Employment incentives and the disaggregated impact on the economy. The Italian case

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Abstract

Over the past two decades, the Italian labour market has undergone a number of profound changes. A thorough analysis of these changes shows that there has been a progressive employment polarisation, although with a very peculiar dynamics. While employment did grow in high-skill and low-skill occupations, and it shrank in the medium-skill ones, these changes did not take place simultaneously, as polarisation assumes. Moreover, wage polarisation is hardly observable in the same period. Quite differently, Italy has been characterised by relatively low or even declining returns to education along with progressively decreasing wages in the low-skill segment of the labour market. In this context, we study the potential of an employment incentive policy, for which we imagine two options, one targeting workers in high-skill and the other in low-skill occupations. The objectives of the policy are enhancing aggregate employment and improving working conditions (wages) either in high-skill or low-skill occupations, depending of the option. For the simulation of the two policy options, we employ an integrated model that combines a macro disaggregated and multi-sectoral Computable General Equilibrium (CGE) model with a micro-simulation model. While the CGE model evaluates how the macroeconomic shock reverberates on the labour demand at industry level, the micro-simulation model computes how the changes in macroeconomic variables affect households' decisions in terms of labour supply and final consumption.

Keywords Skills · Labour force and employment · Labour demand · Social accounting matrix · CGE models · Fiscal policy

JEL codes C68 · E16 · I26 · J21 · J24

Additional results and copies of the computer programs used to generate the results presented in the paper are available from the lead author at francesca.severini@unimc.it.

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1 Introduction

Since the early Nineties, the Italian labour market has undergone a series of profound changes. In the face of the complexity of the whole picture, Basso (2019) observes two main stylised facts. In terms of employment, the labour market experienced a major upgrading in the years before the mid-2000s (e.g. Goos et al. 2009; Olivieri 2012; Olivieri and Nellas 2012), with an expansion in high-skill employment and a contraction in low-skill occupations, and a subsequent downgrading in the following decade (Basso 2019; Bosio and Leonardi 2010; Franzini and Raitano 2009). In terms of wage levels, the periodization is similar but the evolution is different. Between the mid-Eighties and the mid-2000s, there is evidence of a substantial wage polarization (see Rosolia 2010; Olivieri 2012), which reverses in the second period. Beside these two major facts, the Italian labour market exhibits a number of further peculiarities (e.g. the shrinking returns to education, the so-called brain drain phenomenon, the declining probability of finding a job) which make it quite unique among its partners.

Notwithstanding these peculiarities, the overall outcome of the two stylised facts yield a transformation pattern, which very much resembles the one observed in most OECD countries. For Italy, various studies (e.g. Goos et al. 2014; OECD 2017, Basso 2019) confirm in fact that the labour market underwent a major employment polarization. In the conventional wisdom however, polarization involves a contemporaneous expansion in the high-skill *and* in low-skill occupations (Basso 2019), something which has not really happened in Italy. When polarization is due to the so-called routine-biased technical change (e.g. Autor et al. 2003, 2006; Autor and Dorn 2013), employment polarization should typically couple with wage polarization, something, which again has not happened in Italy.[1] These points challenge the view that Italy's labour market has really undergone the same transformation observed in other countries, although they cannot be conclusive to reject it. At the same time trying to ascertain whether Italy's polarization has a similar nature as the other countries is very much an exercise of investigating the reasons behind the observed transformation. In policy perspective, understanding the determinants of a given phenomenon is necessary when the intention is to counteract, or at least, to dampen it.

Yet, policy intervention may also move into another direction. In consideration of the consolidated nature of polarization, it may be sensible to take action *in the framework of* rather than *against* polarization. In other words, rather than targeting the causes of polarisation, policy intervention may serve to dampen its unwanted effects. "One of the main concerns with rising job polarisation is its potential implication for wage inequality" (OECD 2017). Indeed, polarization mostly affects households with medium-skill and low-skill occupations. In the case of Italy, for example, ISTAT (2018a) documents a sharp fall in the wage levels of the low-skilled

[1] As we will observe in Sect. 3, a further fact challenging this view is the slow diffusion of ICT and automation in Italy.

segment.[2] At the same time, the high-skill segment of the Italian labour market also deserves potential attention from policymaking. As we mentioned in the first paragraph of this Introduction, Italy's labour market has a number of peculiarities. One is the shrinking returns to education, which results from the strong supply increase over the last two decades and the weak or stagnating demand (see for example, Piva and Vivarelli 2005; Falzoni and Tajoli 2008). A second issue is the (possibly) related brain-drain phenomenon, and a third one is the generalised fall in the probability to find a job (e.g. Green and Henseke 2017; OECD 2018; Cattani and Pedrini 2020).

The consideration of these issues (lowering living standards in the low-skill segment, poor or even absent growth in high-skill remuneration, brain-drain and unemployment risk) altogether seemingly point to a precise set of policy objectives, which include supporting wages in the low-skill occupations, rising college premia and increasing employment at the aggregate level. Given these objectives, this paper focuses on the possible effects of an employment incentive policy. Employment incentives can take a variety of forms (see Hamermesh 1993), and in the past, they have been used with the broader aim of counteracting the adverse effects of economic downturns (as in the case of the New Jobs Tax Credit[3] after the 1973–1975 crisis). In the case of the Italian labour market, their main justification rests on the objective of maintaining decent living standards for low-skill workers and granting a higher education premium to high-skill workers. In this perspective, employment subsidies allow both to assure the compliance with the profitability rule for firms and social adequacy in terms of take-home gross wage for workers (Hamermesh 1993). Hence, the main goal of employment incentives is not one of contrasting employment polarization, but the rise of wage levels (Burns et al. 2013).

The investigation of the implications of the employment incentive policy relies on an integrated MICRO–MACRO model, which portrays Italy as a small open economy. The model is composed by a macro and a micro module, which are mutually interlinked. The macro module consists in the MAC-19 Computable General equilibrium (CGE) model[4] while the micro module contains a Microeconomic Decision Model (MDM) based on microdata. The MAC-19 model allows for involuntary unemployment and an upward-sloping wage-employment curve, and it is calibrated on the Social Accounting Matrix (SAM) for Italy for the year 2014. The SAM and the model are developed to account for three occupation levels (low-skill, medium-skill and high-skill), eight types of workers and six types of Households. The three occupation levels correspond to the types of labour (as a production factor) that firms may choose to hire. In the MAC-19 model, the distinction between these three types of labour serves the scope of accounting for polarization, as in the conventional polarization literature. Workers differ in terms of gender (male/

[2] Other more severe effects are in order, however. These include for example, the deterioration of acquired professional abilities, or beyond the mere economic sphere, the spread of social problems (Hoon and Phelps 1997).

[3] One of the measures contained in the New Jobs Tax Credit was a tax credit to employers equal to 50% of the first $4200 paid to each worker. Firms 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.

[4] This is the model developed on the basis of Ciaschini et al. (2015) and Severini et al. (2019).

female), formal education level (low/high) and ICT knowledge (present/absent). In order to account for the real-world complexity, we assume that all eight types of workers can (ideally) have a low-level, a medium-level or a high-level occupation. Hence, there are 24 groups of workers altogether. Households are disaggregated in income groups. The data for the MDM are obtained by combining the Statistics on Income Living Conditions (SILC) for 2014 with other survey data, in order to obtain a clearer and more complete representation of the Italian population.

This article seeks to contribute to the empirical literature on employment incentives in Italy.[5] This type of measure has been implemented in the past, as for example in October 2000 with the aim of rebalancing the number of temporary contracts in favour to permanent positions. In order to ascertain the effectiveness of the measure, Cipollone et al. (2005) apply a difference-in-difference estimation to the microdata of the Italian Labour Force Survey, and show that the policy did actually induce a significant increase in the labour force participation (by 1.4% in 2001 and 2.1% in 2002 for males between 35 and 54 years old). This type of study clearly succeeds in capturing the effects of socio-demographic variables, but it neglects the general equilibrium effects (Pauw and Leibbrandt 2012).[6] The integration of microsimulation strategies into CGE settings yields a powerful instrument for policy analysis (Peichl 2009; Cockburn et al. 2010). Yet, the use of an integrated MICRO–MACRO model for Italy is quite a novelty in the debate: to our best knowledge, no study has used yet the micro–macro integration to investigate labor market policies in Italy.[7]

In this perspective, the contribution of this paper to the literature on employment incentives is also due to the methodology adopted. Very often, the micro-level merely consists in a household survey, and the simulated policy is modelled as a macroeconomic shock on the labor demand. In this framework, the microeconomic level serves to evaluate the distributive and poverty consequences of the macroeconomic changes. Only few authors seek to compute labour supply and consumption demand at microeconomic (i.e. individual or household) level (e.g. Franz et al. 2008; Boeters and Feil 2009; Peichl and Schaefer 2009). In our case, the shock is introduced at the macro level and its effects spread to the micro module. The changes at the microeconomic level involve adjustments in the wage and labour demand, as well as in the personal income tax rates in the case of full provision. All these changes affect the decision of participating to labour market and the decision of how much to participate (i.e. extensive and intensive margin) through a discrete-choice model à la Van Soest (1995). The resulting change in the aggregate labour supply is then included in the CGE module as an exogenous shock, in order to obtain a new

[5] A similar literature is also available for other countries. In the case of South Africa, for example, Pauw and Edwards (2006) and Pauw (2009) find that employment subsidies do generally sustain medium- and low-skilled employment. For Switzerland, see for example Mueller (2004). From a methodological point of view, this literature adopts either a partial equilibrium or a general equilibrium approach.

[6] Another type of studies with a partial equilibrium perspective rely on experimental techniques (e.g. Burtless 1985). For a comparison between the two types of approaches, see Hamermesh (1993).

[7] Caiumi (2018) combines a microsimulation with a CGE model in order to simulate the effects of a selection of corporate tax reform options.

general equilibrium. The process is replicated until the micro–macro coherence is obtained.

Section 2 describes the employment incentive policy, and it illustrates its rationale in the case of Italy. Section 3 complements Sect. 2 with a brief overview of the relevant stylised facts regarding Italy's labour market over the last two decades. Section 4 describes the datasets and the integrated MICRO–MACRO model used for policy assessment, and Sect. 5 contains the main simulation results. Section 6 concludes.

2 An employment policy for Italy's labour market

As illustrated in the Introduction, the Italian labour market has undergone profound changes over the last three decades. While the overall transformation seems to take the form of a substantial employment polarization, a more thorough investigation of the whole process reveals that the dynamics behind this major change is quite at odd with the conventional notion of *employment polarization*. For sake of exposition, we discuss this issue and the main stylized facts regarding the Italian labour market in the next Section, and we devote this Section to the illustration of the employment policy that is simulated in this paper. We describe the main features of this intervention, how it fits into Italy's current economic context, and its expected effects.

