EUROLAB, A Multidimensional Labour Supply-Demand model

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Motivation

- ***EUROMOD*** *is a non-behavioural tax-benefit microsimulation model used to assess static distributional & budgetary effects of fiscal reforms.*

- ***Often, fiscal reforms, intentionally or not, can influence*** *labour market responses. Such behavioural effects cannot be assessed using the EUROMOD model.*

- ***Although EUROMOD does not take into account*** *behavioural responses in the assessment of policy effects,* ***its capacity to closely replicate existing and counterfactual fiscal reforms****, together with the heterogeneity of underlying data, is an appropriate environment for constructing a behavioural microsimulation model.*

Labour Supply Effects Using EUROMOD – some examples

- *Klevmarken (1997) is the first attempt to consider behavioural responses in EUROMOD.*
- *Country Analysis: Figari et al., 2019, Figari and Narazani, 2019, Coda Moscarola et al., 2019.*
- *Cross-country Analysis: Colombino et al, 2010, Colombino and Narazani, 2015, Bargain et al., 2014 and Vandelannoote and Verbist, 2020.*

Other Behavioural Models

- *MICSIM for the Netherlands (Jongen et al., 2014).*
- *MITTS and B-TAXBEN for Australia (Creedy et al., 2002).*
- *TAXMOD-B for New Zealand (Mercante and Mok, 2014a, 2014b).*
- *SWEtaxben for Sweden (Ericson et al., 2009),*
- *IZAΨMOD (Peichl et al., 2010) for Germany.*

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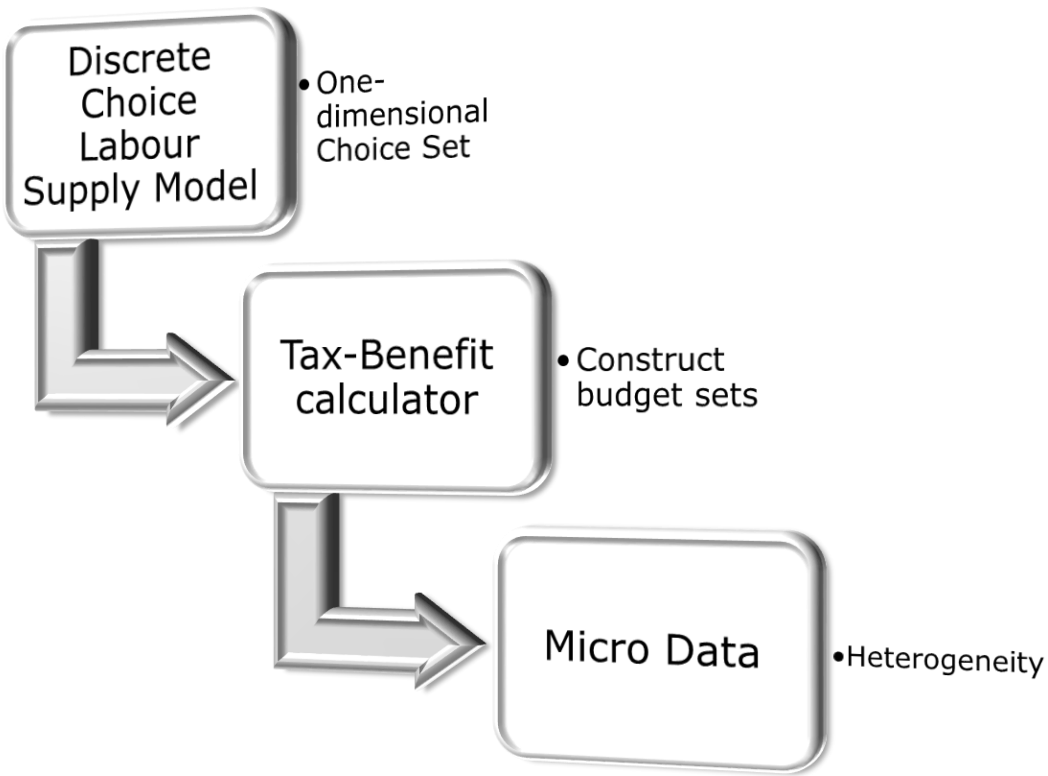
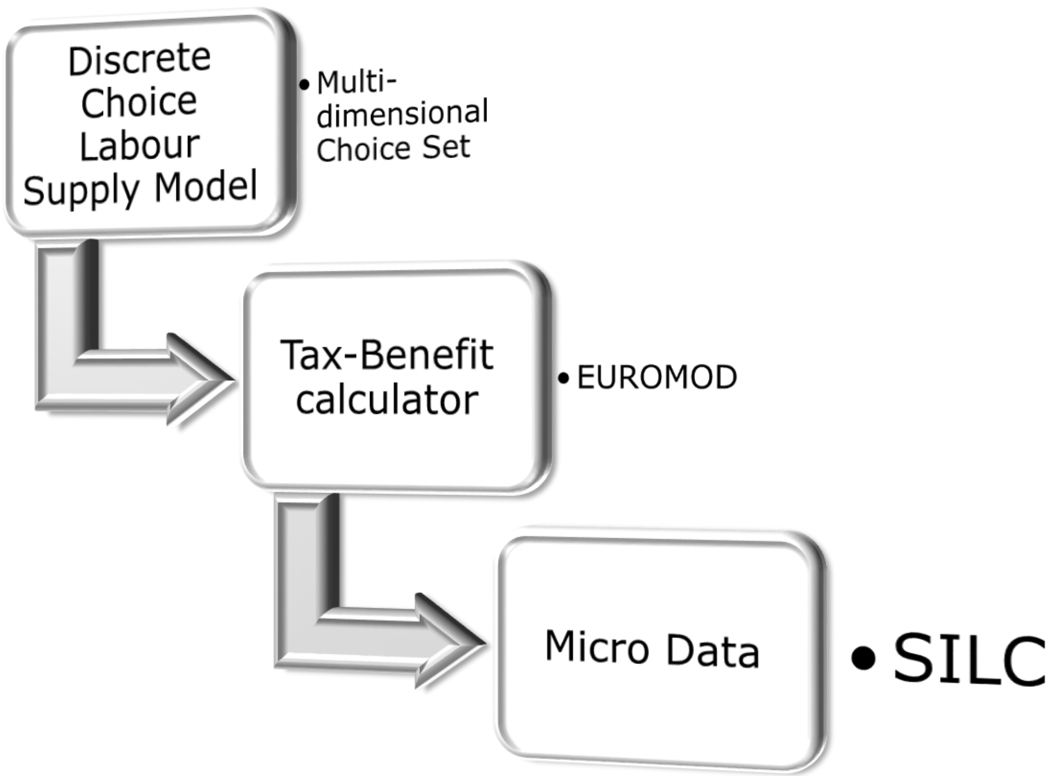
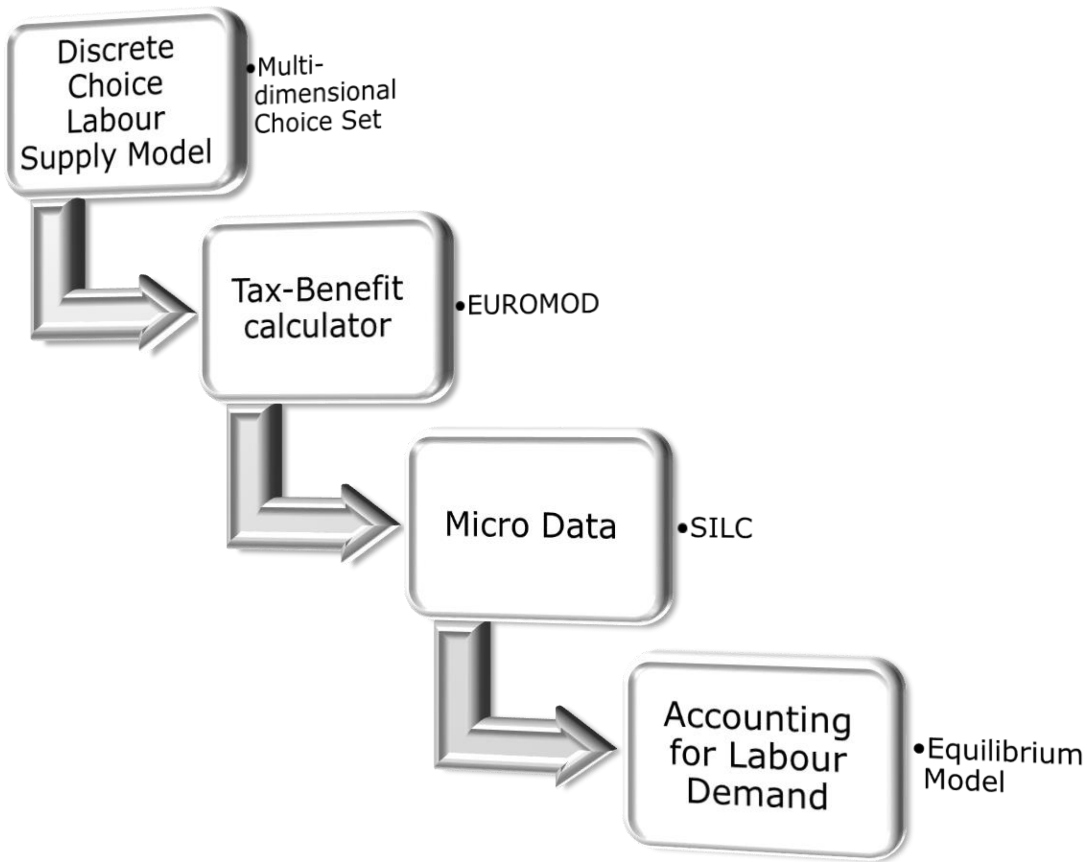
How Behavioural Models are normally built?



