Growth Effects of Structural Reforms and their Impact on the Functional Income Distribution

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Abstract

This paper uses a semi-endogenous growth model to analyse the macroeconomic effects of structural reforms and their impact on the functional income distribution. Households supply three types of labour, low-, medium- and high-skilled and receive income from labour, tangible capital, intangible capital, financial wealth and transfers and we trace how structural reforms affect these types of incomes. The quantification of structural reforms is based on changes in structural indicators that can significantly close the income gap towards best performing countries in the EU. We find a general trade-off between an increase in employment of a particular group and the income of the average group member relative to income per capita. In general, reforms which aim at increasing employment of low skilled workers are associated with a fall in wages relative to income per capita. Capital owners generally benefit from labour market reforms, with an increasing share in total income, due to limited entry into the final goods production sector. This suggests that labour market reforms combined with existing goods market rigidities can lead to suboptimal distributional effects.

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Introduction

The joint occurrence of slower growth and persistent inequality has raised questions about the causes and about potential remedies. Potential drivers of inequality, which include skill-biased technological progress, the effects of globalisation, or the consequences of fiscal consolidation, have received widespread attention in the literature (see, e.g., Card and DiNardo 2002, Agnello and Sousa 2014, Keeley 2015, Lopez Gonzalez et al. 2015). Discussion of remedies beyond standard redistribution by taxes and transfers is patchier. This applies in particular to the role of structural reform and the question of complementarity ("inclusive growth") or incompatibility between the growth and equity objectives.

Traditionally, structural reform proposals have been assessed based on their potential to increase productivity and GDP per capita. However, their distributional impact is rarely addressed in the literature (see Causa et al. 2016). This paper contributes to the emerging literature on the distributional impact of structural reforms. It studies the effects of structural reforms on the functional distribution of income in the EU.

The analysis uses a DSGE model (Roeger et al. 2008) which has been set up to pursue the following goals. The first is that the model should be able to capture many of the dimensions in current reform discussions, i.e. it should allow us to make predictions about the impact of labour and goods market reforms. Second, it should be sufficiently detailed to capture market imperfections, regulatory constraints, fiscal burdens (tax wedges and administrative costs) but also allow to analyse constraints imposed by endowments, which for a modern economy are usually skill shortages. Third, given the importance of TFP for long term growth, it is useful to have a framework where TFP is endogenous and is generated by knowledge investment decisions of firms and households. In our model we extend the Jones (1995, 2005) model to capture the endogenous development of R&D. The preference for semi-endogenous growth models to fully endogenous structures is supported by Bottazzi and Peri (2007) who find evidence of weak scale effects as implied by semi-endogenous models of growth [2]. In addition to the R&D framework, our model also includes the disaggregation of labour into three skill-groups (low-, medium- and high-skilled) in order to capture differences in human capital endowments. In this model households receive income from labour, tangible capital, intangible capital, financial wealth and transfers, and we can trace how structural reforms affect these types of incomes.

In order to use a realistic quantification of structural reforms we rely on Varga and in 't Veld (2014), which applies a distance-to-frontier approach to measure the potential for reforms by assuming a gradual and partial closure of the gap in labour and product market indicators vis-à-vis the average of the three best EU performers. The simulated structural reforms focused on decreasing mark-ups and entry barriers in services and manufacturing, increasing the labour market participation rate for the elderly, the low-skilled and female workers, raising the share of medium- and high-skilled labour force, tax and unemployment benefit reforms and innovation.

Our findings can be summarised as follows. There is a trade-off between employment and relative incomes. In general, reforms which aim at increasing the employment rate of low skilled workers are associated with a fall of wages relative to income per capita. This effect can be decomposed into wage distribution effects across skill groups but the overall increase in the supply of labour also affects the distribution between wage earners and other income categories, especially capital owners. Capital owners generally benefit from labour market reforms, not only in the form of an absolute increase in capital income but also in the form of an increasing share in total income. This is due to a scale effect in

[2] The product-variety paradigm, along with some earlier R&D based models in the literature, shares the prediction of empirically unjustified scale-effects: if the level of resources devoted to R&D - for instance measured by the number of scientists engaged in R&D - is doubled, then the per capita growth rate of output should also double in the steady state. Jones (1995, 2005) offers an alternative setting for the product-variety paradigm, a semi-endogenous growth model which is free from these inconsistent scale-effects.

combination with limited entry into the final goods production sector. The relative increase in the capital income share associated with labour market reforms can only be substantially reduced if we allow for entry in the goods market. This suggests that labour market reforms combined with existing goods market rigidities can lead to suboptimal distributional effects.

The paper focuses on the effect of structural reforms on (functional) income inequality. It does not discuss the dimension inequality in the distribution of wealth. Inequality in wealth (stock) is at the same time one of the drivers and one of the consequences of the inequality in household income (flow). Wealth generates income to its owner in the form of returns to assets, and higher income facilitates the accumulation of wealth.

The paper is structured as follows. Section 2 of the paper provides a sketch of existing research on the distributional impact of reforms. Section 3 gives a description of the model, including the functional definition of income categories in the model, and details on the calibration. Section 4 presents and discusses the results for the impact of reforms in product markets, labour markets, the tax and transfer system, and human capital formation on different income categories. Section 5 summarises our findings and concludes.

2. Empirical work on the distributional impact of structural reforms

With the exception of tax and benefit reforms, the distributional impact of structural reforms has received relatively little attention in the past. In more recent years a substantial body of research on the widening and persistence of income and wealth inequalities has emerged. The efforts of closing the knowledge gap with empirical and theoretical work have addressed causes and potential remedies. Notably, the OECD has devoted particular attention to the role of economic policies for inequality.

2.1 Empirical work

OECD studies on the impact of structural policies on inequality have focused on the net real disposable household income across the distribution, i.e. real disposable household income after taxes and benefits. This work (e.g., Causa et al. 2015a, 2015b) finds that many policies deliver higher income gains at the lower end of the income distribution. These policies include measures that strengthen competition in goods markets (reducing regulatory barriers, trade, and FDI), broader access to education, and active labour market policies (ALMP). A general reduction in the generosity of unemployment benefits is also found to raise relative incomes at the lower end of the income distribution, whereas reducing benefits to long-term unemployed lowers household disposable income at the lower end of the distribution.

Other pro-growth policies may have opposite or ambivalent effects on income inequality (OECD 2015b). Examples include the promotion of innovation that widens skill premia across workers. Policies that increase labour force participation particularly in the low-skilled sector may widen the wage dispersion, but have opposite income-enhancing effects through higher employment.

Causa et al. (2016) broaden the analysis by considering the entire income distribution, instead of focusing on the bottom part relative to the average household, and by decomposing the income effect of structural reforms into labour productivity versus labour utilisation effects. OECD cross-country evidence over the last 30 years suggests that most reforms have little impact on income inequality when the latter is defined by measures that emphasise the middle class, whereas a high number of reforms have significant inequality (reducing or emphasising) effects at the lower end of the distribution. Trade-offs between growth and equity are thereby most common for social protection and labour market reforms. Lowering unemployment benefits and social assistance hurts low-income households in particular, which would call for complementary ALMP measures. No rise in income inequality is recorded for moderate reductions in the minimum wage, due to offsetting wage and employment effects for low-income earners. Lower rates of unionisation, to the contrary, are associated with higher income

inequality. Lowering labour tax wedges is prone to a growth-equity trade-off in the absence of sufficient progressivity of the tax burden. Causa et al. (2016) also confirms the result from Causa et al. (2015a, 2015b) of complementarity between growth and equity effects for competition-promoting product market reform and higher government spending on education.

Regarding the tax and benefit system, Cournède et al. (2013a, 2013b) discuss the growth and equity impact of alternative fiscal consolidation strategies. The discussion suggests that lowering (producer) subsidies and increasing corporate and personal income as well as property taxes reduces inequality in disposable income. Higher social security contributions and lower government spending on health, education and social assistance, in contrast, tend to conflict equity objectives in the short and long term.

De Serres and Murtin (2014) take a different perspective by contrasting the long-term (average) impact of labour market policies with the policies' impact on the response of unemployment to adverse shocks. The approach could be reframed as comparing long-term effects on labour income and implications for labour income and income scarcity in recessions. The empirical evidence for 19 OECD countries suggest that less generous unemployment insurance, more ALMP, and lower minimum wages imply a trade-off between long-term employment and short-term income stability. These policies help low-skilled workers getting out of unemployment but make them more vulnerable to adverse shock. Lowering the labour tax wedge avoids the trade-off between the average employment effect and disposable wage income in downturns.