The policy involves an employment incentive, which takes the form of a cut in firms' social security contribution (SSC) payments. We compare two policy options whereby policy-option LOW targets low-skill occupations and policy-option HIGH focuses on high-skill occupations. Our analysis assumes to implement the policy in the economy as of 2014, i.e. in a time when the occupational structure has already polarised (OECD 2017; Goos et al. 2009). This timing is coherent with the rationale of the policy as an intervention *in the framework of* rather than *against* polarisation. Indeed, none of the policy options has the primary objective of supporting medium-level occupations. In times of fiscal constraints, we assume to finance the employment policy through an increase in the personal income tax (PIT) rates of the three richest income brackets.[8] As a benchmark, we also consider the case of no provision, with a subsequent increase in public deficit. While it is true that the objectives of both policy options are rising employment and wages, it is important to consider (at least) these two (polar-opposite) financing strategies in order to see how policy outcomes differentiate in the two cases.

The two policy options under scrutiny (LOW and HIGH) share the objective of fostering aggregate employment without prioritising one occupation level over the others. This objective reflects the need of coping with the considerable

[8] There is a variety of options to finance the wage-subsidisation policy and the choice among them strongly influences the overall effect of the scheme (Hutton and Ruocco 1999), for example, the savings in welfare expenditures devoted to workers benefitting from the scheme (Hoon and Phelps 1996). Heintz and Bowles (1996) propose to use a capital tax, which could further increase the price of capital relative to wages after the subsidisations.

unemployment rates, which have characterised the Italian economy over these last two decades (in 2014, the average unemployment rate was well above 12%). Indeed, one major purpose of this paper is to investigate the potential of an employment policy in a polarised framework, and this with the awareness that such a policy may possibly foster rather than dampen polarisation. In virtue of their design as an employment incentive, both policy options have also the objective of rising wages (primarily) in the targeted occupational segment. Although this holds true for both policy options (LOW and HIGH), it is important to distinguish between the rationales behind each one them.

With regard to policy-option LOW, the objective of increasing wage levels correspond to the concern that employment polarization has not really proceeded together with wage polarization (Basso 2019). In other words, wages in low-skill occupations have failed to grow with employment. As discussed in Sect. 3, this goes back to the fact that employment polarisation in Italy yields as a result of a first phase of occupational upgrading and a second phase of occupational downgrading. While it is true that "wage polarisation has not been found in later decades in the United States (Mishel et al. 2013; Autor 2015),[9] nor at any point in time in any other country where job polarisation has occurred" (OECD 2017: 93), in the case of Italy, ISTAT (2018a) reports about shrinking wage levels in the low-skill occupations over the last years. This is consistent with the fact that employment in low-skill occupations is increasing because of higher supply (Oesch 2010; Autor 2015). The declining demand for medium-skilled workers in fact, which in Italy has been persistent since the early Nineties, has the effect of pushing this category partly towards high-skill and partly towards low-skill occupations, with the effect of worsening working conditions and wages (Nickel and Bell 1995).

The reasons for policy-option HIGH are more connected with the specific peculiarities of the Italian labour market. While we leave for the next Section a discussion of these peculiarities, here we recall here two main issues, which motivate this policy. One is the relatively low and even declining returns to education, which go together with the rise in precarious contracts and with growing flexibility. The other is the still limited diffusion of ICT knowledge (e.g. Benvenuti et al. 2013) among workers in medium-skill and low-skill occupations. Hence, the policy pursues two indirect effects beyond the objectives in terms of employment and wages that we discussed above in this Section. One is to mitigate the brain drain, i.e. the migration of highly-educated workers, whereas the other is to provide an assessment of the pool of unemployed workers (with low education levels) needing to attend up-skilling programs. It is fair to observe that the first effect is indirect in the sense that factor migration is excluded in our modelling setting. It is clear however, that an improvement in the working conditions of workers in high-skill occupations, as given by the simulated policy option, has a presumably positive impact on brain drain. As for the second effect, this is also indirect because the current setting is incapable of accounting for up-skilling programmes. Their introduction would require a series of changes. It would be necessary to allow for the payment flows regarding their costs

[9] Basso (2019) shows an opposite evidence for the period 2007–2017.

(either for the public administration or for firms), as well as for appropriate mechanisms that depict workers' shifts across types (on the labour supply side) and the reaction of labour demand to factor-specific technological changes.[10]

3 The Italian labour market over the last two decades

This section seeks to provide a short illustration of the main stylised facts, which have characterised the Italian labour market over the last two decades, i.e. since the early Nineties. For sake of exposition, it will consider those aspects of the Italian labour market, which are more closely related to the purpose of this paper. The main issue in this regard is whether Italy's labour market has really undergone a process of polarisation and which dynamics stays behind it. Further issues involve some specific peculiarities of the Italian labour market.

If we observe the overall evolution of the Italian labour market since the early Nineties, we do actually find a substantial process of employment polarisation. In this respect, two different studies (Goos et al. 2014; OECD 2017) come to the same conclusion for two similar time spans (1993–2010 and 1995–2015 respectively). However, a closer look at the whole period allows highlighting that the dynamics behind Italy's polarisation strongly differ from conventional prescriptions in this regard. Indeed, there are two main facts, which make difficult to conclude that the Italian polarization process has the same features *and* the same determinants as polarisation in the other countries. One relates to the evolution of the employment shares of high-skill and low-skill occupations in comparison to medium-skill occupations. The other refers to the pace of ICT adoption and automation diffusion among Italian firms.

With regard to the first fact, Basso (2019) suggests to split the whole period (ranging from the mid-Nineties to the mid-2010s) into two shorter intervals, one going approximately until the 2008 Recession and the second starting at that time. In the first interval, Italy experienced an expansion of employment in high-skill occupations, mainly at the expenses of low-skill occupations (see for example, Goos et al. 2009; Olivieri 2012; Olivieri and Nellas 2012). In the second interval, the evolution was roughly the opposite. Low-skill occupations rose in terms of employment shares while high-skill "registered an ambiguous result" (D'Amuri and Peri 2014), or at best, remained stable. Most of this missing growth in high-skill occupations is due to the Recession. In the period between 2007 and 2010, the employment share of high-skill occupations felt by 2.2% points (Brandolini et al. 2018 and Basso 2019). Once the recovery started, a correspondent reversal did actually take place, but its size remained quite limited (D'Amuri and Peri 2014; Basso 2019). As for medium-skill occupations, the decrease in their employment share persisted during the whole period (from the mid-Nineties

[10] In this perspective, policy-option LOW can also have the indirect effect of granting up-skilling opportunities to low-skilled workers, with consequent changes in labour-supply composition over the medium term.

onward), with an acerbation of this tendency during the second part of the double dip recession (between 2010 and 2013), when it decreased by 3.4% points (Basso 2019). As we observed in Sect. 2, the shrinking employment in middle-skill occupations took the form of an upsurge of labour supply in low-skill occupations (with the predictable consequence of worsening working conditions).

The lack of simultaneity between the employment growth in high-skill and in low-skill occupations seems coherent with the second fact, which has characterized Italy since the Nineties, i.e. "the limited adoption by Italian firms of various types of automating technologies […] or other ICT practices" (Basso 2019: 13). Indeed, in virtue of its nature of demand-driven shock, the so-called skill-biased technological change should bring about a contemporaneous increase in high-skill and low-skill occupations. A further sign of the scarce role, which automation might have had in the labour market polarisation is the substantial absence of wage polarisation. The available evidence in fact, indicates that wage polarisation has occurred between 1985 and 2004 (e.g. Rosolia 2010; Olivieri 2012), whereas in the following period (namely, 2009–2017), wage growth has followed a fairly opposite trend, although with a quite negligible size. It is important to observe that wage polarisation does not necessarily accompany employment polarisation, as we observed in Sect. 2. Indeed, automation is a major engine behind polarisation, but it is not the only one. Other factors as for example, globalization (OECD 2017) and deindustrialization (Bárány and Siegel 2018) can induce polarization.

The missing growth of wages in high-skill occupations is at odd with polarisation, but is coherent with a major peculiarity of the Italian labour market. Over the last two decades the supply of highly educated labour has strongly increased but demand remained quite stagnant. As observed by Schivardi and Schmitz (2018), this fact is well related to the slow and in case limited adoption of ICT and automation, which complement highly educated labour (e.g. Krusell et al. 2000, Bresnahan et al. 2002 and OECD 2003). This had two major effects: returns on education remained very low and high-skill emigration took over, especially during the Recession. Between 2013 and 2018, Italian emigrants with high-school diploma or master degree grew by 45% while the total number of emigrants rose by roughly 42% (ISTAT 2019). This indicates that the number of high-skilled emigrants slightly rose over time. In 2009, it was slightly below 25% while in 2018 it was 30% (males) and 35% (females). According to OECD (2017, p. 161), a further consequence of low wages in high-skill occupations "reduce incentives of workers to train and improve their skills", something which the simulated policy aims to counteract.

4 The databases and the methodology for the policy options impact analysis

The model employed in this paper has a macro and a micro module that are developed on their respective databases and are linked together to allow determining the micro and macro effects of the two policy options suggested in the following section.

4.1 The social accounting matrix and the microeconomic data

The social accounting matrix (SAM) for the Italian economy for the year 2014 represents the database used to develop the macroeconomic model which consists in a CGE model. The SAM provides a detailed description of all phases of the multi-industry and multi-sectoral income circular flow occurring in the economic system and allows the calibration of all the parameters and selected exogenous variables in the CGE model. In the SAM the economic flows related to the final demand, total output and value added generation by commodity (production process) are linked with data on the value added distribution among primary factors, and toward Institutional Sectors in the primary and secondary distribution of incomes (Ciaschini et al. 2015).

The structure of the SAM developed in this study, and thus the balanced economy modelled through the CGE model, is presented in Table 1. It accounts for 63 commodities and 63 activities,[11] 3 value added components (compensation of employees, gross operating surplus and mixed income) and 11 institutional sectors (Households, No-Profit Institution, Financial Firms, Non-Financial Firms, 6 levels of Government, Rest of World). The flows are elaborated combining data from the Input–Output table for 2014 (ISTAT 2019), the National Accounting Matrix for 2014 (ISTAT 2018b) and the Programme for the International Assessment of Adult Competencies (PIAAC) data (OECD 2019).