How EUROLAB labour supply module is build?



How EUROLAB is build?



Discrete Choice Labour Supply Model

- EUROLAB is based on the modelling of discrete choice labour supply (Aaberge et al., 1995; Van Soest, 1995) based on the Random Utility Maximization approach (McFadden, 1974).

- Like other behavioural microsimulation models, EUROLAB estimates a set of structural parameters of the utility function and applies them to predict labour supply behaviour.

Discrete Choice modelling

One-Dimensional

- Hours
- No distinction between Unemployed and Inactive

Multi-Dimensional

- Hours
- Occupational sectors (essential, non-essential)
- Employment statuses (employee, self-employed)
- Unemployment
- Inactivity

Choice Set

Three choice sets – H, S and E – with h, s and e elements, respectively.

For example, a choice set based on three dimensions`:

a) *3 ranges of positive working hours ([15-30], [31-45] and [46-60]),*
b) *two occupational sectors (s1 and s2) and*
c) *two employment statuses (e1 and e2)*

Choice Set

In addition to these combinations of choices, individuals face 2 distinct choices with zero working hours:

1. inactive and receiving no income
2. unemployed but active and may be receiving unemployment benefits.

Unemployment can also be interpreted as a choice of ‘job’ (Colombino et al., 2010) paying a ‘wage’ .

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Random Utility Maximization Model

A household i is faced with a set of feasible discrete alternatives or "job" types $\Omega = (H, S, E)$

A rational household selects the alternative that yields greatest utility. As utility is assumed as a random variable, it can be divided into: a systematic component, V(.) and a random component ε_{ij} *or disturbance.*

$$U = V\left(w_{i,s,e}, H, S, E, \tau; \gamma_i\right) + \varepsilon_i$$

- γ_i *is a vector of parameters (to be estimated) that characterise the preferences of household i.*

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Random Utility Maximization Model

Assuming a Gumbell distribution for the random component and adopting a convenient specification of the probability density function $g(H, S, E)$*, we can obtain the probability that household i is willing to accept a job* (h, s, e)

- $$\mathrm{P}(\mathrm{w_i}, \mathrm{h}, \mathrm{s}, \mathrm{e}, \tau; \gamma_{\mathrm{i},} \delta_{\mathrm{i}}) = \frac{\exp\{\mathrm{V}(\mathrm{w_i},\mathrm{h},\mathrm{s},\mathrm{e},\tau;\gamma_\mathrm{i}) + \mathrm{D_i}(\mathrm{h},\mathrm{s},\mathrm{e})'\delta_\mathrm{i}\}}{\sum_\mathrm{S}\sum_\mathrm{E}\sum_\mathrm{H}\exp\{\mathrm{V}(\mathrm{w_i},\mathrm{h},\mathrm{s},\mathrm{e},\tau;\gamma_\mathrm{i}) + \mathrm{D_i}(\mathrm{h},\mathrm{s},\mathrm{e})'\delta_\mathrm{i}\}}$$

- $D_{1,0} = 1[s = 1, h > 5]$
- $D_{1,1} = 1[s = 1, 16 \leq h < 30]$
- $D_{1,2} = 1[s = 1, 31 \leq h < 45]$ *(3)*
- $D_{1,0} = 1[s = 1, h > 5]$
- $D_{1,1} = 1[s = 1, 16 \leq h < 32]$
- $D_{1,2} = 1[s = 1, 33 \leq h < 42]$
- $D_{Un} = 1[1 \leq h \leq 5]$

