simulations.

		SIM1LS	SIM2 LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2 HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Real GDP	1	0.15	0.15	0.15	0.15	0.14	2.65	0.12	0.12	0.12	0.12	0.11	2.65
	2	0.14	0.14	0.14	0.14	0.14	6.65	0.10	0.10	0.11	0.11	0.11	6.65
	3	0.13	0.13	0.13	0.14	0.15	9.70	0.10	0.10	0.10	0.10	0.11	9.70
	4	0.14	0.14	0.14	0.15	0.17	11.81	0.09	0.09	0.09	0.10	0.12	11.81
	5	0.15	0.15	0.15	0.16	0.17	12.28	0.09	0.09	0.09	0.10	0.12	12.28
Nominal GDP	1	0.15	0.15	0.13	0.11	0.18	-9.41	0.23	0.23	0.21	0.20	0.26	-9.41
	2	0.14	0.14	0.12	0.11	0.19	-5.44	0.21	0.21	0.19	0.18	0.25	-5.44
	3	0.13	0.13	0.12	0.12	0.21	-2.73	0.21	0.21	0.19	0.19	0.27	-2.73
	4	0.14	0.14	0.12	0.14	0.23	-1.26	0.21	0.21	0.20	0.21	0.29	-1.26
	5	0.15	0.15	0.14	0.16	0.25	-1.62	0.23	0.23	0.22	0.23	0.32	-1.62
GDP deflator	1	0.00	0.00	-0.02	-0.04	0.04	-11.75	0.12	0.12	0.09	0.07	0.14	-11.75
	2	0.00	0.00	-0.02	-0.03	0.05	-11.34	0.11	0.11	0.09	0.07	0.14	-11.34
	3	0.00	0.00	-0.02	-0.02	0.06	-11.33	0.11	0.11	0.09	0.08	0.16	-11.33
	4	0.00	0.00	-0.02	-0.01	0.07	-11.69	0.12	0.12	0.10	0.10	0.17	-11.69
	5	0.00	0.00	-0.01	-0.00	0.07	-12.38	0.14	0.14	0.12	0.13	0.20	-12.38