The main aspect of this database relies in the detailed disaggregation of the value added in its components and the disaggregation of the institutional sectors. In particular, the flows related to the "Compensation of employees" paid by each activity, is broken down to emphasize the typology of the occupation and the characteristics of the workers involved, as showed in Table 1. The disaggregation of the flows according to the occupation level refers to the characteristics of the employment that can be low-skilled, medium-skilled and high-skilled. Whereas he categorization of the workers derives from the combination of three attributes: gender, formal education attainment and ICT knowledge. The educational attainment is split between low-medium-educated (no formal education to high school diploma) and high-educated (university degree). Finally, ICT competences are computed on the base of the PIAAC data that collects the answers about the use (or not use) of computers, e-mail and simple/advanced programmes at work. Self-employment (including entrepreneurs, occasional workers, free-lance workers and members of workers' owned companies) is included in the mixed income with other components such as profits. Since these eight types of workers can all work in any of the three occupations, there are 24 workers' categories (or "workers' groups").

The value added allocated to the primary factors is subsequently distributed to the institutional sectors on the base of the property shares of the primary factors. We considered 11 institutional sectors: Households, No-profit Institution, Financial Firms, non-Financial Firms, Government (disaggregated into: central

[11] See Appendix A—Classification of commodities and activities in the SAM.

Table 1 The SAM framework

			Commodities *i=1,…,63*	Activities *j=1,…,63*	Value added			Institutional Sectors						Capital Formation
					Compensation of employees	Gross Operating	Mixed Income	Households *hh=1,…,6*	No-profit Institutions	Financial Firms	Non-financial firms	Gov. *hh=1,…,6*	Rest of World	
					l=1,…,24	Surplus								
		n.	1	2	3	4	5	6	7	8	9	10	11	12
Commodities *i=1,…,63*		1		U				C				C	Ex	I
Activities *j=1,…,63*		2	M											
Value added	Compensation employees *l=1,…,24*	3		VA										
	Gross Operating Surplus	4												
	Mixed Income	5												
Institutional Sectors	Households *hh=1,…,6*	6			Y			Yn						
	No-Profit Inst.	7												
	Financial Firms	8												
	Non-Financial Firms	9												
	Government *g=1,…,6*	10												
	Rest of World	11	Im											
Capital Formation		12						S					b	

U	Intermediate consumption by Industry
M	Domestic primary and secondary production by activity
VA	Value Added generation by activity and components
Im	Imports by commodity
Y	Primary Income Distribution to Institutional Sectors
Yn	Secondary Income Distribution among Institutional Sectors
C	Final Consumption: Government consumption expenditure (1,10), Households' final consumption expenditure (1,6-7)
Ex	Exports by commodity
I	Gross Fixed Capital formation and changes in inventories by commodity
S	Savings by Institutional Sector
b	Net borrowing/lending

administrations, social insurance bodies, regional, provincial, municipal and other local and central administrations) and Rest of World.

Regarding the secondary income distribution, transfers between public administrations have been obtained by elaborating the data on the current transfers from the Information System on the Public Administration operations (SIOPE) database released by the Ministry of Economy and Finance and the Bank of Italy[12] and the Public Finance statistics from ISTAT.[13]

In order to capture the income distributional effects of the policy designed to stimulate the demand of labour by skills, we broken down the Household into 6 groups according to the income level. This means that all the flows related to the allocation of household consumption by commodity, primary income and secondary income distribution are disaggregated accordingly. To this aim, we combined the data from the NAM with the Italian Statistics on Income and Living Conditions (IT-SILC) integrated with the Consumer Survey (both released by ISTAT) and with the Survey on Household Income and Wealth (SHIW) released by the Bank of Italy. We identified six main groups of Households according to the annual level of income: HH1—households without a precise identification and with annual income lower than 2841€; HH2—households with annual income from 2842€ to 15,000€; HH3—households with annual income from 15,001€ to 28,000€; HH4—households with annual income from 28,001€ to 55,000€; HH5—households with annual income from 55,001€ to 75,000€; HH6—households with annual income higher than 75,000€.

If the SAM is functional to the calibration of the CGE model, the microdata are indispensable for the development of the Microeconomic Decision Model (MDM). The microdata is based on the 2014 IT-SILC data with 2014 income data and labor market statuses related to 2013. The base is enriched through matching procedures with the 2014 SHIW dataset 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 the Classification of Individual Consumption by Purpose (COICOP) assured by the Consumer Survey. With particular attention to the disaggregation of consumption by commodity, we estimated the weights transforming COICOP into the NACE classification through an equation system. This step is very useful, as it allows 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.

The micro dataset contains 47,136 obs., representing 60,623,518 people. The dataset includes the gross employees' income with a poor detail by activity, but a rich detail in terms of time (hours/months) worked, type of contract and reasons to work/not work. This is very relevant for our analysis, as it allows us to extract from inactive people's pool the Potential Labor Force (PLF) which includes inactive people not searching for a job, but still available to work. From the dataset we

[12] See https://www.siope.it/Siope/.

[13] See https://www.istat.it/it/archivio/204387.

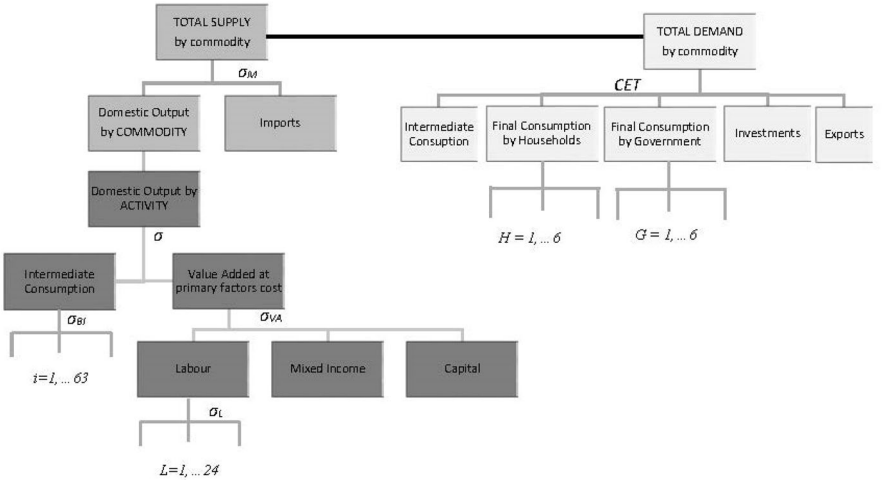

Fig. 1 The production function and final demand in the CGE model

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 expectations, we are able to determine the potential employment and income. The potential employment and income differ from the actual ones because of flows attributed to involuntary part-timer or fixed-term workers, unemployed and PLF members, which can be described as an activation margin in case of a positive shock on employment at the macro level.

4.2 The MICRO–MACRO model

The CGE model calibrated on the SAM for the Italian Economy (the MAC-19) is inspired to the models developed by Ciaschini et al. (2012) and Severini et al. (2019) with a particular attention to the formalization of the labor demand that is activity-specific and classified according to the occupation level and the workers characteristics represented by the gender, formal educational attainment and ICT competences. 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. The set of equation that are solved simultaneously to generate the new equilibrium after the shock can be classified as equations allowing markets balances, equations describing production and consumption functions, equations defining the budget constraint.[14]

[14] See Appendix B for the specification of the CGE model.

Following the scheme of the production by activity and by commodity and the structure of the total demand by commodity described in Fig. 1, we can observe that the total output by activity is obtained using a nested production function.

The total supply by commodity derives from the combination of the total (domestic) output by commodity generated by each activity and the imports. The model works under the small country assumption, that is to say, international prices are considered exogenous since the country has a very small share of world market for the products—so small, that domestic policies are unable to affect the world price of the goods (Suranovic 2010). Therefore, imports depend on relative (domestic/foreign) prices, nominal exchange rate (exogenous) and the elasticity of substitution between domestic and imported goods, following the Armington's assumption (Armington 1969).[15]

The total output by activities derives from the combination of intermediate consumption and value added. The intermediate consumption derives from the aggregation of intermediate goods using a Leontief function. The value added is obtained through the combination of primary factors (Labor and Capital) using a CES production function. Compared to the original version of the model, which encompasses the disaggregation of labour by gender, in this version we consider a combination of 24 labour types, which reflects the occupation level and the workers types according to the classification provided by the SAM. The elasticity of substitution between the labor and capital aggregates derives from the estimation for the Italian economy by Van Der Werf (2008). As for the complementarity/substitution among the 24 different typologies of labour, it is derived from the estimation of Krusell et al. (2000).

All primary factors are perfectly mobile across activities however, while the market of capital is perfectly competitive, the labor market is not perfectly competitive and we assume involuntary unemployment (see the Appendix B for the specification of this assumption). Indeed, in order to mimic the labor market imperfections in the real world, this model incorporates a wage curve based on the incentive wage model following Hamermesh 1993 and Phelps 1997. Therefore, the demand of labor is endogenous and depends on the total production and the labor cost, while the supply of labour is exogenous. The inclusion of the micro-module helps overcoming this limit of the model and make the labor supply as variable endogenously determined.

The total supply equals the total demand by commodity that is allocated according to a Constant Elasticity of Transformation (CET) function among: (i) intermediate consumption by activity, depending on the volume of output; (ii) households' consumption expenditure depending on the relative price of commodities and the consumption level (this latter derives from the disposable income); (iii) Public Administration consumption expenditure that is fixed in real terms; (iv) investment which are assumed to be *saving-driven*; (v) exports to the Rest of the World depending on the domestic price of goods, foreign price of goods (exogenous) and nominal

[15] Domestic commodities and imports are imperfect substitutable since they have some elements of differentiation that can be observed by final consumers (Armington 1969).

exchange rates (exogenous). The process of maximization of the utility function (Cobb–Douglas) under the budget constraint represented by the disposable income, allows computing the demand by commodities of the Institutional Sectors. In particular, the Households' disposable income is given by the amount of the primary incomes that derive from the value added allocation among primary factors and according to the share of factor's property. This value is reduced for the amount of income taxes payed to the Public Administration and increased by the net transfers from other domestic Institutional Sectors and from the Rest of the World, which are considered fixed in nominal terms. As for the Public Administration, the disposable income is obtained as the sum of the revenues from taxes on commodities and activities, revenues from income taxes payed by Institutional Sectors, incomes from primary factors and net of the transfers payed to Institutional Sectors and to activities of production processes.

The model closes with the hypothesis on the balance conditions related to: flows with the rest of the world (balance of payment and exchange rate); saving-investment; public deficit formation. As regard to the Rest of the World, we assume fixed nominal exchange rate and exogenous real exports. Since the imports are endogenous, the level of debit/credit with the rest of the world represents the balancing item. As mentioned above, the investment are assumed to be saving driven, therefore the change in the level of private institutional sectors' and rest of world's savings will determine the total change in investment. Finally, we assume that public consumption expenditure is fixed in real terms and that the tax rates are fixed. Hence, the public deficit (saving) is endogenously determined as the difference between incomes and outcomes.