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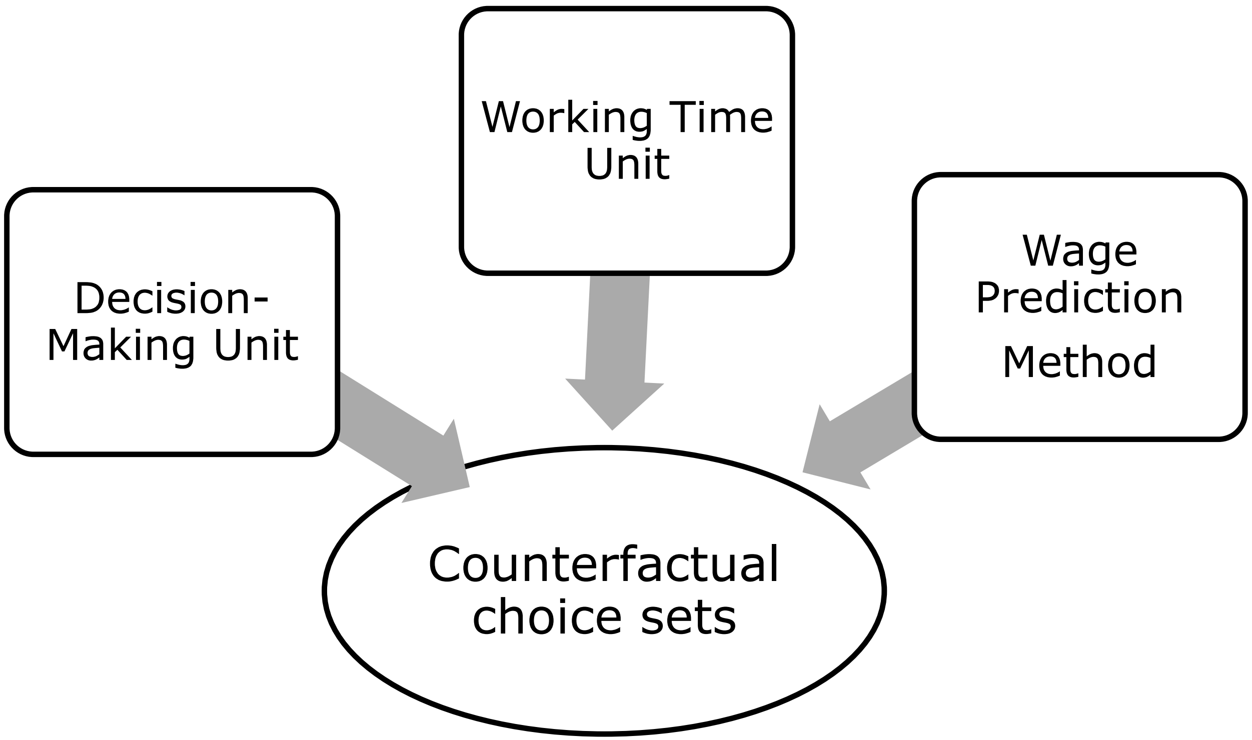
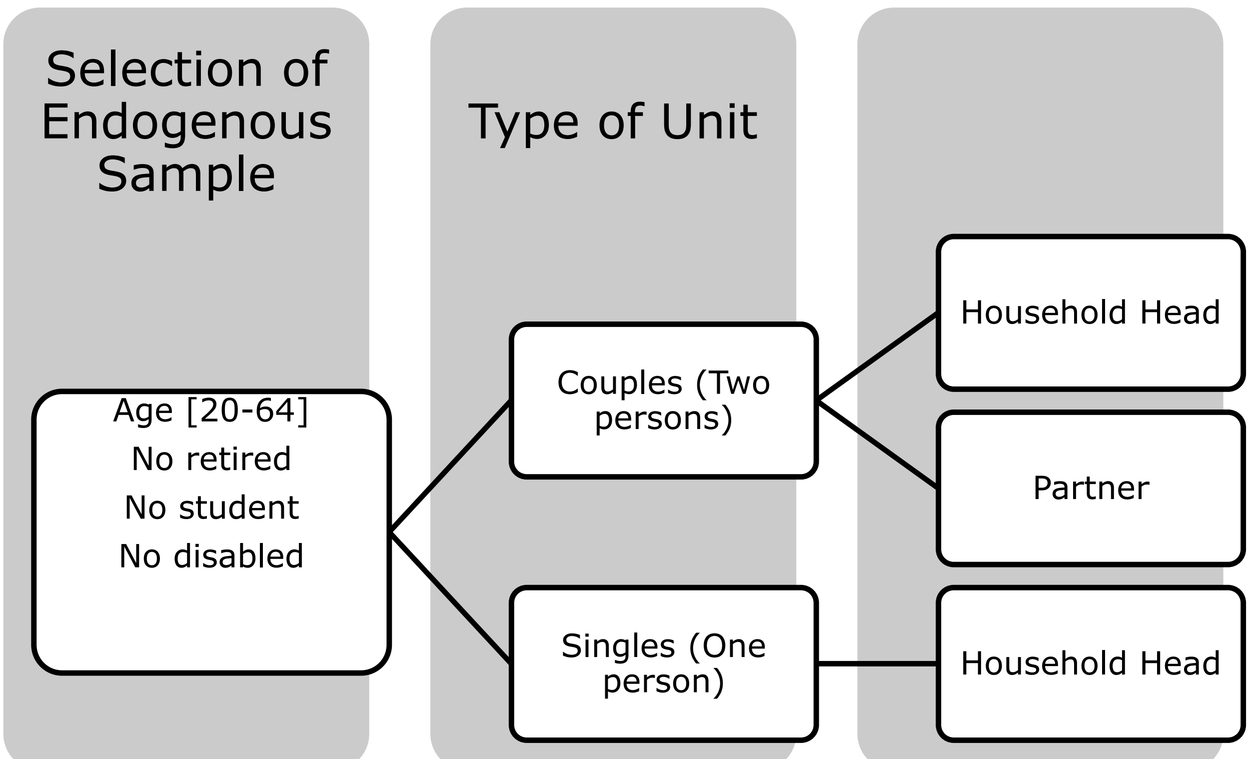
Counterfactual choice sets



Decision-making Unit



Working Time Unit using SILC Data

1) Hours worked per week (survey week, e.g. 2018)

2) Annual Months of PT, FT work and income (income year, e.g. 2017)

Time lag
- Between survey year & income year

Mismatch
- Between Annual Working Hours & income

Missing obs of Annual hours

A combination of 1) and 2) leads to Annual hours

Imputation: Correct “wrong” weekly hours of work using information on gender-specific median hours of part-time and full-time workers, following Brandolini et al. (2010).

Advantage: The information on months in employment refers to the income year and matches with the information on earnings.

Disadvantage: It does a homogenous imputation of working hours and does not account for the potential non-randomness of missing hours of work at the survey year.

Prediction of Wages

Three different methods to control for the possibility of non-random selection.

1. Dagsvik and Strom, 2004: based on the assumption of correlation between the error terms in the wage and selection equation. Estimate wage equation coefficients for (sector j and empl. Stat. e) by OLS on the sub-sample of women/men that work in (sector j and empl. Stat. e) including logPj as an additional explanatory variable in the wage equation.

2. Dubin and McFadden (1984): based on two assumptions: (1) a linear relationship between the error terms in the wage and selection equations, and (2) correlation between the two error terms sum to zero.

3. Modified version of Dubin and McFadden, where the assumption of zero sum of correlation terms is relaxed as suggested by Bourguignon, Fournier and Gurdand (2007).

In EUROLAB we can choose between actual wages or predicted wages for the working sample and for the chosen alternative.

Unemployment alternative

Unemployment benefits are simulated depending on the rules applied in one country and under several assumptions. For example, to simulate unemployment benefits using Italian input data in EUROMOD, we assume that the individual under this alternative

- has worked at least 6 months in the previous year and
- is eligible to receive unemployment benefits for the whole year.

To calculate the amount of the benefit, EUROMOD needs information on the monthly wage earned in the previous year.

- If wage was reported in the data, we use this information to simulate unemployment benefits for the sample of employed individuals.
- If no wage is reported from the previous year, we predict a monthly wage using the predicted wage rate for wage employment.