Real private consumption	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	-0.02	-0.02	-0.02	-0.02	-0.02	0.04	-0.01	-0.01	-0.01	-0.02	-0.02	0.04
	3	-0.03	-0.03	-0.03	-0.03	-0.03	0.07	-0.02	-0.02	-0.02	-0.03	-0.03	0.07
	4	-0.03	-0.03	-0.03	-0.04	-0.04	0.18	-0.03	-0.03	-0.03	-0.04	-0.04	0.18
	5	-0.03	-0.03	-0.04	-0.04	-0.04	0.34	-0.03	-0.03	-0.04	-0.04	-0.04	0.34
Nominal private consumption	1	-0.59	-0.59	-0.61	-0.62	-0.55	-10.83	-0.49	-0.49	-0.52	-0.53	-0.47	-10.83
	2	-0.53	-0.53	-0.55	-0.55	-0.48	-10.30	-0.44	-0.44	-0.46	-0.47	-0.41	-10.30
	3	-0.49	-0.49	-0.50	-0.50	-0.43	-10.06	-0.41	-0.41	-0.42	-0.42	-0.36	-10.06
	4	-0.46	-0.46	-0.48	-0.47	-0.40	-10.09	-0.38	-0.38	-0.39	-0.38	-0.32	-10.09
	5	-0.45	-0.45	-0.46	-0.45	-0.38	-10.38	-0.36	-0.36	-0.37	-0.35	-0.29	-10.38
Private consumption deflator	1	-0.59	-0.59	-0.61	-0.62	-0.55	-10.90	-0.49	-0.49	-0.52	-0.53	-0.47	-10.90
	2	-0.51	-0.51	-0.53	-0.54	-0.47	-10.34	-0.43	-0.43	-0.45	-0.46	-0.39	-10.34
	3	-0.46	-0.46	-0.48	-0.47	-0.40	-10.13	-0.38	-0.38	-0.40	-0.39	-0.33	-10.13
	4	-0.43	-0.43	-0.44	-0.43	-0.36	-10.26	-0.35	-0.35	-0.36	-0.35	-0.28	-10.26
	5	-0.42	-0.42	-0.42	-0.40	-0.33	-10.68	-0.32	-0.32	-0.33	-0.31	-0.24	-10.68
Real GFCF	1	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04
	2	-0.02	-0.02	-0.03	0.01	0.13	20.09	-0.03	-0.03	-0.04	-0.01	0.11	20.09
	3	-0.03	-0.03	-0.05	0.04	0.27	34.90	-0.05	-0.05	-0.07	0.01	0.23	34.90
	4	-0.03	-0.03	-0.05	0.07	0.37	44.52	-0.06	-0.06	-0.08	0.02	0.31	44.52
	5	-0.02	-0.02	-0.04	0.08	0.38	45.52	-0.06	-0.06	-0.08	0.02	0.30	45.52
Nominal GFCF	1	-0.61	-0.60	0.00	0.00	0.00	0.04	-0.49	0.00	0.00	0.00	0.00	0.04
	2	-0.63	-0.63	-0.66	-0.63	-0.46	8.49	-0.52	-0.52	-0.55	-0.53	-0.37	8.49
	3	-0.66	-0.66	-0.70	-0.63	-0.35	21.84	-0.54	-0.54	-0.58	-0.52	-0.26	21.84
	4	-0.70	-0.70	-0.74	-0.64	-0.29	30.10	-0.57	-0.57	-0.61	-0.52	-0.20	30.10
	5	-0.74	-0.74	-0.78	-0.68	-0.34	30.19	-0.59	-0.59	-0.63	-0.55	-0.23	30.19
GFCF deflator	1	-0.61	-0.60	0.00	0.00	0.00	0.00	-0.49	0.00	0.00	0.00	0.00	0.00
	2	-0.61	-0.61	-0.63	-0.64	-0.59	-9.66	-0.49	-0.49	-0.51	-0.52	-0.47	-9.66
	3	-0.63	-0.63	-0.65	-0.66	-0.61	-9.68	-0.49	-0.49	-0.51	-0.53	-0.48	-9.68
	4	-0.67	-0.67	-0.69	-0.70	-0.66	-9.98	-0.51	-0.51	-0.53	-0.55	-0.50	-9.98
	5	-0.72	-0.72	-0.74	-0.76	-0.71	-10.53	-0.53	-0.53	-0.55	-0.57	-0.53	-10.53
Real Government consumption	1	-1.14	-1.14	-1.14	-1.14	-1.14	-0.93	-1.14	-1.14	-1.14	-1.14	-1.14	-0.93
	2	-1.16	-1.16	-1.16	-1.16	-1.16	-0.61	-1.15	-1.15	-1.15	-1.15	-1.15	-0.61
	3	-1.18	-1.18	-1.18	-1.18	-1.18	-0.25	-1.16	-1.16	-1.16	-1.16	-1.16	-0.25
	4	-1.19	-1.19	-1.19	-1.19	-1.19	0.15	-1.17	-1.17	-1.17	-1.17	-1.17	0.15
	5	4.60	4.60	4.60	4.60	4.60	6.50	4.62	4.62	4.62	4.62	4.62	6.50
Nominal Government consumption	1	-1.56	-1.55	-1.57	-1.58	-1.53	-9.70	-1.51	-1.51	-1.52	-1.54	-1.49	-9.70
	2	-1.47	-1.47	-1.49	-1.50	-1.45	-9.87	-1.45	-1.45	-1.47	-1.48	-1.44	-9.87
	3	-1.39	-1.39	-1.41	-1.42	-1.37	-10.25	-1.40	-1.40	-1.42	-1.43	-1.39	-10.25
	4	-1.33	-1.33	-1.35	-1.36	-1.31	-10.84	-1.36	-1.36	-1.38	-1.39	-1.35	-10.84
	5	4.53	4.53	4.51	4.50	4.55	-6.43	4.47	4.47	4.45	4.44	4.49	-6.43
Government consumption deflator	1	-0.42	-0.42	-0.44	-0.45	-0.40	-8.85	-0.37	-0.37	-0.39	-0.41	-0.36	-8.85
	2	-0.31	-0.31	-0.33	-0.34	-0.29	-9.31	-0.30	-0.30	-0.32	-0.34	-0.29	-9.31
	3	-0.22	-0.22	-0.23	-0.24	-0.20	-10.03	-0.24	-0.24	-0.26	-0.27	-0.23	-10.03
	4	-0.14	-0.14	-0.15	-0.16	-0.12	-10.98	-0.19	-0.19	-0.21	-0.22	-0.18	-10.98
	5	-0.07	-0.07	-0.08	-0.09	-0.04	-12.14	-0.15	-0.15	-0.16	-0.17	-0.13	-12.14

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.4 - Percentage changes in macroeconomic variables due to simulations.