2.2. Simulation studies

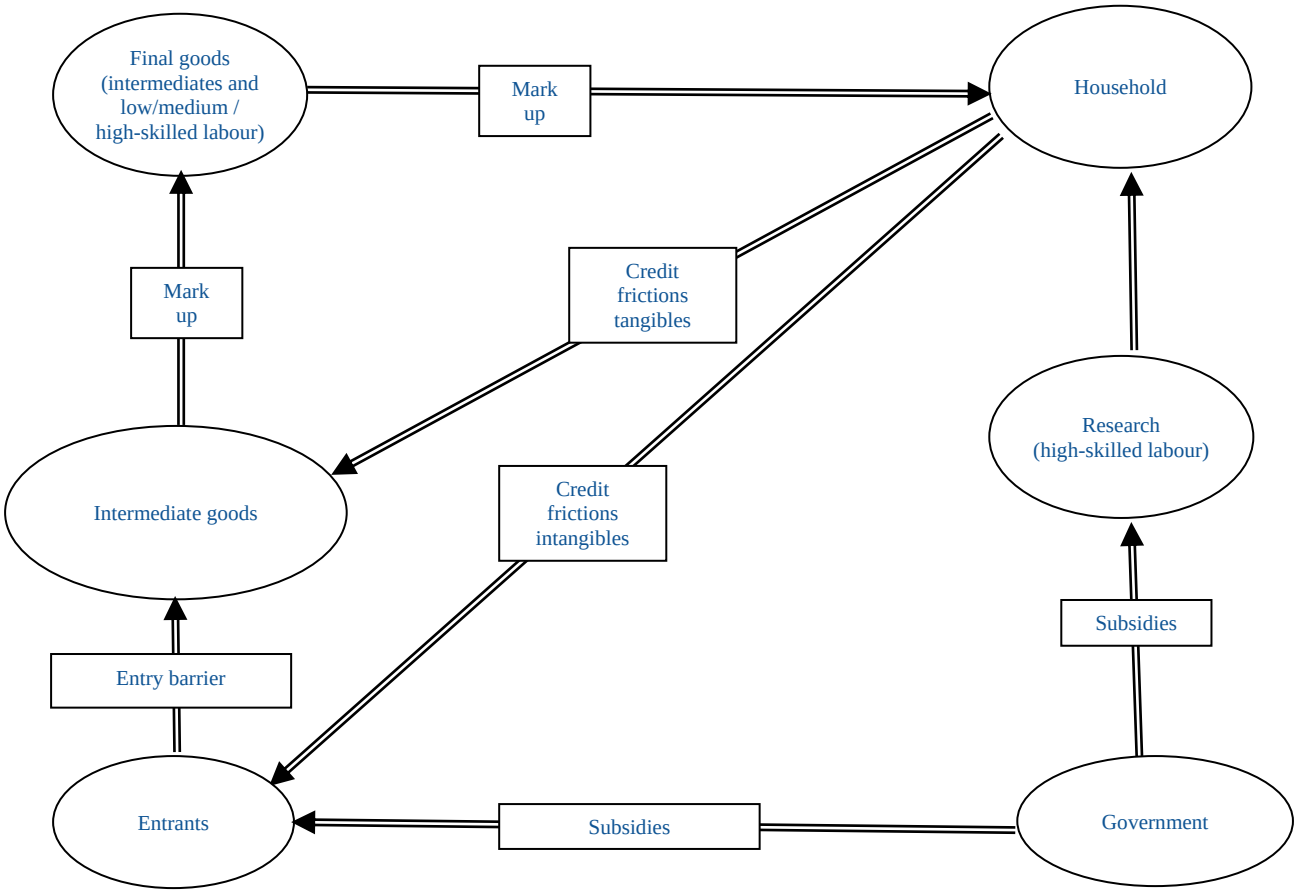
Model-based studies on the distributional impact of structural reforms are limited in number and have focused particularly on tax and benefit reforms. The literature on tax and benefit reforms distinguishes between micro-simulation studies and general equilibrium analysis. The advantage of micro simulation studies lies in their level of detail concerning the income distribution (see Decoster et al. 2010). However, they tend to ignore how the reforms endogenously affect prices and volumes in the economy leading to second-round effects on income distribution. General equilibrium analyses do not aim to map a detailed household income distribution, but instead focus on coherent modelling of different (functional) sources of income such as income from labour, assets, transfers, benefits etc. (see Burgert and Roeger, 2014). Additionally, general equilibrium models can account for price and quantity adjustments in the goods and labour market in response to a reform and their effect on income distribution.

The present simulation study addresses distributional concerns from two angles. First, we focus on how several sources of income (from wages, benefits, transfers, profits and interest payments) are affected by different structural reforms. Tracing the relative development of these income categories allows us to have a disaggregated view on the evolution of households' disposable income. Second, to mimic the income distribution of wage earners, we compare the relative income of low-, medium- and high skilled labour in the model.

Varga and in 't Veld uses the semi-endogenous growth version of the QUEST model specifically adapted for the analysis of structural reforms. The model follows the QUEST3(RD) model structure of Roeger et al. (2008) in a multi-country setting (Varga et al., 2014), and includes the EU Member States individually and the rest of the world as a single separate region. In the next section we show how this aggregate macro model assuming representative households can be used to analyse the effect of reforms or other permanent shocks on the distribution of income. We will focus only on those elements of the model which are crucial to understand these distributional effects. The subsequent section presents the income distribution effects of structural reform simulations in detail, and the final section concludes.

3. The Model

The model we use in this paper is an extension of the QUEST III model with semi-endogenous growth à la Jones (2005). The Jones (2005) model is a closed economy semi-endogenous model with only one type of households supplying labour services for final and R&D goods production. In order to assess the impact of various structural reforms like greater competition in the final goods sector, reducing administrative entry barriers in the intermediate sector, skill-upgrading of the labour force and increasing R&D subsidies, we introduce additional features into the model. We extend the Jones (2005) model by introducing mark-ups for the final goods sector and entry costs for the intermediate sector. We also add two types of households, liquidity and non-liquidity constrained. We consider three types of labour skills that allow us to conduct more detailed human capital reforms. The model also includes a fiscal and monetary authority with the appropriate decision rules. Importantly, our extended model is a multicountry model in which individual country blocks are interlinked with international trade and knowledge spillovers. Finally, while Jones (1995, 2005) were theoretical, illustrative models, we bring our model to data and calibrate it on actual data of the countries of interest. The model is described in detail in Roeger et al. (2008, 2014) and is presented here by a flow chart followed by a more detailed description of the functional income distribution in the model.



The model economy is populated by households, final and intermediate goods producing firms, a research industry, a monetary and a fiscal authority. In the final goods sector firms produce differentiated goods which are imperfect substitutes for goods produced abroad. Final good producers use a composite of intermediate goods and three types of labour - low-, medium-, and high-skilled. Non-liquidity constrained households buy the patents of designs produced by the R&D sector and

license them to the intermediate goods producing firms. The intermediate sector is composed of monopolistically competitive firms, which produce intermediate products from rented capital input using the designs licensed from the household and by making an initial payment to overcome administrative entry barriers. The production of new designs takes place in research labs, employing high skilled labour and making use of the commonly available domestic and foreign stock of knowledge. Technological change is modelled as increasing product variety in the tradition of Dixit & Stiglitz (1977).

In the following we discuss those aspects of the model which are relevant for the understanding how structural reforms affect the functional income distribution.

3.1 The budget constraint of the representative household

The household supplies labour (L_t), holds tangible capital (K_t), intangible assets (patents) (A_t), and financial assets (B_t). He receives net wage income from labour at wage rate (W_t^N), rental income form physical capital and intangible assets at rate (i_t^K) and (i_t^A) and interest income from financial assets at rate (i_t). Apart from the rental income on capital, the household also receives monopoly rents from the final goods production sector (PR_t^Y) and the A firms in the intermediate goods sector ($A_t PR_t^x$). Monopoly rents will be treated as part of capital income. Finally, the household receives transfers, which are split into unemployment benefits (BEN_t) and other transfers (TR), mostly pensions. The total income received by the household in period *t* (see RHS of eq. 1) can be used for consumption and gross savings (investment including depreciation) (see LHS of eq 1)

$$(1+t_t^C)C_t + \Delta B_t + P_t^K J_t^K + (1-\tau^A)P_t^A \Delta A_t = \\ i_{t-1}B_{t-1} + W_t^N L_t + i_{t-1}^K P_t^K K_{t-1} + i_{t-1}^A P_t^A A_{t-1} + PR_t^Y + A_t PR_t^x + BEN_t + TR_t \ , \quad (1)$$

Here we assume that wages paid by the household are after labour taxes and we also assume that the household does not pay interest on rental income, but taxes on capital are paid by the firm. If we want to look at disposable income we also have to deduct depreciation and express the budget constraint in terms of net savings and subtract depreciation from the capital income received by the household. This yields the following budget constraint

$$(1+t_t^C)C_t + \Delta B_t + P_t^K \Delta K_t + (1-\tau^A)P_t^A \Delta A_t = \\ i_{t-1}B_{t-1} + W_t^N L_t + (i_{t-1}^K - \delta^K)P_t^K K_{t-1} + i_{t-1}^A P_t^A A_{t-1} + PR_t^Y + A_t PR_t^x + BEN_t + TR_t \ . \quad (2)$$