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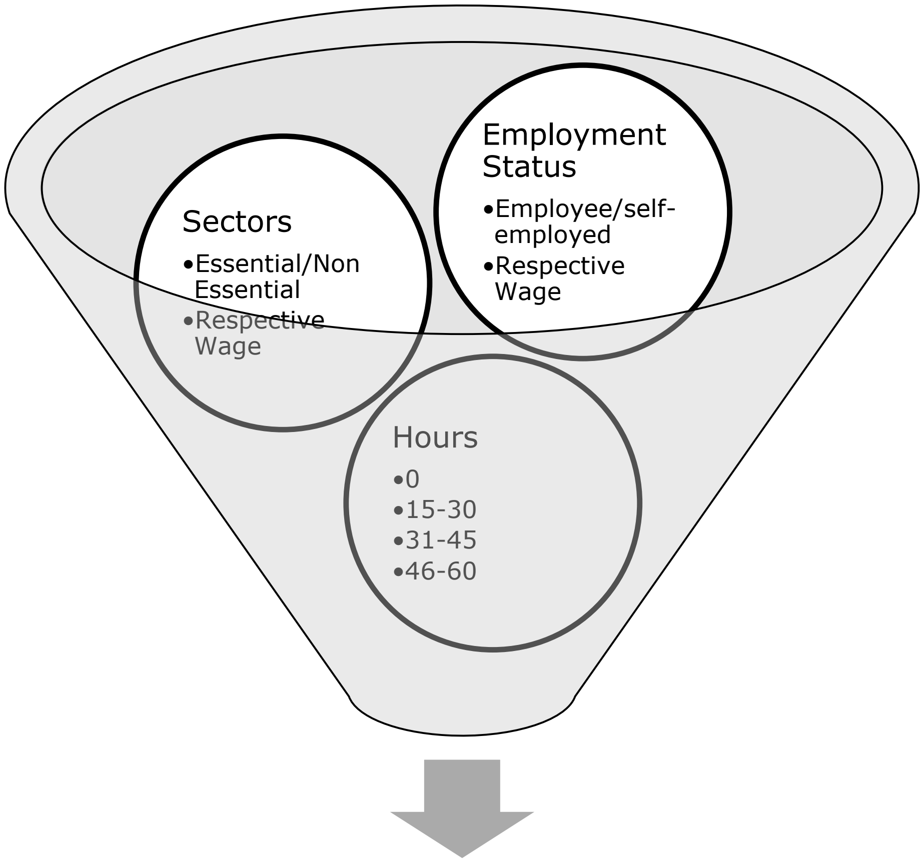
Linking EUROMOD with EUROLAB



Disposable Income at each counterfactual choice

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Labour supply/demand equilibrium (based on Colombino, 2013)

$$P\left(w_i, h, s, e, \tau; \gamma_{i,}\delta_i\right) = \frac{\exp\{V(w_i, h, s, e, \tau; \gamma_i) + D_i(h, s, e)'\delta_i\}}{\sum_S \sum_E \sum_H \exp\{V(w_i, h, s, e, \tau; \gamma_i) + D_i(h, s, e)'\delta_i\}}$$

$$\delta_{s,e,0} = \ln\left(A_{s,e,0} J_{s,e}\right), s = 1,2,3, e = 1,2$$

$$\delta_{s,e,l} = \ln\left(A_{s,e,l} \frac{J_{s,e,l}}{J_{s,e}}\right), s = 1,2,3, e = 1,2, l = 1,2 \qquad (4)$$

$J_{s,e}$ *= number of jobs in sector s and employment status e*

$J_{s,e,l}$ *= number of jobs in sector s, employment status e and hour range l*

Equilibrium after a new reform is implemented

$J(v) = J\mathbf{e}^{\mathbf{v}}$

$\delta(v) = \ln(Je^{v}) + \ln(A) = \ln J + a + v = \boldsymbol{\delta} + \mathbf{v}$

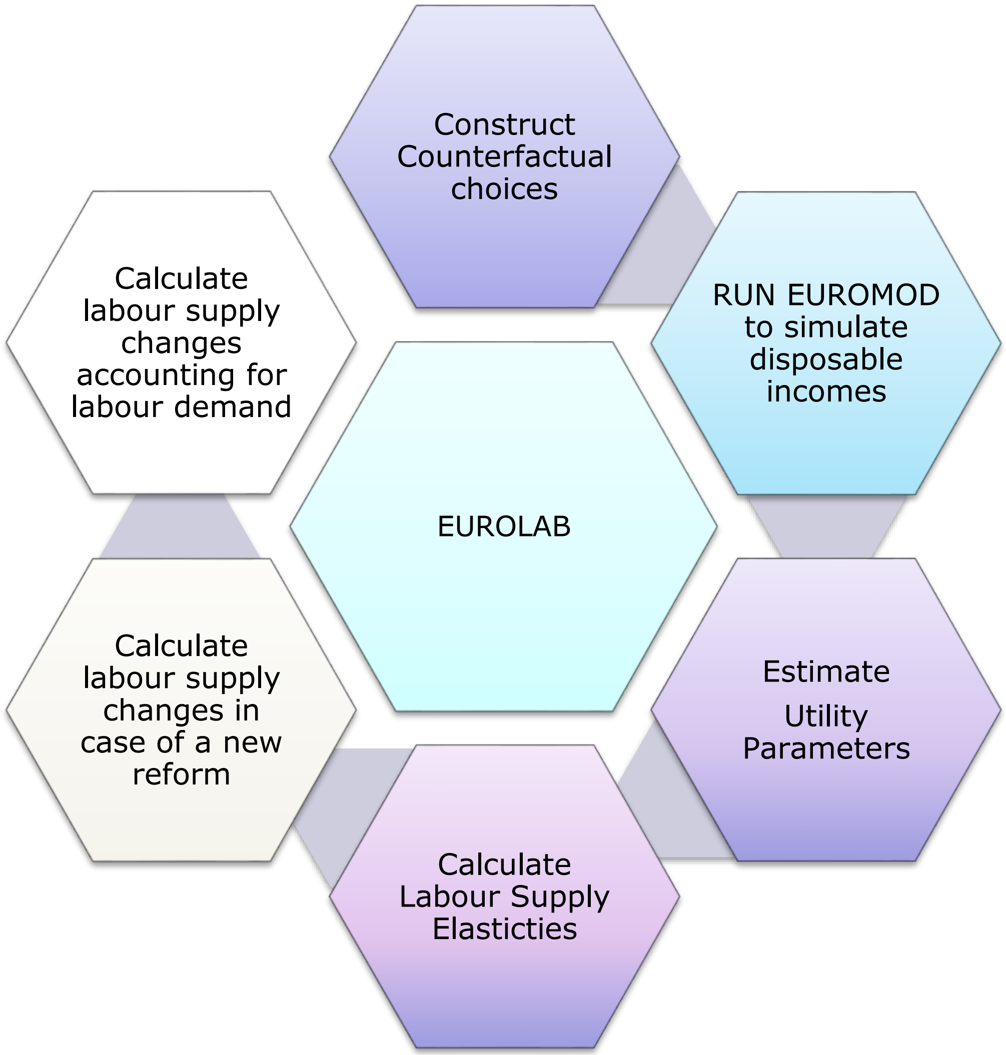
By assuming $J = Kw^{-\eta}$ *or* $w = K^{1/\eta}J^{-1/\eta}$ *we get the wage rate corresponding to* Je^{v}*:*

$w = K^{1/\eta}(Je^{v})^{-1/\eta} = K^{1/\eta}J^{-1/\eta}e^{-v/\eta} = \mathbf{we}^{-\mathbf{v}/\boldsymbol{\eta}}$