		SIM1LS	SIM2 LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2 HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Real export	1	0.48	0.47	0.49	0.50	0.45	5.01	0.38	0.38	0.39	0.41	0.36	5.01
	2	0.49	0.49	0.50	0.51	0.46	4.79	0.37	0.37	0.39	0.39	0.35	4.79
	3	0.52	0.52	0.53	0.53	0.48	4.74	0.37	0.37	0.39	0.39	0.34	4.74
	4	0.56	0.56	0.57	0.56	0.51	4.84	0.38	0.38	0.39	0.39	0.35	4.84
	5	0.61	0.61	0.62	0.61	0.55	5.07	0.40	0.40	0.41	0.40	0.35	5.07
Nominal export	1	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.05
	2	0.00	-0.00	-0.00	-0.00	-0.00	0.10	-0.00	-0.00	-0.00	-0.00	-0.00	0.10
	3	0.00	-0.00	-0.00	-0.00	-0.00	0.15	-0.00	0.00	-0.00	-0.00	-0.00	0.15
	4	-0.00	-0.00	-0.00	-0.00	-0.00	0.20	-0.00	-0.00	-0.00	-0.00	-0.00	0.20
	5	-0.00	-0.00	-0.00	-0.00	-0.00	0.25	-0.00	-0.00	-0.00	-0.00	-0.00	0.25
Export deflator	1	-0.47	-0.47	-0.49	-0.50	-0.45	-4.72	-0.38	-0.38	-0.39	-0.40	-0.36	-4.72
	2	-0.49	-0.49	-0.50	-0.50	-0.46	-4.48	-0.37	-0.37	-0.38	-0.39	-0.35	-4.48
	3	-0.51	-0.51	-0.53	-0.53	-0.48	-4.39	-0.37	-0.37	-0.38	-0.39	-0.34	-4.39
	4	-0.55	-0.55	-0.56	-0.56	-0.51	-4.42	-0.38	-0.38	-0.39	-0.39	-0.34	-4.42
	5	-0.61	-0.61	-0.61	-0.61	-0.55	-4.59	-0.40	-0.40	-0.41	-0.40	-0.35	-4.59
Real import	1	-0.09	-0.09	-0.10	-0.10	-0.09	-0.96	-0.07	-0.07	-0.08	-0.08	-0.07	-0.96
	2	-0.11	-0.11	-0.12	-0.11	-0.05	-1.19	-0.09	-0.09	-0.10	-0.09	-0.04	-1.19
	3	-0.12	-0.12	-0.13	-0.10	-0.01	-1.25	-0.11	-0.11	-0.12	-0.10	-0.01	-1.25
	4	-0.12	-0.12	-0.13	-0.09	0.02	-1.17	-0.11	-0.11	-0.13	-0.09	0.01	-1.17
	5	-0.11	-0.11	-0.12	-0.09	0.03	-1.03	-0.11	-0.11	-0.13	-0.10	0.01	-1.03

Nominal import	1	-0.09	-0.09	-0.10	-0.10	-0.09	-0.96	-0.07	-0.07	-0.08	-0.08	-0.07	-0.96
	2	-0.11	-0.11	-0.12	-0.11	-0.05	-1.19	-0.09	-0.09	-0.10	-0.09	-0.04	-1.19
	3	-0.12	-0.12	-0.13	-0.10	-0.01	-1.25	-0.11	-0.11	-0.12	-0.10	-0.01	-1.25
	4	-0.12	-0.12	-0.13	-0.09	0.02	-1.17	-0.11	-0.11	-0.13	-0.09	0.01	-1.17
	5	-0.11	-0.11	-0.12	-0.09	0.03	-1.03	-0.11	-0.11	-0.13	-0.10	0.01	-1.03
Import deflator	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00	0.00	0.00
	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trade balance on nominal GDP	1	0.03	0.03	0.03	0.03	0.03	0.15	0.03	0.03	0.03	0.03	0.03	0.15
	2	0.03	0.03	0.03	0.03	0.02	0.25	0.03	0.03	0.03	0.03	0.02	0.25
	3	0.03	0.03	0.04	0.03	0.01	0.30	0.03	0.03	0.04	0.03	0.01	0.30
	4	0.03	0.03	0.04	0.03	-0.00	0.32	0.03	0.03	0.04	0.03	0.00	0.32
	5	0.03	0.03	0.03	0.03	-0.00	0.31	0.03	0.03	0.04	0.03	0.00	0.31