The microeconomic model (MICRO-module) integrates the MACRO-module with the description of the agents' behavior as individual and Households. This distinction is necessary because decisions regarding the labor engagement, affecting the labor supply, are taken at individual level while decisions regarding optimal consumption are taken at household level. Indeed, the micro-module allows computing how the labor supply (at individual level) and the demand for consumption (at household level) react to changes at the micro level (as in the case of changes in the Tax and Benefit system or at the macro level).

With regard to the labor supply, the microeconomic model contains two logit regressions: one is used in simulations with an increase in employment, the other in the opposite case. Both regressions estimates the coefficients for each labor type in order to compute the changes in the labor supply. The first logit regression computes the probability of being employed against the levels of six explanatory variables (gender, region of residence, education level, age, number of household's components and number of infants in the household). These coefficients are used to compute the probability that any single underemployed individual rises his labor supply. Individuals are ordered according to the decreasing probability of improving their working hours, therefore new job opportunities will be attributed to workers with higher scores.

In broader terms, for every labor typology, the CGE model computes the change in the labor demand by activity and in wage levels. Whereas the change in wages are directly implemented in the microsimulation model, the changes in the labor

Table 2 Classification of labor in the SAM

Labour types or occupation levels		Workers types		
		Gender	Education	ICT competences
1	Low-skill	Male	Low-medium	Yes
2				No
3			High	Yes
4				No
5		Female	Low-medium	Yes
6				No
7			High	Yes
8				No
9	Medium-skill	Male	Low-medium	Yes
10				No
11			High	Yes
12				No
13		Female	Low-medium	Yes
14				No
15			High	Yes
16				No
17	High-skill	Male	Low-medium	Yes
18				No
19			High	Yes
20				No
21		Female	Low-medium	Yes
22				No
23			High	Yes
24				No

demand are applied according a score estimated computed using coefficients estimated by the logit regression (see the Appendix C for a more detailed description of the micro-module).

At the macro-layer, the increased labor demand generates a greater employment and so a greater income according to the labor 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 the maximization responses by Institutional Sectors and by activities. The new macroeconomic situation has to coincide with the microeconomic one. In other words, the changes of labor demand obtained at the macro-economic level is divided among individuals according to scores estimated by LOGIT regressions within the limits of the before estimated hours margins. In this way each household can adjust his consumption demand. The new level of demand can be introduced in the macro-model as shocks in the second round of the simulation. This provides new labor demand patterns and so we can find an iterative solution until the first and the second layer do not reproduce the same picture of the economy.

Therefore, the integration of micro and macro modules in this paper follows 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 equal levels in aggregate variables and the consistency

Table 3 Policy-option LOW: endogenous changes in the PIT rates (FP strategy). Source: Own elaboration on National Accounts, PIAAC and EU-SILC data

Income brackets	Benchmark rates (%)	% change	New rates (%)
≤ 15,000	23	–	23.00
15,000 ≤ 28,000	27	–	27.00
28,000 ≤ 55,000	38	1.15	39.15
55,000 ≤ 75,000	41	1.38	42.38
> 75,000	43	1.66	44.66
Total		0.69	

of the micro level with the macro one is achieved in terms of changes from the starting values. The iteration assures to consider feedback effects, which not necessarily are small enough to be overlooked.

5 Simulation strategy and results

The policy described in Sect. 2 targets employment in all activities but agriculture, forestry, fishing, public administration and social and personal services.[16] In policy-option LOW, the intervention targets low-level occupations (i.e. workers' categories 1–8 in Table 2) whereas high-level occupations (i.e. workers' categories 17–24 in Table 2) are the target of policy-option HIGH.

Technically, firms receive a reimbursement on the SSC paid on the number of their employees. Hence, the incentive is on new hiring insofar the SSC cut also regards newly hired workers. Strictly considered, it is not necessarily an incentive to hire more, as firms might simply turn the reimbursement into a windfall gain without changing their hiring decisions, with the effect that employment might fail to rise as desired. However, competition on product markets eliminate extra-profits, with the consequence of reducing prices and rising quantities of final products, something which should lead to higher demand on the labour market. If the incentive were computed on new hiring, there would be risk of an acceleration in employees' turnover and this would negatively affect both the public administration and firms' productivity: it increases administrative difficulties by the Government and reduces the interest of firms and employees to invest in the working relationship.

In terms of policy evaluation, we distinguish (see Sect. 2) between full *financial provision* (henceforth: FP) and *deficit financing* (henceforth: DF). In the first case (FP), we show the importance of the MDM by distinguishing the case without microeconomic response (indicated with FP) from the case with it (FP_MDM). The results in the next two subsections show that the policy is in general effective in achieving the desired objectives. In the case of policy-option LOW, its effectiveness is clearly higher in the case of DF, as intuition may suggest. When the policy

[16] Targeted activities are 4–53 in the ESA-2010 classification (see Appendix A).

Table 4 Policy-option LOW: impact on real macroeconomic variables (percent changes from benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

	FP	FP_MDM	DF
GDP	− 0.03	− 0.03	0.14
GFCF	− 0.09	− 0.11	0.18
Private consumption	− 0.03	− 0.03	0.17
Export	− 0.05	− 0.10	0.05
Import	− 0.01	0.01	0.20
Disposable Income	0.04	0.04	0.23
Compensation of employees	0.04	0.01	0.07
Employment rate	0.07 pp	0.00 pp	0.12 pp

Table 5 Policy-option LOW: Effects on real disposable income and consumption (percentage changes from benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Disposable Income	FP	FP_MDM	DF
HH1	0.53	0.79	1.14
HH2	0.21	0.22	0.28
HH3	0.25	0.29	0.48
HH4	0.04	0.05	0.19
HH5	− 0.16	− 0.17	0.12
HH6	− 0.28	− 0.31	− 0.02
Consumption	FP	FP_MDM	DF
HH1	0.70	1.81	1.99
HH2	0.22	0.23	0.29
HH3	0.25	0.29	0.48
HH4	0.05	0.05	0.20
HH5	− 0.21	− 0.27	− 0.01
HH6	− 0.32	− 0.41	− 0.13

is financed through higher taxation on the richest income brackets, it gains in terms of equity, as it manages to shift its positive effects in favour of the poorest income categories (namely Households' categories HH1 and HH2).

5.1 Policy-option LOW

The simulated policy targets workers in low-skill occupations. Its net impact on public finances is approximately 1,664.8 million euros, and it is one of the results of our simulation. This impact is net in the sense that it yields from the difference between the lower revenues due to the SSC cut and the lower unemployment and poverty transfers, which follow from the positive effects of the policy option in terms of lower unemployment and better economic conditions for low-income Households. According to our model calculations, the decrease in transfers lies in the range of 40

Table 6 Policy-option LOW: Impact on unemployment rates by workers' category (percentage change from the benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Occupation levels	Workers' categories						
		Gender	Education	ICT competences	FP	FP_MDM	DF
Low-skill	1	Males	Low-medium	Yes	– 0.10	– 0.12	**– 0.14**
	2			No	– 0.10	– 0.12	**– 0.14**
	3		High	Yes	– 0.03	– 0.05	– 0.05
	4			No	– 0.10	– 0.12	**– 0.15**
	5	Females	Low-medium	Yes	– 0.10	– 0.13	**– 0.15**
	6			No	– 0.11	– 0.15	**– 0.16**
	7		High	Yes	– 0.05	– 0.07	– 0.09
	8			No	– 0.10	– 0.13	**– 0.15**
Medium-skill	9	Males	Low-medium	Yes	– 0.03	– 0.06	– 0.07
	10			No	– 0.01	– 0.03	– 0.04
	11		High	Yes	– 0.02	– 0.03	– 0.04
	12			No	– 0.03	– 0.06	– 0.07
	13	Females	Low-medium	Yes	– 0.03	– 0.06	– 0.08
	14			No	– 0.03	– 0.04	– 0.05
	15		High	Yes	– 0.02	– 0.04	– 0.05
	16			No	– 0.04	– 0.09	– 0.09
High-skill	17	Males	Low-medium	Yes	– 0.03	– 0.06	– 0.08
	18			No	– 0.02	– 0.05	– 0.06
	19		High	Yes	– 0.02	– 0.04	– 0.04
	20			No	– 0.01	– 0.04	– 0.04
	21	Females	Low-medium	Yes	– 0.03	– 0.06	– 0.09
	22			No	– 0.03	– 0.06	– 0.07
	23		High	Yes	– 0.03	– 0.09	– 0.06
	24			No	– 0.02	– 0.06	– 0.05
Total unemployment					– 0.06	– 0.09	– 0.10

million euros (i.e. 0.01% of total transfers) and it is in line with the results of previous studies in the literature (Hoon and Phelps 1992). In the case of financial provision, PIT rates are endogenously adjusted using the distribution of taxable income. Table 3 shows the changes in the PIT rates.

Table 4 below illustrates the effects of this policy option on the main macroeconomic variables. The effect on real GDP is negligible and slightly negative in the case of financial provision, both in the case without microeconomic response (FP) and with microeconomic response (FP_MDM). When the policy is financed through higher deficit (deficit financing, DF), the effect remains fairly tiny, but it becomes positive (+0.14%).

In view of the objective of the policy, there are other results, which are worth consideration, however. These are the ones on Households' disposable income, on

Table 7 Policy-option LOW: Impact on compensation of employees (real values) (percentage changes from the benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Occupation levels	Workers' categories						
		Gender	Education	ICT competences	FP	FP_MDM	DF
Low-skill	1	Males	Low-medium	Yes	0.12	0.14	0.17
	2			No	0.12	0.12	0.16
	3		High	Yes	0.04	0.05	0.06
	4			No	0.12	0.14	0.17
	5	Females	Low-medium	Yes	0.12	0.16	0.18
	6			No	0.14	0.10	0.20
	7		High	Yes	0.06	0.08	0.10
	8			No	0.12	0.07	0.18
Medium-skill	9	Males	Low-medium	Yes	0.03	− 0.04	0.09
	10			No	0.02	0.03	0.04
	11		High	Yes	0.02	0.03	0.04
	12			No	0.04	0.07	0.09
	13	Females	Low-medium	Yes	0.04	0.06	0.10
	14			No	0.03	0.05	0.06
	15		High	Yes	0.02	− 0.06	0.06
	16			No	0.05	0.10	0.11
High-skill	17	Males	Low-medium	Yes	0.04	0.07	0.10
	18			No	0.02	− 0.13	0.07
	19		High	Yes	0.02	0.04	0.04
	20			No	0.02	− 0.20	0.04
	21	Females	Low-medium	Yes	0.04	0.08	0.12
	22			No	0.03	− 0.01	0.08
	23		High	Yes	0.03	− 0.59	0.06
	24			No	0.03	− 0.25	0.06

unemployment and on the compensation of employees. These effects indicate that the policy has a certain, albeit limited effectiveness. This effectiveness is clearly higher in the case of deficit financing. In this case, the increase in GDP is mainly supported by an increase in consumption and investment (GFCF).