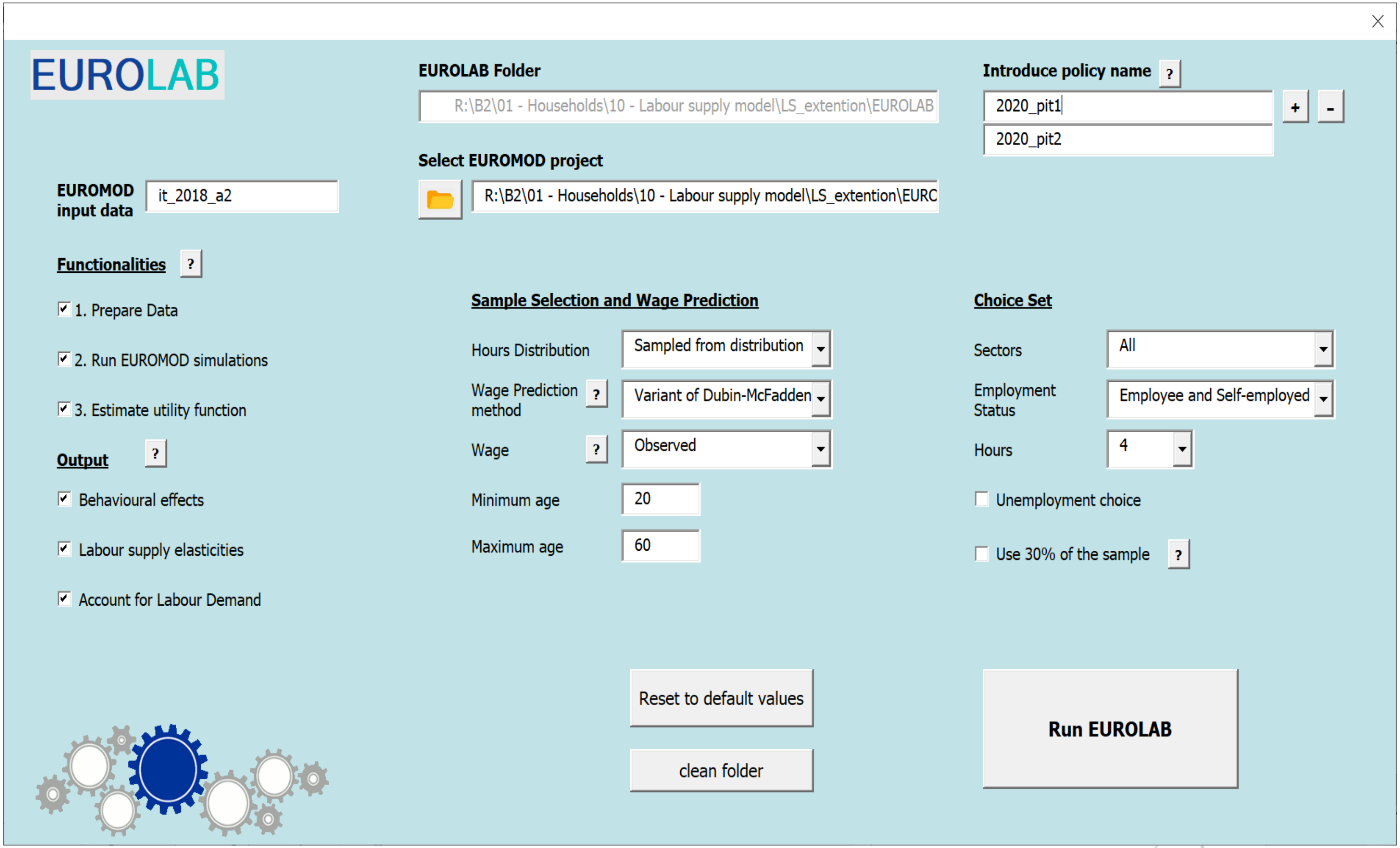
Under Equilibrium we have

$\sum_i \sum_{h,s,e>0} P(w_i(v^*), h, s, e, \tau'; \gamma, \delta(v^*)) = J(v^*)$

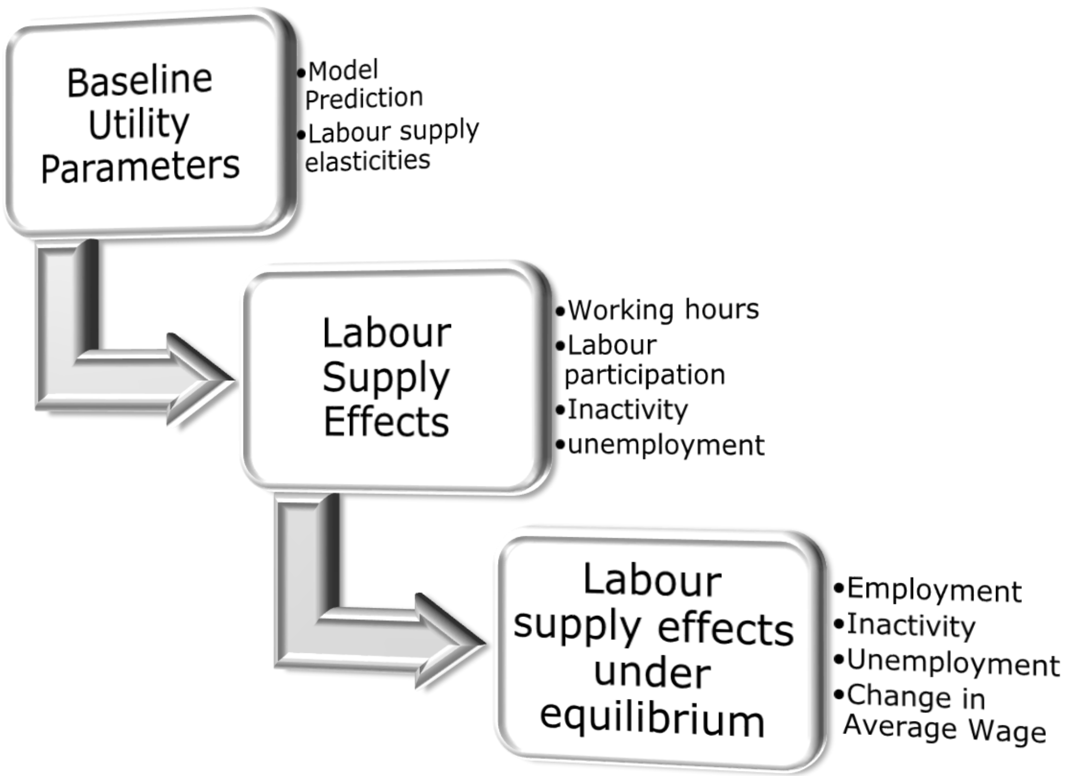
Simplified diagram of EUROLAB



EUROLAB Interface



EUROLAB OUTPUTS



An example using EUROLAB

PIT Reforms to the Italian Personal Income Tax

- PIT1
  - increases of income tax rates in 1st Bracket (from 0.23 to 0.30) & 2nd bracket (from 0.27 to 0.32)
  - decreases of income tax rates in 3rd Bracket (from 0.38 to 0.34), 4rth bracket (from 0.41 to 0.36) & last tax bracket (0.43 to 0.38).

- PIT2
  - Decreases of income tax rates across the entire income distribution from 0.23, 0.27, 0.38, 0.41 and 0.43 to 0.1, 0.16, 0.22, 0.28 and 0.34 respectively.

SILC 2018 data and policy year 2020 have been used for simulating the reforms in EUROMOD.