The following accumulation equations for tangible and non-tangible assets are used. Note in particular that we assume zero depreciation for intangible capital

$$J_t^K = \Delta K_t + \delta^K K_{t-1} \quad (3)$$
$$J_t^A = \Delta A_t \quad (4)$$

Wages:

Net wage income (from final goods production) is the sum of wage income from final production $W_t^{Y,N} L_{Yt}$ and from research $W_t^{A,N} L_{A,t}$

$$W_t^N L_t = W_t^{Y,N} L_{Yt} + W_t^{A,N} L_{At} \quad (5)$$

Employment in final goods production is divided up into three skill groups, therefore

$$W_t^{Y,N} L_{Yt} = (1-t_t^{W_L})W_t^L L_{Lt} + (1-t_t^{W_M})W_t^M L_{M,t} + (1-t_t^{W_H})W_t^H L_{H,t}, \quad (6)$$

While the research sector only employs high skilled workers

$$W_t^{A,N} L_{A,t} = (1 - t_t^{W_H}) W_t^H L_{Ht}^A \quad (7)$$

Note that there are three types of taxes: labour income tax, consumption tax and corporate income tax but this formulation ignores redistribution of income across functional income categories. This is what we turn to next.

Transfers and benefits:

The household receives transfers (TR_t) and unemployment benefits (BEN_t). Both types of transfers are indexed to the consumer price deflator

$$BEN_t = \sum_{s\epsilon\{L,MH\}} BEN_0 P_t^C (1 - NPART_{s,t} - L_{s,t}) \quad (8)$$
$$TR_t = TR_0 P_t^C \quad (9)$$

where $1\text{-}NPART_{s,t} - L_{s,t}$ is the number of unemployed per skill group.

Capital income:

The household receives interest income from the holding of government bonds and from net foreign assets,

$$Y(financial\ wealth) = i_{t-1} B_t \quad (10)$$

as well as rental income from tangible and intangible capital.

$$Y(net\ rental, tangible\ capital) = (i_{t-1}^K - \delta^K) P_t^K K_{t-1} \quad (11)$$
$$Y(rental, intangible\ capital) = i_{t-1}^A P_t^A A_{t-1} + \tau^A P_t^A \Delta A_t \quad (12)$$

Arbitrage in financial markets implies that rates of return are equalised across different assets (up to a risk premium[3]). Therefore the rental rate on physical capital and the rental rate on intangible assets is related to the nominal interest rate on financial assets as follows

- Tangible capital:

$$i_t^K = r_t + \pi_{t+1}^Y - \pi_{t+1}^K + \delta^K + rp^K = i_t - \pi_{t+1}^K + \delta^K + rp^K \quad (13)$$

- Non-tangible capital:

$$i_t^A = (1 - \tau^A)(r_t + \pi_{t+1}^Y - \pi_{t+1}^A) + rp^A = (1 - \tau^A)(i_t - \pi_{t+1}^A) + rp^A. \quad (14)$$

The (nominal) return on tangible capital exceeds the (nominal) return on financial assets by the rate of depreciation (and the risk premium). In case of expected capital gains arbitrage reduces i_t^K. Similarly the rate of return on intangible assets differs from the risk free rate by an expected capital gain, a tax credit τ^A on intangible investment (and a risk premium). A second source of capital income are pure profits or monopoly rents.

$$Monopoly\ rents = (1 - t_t^P)(Y_t - (1 + scc_t) W_t L_t) - A_t x_t P_t^x \quad (15)$$

The next section explains how capital income is generated, given the specification of technology and market structure in the model.

3.2 Profits

[3] We assume that reforms do not affect risk premia.

Intermediate production:

There are A (as many as there are patents for producing intermediate goods) intermediate goods producers. Intermediate goods producers rent tangible and intangible capital. The technology is constant returns in tangible capital, while intangible capital is a fixed cost for the firm. The production technology is given by

$$x_t^i = K_t^i \tag{17}$$

The profit of producer *i* ($PR_{t,i}^x$) is the difference between revenues and the rental price of physical capital i_t^K and intangible capital i_t^A.

$$PR_{t,i}^x = P_t^{x_i} x_t^i - i_t^K P_t^K K_t^i - i_t^A P_t^A \tag{18}$$

Intermediate goods producers charge a mark up over marginal cost which is a function of the elasticity of substitution between alternative intermediate inputs in final production. However, free entry reduces profits to zero

$$PR_{t,i}^x = 0 \tag{19}$$

The rental cost for physical capital can be seen as variable cost for the firm, since these costs are proportional to the level of output, while the rental cost for the patent are fixed costs, they must be paid irrespective of the level of output. Consequently, marginal cost for intermediate firm *i* is given by

$$MC_t^i = i_t^K P_t^K \tag{20}$$

And the intermediate good price is set as a mark up mup_t^x over marginal cost

$$P_t^{x_i} = (1 + mup_t^x) i_t^K P_t^K \tag{21}$$

We define aggregate capital services sold to the final goods sector as aggregate capital

$$K_t = A_t x_t = A_t K_t^i \tag{22}$$

Aggregate profits of the intermediate goods sector are also equal to zero, which implies that monopoly rents are equal to capital costs for intangibles/patents

$$A_t PR_{t,i}^x = P_t^{x_i} A_t x_t^i - i_t^K P_t^K A_t K_t^i - i_t^A P_t^A A_t = 0 \tag{23}$$

or

$$A_t PR_{t,i}^x = (1 + mup_t^x) i_t^K P_t^K A_t K_t^i - i_t^K P_t^K A_t K_t^i - i_t^A P_t^A A_t = 0 \tag{24}$$

From this is follows that

$$i_t^A P_t^A A_t = mup_t^x i_t^K P_t^K K_t \tag{25}$$

Final goods producers:

The final goods producers are buying capital services as intermediate input for production and hires labour. Final output is produced using labour $L_{Y,t}$, intermediate capital inputs $x_{m,t}$ and public capital. Production is subject to general fixed costs.

$$Y_t = \left(L_{Y,t}\right)^{\alpha} \left(\int^{A_t} (x_t(i))^{\theta} di\right)^{(1-\alpha)/\theta} KG_t^{\alpha_G} - FC_Y \tag{26}$$

Labour is itself a CES aggregate of different skill types with

$$L_{Y,t} = \left(\Lambda_L^{1/\mu}\left(\chi_L L_{L,t}\right)^{(1-\mu)/\mu} + \Lambda_M^{1/\mu}\left(\chi_M\left(L_{M,t} - FC_L\right)\right)^{(1-\mu)/\mu} + \Lambda_{HY}^{1/\mu}\left(\chi_{HY} L_{HY,t}\right)^{(1-\mu)/\mu}\right)^{\mu/(1-\mu)} \tag{27}$$

where $L_{L,t}$, $L_{M,t}$ and $L_{HY,t}$ denote the employment of low, medium and high-skilled in final goods production and FC_L is overhead labour. Parameter Λ_z is the corresponding share parameter $\left(z \in \{L, M, HY\}\right)$, χ_z is the efficiency unit, and μ is the elasticity of substitution between different labour types.

The final goods producer is monopolistically competitive and faces a demand cuve with with a price elasticity equal to $-\varepsilon_t^Y$. The firm maximises net profits PR_t^Y with a tax rate on profits equal to t_t^P.

$$PR_t^Y = (1 - t_t^P)(P_t^Y Y_t - (1 + scc_t) W_t\, N_t) - A_t x_t P_t^x. \tag{28}$$

The FOCs w. r. t. labour and intermediate inputs is given by

$$(1 - t_t^P)(1 - mup_t^Y)\alpha \frac{(Y_t + FC_Y)}{L_Y - FC_L} = (1 + scc)\frac{W_t}{P_t^Y} \tag{29}$$

$$(1 - t_t^P)(1 - mup_t^Y)(1 - \alpha)\frac{(Y_t + FC_Y)}{Ax_i} = \frac{P_t^x}{P_t^Y} \tag{30}$$

Where $mup_t^Y = \frac{1}{\varepsilon_t^Y}$ is the price mark up. From the FOCs it follows that profits of the final goods producing sector can also be expressed as a positive function of monopoly rents and depend negatively on fixed costs

$$PR_t^Y = mup_t^Y P_t^Y Y_t - (1 - mup_t^Y) P_t^Y FC_Y - W_t FC_L \tag{31}$$

In the simulations we present below we distinguish between a no entry case into the final goods sector and entry case. In the no entry case it is assumed that the mark up stays constant, while in the entry case it is assumed that profits stay constant. The constancy of profit assumption will generally imply that the mark up in the final goods production sector will decline, reforms which increase the level of output will with constant fixed costs increase the profit rate.