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.5 - Percentage changes in real consumption by household type and for NPISHs due to simulations.

Real private consumption		SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
FAM1	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.50	1.50	1.50	1.50	1.50	1.60	1.50	1.50	1.50	1.50	1.50	1.56
	3	2.99	2.99	2.99	2.99	2.99	3.16	2.99	2.99	2.99	2.99	2.99	3.10
	4	4.48	4.48	4.48	4.47	4.47	4.75	4.48	4.48	4.48	4.47	4.47	4.71
	5	5.97	5.97	5.96	5.96	5.96	6.37	5.96	5.96	5.96	5.95	5.95	6.37
FAM2	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.53	1.53	1.53	1.53	1.53	1.63	1.53	1.53	1.53	1.53	1.53	1.58
	3	3.05	3.05	3.05	3.05	3.05	3.21	3.05	3.05	3.05	3.05	3.05	3.15
	4	4.57	4.57	4.56	4.56	4.56	4.83	4.57	4.57	4.56	4.56	4.56	4.78
	5	6.08	6.08	6.07	6.07	6.07	6.47	6.08	6.08	6.07	6.07	6.07	6.47
FAM3	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.53	1.53	1.53	1.53	1.53	1.62	1.53	1.53	1.53	1.53	1.53	1.58
	3	3.05	3.05	3.05	3.05	3.05	3.21	3.06	3.06	3.05	3.05	3.05	3.15
	4	4.57	4.57	4.56	4.56	4.56	4.82	4.57	4.57	4.57	4.56	4.56	4.78
	5	6.08	6.08	6.08	6.07	6.07	6.47	6.08	6.08	6.08	6.07	6.07	6.47
FAM4	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.53	1.53	1.53	1.53	1.53	1.63	1.53	1.53	1.53	1.53	1.53	1.58
	3	3.05	3.05	3.05	3.04	3.04	3.21	3.05	3.05	3.05	3.05	3.05	3.15
	4	4.56	4.56	4.56	4.55	4.55	4.82	4.57	4.57	4.56	4.56	4.56	4.78
	5	6.07	6.07	6.07	6.06	6.06	6.47	6.07	6.07	6.07	6.06	6.06	6.46
FAM5	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.53	1.53	1.53	1.53	1.53	1.64	1.54	1.54	1.53	1.53	1.53	1.59
	3	3.05	3.05	3.05	3.05	3.05	3.14	3.06	3.06	3.05	3.05	3.05	3.08
	4	4.57	4.57	4.56	4.56	4.56	4.84	4.57	4.57	4.57	4.56	4.56	4.79
	5	6.08	6.08	6.07	6.07	6.07	6.49	6.08	6.08	6.07	6.07	6.07	6.47
FAM6	1	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08
	2	1.52	1.52	1.52	1.52	1.51	1.63	1.52	1.52	1.52	1.52	1.52	1.58
	3	3.02	3.02	3.02	3.02	3.02	3.21	3.03	3.03	3.03	3.02	3.02	3.14
	4	4.53	4.53	4.52	4.52	4.52	4.81	4.53	4.53	4.52	4.52	4.52	4.75
	5	6.02	6.02	6.02	6.01	6.01	6.43	6.02	6.02	6.02	6.01	6.01	6.42
NPISH	1	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.14
	2	1.31	1.31	1.31	1.30	1.30	1.58	1.31	1.31	1.31	1.31	1.31	1.58
	3	2.61	2.61	2.61	2.61	2.61	3.07	2.62	2.62	2.62	2.61	2.61	3.10
	4	3.92	3.92	3.92	3.92	3.92	4.60	3.93	3.93	3.93	3.92	3.92	4.68
	5	5.24	5.24	5.24	5.23	5.23	6.17	5.25	5.25	5.24	5.24	5.24	6.32

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.6 - Percentage changes in the deflator of private consumption by household type and for NPHOs due to simulations.