The effectiveness of the policy emerges more sharply from the results regarding the six categories of Households (see Table 5). Households with the lowest income levels (mainly HH1) enjoy the highest improvement in disposable income (+1.14%) and hence in consumption (1.99%). The disaggregation of results according to Households' categories also show the positive impact of this policy option in terms of equity. The increase in disposable income becomes gradually lower as the average households' income level rises. The policy has a fairer effect in the FP case. This derives from its intrinsic design, which assumes to finance the SSC cut through higher PIT rates for the three richest income brackets (i.e. HH4, HH5 and HH6). The

Table 8 Policy-option HIGH: endogenous changes in the PIT tax rates (FP strategy). Source: Own elaboration on National Accounts, PIAAC and EU-SILC data

Income brackets	Gross PIT tax rate	percentage change	New PIT tax rate
≤ 15,000	23%	0.00%	23.00%
15,000 ≤ 28,000	27%	0.00%	27.00%
28,000 ≤ 55,000	38%	0.60%	38.60%
55,000 ≤ 75,000	41%	0.71%	41.71%
> 75,000	43%	0.86%	43.86%
Total		0.36%	

Table 9 Policy-option HIGH: impact on real macroeconomic variables (percentage changes from benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

	FP	FP_MDM	DF
GDP	− 0.01	− 0.01	0.06
Gross investment	− 0.02	− 0.02	0.10
Household consumption	− 0.01	− 0.01	0.07
Export	− 0.01	− 0.04	0.03
Import	0.00	0.02	0.10
Disposable Income	0.03	0.05	0.12
Compensation of employees	0.03	− 0.01	0.05
Employment rate	0.03 pp	− 0.01 pp	0.05 pp

effect on disposable income falls more remarkably when the SSC cut is financed through provision. Both at disaggregated level and at aggregate level (Table 4) the policy effectiveness is generally lower under FP in comparison to the case with DF.

The effectiveness of the policy is also visible in terms of unemployment and employees' compensation. Table 6 and Table 7 below provide disaggregated information for the 24 workers' categories. In terms of unemployment, Table 6 shows that all workers' categories broadly benefits from this policy with the already highlighted (and intuitive) difference that the effects in the case of DF are higher than in the case of FP. The policy rebalances labour market polarization in favour of low-skill occupations, but it does not really damp it. Unemployment falls in fact in the case of low-skill occupations (i.e. workers' categories 1, 2, 4 and 5, 6, 8) more than in medium-skilled work (i.e. categories 13 and 17) and in the case high-skilled male labour employed in medium occupations (categories 10 and 11) and in high ones (see categories 19 and 20) with a reduction of 0.04% points. A comparison between the results for male labour and female labour indicate that the policy without provision seems to reduce the gender gap in terms of unemployment rate.

While this policy option does not contribute to dampen polarization, and this actually reflects the design of the policy, which does not directly target medium-skilled labor, it is indeed the case that the policy is effective in improving employees' compensation in low-skill occupations (i.e. categories 1–8). This outcome is clearly visible in Table 7 below, which shows that wages and salaries mostly increase in the case of workers' categories 1, 2 and 4 (males) and 5, 6 and 8 (females).

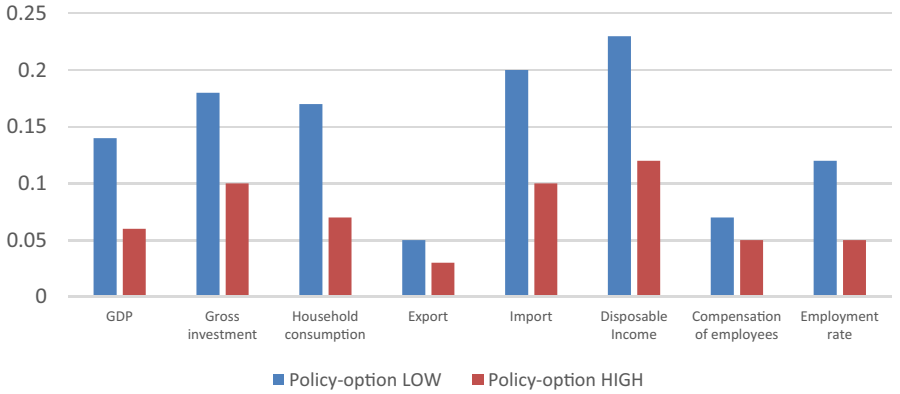

Fig. 2 The Impact on real macroeconomic variables under DF (policy-option LOW and policy-option HIGH)

5.2 Policy-option HIGH

The policy targets workers in high-skill occupations. In terms of public outflows, the intervention implies a burden of 880 million euros.[17] Table 8 below shows the changes in the PIT rates, which are necessary to cover the policy costs under FP. The employment effects at macroeconomic level reverberate at microeconomic level. In the case of DF, the main consequences pertain to the distributional and poverty-related sphere. The case of FP is more interesting because it involves a change in the personal income marginal tax rates.

Table 9 contains the main macroeconomic effects of this policy option. These effects are in line with those of policy-option LOW in the sense that the impacts on the economy in the case of DF are higher than in the case of FP. However, the size of these effects is different, and it deserves some attention. With reference to the case of DF, Fig. 2 shows that the impact of this policy-option is lower than in the case of policy-option LOW. Two possible reasons are worth mentioning. First, the size of the intervention (in terms of net impact on public finances and hence on the economy) in the case of this policy option is lower than in the case of policy-option LOW (i.e. 1664.8 million euros vs. 880 million euros). Second, the first beneficiaries are upper-income households, who have a lower consumption propensity than lower-income layers. Indeed, aggregate consumption increases by less in this case (+0.07% against 0.17% in policy-option LOW).

In the case of FP, by contrast, agents who are contemporaneously hurt and benefitted tend to overlap more in the case of this policy option than in policy-option LOW. This provides a possible explanation for the negligible size of the aggregate effects. The effects on employment are also milder in the case of this policy option, but they reflect the same pattern of policy-option LOW. When workers in high-skill

[17] As in policy-option LOW, this figure yields as a result of our model calculations.

Table 10 Policy-option HIGH: effects on real disposable income and consumption (percentage changes from benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Disposable income	FP	FP_MDM	DF
HH1	0.13	0.29	0.39
HH2	0.02	0.03	0.05
HH3	0.03	0.06	0.13
HH4	0.02	0.02	0.09
HH5	− 0.04	− 0.04	0.08
HH6	− 0.08	− 0.10	0.03
Consumption	FP	FP_MDM	DF
HH1	0.35	0.98	0.92
HH2	0.02	0.03	0.06
HH3	0.03	0.06	0.13
HH4	0.02	0.03	0.09
HH5	− 0.06	− 0.09	0.03
HH6	− 0.10	− 0.15	− 0.02

occupations can react at microeconomic level (in terms of labour supply), they tend to work less because of the substitution effect in the labour-leisure choice at individual level. In other words, the positive effect due to the SSC cut is more than counterbalanced by the higher taxation for its financing.

The disaggregated effects on disposable income and consumption are given in Table 10. In comparison to policy-option LOW, policy-option HIGH has a tinier impact on the economy as a whole, and this is also visible on disposable income and consumption at disaggregated level. In the case of DF, the tinier effect is possibly due to the already mentioned fact that the policy involves a lower injection of public resources into the economy. In the case of FP, the overall benefit of the policy is more fairly distributed across Households' categories because the two effects of the policy (i.e. the SSC cut and the negative income effect due to higher taxation) affect two groups of actors (i.e. workers in high-skill occupations and high-income households), which partly overlap, and hence they are winner and losers at the same time. Independently on its financing however, the policy does have a certain effectiveness in sustaining low-income relatively to high-income households. Although it primarily favours workers in high-skill occupations (and hence upper-income households) by design, it brings about a certain pro-poor distributional effect. A comparison between the effects on disposable income at aggregate level and the results at disaggregated (household) level reveals that low income households (e.g. HH1 and HH3) tend to benefit more (in percentage terms) than their high income counterparts, which in the case of provision even lose slightly (e.g. HH5 or HH6).

Tables 11 and 12 display the effects of the policy option on the 24 workers' categories. They convey a basic message in this regard. Bar some exceptions (i.e. categories 17, 18 and 21), the policy has a fairly homogeneous effect on all workers' categories. It is effective in raising both employment and employees' compensation across all categories, although with a bias in favour to workers with a low-medium

Table 11 Policy-option HIGH: impact on unemployment rates by workers' category (percentage change from the benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Occupation levels	Workers' categories						
		Gender	Education	ICT competences	FP	FP_MDM	DF
Low-skill	1	Males	Low-medium	Yes	– 0.01	– 0.03	– 0.03
	2			No	– 0.01	– 0.02	– 0.03
	3		High	Yes	– 0.01	– 0.02	– 0.02
	4			No	– 0.01	– 0.03	– 0.03
	5	Females	Low-medium	Yes	– 0.02	– 0.03	– 0.04
	6			No	– 0.02	– 0.04	– 0.04
	7		High	Yes	– 0.01	– 0.02	– 0.03
	8			No	– 0.02	– 0.03	– 0.04
Medium-skill	9	Males	Low-medium	Yes	– 0.02	– 0.03	– 0.04
	10			No	– 0.01	– 0.01	– 0.02
	11		High	Yes	– 0.01	– 0.01	– 0.02
	12			No	– 0.02	– 0.04	– 0.04
	13	Females	Low-medium	Yes	– 0.02	– 0.03	– 0.04
	14			No	– 0.01	– 0.02	– 0.02
	15		High	Yes	– 0.01	– 0.02	– 0.03
	16			No	– 0.03	– 0.06	– 0.05
High-skill	17	Males	Low-medium	Yes	– 0.11	– 0.12	**– 0.13**
	18			No	– 0.07	– 0.09	**– 0.09**
	19		High	Yes	– 0.02	– 0.04	– 0.03
	20			No	– 0.04	– 0.06	– 0.05
	21	Females	Low-medium	Yes	– 0.14	– 0.15	**– 0.17**
	22			No	– 0.02	– 0.03	– 0.03
	23		High	Yes	– 0.02	– 0.08	– 0.04
	24			No	– 0.05	– 0.07	– 0.06
Total unemployment					– 0.02	– 0.04	– 0.04

level of formal education (categories 17 and 21), which are employed in high-skill occupations. The figures regarding these workers' categories 17, 18 (for males) and 21 (for females) indicate that the policy-option HIGH has the effect of increasing employment among workers in high-skill occupations, who have however a low-medium formal education level. This result bears two messages. On the one side, the policy does actually reinforces polarization because employment in high-skill occupations grows. Employment in medium-skill occupations with yet high level of education (i.e. categories 11 and 12 for males and 15 and 16 for females) remains almost unchanged or changes very little. On the other side, the outcomes of this policy option confirms the need of up-skilling programmes (see Sect. 2), which enable workers in medium-skill occupations to move to the high-skill ones.