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LS Elasticities

Table 2. Labour elasticities for Men, it

		All			Couples			Singles		
		Total	**Extensive**	**Intensive**	**Total**	**Extensive**	**Intensive**	**Total**	**Extensive**	**Intensive**
Education	Low level	0.113	0.100	0.013	0.093	0.078	0.015	0.134	0.123	0.011
	Middle level	0.112	0.095	0.017	0.080	0.060	0.020	0.147	0.134	0.013
	High level	0.087	0.068	0.019	0.041	0.021	0.019	0.149	0.130	0.019
Age	20-30	0.163	0.154	0.009	0.078	0.058	0.021	0.178	0.171	0.007
	31-40	0.118	0.101	0.017	0.077	0.055	0.023	0.154	0.142	0.013
	41-on	0.094	0.078	0.017	0.074	0.058	0.017	0.126	0.110	0.016
Child	Yes	0.132	0.119	0.014	0.100	0.085	0.015	0.144	0.130	0.013
	No	0.067	0.047	0.020	0.064	0.044	0.020	0.124	0.107	0.017
Total		0.107	0.091	0.016	0.075	0.057	0.018	0.143	0.130	0.013

Table 3. Labour elasticities for Woman, it

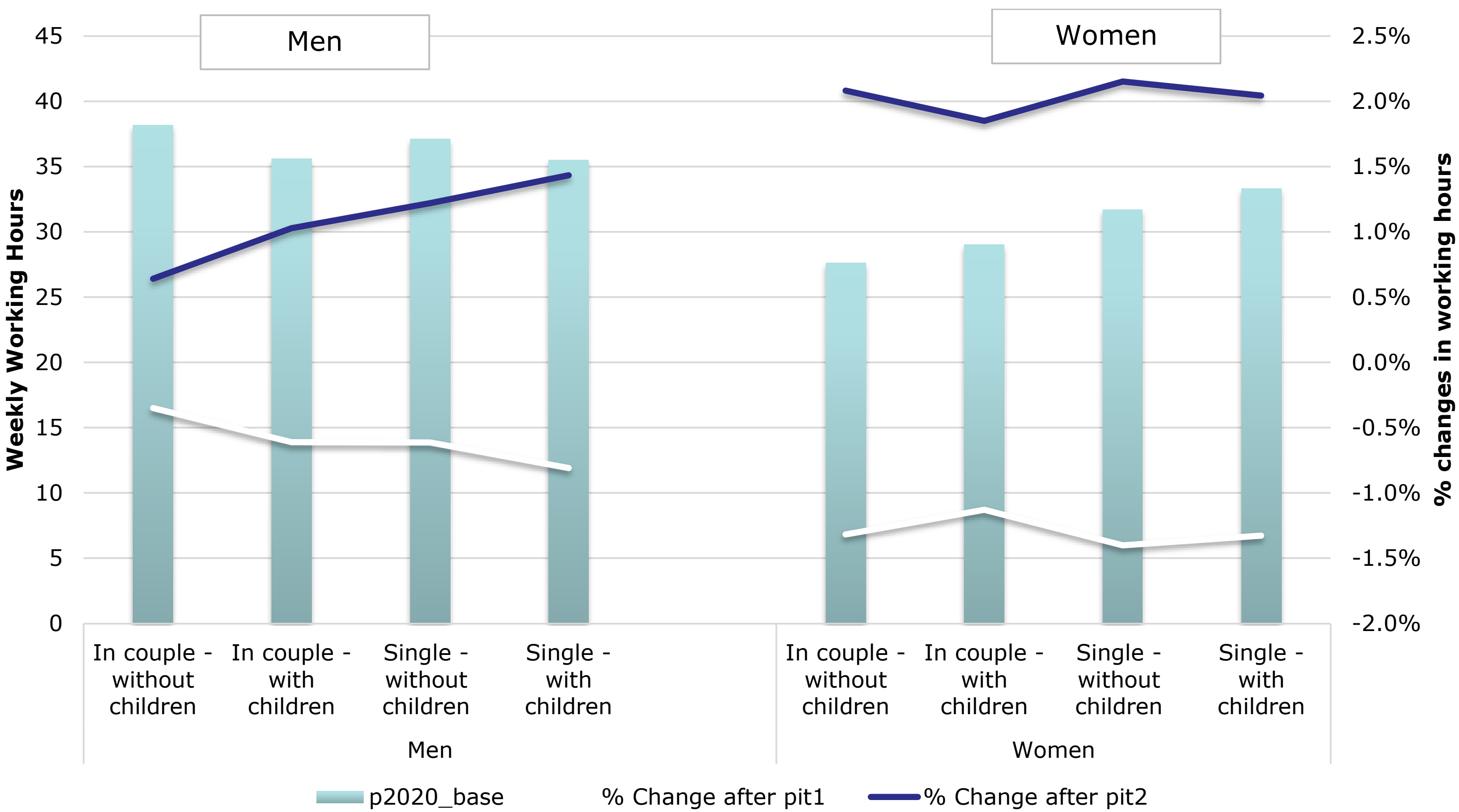
		All			Couples			Singles		
		Total	**Extensive**	**Intensive**	**Total**	**Extensive**	**Intensive**	**Total**	**Extensive**	**Intensive**
Education	Low level	0.225	0.183	0.042	0.180	0.146	0.034	0.286	0.233	0.054
	Middle level	0.182	0.143	0.039	0.161	0.120	0.040	0.210	0.174	0.036
	High level	0.151	0.111	0.040	0.137	0.096	0.040	0.169	0.128	0.040
Age	20-30	0.261	0.215	0.046	0.228	0.186	0.042	0.280	0.231	0.049
	31-40	0.200	0.159	0.041	0.190	0.148	0.043	0.213	0.176	0.038
	41-on	0.164	0.125	0.039	0.137	0.100	0.036	0.202	0.160	0.042
Child	Yes	0.181	0.142	0.039	0.141	0.100	0.040	0.203	0.164	0.038
	No	0.185	0.144	0.041	0.166	0.128	0.038	0.253	0.201	0.052
Total		0.183	0.143	0.040	0.159	0.120	0.039	0.215	0.174	0.042

LS effect, by household type

Table 3: Labour supply changes at intensive and extensive margin

		p2020 _base	p2020 _pit1	% Change after p2020_ pit1	p2020 _pit2	% Change after p2020_ pit2
Hours of work						
Men	In couple - without children	38.18	38.04	-0.35%	38.42	0.64%
	In couple - with children	35.60	35.38	-0.61%	35.97	1.03%
	Single - without children	37.12	36.90	-0.61%	37.58	1.22%
	Single - with children	35.52	35.23	-0.81%	36.02	1.43%
Women	In couple - without children	27.64	27.28	-1.32%	28.22	2.08%
	In couple - with children	29.04	28.71	-1.13%	29.58	1.85%
	Single - without children	31.70	31.26	-1.40%	32.38	2.15%
	Single - with children	33.32	32.88	-1.33%	34.00	2.04%