Deflator of private consaumption		SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
FAM1	1	-0.58	-0.58	-0.60	-0.61	-0.55	-6.88	-0.48	-0.48	-0.50	-0.52	-0.46	-10.68
	2	-0.51	-0.51	-0.53	-0.54	-0.47	-6.51	-0.42	-0.42	-0.44	-0.45	-0.39	-10.15
	3	-0.47	-0.47	-0.48	-0.48	-0.41	-6.38	-0.37	-0.37	-0.39	-0.39	-0.33	-9.98
	4	-0.44	-0.44	-0.45	-0.44	-0.37	-6.45	-0.34	-0.34	-0.35	-0.34	-0.28	-10.13
	5	-0.44	-0.44	-0.44	-0.42	-0.36	-6.71	-0.31	-0.31	-0.32	-0.31	-0.24	-10.57
FAM2	1	-0.59	-0.59	-0.61	-0.62	-0.55	-7.01	-0.49	-0.49	-0.51	-0.53	-0.47	-10.87
	2	-0.52	-0.52	-0.53	-0.54	-0.47	-6.61	-0.43	-0.43	-0.45	-0.46	-0.39	-10.31
	3	-0.47	-0.47	-0.48	-0.47	-0.40	-6.46	-0.38	-0.38	-0.40	-0.40	-0.33	-10.11
	4	-0.44	-0.44	-0.45	-0.43	-0.36	-6.52	-0.35	-0.35	-0.36	-0.35	-0.28	-10.24
	5	-0.43	-0.42	-0.43	-0.41	-0.34	-6.77	-0.32	-0.32	-0.33	-0.31	-0.25	-10.68
FAM3	1	-0.59	-0.59	-0.61	-0.62	-0.55	-7.02	-0.49	-0.49	-0.52	-0.53	-0.47	-10.89
	2	-0.51	-0.51	-0.53	-0.54	-0.47	-6.62	-0.43	-0.43	-0.45	-0.46	-0.39	-10.33
	3	-0.46	-0.46	-0.48	-0.47	-0.40	-6.46	-0.38	-0.38	-0.40	-0.40	-0.33	-10.12
	4	-0.43	-0.43	-0.44	-0.43	-0.36	-6.52	-0.35	-0.35	-0.36	-0.35	-0.28	-10.24
	5	-0.42	-0.42	-0.43	-0.40	-0.34	-6.77	-0.32	-0.32	-0.33	-0.31	-0.25	-10.67
FAM4	1	-0.59	-0.59	-0.61	-0.62	-0.55	-7.07	-0.49	-0.49	-0.52	-0.53	-0.47	-10.96
	2	-0.51	-0.51	-0.53	-0.53	-0.46	-6.66	-0.43	-0.43	-0.45	-0.46	-0.39	-10.38
	3	-0.46	-0.46	-0.47	-0.47	-0.40	-6.49	-0.38	-0.38	-0.40	-0.39	-0.33	-10.16
	4	-0.43	-0.43	-0.44	-0.42	-0.35	-6.53	-0.35	-0.34	-0.36	-0.34	-0.28	-10.27
	5	-0.41	-0.41	-0.42	-0.39	-0.32	-6.78	-0.32	-0.32	-0.33	-0.31	-0.24	-10.68
FAM5	1	-0.59	-0.59	-0.62	-0.63	-0.56	-7.11	-0.50	-0.50	-0.52	-0.53	-0.47	-11.04
	2	-0.52	-0.51	-0.53	-0.54	-0.47	-6.70	-0.43	-0.43	-0.45	-0.46	-0.39	-10.44
	3	-0.46	-0.46	-0.47	-0.47	-0.40	-6.52	-0.38	-0.38	-0.40	-0.39	-0.33	-10.21
	4	-0.43	-0.43	-0.44	-0.42	-0.35	-6.57	-0.34	-0.34	-0.35	-0.34	-0.27	-10.32
	5	-0.41	-0.41	-0.42	-0.39	-0.32	-6.81	-0.32	-0.32	-0.32	-0.30	-0.24	-10.73
FAM6	1	-0.59	-0.59	-0.61	-0.62	-0.55	-6.99	-0.49	-0.49	-0.51	-0.53	-0.47	-10.85
	2	-0.51	-0.51	-0.53	-0.53	-0.46	-6.60	-0.43	-0.43	-0.45	-0.45	-0.39	-10.29
	3	-0.46	-0.46	-0.48	-0.47	-0.40	-6.44	-0.38	-0.38	-0.40	-0.39	-0.33	-10.08
	4	-0.43	-0.43	-0.44	-0.43	-0.35	-6.49	-0.35	-0.35	-0.36	-0.34	-0.28	-10.20
	5	-0.42	-0.42	-0.43	-0.40	-0.33	-6.73	-0.32	-0.32	-0.33	-0.31	-0.24	-10.62
ISP	1	-0.55	-0.54	-0.56	-0.58	-0.51	-6.58	-0.46	-0.46	-0.48	-0.49	-0.43	-10.28
	2	-0.47	-0.47	-0.49	-0.49	-0.42	-6.49	-0.40	-0.40	-0.42	-0.42	-0.36	-10.18
	3	-0.41	-0.41	-0.43	-0.42	-0.35	-6.61	-0.35	-0.35	-0.36	-0.36	-0.30	-10.41
	4	-0.37	-0.37	-0.38	-0.37	-0.30	-6.91	-0.31	-0.31	-0.32	-0.31	-0.25	-10.93
	5	-0.35	-0.35	-0.35	-0.33	-0.26	-7.37	0.18	-0.28	-0.29	-0.27	-0.20	-11.72