3.3 Calibration

The calibration of model parameters is explained in more detail in the appendix to this paper. Here we only discuss those aspects of the calibration which are crucial for this exercise. We estimate sectoral mark-ups using EU KLEMS data. Aggregating mark ups across sectors suggests an aggregate final goods mark up in the range between 10 and 30% across EU countries (all MS). We determine fixed costs such that the model can reconcile relatively large mark ups with modest profit rates. We choose steady state rental rates such that the model can generate a capital output ratio of 3 and an R&D share of 0.5-3%. The mark up estimates, together with the output elasticity of labour are set such that the model can replicate the wage share across euro area Member States.

Since many labour market reforms are affecting the skill composition of employment, special emphasis must be given to the skill parameters in production and labour supply by skill. The consensus estimate of the elasticity of substitution between skilled and unskilled labour is between 1.0 and 2.0 (Katz and Autor, 1999). Acemoglu and Autor (2011) updated the seminal reference of this elasticity parameter by Katz and Murphy (1992, "KM" hereafter). While KM estimated that the elasticity of substitution between skilled and unskilled labour is about 1.4, Acemoglu and Autor (2011) argues for somewhat higher estimates in the range of 1.6-1.8 using an extended data sample of KM (from 1963 to 2008 as opposed to 1968-1987). In the simulation exercise we used the middle value of this range μ=1.7. Note that an elasticity of μ<1 could result in a simultaneous decline of high-skilled real wages and relative wage shares after an increase in their population share. Concerning labour supply we calibrate the elasticity parameters such that the model can replicate skill specific unemployment rates.

4. Quantifying the impact of structural reforms

4.1 Methodology

In this exercise we apply a benchmarking approach to all European Union Member States. Reform shocks are based on a set of structural reform indicators covering a wide range of areas, including market competition and regulation, R&D expenditure, skill structure, tax structure, labour market participation, unemployment benefit 'generosity' and active labour market policies (see Table 1). We define the potential for reform as a closing by one-half of the gap in these indicators vis-à-vis the three best-performing countries in the EU (as reported in the final column in Table 1). To allow for implementation lags, all reforms are phased-in gradually. Closing half the gap implies that for almost all Member States there is potential to introduce further reforms, without imposing 'unrealistic' changes for countries that fall far short of best performance.

It is important to note a number of caveats as to the scope of this exercise. First, while this benchmarking approach shows the potential that reforms could deliver, it is not an assessment of measures that have actually been taken. The latter requires detailed information on reform measures adopted and/or planned in each Member State, and an assessment of how they impact on structural indicators that feed into the model.[4] But the results reported here, given their wider-ranging scope, could be seen as providing an upper limit for such impact assessments. The indicators used in this exercise are based on the most recent available data (see sources, Table 1), but these may not always capture some recent changes due to reforms that have already been adopted. In particular, some Member States (particularly some of the most vulnerable) have recently launched ambitious reform processes, the benefits of which would be included in the simulations presented here. Second, there could be considerable time-lags before actual reforms have a measurable macroeconomic impact. Delays in implementing reform measures are likely and it also takes time before measures have a visible impact on structural indicators (e.g. time between creating more childcare facilities and an actual rise in female participation rates). In this exercise, we assume that reforms are implemented gradually. 'Speed limits' are applied, e.g. changes in mark-ups of at most one percentage point (pp) per year. Tax reforms are phased in over a five-year period, while educational reforms lead to only very gradual changes in skill levels due to cohort effects. However, the overall results may still overestimate how quickly reforms can have an impact in the short term, in particular at the current juncture, with depressed demand and tight credit conditions due to public and private deleveraging.[5] We therefore focus our discussion mainly on effects over five and ten years, rather than the short term. Third, the improvement in public finances due to higher tax revenues, and lower unemployment transfers, is gradually recycled through lower taxes on labour. In the model the debt-to-GDP ratio is stabilised in the long-run through a fiscal closure rule that gradually reduces labour taxes to target the initial debt-to-GDP ratio. This stabilisation is not instantaneously, but only in the medium/long run, and the assumption of no change in the steady-state debt ratio permits us to focus on the direct effects of structural reforms excluding debt-consolidation effects. [6]

[4] For an example, see European Commission (2016).

[5] Some authors have also claimed the impact of structural reforms on economic activity in the short term can be counter-productive when the zero bound on monetary policy rates is temporarily binding, due to the downward pressure on prices and increase in real interest rates (e.g mark-up reductions in Eggertsson et al., 2014). In a larger macroeconomic model like QUEST, the contractionary short term effects of deflationary supply-side reforms at the ZLB are smaller due to various mitigating factors: the impact of reforms on the profitability of investment, the disposable income of liquidity-constrained households and the competitiveness effect in external trade. The adverse real interest rate effect also depends on the short term deflationary impact of the reform (which can be smaller for other measures). (see European Commission, 2014)

[6] A lower debt-to-GDP ratio reduces debt financing costs and allows for more fiscal space, which could be used for higher productive investment or lower taxes, both of which have positive growth effects. Alternative model scenarios in which the fiscal closure rule is turned off for 25 years show large improvements in public balances, which are then subsequently recycled though lower labour taxes.

Table 1. Structural indicators and benchmarks

		AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	Average 3 best EU performers
Market competition	Services sector markups (%)	15.3	15.9	11.9	13.4	17.0	15.0	12.7	16.4	19.7	14.9	17.3	15.7	n.a.	15.2	13.8	14.1	17.6	18.2	19.1	10.6	13.9	15.4	15.1	20.8	13.3	15.2	17.2	12.2	11.6
Market regulation	Entry costs (%)	11.7	6.3	5.9	14.3	12.6	9.1	1.8	3.3	23.8	12.3	4.9	2.7	9.2	9.5	2.6	18.0	6.2	4.8	6.5	20.3	6.4	22.1	3.2	5.3	5.0	1.6	5.4	3.9	2.0
Tax reform	Labour to consumption tax revenue ratio	2.4	3.0	0.7	1.1	1.7	2.5	1.9	1.3	1.7	2.6	2.0	2.8	1.0	1.4	1.6	3.0	1.4	1.9	1.4	1.2	2.6	1.5	1.3	1.0	1.9	1.7	1.7	1.5	0.9
Skill enhancing reforms	Share of high-skilled (%)	6.4	7.9	6.4	9.1	6.0	9.2	7.5	11.4	7.3	9.8	12.2	8.5	4.5	4.9	9.3	4.2	9.9	8.2	7.2	3.5	6.3	6.0	4.1	4.9	9.0	6.7	5.2	9.4	11.2
	Expenditure on high-skilled education (% GDP)	0.4	0.2	0.2	0.4	0.3	0.4	0.5	0.3	0.4	0.3	0.7	0.3	0.2	0.2	0.4	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.5	0.4	0.2	0.3	0.5
	Share of low-skilled (%)	16.9	27.2	18.2	21.5	7.2	13.7	21.7	9.4	32.8	44.5	14.1	24.9	18.7	17.5	23.3	41.8	6.6	19.5	10.6	59.4	24.2	9.9	60.2	23.7	16.8	14.6	8.1	21.6	7.3
	Expenditure on medium-skilled education (% GDP)	3.8	4.0	2.1	4.8	2.8	3.3	4.8	3.1	3.2	2.6	4.3	3.5	1.6	2.8	3.5	2.6	3.4	2.6	2.5	6.2	3.9	2.6	3.0	1.7	3.9	3.1	2.5	3.4	2.9
Labour market reforms	Female non-participation (%, 25-55ys):																													
	- low-skilled	30.1	44.4	47.1	28.8	34.1	38.2	32.0	34.3	39.9	27.8	38.4	33.2	47.3	43.6	54.4	50.2	36.5	27.1	36.3	59.1	34.7	46.9	22.4	46.5	31.8	29.2	39.8	40.5	25.8
	- medium-skilled	12.9	19.6	18.1	20.4	17.2	16.2	13.9	17.4	27.8	17.8	17.6	15.3	22.9	20.6	31.2	27.7	14.9	22.5	17.3	21.7	15.4	24.8	8.7	27.6	11.6	11.4	18.9	19.8	10.8
	- high-skilled	8.8	9.0	10.0	11.2	19.1	11.1	7.3	13.6	10.9	10.3	11.7	8.7	8.0	17.2	15.8	17.3	4.5	13.3	9.1	10.8	7.3	9.3	4.8	8.5	6.6	4.9	17.1	11.8	4.8
	Low-skilled male non-participation (%, 25-55ys)	17.1	19.6	33.2	12.3	20.2	16.5	20.2	19.2	7.9	10.4	21.1	13.6	25.4	27.8	20.6	15.0	28.4	8.0	17.6	7.7	14.9	28.0	10.6	22.1	13.9	18.7	24.7	18.0	7.9
	Elderly non-participation (%, 55-64ys):																													
	- low-skilled	22.9	25.0	19.9	19.5	29.5	13.2	16.0	14.4	20.5	15.0	23.6	22.4	28.7	25.6	17.9	20.0	18.3	19.5	16.4	22.6	17.6	32.1	14.5	19.6	12.6	31.4	28.2	14.5	13.4
	- medium-skilled	10.5	10.6	11.2	7.0	11.2	8.3	8.1	9.3	9.9	6.1	9.7	11.9	12.9	14.0	6.7	7.6	11.4	13.9	10.3	6.8	6.9	15.6	4.2	12.3	4.8	15.9	11.4	7.1	5.0
	- high-skilled	5.5	6.5	6.7	4.6	3.5	4.6	4.4	4.5	7.5	3.5	5.4	5.6	8.0	7.0	4.1	4.4	4.0	4.6	4.3	4.4	4.2	4.6	5.0	5.0	2.6	7.3	5.2	5.5	3.2
	ALMP (% of GDP over unemployment share)	25.2	18.9	3.8	7.5	4.4	12.3	36.7	3.9	3.9	6.5	22.7	15.2	2.4	12.7	10.3	7.7	2.3	19.8	2.4	1.8	22.9	7.3	5.7	1.0	24.0	4.3	2.8	2.0	28.6
	Benefit replacement rate* (%)	68.8	65.1	38.5	n.a.	57.4	60.9	73.1	42.8	10.8	46.9	71.7	57.8	n.a.	30.1	74.1	9.2	52.5	72.5	56.6	52.8	71.7	45.6	48.8	25.6	64.3	61.0	39.0	62.2	52.3
R&D measure	R&D tax-credit rates	0.12	0.15	n.a.	n.a.	0.18	-0.02	-0.01	n.a.	0.01	0.34	0.25	0.38	n.a.	0.25	0.26	0.12	n.a.	-0.01	n.a.	n.a.	0.23	0.00	0.49	n.a.	-0.01	0.16	-0.01	0.17	0.41