Finally, some changes can be found in the simulation with micro-response to micro-simulated changes in labour supply (i.e. with an overall reduction with

Table 12 Policy-option HIGH: impact on compensation of employees (percentage changes from the benchmark). Source: Own elaboration on MAC-19 integrated with the micro-module

Occupation levels	Workers' categories						
		Gender	Education	ICT competences	FP	FP_MDM	DF
Low-skill	1	Males	Low-medium	Yes	0.02	0.03	0.04
	2			No	0.01	0.03	0.03
	3		High	Yes	0.01	0.02	0.02
	4			No	0.01	0.03	0.04
	5	Females	Low-medium	Yes	0.02	0.04	0.05
	6			No	0.02	0.01	0.05
	7		High	Yes	0.01	0.03	0.03
	8			No	0.02	0.04	0.04
Medium-skill	9	Males	Low-medium	Yes	0.02	0.03	0.04
	10			No	0.01	0.01	0.02
	11		High	Yes	0.01	0.13	0.02
	12			No	0.02	0.04	0.04
	13	Females	Low-medium	Yes	0.02	0.04	0.05
	14			No	0.01	0.02	0.02
	15		High	Yes	0.01	0.03	0.03
	16			No	0.03	0.07	0.06
High-skill	17	Males	Low-medium	Yes	0.13	0.15	0.16
	18			No	0.08	0.10	0.10
	19		High	Yes	0.03	0.04	0.04
	20			No	0.04	− 0.15	0.05
	21	Females	Low-medium	Yes	0.17	0.19	0.21
	22			No	0.02	0.02	0.04
	23		High	Yes	0.03	− 0.61	0.04
	24			No	0.05	− 0.14	0.07

minimums for high-skilled work). The outcomes in terms of unemployment rate for matched high skilled labour input (see 19 and 20 for males and 23 and 24 for females), as well as for the medium-skilled male work performing high occupations (see 10 and 11) show a better results than in the simulation set LOW with the other component recovering losses determined by the introduction of the provision without micro-simulated labour supply.

6 Conclusions

This paper employs an integrated micro–macro model to assess the effects of an employment incentive policy on Italy's labour market and on the Italian economy. The motivation for the policy rests on the high levels of unemployment in the Country and on the specific conditions of the labour market. Although the Italian labour market features a number of peculiarities, which make it quite unique at international

level, it is possible to identify a process of substantial employment polarisation over the last two decades. The main outcome of this process is a rise in the employment shares of high-skill and low-skill occupations along with a correspondent decrease of medium-skill occupations. While the evidence regarding the process of employment polarisation is seemingly unconfutable, the same is not observable for wages. The tendency towards wage polarisation, which seemingly emerged between the early Eighties and the early 2000 started to reverse with the 2008 recession, with the consequence that wages did not really polarised. More specifically, wages in the high-skill occupations rose very slowly over the whole period because of the poor growth on the demand side and the strong increase in highly-educated supply. In turn, wages in low-skill occupations also has also shrunk since the Recession.

The employment incentive takes the form of a (one percentage point) cut in firms' social security contribution (SSC) payments. We simulate two alternative policy-options, whereby one (policy-option LOW) targets low-skill and the other (policy-option HIGH) high-skill occupations. For a more comprehensive analysis of both options, we distinguish between two polar-opposite financing strategies, i.e. deficit financing and full financial provision. In this latter case, we allow for higher personal income taxation on the three richest income brackets.

Independently on the policy option, the aggregate effects on the economy are more favourable in the case of deficit financing, as one may expect. Indeed, in this case the main macroeconomic variables slightly rise in comparison to the benchmark whereas in the case of financial provision, they slightly fall. A comparison between the two policy-options shows that the policy targeting high-skill has milder effects than the one targeting low-skill occupations. In the case of deficit financing, this may be due to the different amount of public resources injected into the economy, which is lower in the case of policy-option LOW. When it is financed through higher PIT, the higher taxation seemingly counterbalances the positive effect of the SSC cut on labour demand in high-skill occupations, and the overall effect is tinier. In the case of policy-option LOW, the positive effect of the policy is insufficient to counterbalance the negative effect arising from the higher taxation required to finance the policy.

The assessment of the policy in terms of effectiveness requires focusing on two variables, the unemployment rate and the compensations of employees. In the case of policy-option LOW, the intervention manages to improve workers' economic conditions in low-skill occupations whereas this improvement is much tinier in high-skill occupations. Policy-option HIGH has a more homogeneous effect throughout the 24 labour categories, which means that the policy does not manage to counteract polarization. In this regard, the policy could be considered effective if unemployment in medium-skilled occupations fell, and workers' compensation possibly rose. Indeed, independently of the policy option, the unemployment rate falls in all labour categories, although with heterogeneous magnitude throughout them. A closer look at the size of these reductions reveals that unemployment reductions in medium-skill occupations are quite limited in the case of both policy options. Improvements in wages and salaries are also quite negligible. All in all, the policy does not really improve workers' conditions in medium-skill occupations.

In front of these effects, two considerations are in order. First, the policy is not designed to target labour demand in medium-skill occupations, but in low-skill and high-skill ones. In this perspective, policy-option LOW is actually effective, as both employment and workers' compensations rise in low-skill occupations, and this outcome is larger than in the high-skill ones. Second and more important, policy-option HIGH has a relevant impact on high-skilled labour categories in the medium-skill occupations. These categories seemingly move from medium-skilled to high-skilled occupations if high-skilled occupations are given an incentive to hire. In counterfactual terms, this could be seen as a sign that high-skilled workers in medium-skilled occupations might possibly move to high-skilled occupations if they attended appropriate up-skilling programmes.

Appendix A: Classification of commodities and activities in the SAM

See Tables 13 and 14.

Appendix B: Main aspects of the CGE model specification

In the CGE model, each activity produces homogeneous goods using a nested constant return to scale technology following the nested scheme reported in Fig. 1. In the first nest from the top-left, the price of each commodity derive from the combination of imported and domestically produced commodities as summarised by the following equation:

$$p_{TY_n} = \overline{p_{TY_n}}\left[\frac{\overline{p_{Y_n}}\,\overline{Y_n}}{\overline{p_{TY_n}}\,\overline{TY_n}}\left(\frac{p_{Y_n}}{\overline{p_{Y_n}}}\right)^{1-\sigma_n^M} + \frac{\overline{p_{M_n}}\,\overline{M_n}}{\overline{p_{TY_n}}\,\overline{TY_n}}\left(\frac{p_{M_n}}{\overline{p_{M_n}}}\right)^{1-\sigma_n^M}\right]^{\frac{1}{1-\sigma_n^M}}$$

TY_n is the total output by commodity, $\frac{\overline{p_{Y_n}}\,\overline{Y_n}}{\overline{p_{TY_n}}\,\overline{TY_n}}$ is the value share of domestic production on total output, $\frac{\overline{p_{M_n}}\,\overline{M_n}}{\overline{p_{TY_n}}\,\overline{TY_n}}$ is the value share of imports on total output, M_n is the imports, σ_n^M is the elasticity of substitution by commodity between imports and domestic output, p_{TY_n} is the price of commodities, p_{Y_n} is the price of domestic output, p_{M_n} is the price of imports (fixed in foreign currency).

The price of domestic output by activity can be formalized as:

$$p_{Y_n} = \left[\frac{\overline{p_{VA_n}}\,\overline{VA_n}}{\overline{p_{Y_n}}\,\overline{Y_n}}\left(\frac{p_{VA_n}}{\overline{p_{VA_n}}}\right)^{1-\sigma} + \frac{\overline{p_{B_n}}\,\overline{B_n}}{\overline{p_{Y_n}}\,\overline{Y_n}}\left(\frac{p_{B_n}}{\overline{p_{B_n}}}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

VA_n is the value added generated by activity, $\frac{\overline{p_{VA_n}}\,\overline{VA_n}}{\overline{p_{Y_n}}\,\overline{Y_n}}$ is the value share of value added on total output by activity, $\frac{\overline{p_{B_n}}\,\overline{B_n}}{\overline{p_{Y_n}}\,\overline{Y_n}}$ is the value share of intermediate consumption on

Table 13 Classification of commodities in SAM

Nr.	Commodity	Nr.	Commodity
1	Products of agriculture, hunting and related services	33	Air transport services
2	Products of forestry, logging and related services	34	Warehousing and support services for transportation
3	Fish and other fishing products; aquaculture products; support services to fishing	35	Postal and courier services
4	Mining and quarrying	36	Accommodation and food services
5	Food products, beverages and tobacco products	37	Publishing services
6	Textiles, wearing apparel and leather products	38	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services
7	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	39	Telecommunications services
8	Paper and paper products	40	Computer programming, consultancy and related services; information services
9	Printing and recording services	41	Financial services, except insurance and pension funding
10	Coke and refined petroleum products	42	Insurance, reinsurance and pension funding services, except compulsory social security
11	Chemicals and chemical products	43	Services auxiliary to financial services and insurance services
12	Basic pharmaceutical products and pharmaceutical preparations	44	Real estate services including imputed rents of owner-occupied dwellings
13	Rubber and plastics products	45	Legal and accounting services; services of head offices; management consulting services
14	Other non-metallic mineral products	46	Architectural and engineering services; technical testing and analysis services
15	Basic metals	47	Scientific research and development services
16	Fabricated metal products, except machinery and equipment	48	Advertising and market research services
17	Computer, electronic and optical products	49	Other professional, scientific and technical services; veterinary services
18	Electrical equipment	50	Rental and leasing services
19	Machinery and equipment n.e.c.	51	Employment services
20	Motor vehicles, trailers and semi-trailers	52	Travel agency, tour operator and other reservation services and related services
21	Other transport equipment	53	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services

Table 13 (continued)