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.7 – Percentage changes in the employment and labour costs due to simulations.

		SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Total employment	1	-0.06	-0.06	-0.08	-0.08	-0.02	-5.70	-0.22	-0.22	-0.24	-0.25	-0.19	-9.42
	2	0.44	0.44	0.42	0.44	0.53	-4.95	0.03	0.03	0.01	0.02	0.11	-8.22
	3	0.93	0.93	0.92	0.95	1.07	-4.27	0.27	0.27	0.26	0.29	0.40	-7.40
	4	1.42	1.42	1.41	1.45	1.56	-3.67	0.51	0.51	0.51	0.55	0.65	-6.99
	5	1.91	1.91	1.91	1.93	1.98	-3.19	0.75	0.75	0.75	0.78	0.83	-7.08
Real labour cost per employee	1	0.59	0.59	0.61	0.62	0.56	7.56	0.50	0.49	0.52	0.53	0.47	12.24
	2	0.13	0.13	0.14	0.14	0.07	6.70	0.24	0.24	0.26	0.26	0.19	11.41
	3	-0.32	-0.32	-0.31	-0.32	-0.38	6.12	-0.01	-0.01	0.01	-0.00	-0.06	11.01
	4	-0.75	-0.75	-0.75	-0.76	-0.79	5.78	-0.24	-0.24	-0.24	-0.25	-0.28	11.00
	5	-1.17	-1.17	-1.17	-1.16	-1.15	5.66	-0.47	-0.47	-0.47	-0.47	-0.46	11.35
Total real labour cost	1	0.53	0.53	0.54	0.54	0.53	1.42	0.28	0.28	0.28	0.28	0.28	1.66
	2	0.57	0.56	0.56	0.58	0.60	1.42	0.27	0.27	0.27	0.28	0.30	2.25
	3	0.61	0.61	0.60	0.63	0.68	1.59	0.27	0.27	0.26	0.29	0.34	2.79
	4	0.66	0.66	0.66	0.69	0.75	1.90	0.27	0.27	0.27	0.30	0.36	3.24
	5	0.72	0.72	0.71	0.74	0.81	2.30	0.28	0.28	0.28	0.30	0.37	3.46
Total business sector employment	1	0.10	0.10	0.08	0.08	0.14	-6.11	-0.16	-0.16	-0.18	-0.19	-0.13	-10.29
	2	0.83	0.83	0.81	0.83	0.95	-5.10	0.20	0.20	0.18	0.20	0.31	-8.50
	3	1.57	1.57	1.55	1.60	1.75	-4.13	0.56	0.56	0.55	0.59	0.73	-7.16
	4	2.31	2.31	2.30	2.36	2.50	-3.20	0.93	0.93	0.92	0.98	1.11	-6.32
	5	3.07	3.07	3.06	3.09	3.16	-2.38	1.30	1.30	1.30	1.34	1.41	-6.15