Graph 1: Changes in average working hours

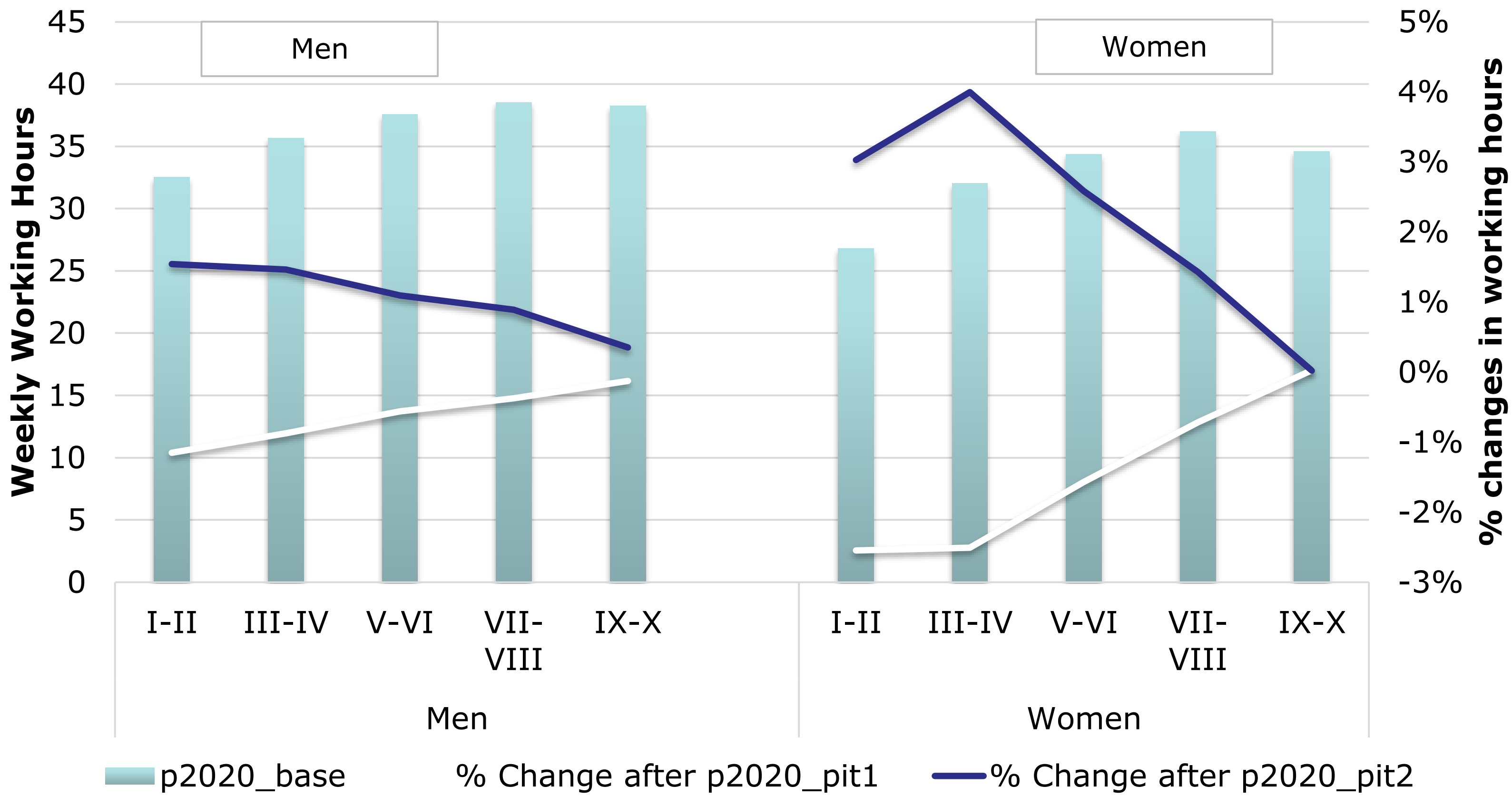


LS effect, by income quintile

Table 4: Labour supply changes by income quintiles

		p2020_ base	p2020_ pit1	% Change after p2020_pit1	p2020_ pit2	% Change after p2020_pit2
Hours of work						
Men	I-II	32.53	32.15	-1.15%	33.03	1.54%
	III-IV	35.67	35.36	-0.87%	36.19	1.46%
	V-VI	37.55	37.34	-0.56%	37.97	1.09%
	VII-VIII	38.54	38.39	-0.38%	38.88	0.89%
	IX-X	38.25	38.20	-0.13%	38.38	0.35%
Women	I-II	26.80	26.12	-2.55%	27.61	3.03%
	III-IV	32.04	31.24	-2.51%	33.33	4.00%
	V-VI	34.39	33.85	-1.57%	35.28	2.58%
	VII-VIII	36.22	35.96	-0.72%	36.74	1.43%
	IX-X	34.61	34.62	0.03%	34.62	0.02%

Graph 2: Changes in average working hours, by income quintiles



LS – Accounting for Demand side

Table 1: % Changes in employment, unemployment and inactivity rate

pit1 Reform

	Baseline	No Equilibrium	With Equilibrium	No Equilibrium (%)	With Equilibrium (%)
Employment	15481124.96	15356684.14	15394522.72	-0.80%	-0.56%
Inactivity	1339669.173	1375306.5	1358925.861	2.66%	1.44%
Unemployment	1117347.457	1206150.944	1184693.003	7.95%	6.03%
v					3.434135839

pit2 Reform

	Baseline	No Equilibrium	With Equilibrium	No Equilibrium (%)	With Equilibrium (%)
Employment	15481124.96	15704434.32	15695696.51	1.44%	1.39%
Inactivity	1339669.173	1244382.773	1248423.046	-7.11%	-6.81%
Unemployment	1117347.457	989324.4967	994022.0331	-11.46%	-11.04%
v					-0.800336563

Graph 3: % Changes in employment, unemployment and inactivity rate under equilibrium