Nr.	Commodity	Nr.	Commodity
22	Furniture; other manufactured goods	54	Public administration and defence services; compulsory social security services
23	Repair and installation services of machinery and equipment	55	Education services
24	Electricity, gas, steam and air-conditioning	56	Human health services
25	Natural water; water treatment and supply services	57	Social work services
26	Sewerage; waste collection, treatment and disposal industries; materials recovery; remediation industries and other waste management services	58	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services
27	Constructions and construction works	59	Sporting services and amusement and recreation services
28	Wholesale and retail trade and repair services of motor vehicles and motorcycles	60	Services furnished by membership organisations
29	Wholesale trade services, except of motor vehicles and motorcycles	61	Repair services of computers and personal and household goods
30	Retail trade services, except of motor vehicles and motorcycles	62	Other personal services
31	Land transport services and transport services via pipelines	63	Services of households as employers; undifferentiated goods and services produced by households for own use
32	Water transport services		

Table 14 Classification of activities in SAM

Nr.	Activity	Nr.	Activity
1	Crop and animal production, hunting and related service industries	33	Air transport
2	Forestry and logging	34	Warehousing and support industries for transportation
3	Fishing and aquaculture	35	Postal and courier industries
4	Mining and quarrying	36	Accommodation and food service industries
5	Manufacture of food products; beverages and tobacco products	37	Publishing industries
6	Manufacture of textiles, wearing apparel, leather and related products	38	Motion picture, video, television programme production; programming and broadcasting industries
7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	39	Telecommunications
8	Manufacture of paper and paper products	40	Computer programming, consultancy, and information service industries
9	Printing and reproduction of recorded media	41	Financial service industries, except insurance and pension funding
10	Manufacture of coke and refined petroleum products	42	Insurance, reinsurance and pension funding, except compulsory social security
11	Manufacture of chemicals and chemical products	43	Industries auxiliary to financial services and insurance industries
12	Manufacture of basic pharmaceutical products and pharmaceutical preparations	44	Real estate industries including imputed rents of owner-occupied dwellings
13	Manufacture of rubber and plastic products	45	Legal and accounting industries; industries of head offices; management consultancy industries
14	Manufacture of other non-metallic mineral products	46	Architectural and engineering industries; technical testing and analysis
15	Manufacture of basic metals	47	Scientific research and development
16	Manufacture of fabricated metal products, except machinery and equipment	48	Advertising and market research
17	Manufacture of computer, electronic and optical products	49	Other professional, scientific and technical industries; veterinary industries
18	Manufacture of electrical equipment	50	Rental and leasing industries
19	Manufacture of machinery and equipment n.e.c.	51	Employment industries
20	Manufacture of motor vehicles, trailers and semi-trailers	52	Travel agency, tour operator reservation service and related industries
21	Manufacture of other transport equipment	53	Security and investigation, service and landscape, office administrative and support industries
22	Manufacture of furniture; other manufacturing	54	Public administration and defence; compulsory social security

Table 14 (continued)

Nr.	Activity	Nr.	Activity
23	Repair and installation of machinery and equipment	55	Education
24	Electricity, gas, steam and air conditioning supply	56	Human health industries
25	Water collection, treatment and supply	57	Residential care industries and social work industries without accommodation
26	Sewerage, waste management, remediation industries	58	Creative, arts and entertainment industries; libraries, archives, museums and other cultural industries; gambling and betting industries
27	Construction	59	Sports industries and amusement and recreation industries
28	Wholesale and retail trade and repair of motor vehicles and motorcycles	60	Industries of membership organisations
29	Wholesale trade, except of motor vehicles and motorcycles	61	Repair of computers and personal and household goods
30	Retail trade, except of motor vehicles and motorcycles	62	Other personal service industries
31	Land transport and transport via pipelines	63	Industries of households as employers; undifferentiated goods- and services-producing industries of households for own use
32	Water transport		

total output by activity, B_n is the intermediate consumption, $\sigma = 0$ elasticity of substitution between value added and intermediate consumption, p_{B_n} is the price of the intermediate consumption aggregate, p_{VA_n} is the price of value added.

The value added is obtained combining together the costs for primary inputs by activity. Cost functions for each primary factor are presented as the follows:

$$p_L = \overline{p_L}\left[\sum_{L=1}^{24} \frac{\overline{w_L}(1+t_{l,L})\overline{L_L}}{\overline{p_L}\overline{L}}\left(\frac{w_L}{\overline{w_L}(1+t_{l,L})}\right)^{1-\sigma^L}\right]^{\frac{1}{1-\sigma^L}}$$

$$p_{VA} = \overline{p_{VA}}\left[\frac{\overline{p_L}(1+t_{l,L})\overline{L}}{\overline{p_{VA}}\overline{VA}}\left(\frac{p_L}{\overline{p_L}(1+t_L)}\right)^{1-\sigma^{VA}} + \frac{\overline{p_{MI}}(1+t_{MI})\overline{MI}}{\overline{p_{VA}}\overline{VA}}\left(\frac{p_{MI}}{\overline{p_{MI}}(1+t_{MI})}\right)^{1-\sigma^{VA}} + \frac{\overline{p_K}(1+t_K)\overline{K}}{\overline{p_{VA}}\overline{VA}}\left(\frac{p_K}{\overline{p_K}(1+t_K)}\right)^{1-\sigma^{VA}}\right]^{\frac{1}{1-\sigma^{VA}}}$$

L_L is the labour demand by labour type, w_L is the wages before tax by labour type, p_{MI} is the mixed income, p_K is the capital compensation, σ^L. is the elasticity of substitution between labour type, elasticity of substitution between labour, capital and mixed income (differentiated by activity), t_L is the payroll tax rate by labour type, t_{MI} is the tax rate on mixed income, t_K is the capital income tax rate.

From the demand-side specification of the model market demands are the sum of each consumer's demands. The economic agents maximize their utility function, restricted to the disposable income condition that is represented by net endowments. In the calibrated share form:

$$U_h = \left[\sum \theta_h^C\left(\frac{C_h}{\overline{C_h}}\right)^{\frac{1-\sigma_{U_h}}{\sigma_{U_h}}} + \left(1-\theta_h^C\right)\left(\frac{S_h}{\overline{S_h}}\right)^{\frac{1-\sigma_{U_h}}{\sigma_{U_h}}}\right]^{\frac{\sigma_{U_h}}{1-\sigma_{U_h}}}$$

where θ_h^C represents the value share of current consumption on income by Institutional Sector. The spending function associated with the utility function of each Institutional Sector is given by:

$$p_{U_h} = \overline{p_{U_h}}\left[\sum_{n=1}^{63} \frac{\overline{p_{TY_n}}\overline{C_{n,h}}}{\overline{p_{U_h}}\overline{U_h}}\left(\frac{p_{TY_n}}{\overline{p_{TY_n}}}\right)^{1-\sigma_{U_h}} + \frac{\overline{p_{S_h}}\overline{S_h}}{\overline{p_{U_h}}p_{U_h}}\left(\frac{p_{S_h}}{\overline{p_{S_h}}}\right)^{1-\sigma_{U_h}}\right]^{\frac{1}{1-\sigma_{U_h}}}$$

from which getting the demand function for saving by Institutional Sector:

$$S_h = \overline{S_h}\left(\frac{\overline{p_S}}{\overline{p_{U,h}}}\frac{p_{U,h}}{p_S}\right)^{\sigma_{S_h}}$$

The total consumption of institutional sectors is distributed between different goods *Cn* according to the CES function:

$$\frac{C_n}{\overline{C_n}} = \frac{C}{\overline{C}}\left(\frac{\overline{p_{C_n}}}{\overline{p_C}}\frac{p_C}{p_{C_n}}\right)^{\sigma_C}$$

p_C is the consumer price index, θ_h^C is the benchmark value share of consumption goods, p_{C_n} is the producer price of good, t_{C_n} is the consumption tax, σ_C is the elasticity of substitution in consumption, C_n is the consumption of good n, C is the aggregate consumption.

The present model includes an initial "involuntary" unemployment rate and wages that are differentiated by labour type. All workers are supposed to be represented by Unions and a wage per each typology of labour is determined through the negotiation between Firms and Unions. The approach to wage negotiation is modelled as a "right to manage" Nash-bargaining approach in which Union and Firm bargain over wages but the Firm chooses the level of employment to maximize profits by taking the negotiated wage as it is given (Pissarides 1998). Assuming that all workers are members of the Union, we can describe the Labour Union utility function as follow (Pissarides 1998):

$$U_{LU} = n_i \frac{w_{L_i}^{1-\gamma}}{1-\gamma} + u_i \frac{b^{1-\gamma}}{1-\gamma} \text{ with } i = 24$$

where *ni* is the employment rate per each labour type, *ui* is the unemployment rate, *wi* is the wage negotiated, b is the unemployment compensation and γ is the parameter that represents the Labour Union risk aversion. We consider that the Union is risk neutral, thus we set $\gamma = 0$. We are considering a bilateral monopoly, where the Union chooses the wage and the Firm chooses employment. The bargaining allows determining the wage that can be summarised as (Severini et al. 2019):

$$w_{L_i} = \frac{\varepsilon_{n,w_L} * u * b}{1 + \varepsilon_{n,w_L} * u}$$

with $\varepsilon n,wL$ representing the elasticity of the number of employees to the negotiated wage. The elasticity ε is obtained applying the Shepard' lemma[18] for which:

$$\varepsilon_{n,w_L} = \sum_{k=1}^{n} -\sigma_k \Gamma_k \prod_{j=1}^{k-1} (1 - \Gamma_j)$$

where σk is the elasticity of substitution between the input in the *K*th production function stage, *n* is the number of stages in the production function and Γk is the

[18] Shephard's Lemma states that the conditional demand of the *i*th factor corresponds to that amount which minimizes the cost for the Firm. In practice, a change in production factor's price, leads to a change into the total cost (minimum) of the Firm equal to the use of the same factor.

total share of costs attributable to the aggregate not containing labour in the same stage of production function.

Appendix C: The micro-module specification

The first logit regression computes the probability of being employed against the levels of six explanatory variables (gender, region of residence, education level, age, number of household's components and number of infants in the household). The associated equation is

$$\Pr(attivabili1 = 1) = \frac{1}{1 + e^{-\beta_0 - \beta_1 \cdot gen - \beta_2 \cdot reg - \beta_3 \cdot edu - \beta_4 \cdot age - \beta_5 \cdot com - \beta_6 \cdot \inf}} \quad (1)$$

where *attivabili1* is the dependent variable, which is 0 for workers who cannot increase their hours worked (i.e. full-timers and voluntary part-time/temporary workers) and 1 for workers who can (i.e. involuntary part-time and temporary workers, unemployed and inactive people members of the potential labor force [1]). Furthermore, *gen* is the gender dummy (1 = MALE, 0 = FEMALE), *reg* is a discrete variable indicating the region of residence (from 1 to 20), *edu* is the educational attainment (edu = 1 for LOW; = 2 for MEDIUM; 3 for HIGH), age (from 15 to 75 years old), *com* is the number of household components (ranging from 0 to 6) and inf the number of components under three years (ranging from 0 to 5).