Real business sector labour cost per employee	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	-0.47	-0.47	-0.47	-0.48	-0.48	-0.45	-0.24	-0.24	-0.24	-0.24	-0.24	-0.14
	3	-0.95	-0.95	-0.96	-0.96	-0.95	-0.91	-0.48	-0.48	-0.48	-0.49	-0.48	-0.30
	4	-1.44	-1.44	-1.44	-1.44	-1.40	-1.37	-0.72	-0.72	-0.73	-0.74	-0.70	-0.49
	5	-1.93	-1.93	-1.94	-1.91	-1.81	-1.83	-0.97	-0.97	-0.99	-0.97	-0.89	-0.68
Total business sector real labour cost	1	0.10	0.10	0.08	0.08	0.14	-6.11	-0.16	-0.16	-0.18	-0.19	-0.13	-10.29
	2	0.36	0.36	0.34	0.35	0.47	-5.53	-0.03	-0.04	-0.06	-0.05	0.06	-8.62
	3	0.60	0.60	0.58	0.62	0.78	-5.00	0.08	0.08	0.06	0.10	0.25	-7.44
	4	0.84	0.84	0.82	0.88	1.06	-4.52	0.20	0.20	0.18	0.23	0.40	-6.78
	5	1.08	1.08	1.06	1.12	1.29	-4.17	0.31	0.31	0.30	0.35	0.51	-6.79
Real wages	1	0.59	0.59	0.61	0.62	0.56	7.56	0.50	0.49	0.52	0.53	0.47	12.24
	2	0.13	0.13	0.14	0.14	0.07	6.70	0.24	0.24	0.26	0.26	0.19	11.41
	3	-0.32	-0.32	-0.31	-0.32	-0.38	6.12	-0.01	-0.01	0.00	-0.00	-0.06	11.02
	4	-0.75	-0.75	-0.75	-0.76	-0.79	5.79	-0.24	-0.24	-0.24	-0.25	-0.28	11.01
	5	-1.17	-1.17	-1.17	-1.17	-1.15	5.67	-0.47	-0.47	-0.47	-0.48	-0.46	11.37
Real labor compensation	1	0.53	0.53	0.54	0.54	0.53	1.42	0.28	0.28	0.28	0.28	0.28	1.66
	2	0.57	0.56	0.56	0.58	0.60	1.42	0.27	0.27	0.27	0.28	0.30	2.26
	3	0.61	0.61	0.60	0.63	0.68	1.59	0.27	0.26	0.26	0.29	0.34	2.80
	4	0.66	0.66	0.65	0.69	0.75	1.91	0.27	0.27	0.27	0.30	0.36	3.25
	5	0.72	0.72	0.71	0.74	0.81	2.30	0.28	0.28	0.28	0.30	0.37	3.48

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.8 - Percentage changes in employment by skill due to simulations.

Total employment		SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Low Skilled	1	0.35	0.35	0.33	0.31	0.35	-5.40	-0.45	-0.45	-0.47	-0.49	-0.45	-9.82
	2	1.29	1.29	1.26	1.23	1.28	-4.49	-0.42	-0.42	-0.45	-0.48	-0.44	-9.00
	3	2.23	2.23	2.19	2.13	2.16	-3.65	-0.40	-0.40	-0.44	-0.49	-0.48	-8.61
	4	3.17	3.17	3.13	3.02	2.96	-2.89	-0.39	-0.39	-0.43	-0.54	-0.59	-8.66
	5	4.12	4.12	4.06	3.86	3.67	-2.26	-0.38	-0.38	-0.43	-0.62	-0.80	-9.24
Medium-High Skilled	1	-0.47	-0.47	-0.49	-0.48	-0.41	-6.01	0.01	0.01	-0.00	0.00	0.07	-9.01
	2	-0.42	-0.42	-0.42	-0.36	-0.23	-5.43	0.48	0.48	0.48	0.53	0.66	-7.43
	3	-0.37	-0.37	-0.36	-0.24	-0.03	-4.90	0.95	0.95	0.96	1.08	1.28	-6.18
	4	-0.34	-0.34	-0.31	-0.12	0.14	-4.46	1.42	1.42	1.45	1.64	1.89	-5.32
	5	-0.31	-0.32	-0.26	-0.01	0.28	-4.12	1.89	1.89	1.94	2.19	2.48	-4.92