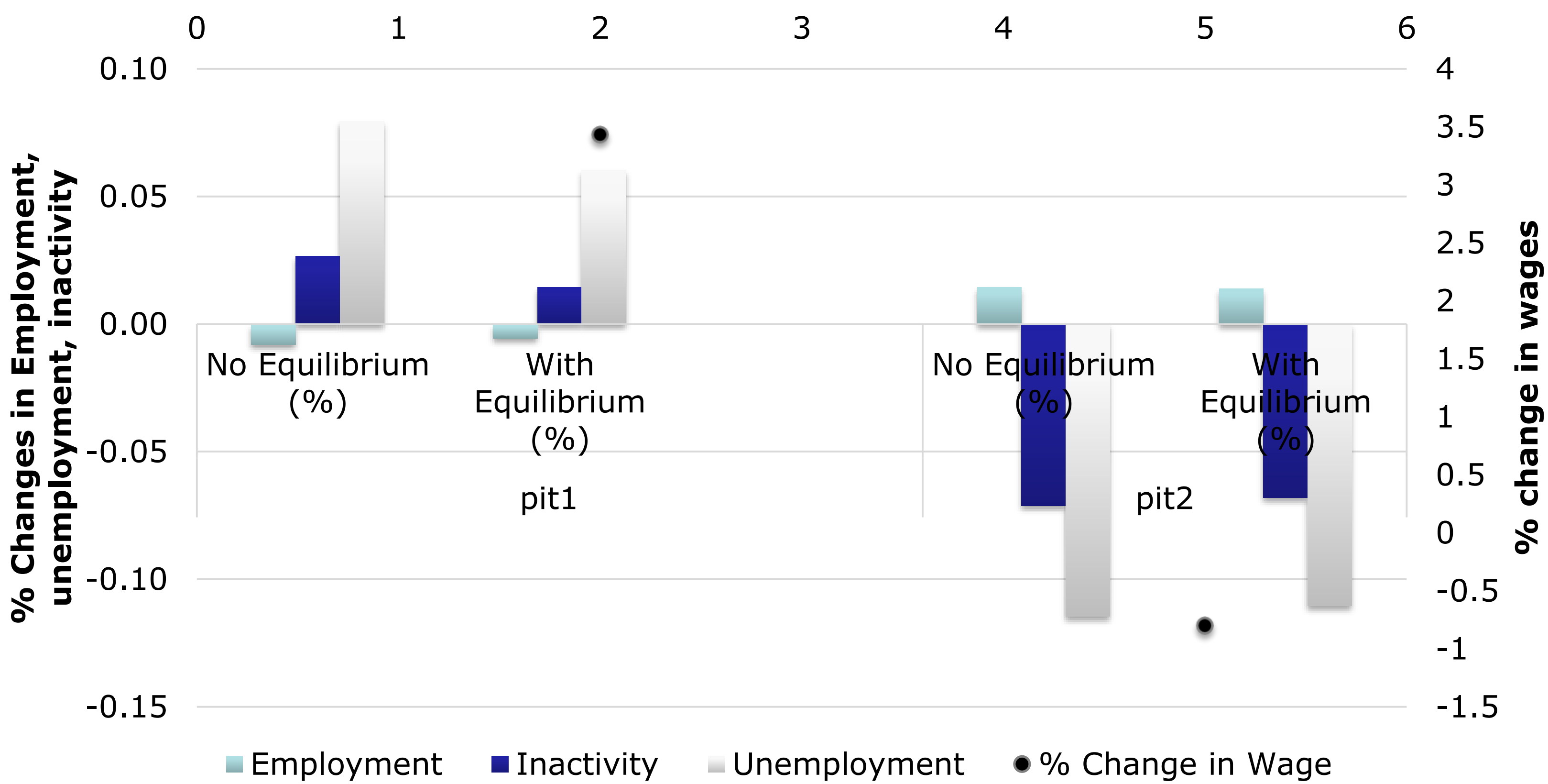
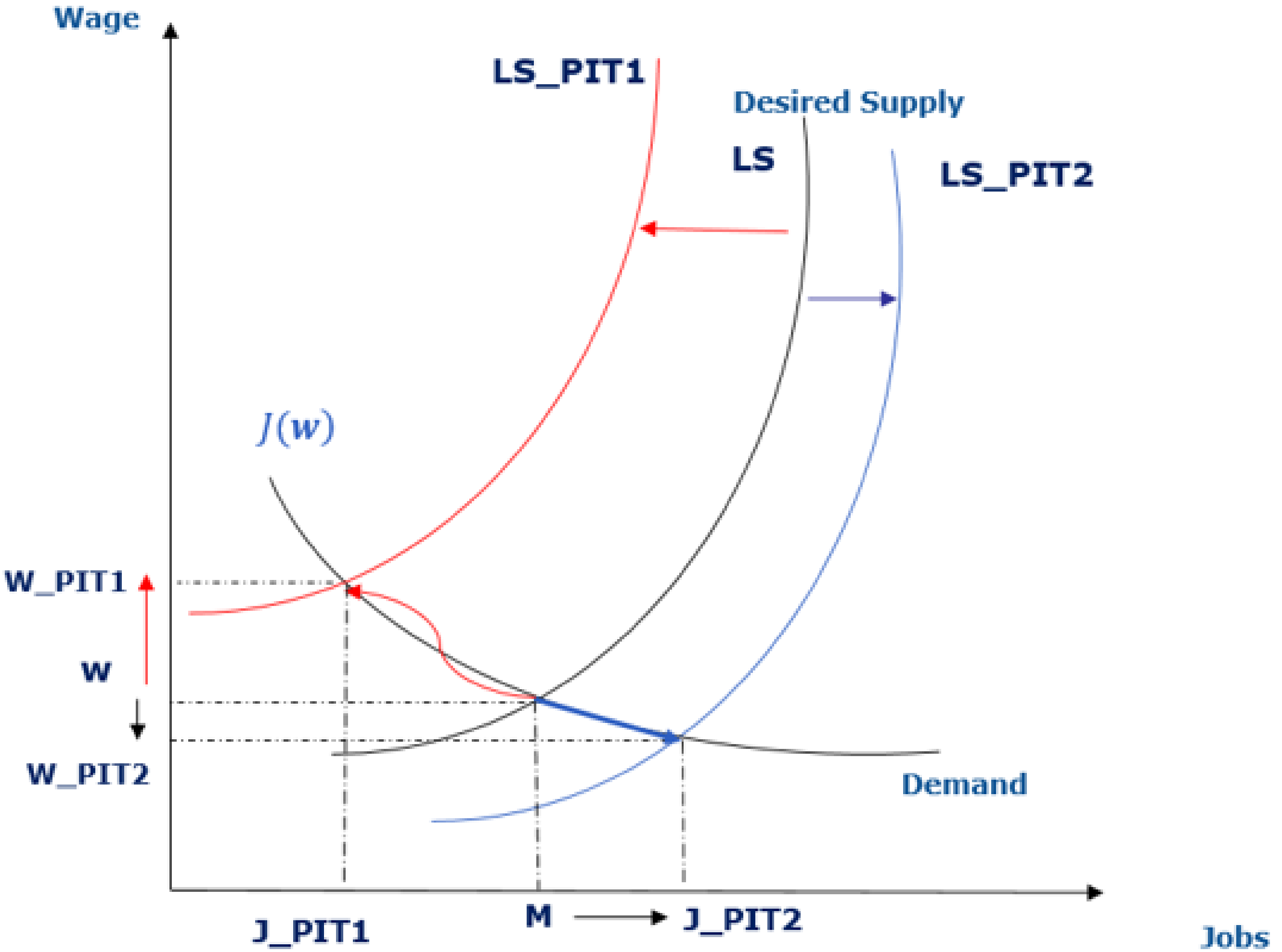


Fig.1 Adjustment along Labor Demand curve



Potential Synergies Of EUROLAB with EUROMOD functionalities

- *Indirect Tax Tool – version 3 (IITv3)*
  - Assess labour supply effects of VAT reforms or tax shifts reforms from labour to VAT.

- *EUROMOD WEALTH Taxation Tool (EWIGE)*
  - Assess the effects of announced changes in inheritance tax parameters on labour supply of potential heirs.

- *Labour Market Transition tool (LMA).*
  - Help automatizing the construction of unemployment alternatives in EUROLAB,
  - Assess behavioural responses triggered by monetary compensation schemes or similar policy interventions in a medium and long-run perspective using the labour demand module of EUROLAB.

Conclusions

- *EUROLAB is the EU labour supply-demand microsimulation model build on EUROMOD.*

- *The main contributions of EUROLAB are the assessment of:*
  - (i) labour supply elasticities,
  - (ii) changes in the labour participation rate and working hours, and
  - (iii) changes in labour supply when labour demand is taken into account.

- *The flexible design of choice set in EUROLAB can help the user to construct extensions of the model covering other individual or household decisions.*

Future Extensions of EUROLAB - 1

- *Predicting the aggregated behavioural effects **of future changes in the working-age population** that are related to internal or external migration flows, ageing of specific population groups or educational composition.*

- *Accommodating **childcare decisions of mothers** in a labour supply-demand framework can be a potential extension of the model. Information on childcare rationing and childcare costs together with type of observed formal/informal childcare are needed to build up this EUROLAB extension.*

- *Assessing behavioural effects of policies different from fiscal policies - **increases in minimum wages** - can be another extension.*

Future Extensions of EUROLAB - 2

- ***Optimal taxation is*** *another domain where EUROLAB can provide valuable assistance for policy analysis in the EU area. For that, first we have to choose a criterion that establishes the optimality of a given policy reform.*

- ***Focusing on Taxable Income*** *rather than hours of work would be another important extension of the model. Elasticity of taxable income (Feldstein, 1995) has received attention because it can help assessing the budgetary impact of fiscal reforms.*

- *Incorporating* ***Commuting Time*** *in the model is also important in front of the new hybrid work habits triggered by the pandemic crisis. This extension would help predicting future changes in working pattern.*

Future Extensions of EUROLAB - 3

Intertemporal dimension is another interesting extension, in the sense of modelling forward-looking households.

The motivation for this extension relies on the fact that the most important effects from tax-transfer reforms are not so much changes in hours of work but rather changes in educational and occupational decisions.

For example Imai & Keane, 2004, using an intertemporal model, have estimated that the elasticity of labour supply (in a comprehensive sense, including investment in human capital) is very much higher if one accounts for the intertemporal decision. This is extremely important from the (more long-run) policy perspective.

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