Notes: * for benefit replacement rate: EU average. Darker shades correspond to larger gap vis-à-vis the benchmark Sources: final goods mark-ups, 2013: Roeger et al. (2014); entry costs: starting business costs in % of income per capita, 2014: Doing business database. www.doingbusiness.org; Tax revenues, 2012: European Commission, Taxation trends in the European Union, 2014 edition, Luxembourg, 2014.; Skill-shares, non-participation rates, 2013 or latest available: EUROSTAT; Education expenditures: 2011 or latest available: EUROSTAT, corrected with the share of high and medium skilled shares; ALMP: 2012 or latest available: EUROSTAT; benefit replacement rates, 2012: OECD, Benefits and Wages Statistics. www.oecd.org/els/benefitsandwagesstatistics.htm; average of net replacement rates over 60 months of unemployment, 2012; R&D tax-credit rates, EL and IT : 2008 data, average over large and small firms Warda, J. (2009). An Update of R&D Tax Treatment in OECD Countries and Selected Emerging Economies, 2008-2009, mimeo, AT, BE, CZ, DE, DK, EL, ES, FI, FR, HU, IE, LU, NL, PL, PT, SE, SI, SK, UK: 2013 data, average over large and small firms OECD (2013), OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth, OECD Publishing.

Another reason why the results could be considered as an upper limit is that some reforms may have considerable budgetary costs which could not always be taken into account, as they can be difficult to quantify. To the extent that reform measures have additional costs which would have to be financed through higher taxes, macroeconomic impacts could be smaller than those presented here.

4.2 Reform measures

4.2.1 Product market reforms

Market competition and regulation

We distinguish between service-sector reforms and manufacturing reforms. The stylised facts from mark-up estimates indicate that mark-ups in services are larger than in manufacturing and vary more across countries (see Roeger et al. 2014 and Christopoulou and Vermeulen, 2012). This finding is explained by high international competition in manufacturing, which limits the ability of manufacturing firms to reap large economic rents. While mark-up estimates indicate that there is scope for reducing profit margins in services, there also remains some room for reforms in manufacturing. In the simulations, we also consider administrative entry barriers in the form of the costs of setting up a business, for which country-specific indicators exist.

Negative mark-up shocks in services:

Reforms which increase competition force firms to reduce prices by lowering mark-ups. Depending on demand elasticity, this raises output and increases demand for all factors of production (tangible capital, intangible capital and labour) in the medium term. The combination of price declines and increased factor demand yields comprehensive benefits. In particular, wage income rises due to higher employment and real wages. Real wages also benefit from higher investment rates. Because of higher labour-supply elasticities for low-skilled workers, the positive employment effects will be greater for the low-skilled. Mark-up reductions also reduce export prices. In the short to medium term, the trade balance improves, largely due to a decline of private consumption in the short term due to a fall in economic rents. In turn, workers' consumption rises more gradually. With higher consumption, the trade balance returns to baseline values.

Reducing entry barriers for start-ups in manufacturing:

By lowering profit requirements to cover initial costs, reducing administrative entry barriers increases the entry of new firms in manufacturing and the search for new business ideas. This is captured in the model as increased demand for patents, which comes from high-skilled workers. It is important to note that a reduction of entry barriers lowers fixed costs for firms and does not translate into price declines and productivity improvements at firm level, but to a wider variety of goods produced in the country in question (product innovation). Nevertheless, domestic firms can benefit indirectly from the use of more innovative intermediate and investment goods. The aggregate real wage increases because there is a higher proportion of high-skilled workers, but their wage also rises because of short-to-medium-term high-skilled labour supply constraints. These wage increases partly offset the gains from wider variety. In the short term, the effects on GDP can actually be slightly negative, since increased demand for R&D leads to a reallocation of workers from the production of goods and services into research. However, the innovation resulting from R&D activities (as measured by the number of patents) yields marketable benefits in the medium term. Because of persistent growth effects generated by reduced entry barriers and increased demand for labour resulting in higher wage income early on, this policy already increases important tax bases and generates beneficial budgetary effects in the short term.

4.2.2 Tax reform

Shifting the burden of taxation from labour incomes to consumption in a budget-neutral way makes returns to labour income more attractive and hence boosts employment, particularly at the lower end of the wage scale. Labour supply (and therefore wages) depends on the total tax burden, but shifting the burden away from wage income can reduce total distortions on employment decisions and leads to an increase in employment and output. It also improves competitiveness and mimics the effects of a currency devaluation on the terms of trade ('fiscal devaluation'). Real wage costs fall only temporarily in these simulations. Nevertheless, there is a positive effect on employment and GDP. A temporary increase in employment leads to an increase in the capital stock in the medium term, until the pre-existing capital-labour ratio is re-established. At this point, however, the marginal product of labour returns to its initial level and therefore real wages that firms are willing to pay return to the baseline level at a higher level of employment and capital. [7]

In our benchmarking approach, we define the benchmark in terms of the ratio of labour to consumption tax revenues. Rather than moving Member States towards the lowest labour tax rates in the EU, the reforms are designed to move them towards the lowest labour to consumption tax revenue ratio by increasing indirect tax rates and using the fiscal space to reduce personal income tax rates accordingly (i.e. ex-ante budgetary neutrality). It should be stressed that the effects of a switch from labour to consumption taxation will depend on how different income groups are compensated for the consumption tax increase. In particular, if unemployment benefits and other transfers are indexed to consumer prices, the output and employment effects will be smaller.

4.2.3 Labour market reforms

Unemployment benefit reform

A reduction in the benefit replacement rate acts in the model like a reduction in the reservation wage, which puts downward pressure on wages and so boosts labour supply.[8] The calibration of the wage elasticity to unemployment benefits is based on information from regression studies on the link between the unemployment rate and the benefit replacement rate.[9] As the employment rate is lowest for the low-skilled group, the same increase in employment means a proportionally smaller reduction in leisure for this group and this puts less upward pressure on their wages. As a result, the decline in wages for the low-skilled is larger than that for other skill groups, and the increase in their employment is also greater.

As regards the impact on other variables, the effects of lowering benefit transfers are similar to those of reducing wages. Lower benefits would reduce consumption by liquidity-constrained households, but this is more than offset by an increase in consumption by non-constrained households due to higher permanent income. The benefit reduction acts like a negative shock to wages, which increases the demand for labour and reduces labour productivity initially. Wages and productivity increase over time and return to their baseline values as investment picks up. Unlike in a model with exogenous technical progress, there is a small positive long-term productivity effect due to higher employment of high-skilled workers in the R&D sector and increased demand for new patents from the entry of new firms in the intermediate sector. The government balance improves directly as a result of the reduction in benefits and additionally as a result of indirect effects as the economy improves (i.e. higher GDP, consumption and employment).

[7] In our model the long-term output effect is greater than the increase in employment and capital accumulation, due to an endogenous R&D increase. Employment in the R&D sector is higher and the increase in output ('ideas/patents') leads to an increase in total productivity.

[8] The target is defined as the EU average replacement rate; this reform is not included for Member States below the average.