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.9 – Percentage changes in the real labour-cost per employee by skill due to simulations.

Real labour cost per employee		SIM1LS	SIM2LS	SIMTRAIN_LE_LS	SIMTRAIN_LS	SIMTRAIN_HE_LS	SIMTRAIN_HE_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LE_HS	SIMTRAIN_HS	SIMTRAIN_HE_HS	SIMTRAIN_HE_ICT_HS
Low Skilled	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	-0.87	-0.87	-0.86	-0.84	-0.80	-0.87	0.01	0.01	0.01	0.04	0.07	0.16
	3	-1.74	-1.74	-1.73	-1.66	-1.57	-1.73	0.01	0.01	0.02	0.09	0.18	0.33
	4	-2.62	-2.62	-2.60	-2.46	-2.27	-2.59	0.02	0.02	0.04	0.17	0.36	0.50
	5	-3.51	-3.51	-3.47	-3.24	-2.90	-3.45	0.02	0.02	0.06	0.29	0.62	0.68
Medium-High Skilled	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	-0.18	-0.18	-0.18	-0.20	-0.21	-0.15	-0.28	-0.28	-0.28	-0.30	-0.31	-0.22
	3	-0.35	-0.35	-0.37	-0.40	-0.43	-0.31	-0.56	-0.56	-0.57	-0.61	-0.64	-0.48
	4	-0.53	-0.53	-0.55	-0.61	-0.64	-0.47	-0.84	-0.84	-0.86	-0.92	-0.95	-0.76
	5	-0.72	-0.72	-0.74	-0.81	-0.84	-0.63	-1.13	-1.13	-1.16	-1.23	-1.26	-1.06

Source: Own simulations on ISTAT, EUKLEMS and SILC data.

Table 12.3.10 – Percentage changes in the real wages by skill due to simulations.

Real wages		SIM1LS	SIM2LS	SIMTRAIN_LowEff_LS	SIMTRAIN_LS	SIMTRAIN_HghEff_LS	SIMTRAIN_HgEff_ICT_LS	SIM1HS	SIM2HS	SIMTRAIN_LowEff_HS	SIMTRAIN_HS	SIMTRAIN_HghEff_HS	SIMTRAIN_HghEff_ICT_HS
Low Skilled	1	0.94	0.94	0.94	0.93	0.91	1.75	0.05	0.05	0.05	0.04	0.02	1.21
	2	1.02	1.02	1.02	1.01	1.02	1.50	0.01	0.01	0.01	0.01	0.01	1.62
	3	1.10	1.10	1.10	1.10	1.13	1.44	-0.01	-0.01	-0.02	-0.02	0.01	1.96
	4	1.20	1.20	1.19	1.19	1.23	1.51	-0.03	-0.03	-0.04	-0.04	-0.00	2.19
	5	1.30	1.30	1.29	1.28	1.31	1.66	-0.04	-0.04	-0.06	-0.06	-0.04	2.17
Medium-High Skilled	1	0.12	0.11	0.12	0.14	0.15	1.09	0.51	0.51	0.51	0.53	0.54	2.12
	2	0.11	0.10	0.11	0.14	0.18	1.33	0.52	0.52	0.53	0.56	0.60	2.90
	3	0.11	0.10	0.11	0.15	0.23	1.75	0.54	0.54	0.55	0.59	0.66	3.65
	4	0.11	0.11	0.12	0.18	0.27	2.30	0.57	0.57	0.58	0.63	0.73	4.32
	5	0.13	0.13	0.13	0.20	0.30	2.95	0.61	0.61	0.61	0.67	0.77	4.79

Source: Own simulations on ISTAT, EUKLEMS and SILC data.