These coefficients are used to compute the probability that any single underemployed individual rises his labor supply. Individuals are ordered according to the decreasing probability of improving their working hours, so that 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

Individuals ordered by the variable '*ordinamento*' are eligible to increases in employment established according the CGE model results, 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 the inactive in the Potential Labor Force (PLF).[19]

[19] 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.

As for the reduction in employment, a score estimated on the basis of a LOGIT regression (Eq. 2) by using as the dependent variable the variable *employed*(dummy with 0 for workers without employment and 1 for workers with employment) 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 $\#_{component}$ (discrete variable from 0 to 6) and the number of components under three years old $\#_{component<3}$ (discrete variable from 0 to 5):

$$PR\left(employed = 1 | gender, reg, edu, age, \#_{component}, \#_{components<3}\right) = \frac{1}{1 + \exp\left(-\beta_0 - \beta_1 \cdot gender - \beta_3 \cdot reg - \beta_4 \cdot edu - \beta_5 \cdot age - \beta_6 \cdot \#_{component} - \beta_7 \cdot \#_{component<3}\right)}. \quad (2)$$

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 labor 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 labor categories with increases and decreases in employment.

The microsimulation model could be used in the final version of the model in a fully integration approach in the following way. Let gross income be:

$$Y_{h,i} = w_{h,i} \cdot L_{h,i} + \cdots$$

where $w_{h,i}$ is the wage of individual i of household h, $L_{i,h}$ is the number of hours worked is labor income, the income of self-employed $Yaut^0_{h,i}$, the income from capital $Ycap^0_{h,i}$, the pensions $Ypen^0_{h,i}$ and the other incomes $Yothers^0_{h,i}$.

Hence, disposable income of individual i in household h is

$$YD_{h,i} = Y_{h,i}(1 - t) + C_{h,i} \quad (2)$$

where t is the tax rate, which is a function of the income level:

$$t = t\left(Y_{h,i}\right)$$

and $TaxCredit_{h,i}$ is the tax credits.:Changes in wages and employment obtained at the first stage in the CGE simulation can be used to construct the new disposable income:

$$Y_{h,i}^{D,CGE} = \left(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right) \cdot$$
$$\left(1 - t^{gross}\left(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right)\right) + TaxCredit_{h,i}. \quad (3)$$

We can apply the change in the PIT tax rates $t^{gross,PROVISION}$ of the third, fourth and fifth tax bracket needed to increase the net PIT revenues by an amount coherent with the provisions of the cut in employers' SSCs:

$$Y_{h,i}^{D,CGE1} = \left(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right) \cdot$$
$$\left(1 - t^{gross,PROVISION}\left(w_{h,i}^{CGE} \cdot HW_{h,i}^{CGE} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right)\right) + TaxCredit_{h,i}. \quad (4)$$

The household disposable income is computed as:

$$YD_h = \sum_i YD_{h,i}$$

by household $\sum_{i=1}^{imax} Y_{h,i}^{D,CGE1}$ gives us the new consumption patterns by NACE/CPA $C_h^{NACE/CPA}$ according to households' consumption propensity c_h^0 and the share of consumption by NACE/CPA $\frac{C_h^{0,NACE/CPA}}{\sum_{NACE/CPA} C_h^{0,NACE/CPA}}$ (under the assumption that shares are unresponsive to changes in disposable income):

$$C_h^{NACE/CPA} = \sum_{i=1}^{imax} Y_{h,i}^{D,CGE1} \cdot c_h^0 \cdot \frac{C_h^{0,NACE/CPA}}{\sum_{NACE/CPA} C_h^{0,NACE/CPA}}. \quad (5)$$

The labor supply by individuals is obtained by calculating the disposable income with the wages obtained at the first CGE stage under different assumptions in terms of worked. There are three aspects to stress: (i) for married persons or life partners, decisions are made on the couple basis, whereas it is individual for the other components; (ii) the set of choices of the first earner in a couple (i.e. 33, 35, 37, 39, 41, 43, 45, 48 and 50 weekly worked hours) is more limited than that one of the second earner in the couple and of other components (i.e. 10, 15, 18, 20, 22, 25, 30, 33, 35,

37, 39, 41, 43, 45, 48 and 50 weekly worked hours[20]) with a matrix of choices of 144 cells for couples and a vector of 9 choices; (iii) the set of hours worked by individuals, as well the matrix of hours worked by the members of the couple, before and after the change in the tax system is established according the principle of the minimization of the percentage loss (in case of an increase in taxation) or of maximization of the percentage gains (in case of decrease in taxation) in terms of disposable income in the simulation scenario compared to the benchmark scenario.For couples, the mechanism can be described as follows. Let gross income be:

$$YD_{h,i}^{*,CGE,PROVISION} = [(w_{h,i}^{CGE} \cdot HW_{h,i}^{*} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}) \cdot$$

$$\left(1 - t^{gross,PROVISION} \cdot \left(w_{h,i}^{CGE} \cdot HW_{h,i}^{*} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right)\right) + TaxCredit_{h,i}] \tag{6}$$

which calculates the disposable income obtained by applying the CGE level of wages and the new tax scheme needed to give the provision of the manoeuvre under the different values of the hours worked of the both components 1 and 2 of the couple and for individuals;

$$YD_{h,i}^{*,CGE,FORCE} = [w_{h,i}^{CGE} \cdot HW_{h,i}^{*} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}) \cdot$$

$$\left(1 - t^{gross,} \cdot \left(w_{h,i}^{CGE} \cdot HW_{h,i}^{*} + Yaut_{h,i}^{0} + Ycap_{h,i}^{0} + Ypen_{h,i}^{0} + Yothers_{h,i}^{0} - Deduction_{h,i}\right)\right) + TaxCredit_{h,i}] \tag{7}$$

which calculates the hypothetical disposable income obtained by applying the CGE level of wages and the tax scheme in force under the different values of the hours worked of the both components 1 and 2 of the couple and for individuals;

$$(HW_{h,1}^{*}, HW_{h,2}^{*}) = argmin\left(\sum_{i=1}^{2} YD_{h,i}^{*,CGE,PROVISION} / \sum_{i=1}^{2} YD_{h,i}^{*,CGE,FORCE} \cdot 100 - 100\right) \tag{8}$$

which applies the types of disposable income estimated in both the above mentioned equations and calculates the percentage difference between the scenario with provision and that one under the legislation in force cumulatively for the both members of the couple.

As for individuals, the choice mechanism cam be seen as it follows:

[20] This full set of hours worked is obtained on the basis of the distribution of hours by individual. We have to mention the circumstance that working implies a fixed cost, so that the choice of some working hours determines a marginal benefit lower than the cost in terms of disutility.

$$HW^{*}_{h,i} = argmin\left(YD^{*,CGE,PROVISION}_{h,i} / YD^{*,CGE,FORCE}_{h,i} \cdot 100 - 100 \right) \tag{9}$$

which estimates the percentage difference of hypothetical disposable income for each individual under the hours worked identified in the hour patterns between the scenario with provision and that one under the legislation in force for each individual.

Currently, the microsimulation stage does not interact with the CGE stage with the exception of the change in the labor supply due to the new tax system to assure the provision of the manoeuvre at the CGE level:

$$\begin{aligned} YD^{*,0,PROVISION}_{h,i} = [(w^{0}_{h,i} \cdot HW^{*}_{h,i} + Yaut^{0}_{h,i} + Ycap^{0}_{h,i} + Ypen^{0}_{h,i} + Yothers^{0}_{h,i} - Deduction_{h,i}) \cdot \\ \left(1 - t^{gross,PROVISION} \cdot \left(w^{0}_{h,i} \cdot HW^{*}_{h,i} + Yaut^{0}_{h,i} + Ycap^{0}_{h,i} \right.\right. \\ \left.\left. + Ypen^{0}_{h,i} + Yothers^{0}_{h,i} - Deduction_{h,i} \right)\right) + TaxCredit_{h,i}] \end{aligned} \tag{10}$$

which calculates the hypothetical disposable income obtained by applying the benchmark level of wages and the new tax scheme needed to give the provision of the manoeuvre under the different values of the hours worked of the both components 1 and 2 of the couple and for individuals;

$$\begin{aligned} YD^{*,0,FORCE}_{h,i} = [w^{0}_{h,i} \cdot HW^{*}_{h,i} + Yaut^{0}_{h,i} + Ycap^{0}_{h,i} + Ypen^{0}_{h,i} + Yothers^{0}_{h,i} - Deduction_{i}) \\ \cdot \left(1 - t^{gross,} \cdot \left(w^{CGE}_{h,i} \cdot HW^{*}_{h,i} + Yaut^{0}_{h,i} + Ycap^{0}_{h,i} + Ypen^{0}_{h,i} + Yothers^{0}_{h,i} \right.\right. \\ \left.\left. - Deduction_{h,i} \right)\right) + TaxCredit_{h,i}] \end{aligned} \tag{11}$$

which calculates the hypothetical disposable income obtained by applying the benchmark level of wages and the tax scheme in force under the different values of the hours worked of the both components 1 and 2 of the couple and for individuals;

$$(HW^{*}_{h,1}, HW^{*}_{h,2}) = argmin\left(\sum_{i=1}^{2} YD^{*,0,PROVISION}_{h,i} / \sum_{i=1}^{2} YD^{*,0,FORCE}_{h,i} \cdot 100 - 100 \right). \tag{12}$$

which applies the types of disposable income estimated in both the above mentioned equations and calculates the percentage difference between the scenario with provision and that one under the legislation in force cumulatively for the both members of the couple.

As for individuals, the choice mechanism cam be seen as it follows:

$$HW^{*}_{h,i} = argmin\left(YD^{*,0,PROVISION}_{h,i} / YD^{*,0,FORCE}_{h,i} \cdot 100 - 100 \right) \tag{13}$$

which estimates the percentage difference of hypothetical disposable income for each individual under the hours worked identified in the hour patterns between

the scenario with provision and that one under the legislation in force for each individual.

We have to stress that the resolution of the maximization problem does follow a continuous approach, but a discrete one *a là* Van Soest. In particular, we build the whole matrix of the set of hours worked and the type of tax system (without provision and with provision) and choose the combination of hours worked for the both members of the couple and for individuals.

The procedure is illustrated in A.H.O. Van Soest (1995), 'Structural models of family labor supply', and in Kornstad and Thoresen (2007), 'A Discrete Choice Model for Labor Supply and Child Care'.

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