[9] For example, results from Bassanini and Duval (2006) and Orlandi (2012) point to an average effect for a panel of OECD/EU countries of somewhat less than 0.2 % from a 1 pp reduction in the unemployment benefit replacement rate. We obtain results at a similar order of magnitude, but somewhat differentiated across countries.

Other labour market reforms

Rising participation rates for women, low-skilled male workers and 55-64 year-olds increase the labour force. Such reforms form an important part of our simulated packages and yield significant improvements in GDP. They have different budgetary implications: improving childcare facilities to raise female participation rates has budgetary costs, while raising the retirement age reduces pension payments and provides budgetary savings.

4.2.4 Human capital investment

Changes in the quality of education and their effects on the quality of the labour force can be captured in the model as changes in the skill composition. Thus, in this exercise human capital investment is modelled as changing the relative weights of the different skill categories (or participation rates within categories). The increase of the average skill level in the economy (e.g. reducing the proportion of low-skilled) is modelled as a gradual change, accounting for the substantial lags in achieving that objective, including lags in reforming the education system and the gradual passing through of new cohorts onto the labour market. The reform cost is modelled as an increase in education-related expenditure.

As regards the impact of such a measure, the results of the model are in line with empirical estimates.[10] Other effects in the model imply that, given imperfect substitutability between worker types, an increase in the share of medium-skilled workers would have positive wage effects on other types, especially low-skilled workers.

Policies aimed specifically at increasing the share of high-skilled workers (engaged in R&D activities) are also modelled. Initially, a fraction of the additional high-skilled labour will be employed in the production of final goods (replacing less efficient medium-skilled workers). Over time, however, there is a dynamic increase in employment in the R&D sector because of a decline in the wage of high-skilled workers. This reduces the price of patents and stimulates the entry of new firms. In the medium and long term, increasing the high-skilled share results in a strong 'real' R&D effect in terms of R&D employment and patent growth, yielding the highest output effect as compared with other human capital investment scenarios.

4.2.5 R&D investment

Firms undertake tangible and intangible (or R&D) investment. Policy can affect R&D investment; e.g. R&D tax credits reduce the capital costs of intangibles and increase R&D activities, resulting in the production of more patents, which can be used to open up new product lines. On the labour side, this is accompanied by reallocating high-skilled workers from production to research activities and by increasing the demand for high-skilled workers. The size of the output effect will therefore depend crucially on the high-skilled labour supply elasticity. Because of reallocation of high-skilled workers, the effects on GDP are small in the short term and positive output effects will materialise only in the longer term, once the R&D activities have been successfully transformed into marketable products. For countries with limited high-skilled labour and limited scope for substituting high-skilled for medium-skilled workers in production, the crowding-out effect of R&D subsidies will be greater. It is also important to note that R&D tax credits are not self-financing, but lead to a deterioration of the government balance in the short and medium term.

The model can simulate only the effect of public subsidies to private R&D, e.g. in the form of tax incentives. Subsidies to R&D in public research institutes or universities could have different transmission channels

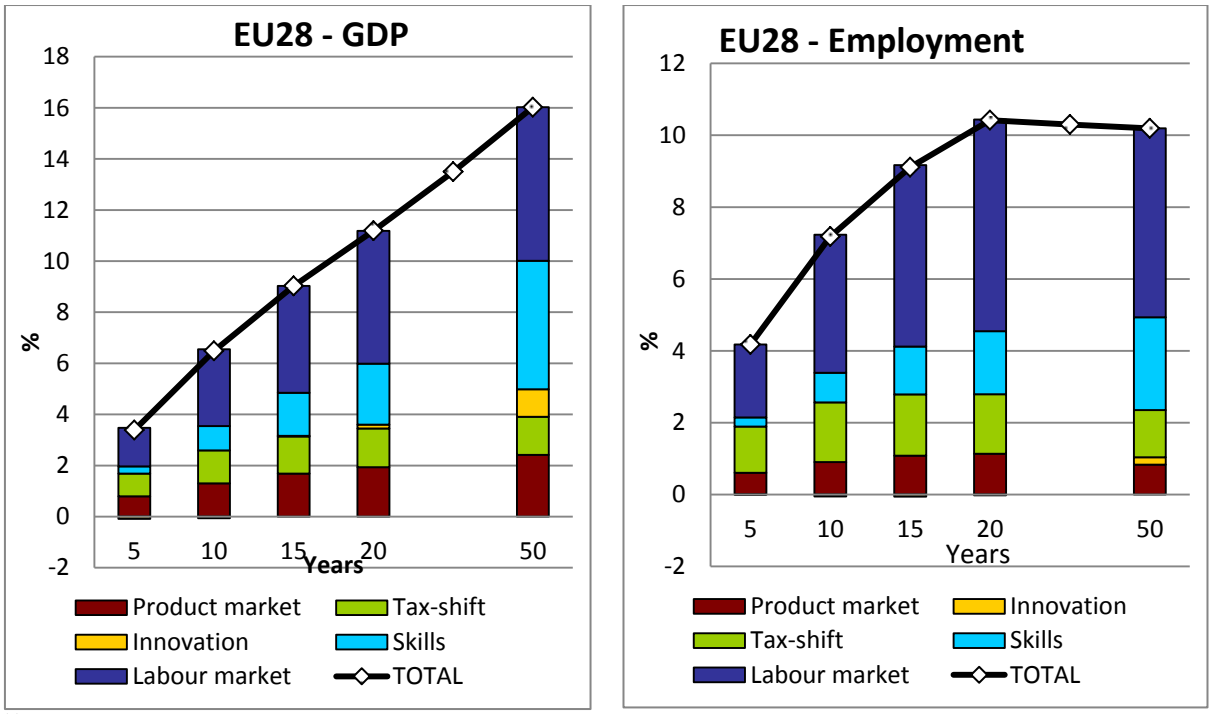
[10] In particular, de la Fuente (2003) estimates the impact of an extra year's schooling in the EU on long-term productivity at 9.3 %, which is close to the result yielded in our model.

and less of a crowding-out effect because business-financed R&D programmes typically focus on applied research, while public institutes and universities typically concentrate on basic research programmes which are too costly or less profitable for private R&D firms.[11]

4.3 Macro-economic effects of reforms

Figure 1 shows the aggregate EU GDP and employment effects in the model when closing half the gap with best performers. It shows that (even such not overambitious) reforms can have significant macroeconomic effects. The reforms are simulated for all countries simultaneously, and aggregated EU effects are shown. [12] They thus include spillover effects.

Figure 1: GDP and employment effects after 5, 10, 15, 20, and 50 years, by reform areas[(1)]



(1) Difference from baseline.

The left panel in Figure 1 shows the impact of structural reforms on GDP after five, ten, fifteen and twenty years, as well as the long run effect. The right panel show the results for employment. Results are presented in the standard format as deviations from a 'no-reform' baseline. The simulated reform shocks boost GDP levels in the EU by 3% after five years, 6½% after ten years, and 11% after twenty years. Employment shows similarly high increases, up to 7% after ten years, 10% in the long run.

[11] The model is calibrated on total R&D expenditure by taking into account the new ESA 2010 accounting framework. All R&D is undertaken by an aggregate R&D sector.

[12] For country-specific results, see Varga and in 't Veld (2014). The long run gains are largest for Greece, due to the considerable scope for reforms identified in all areas by the distance-to-frontier approach (see Table 1). Countries closest to the best performance frontier have the smallest output gains, although even there benefits from further reforms can be significant (Sweden, Denmark, Estonia, and the UK).

Output and employment differences across countries closely reflect the size of the reform gaps as compared with best practice. Output effects are largest in those countries for which the benchmarking methodology shows the largest potential for reforms, even when only half the identified gaps are closed. To some extent, however, differences also reflect the degree to which the simulated reforms are biased towards measures which have a faster short-term impact on growth. Education reforms improving skill distribution and participation rates yield positive results only in the longer term, with smaller GDP effects in the first five to ten years, but up-front budgetary costs. Other reforms, such as shifting the tax burden from labour to consumption, can yield faster growth effects. However, as emphasised above, these scenarios may underestimate the timescale over which reforms can be expected to deliver positive growth effects, and the focus should be more on the medium/long-term effects. The effects after ten years indicate that significant GDP and employment improvements can be realised in all countries if reforms are implemented.

Which reforms have the largest impact? This is obviously related to the identified performance gaps. The relative contribution of different reforms also changes over time, as Figure 1 shows. In the short run labour market reforms (increased participation, active labour market policies, and benefit reforms), tax reforms (shifting taxation towards indirect taxes) and product market reforms (higher competition in services sector and lower entry costs) have the largest effects. Which of these can deliver the fastest growth effects is not something that can be unequivocally answered by these model simulations, as it would crucially depend on implementation assumptions. In these scenarios, changes in structural indicators are introduced gradually and ‘speed limits’ are applied. Larger output effects may be attainable in the short run if implementation could be speeded-up, and if product market reforms could be introduced quicker than labour market reforms then the relative ranking would be different. But it is clear that education/training (or skills enhancing) reforms cannot be expected to deliver significant growth effects in the short run. In the medium to long run though the effects of these reforms become sizeable. This also holds for innovation reforms (R&D promoting policies), which may not have a significant impact in the short to medium run, but can make a contribution to higher output in the very long run.

5. Impact of reforms on functional income distribution

In this section we will discuss, for each of the reform measures considered here, the effects on the functional income distribution. In order to use a realistic quantification of structural reforms, we base the magnitude of each reform shock on a benchmarking exercise, which applies a distance-to-frontier approach to measure the potential for reforms by assuming a gradual and partial closure of the gap in labour and product market indicators vis-à-vis the average of the three best EU performers. The results for all EU member states are then aggregated to show the impact on the EU aggregate. The simulated structural reforms focus on decreasing mark-ups and entry barriers in services and manufacturing, increasing the labour market participation rate for the elderly, the low-skilled and female workers, raising the share of medium- and high-skilled labour force, tax and unemployment benefit reforms and innovation. For each reform, graphs show the change in income shares after 5, 10, 20 and 50 years, and developments in wages and wage sums in the first 10 years and in the long term (Appendix B gives a more detailed description of these structural reform scenarios based on Varga and in 't Veld (2014).

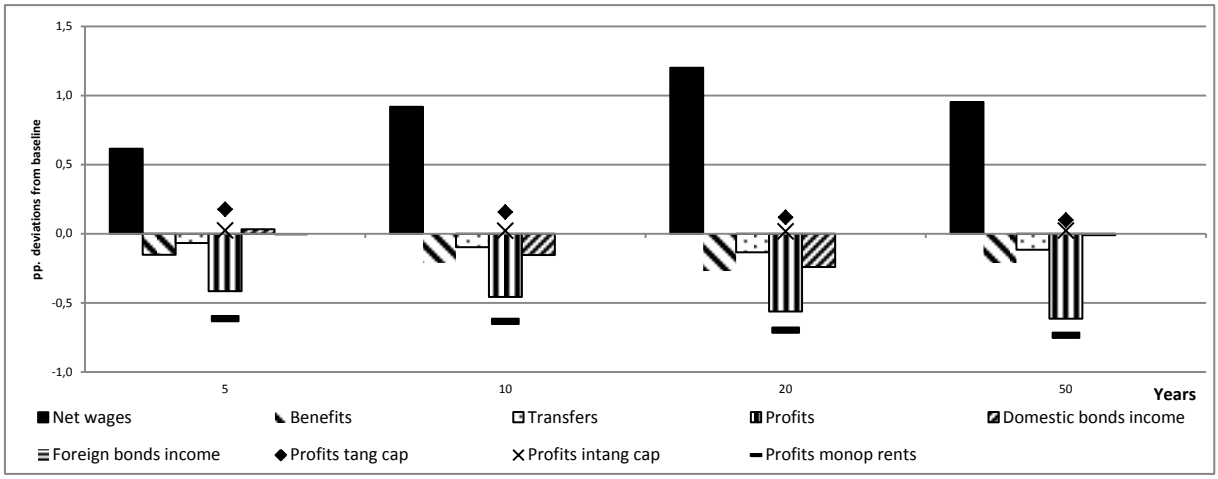
5.1. PRODUCT MARKET REFORMS: SERVICES MARK-UPS

Product market reforms aim to increase competition, which puts pressure on firms to reduce mark-ups and lower their prices. This in turn raises output and increases demand for all factors of production (tangible capital, intangible capital and labour) in the medium term. The simulated mark-up shock corresponds to 1.5 pp. lower services mark-ups at the EU level. The combination of price declines and increased factor demand raise wage income due to higher employment and real wages (see Graphs 1.2-1.5 below) while the share of profit income is shrinking (Graph 1.1). The share of transfers to households is also falling slightly as a percentage of net disposable income, while the share of unemployment benefits falls more strongly as employment increases.

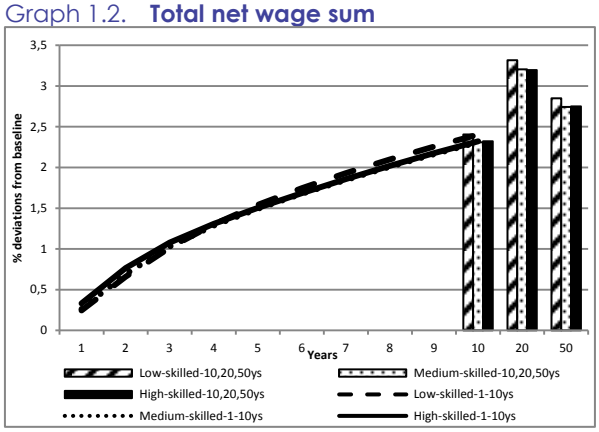
However, this scenario does not take into account that in the short run increased competition also reduces the profitability of less productive firms and induces lay-offs. While the destruction of existing jobs is immediate, job creation is only gradual, therefore the unemployment rate is likely to first increase before it declines gradually as new jobs are created (see Cacciatore and Fiori, 2016). In order to address this element of the reform we run a slightly modified version of this simulation scenario by proportionally decreasing overhead labour costs to account for the job losses in the services sector. The corresponding simulation results of Graphs 1b.1-1b.5 show that product market reforms can be less favourable in terms of wage income. The decrease in overhead labour is assumed to be restricted to medium skilled labour, and this skill group faces an initial decline in heir relative wage share. Overall the share of wages is initially shrinking and only later increasing, but by less than in the previous scenario, while the profit share in income is actualy increasing. All this comes at the expense of lower income shares for benefit and transfer recipients, and bond holders.

Graph 1 Services mark-up shocks

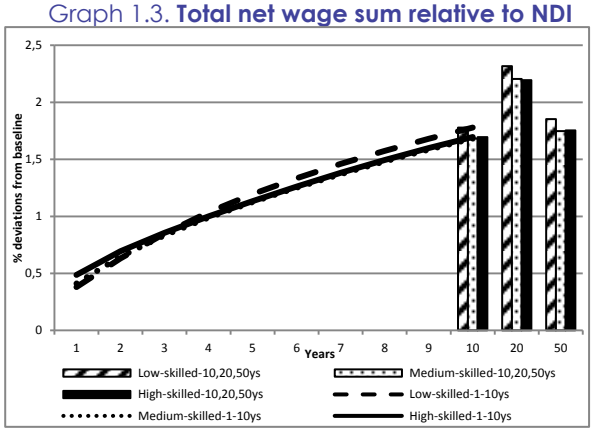
Graph1.1 **Change in income shares (% of NDI)**



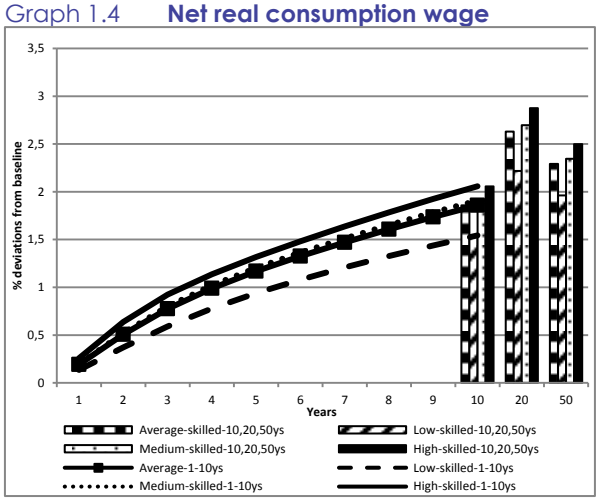
Graph 1.2. **Total net wage sum**



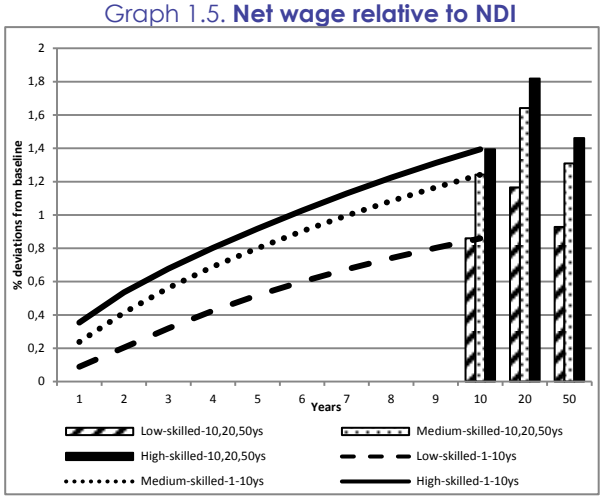
Graph 1.3. **Total net wage sum relative to NDI**



Graph 1.4 **Net real consumption wage**



Graph 1.5. **Net wage relative to NDI**

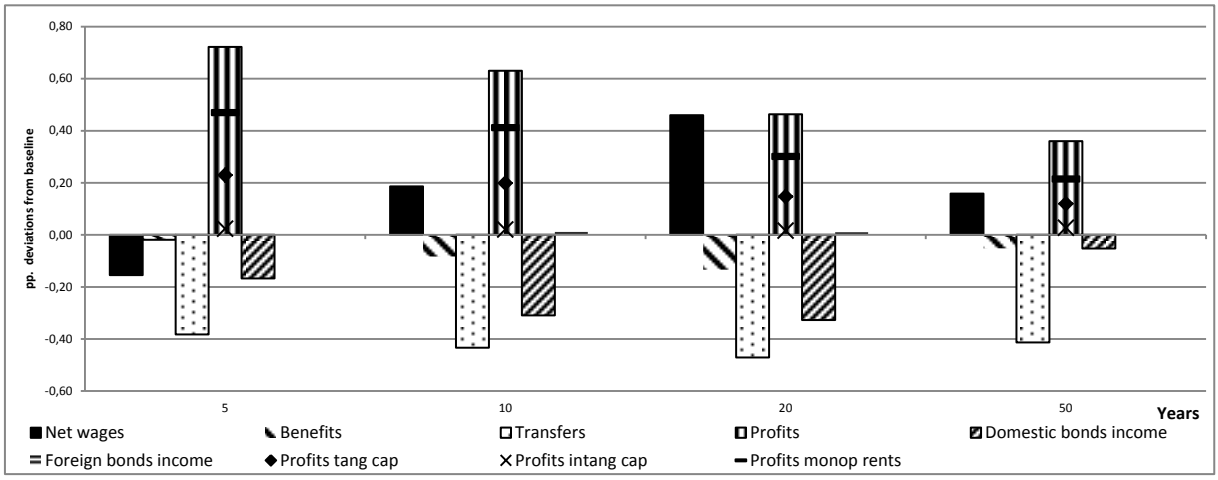


Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years. The second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

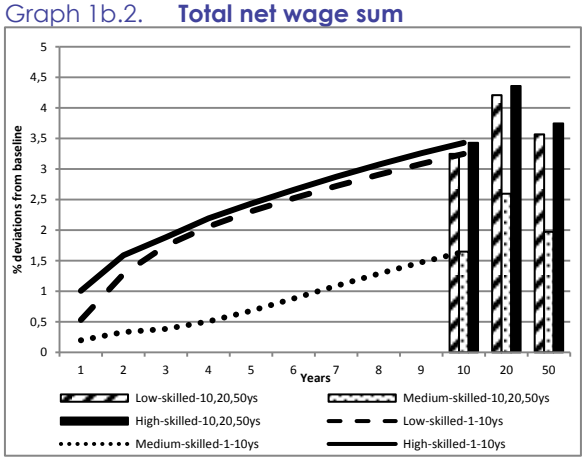
Source: Commission services

Graph 1b. Services mark-up shocks with overhead labour cut

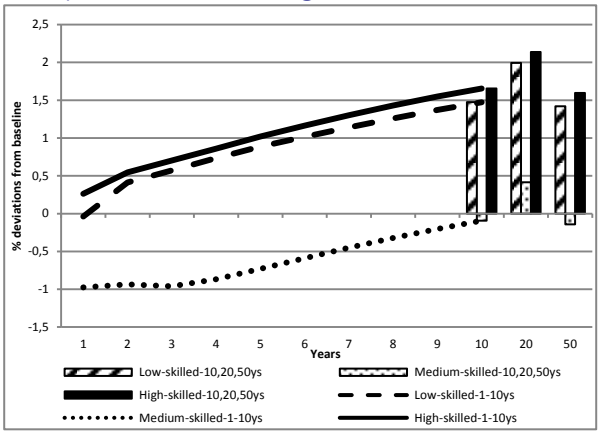
Graph 1b.1 **Change in income shares (% of NDI)**



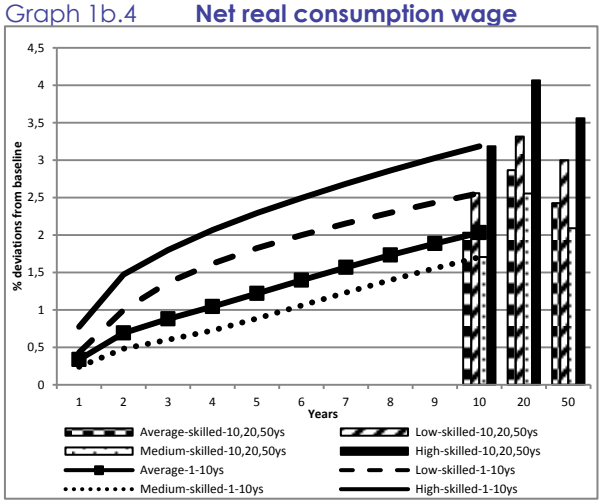
Graph 1b.2. **Total net wage sum**



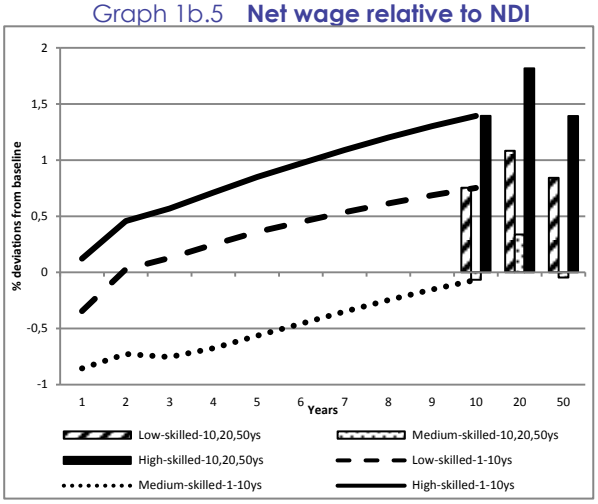
Graph 1b.3 **Total net wage sum relative to NDI**



Graph 1b.4 **Net real consumption wage**



Graph 1b.5 **Net wage relative to NDI**



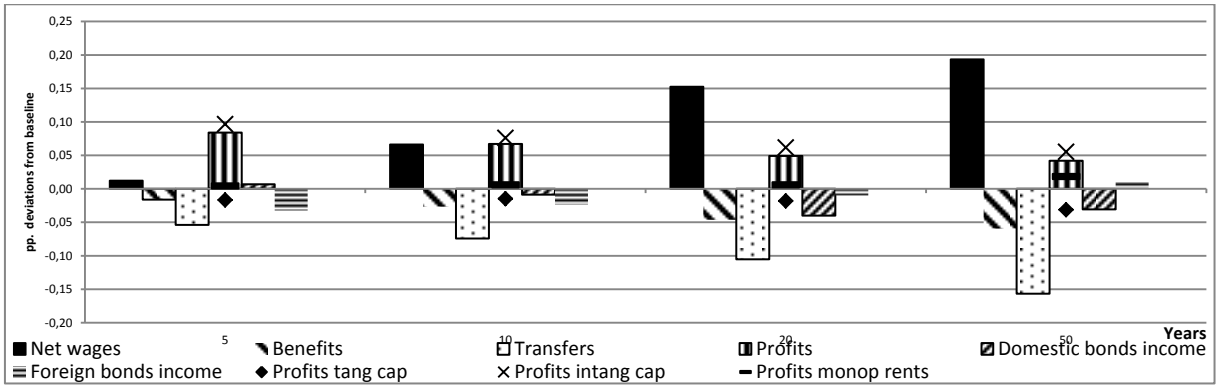
Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

Source: Commission services

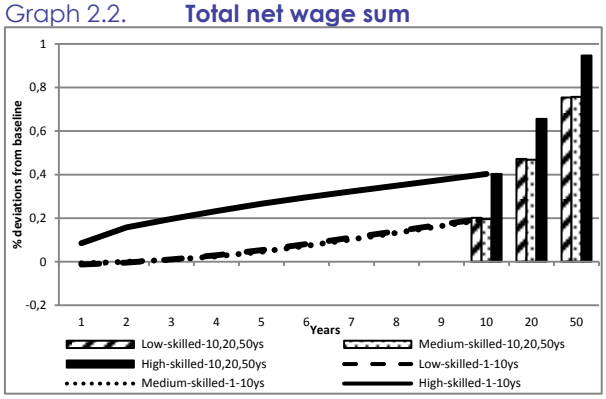
5.1.b Product market reforms: Entry barriers

This reform scenario was simulated as a decrease in administrative entry costs of 3 pps on average for the EU in terms of income per capita. Reducing administrative entry barriers increases the entry of new firms by lowering profit requirements to cover initial costs. Decreasing the entry costs for new intermediate firms leads in the model to an increase in demand for patents as each firm needs a new product-variety. Patents are produced by the research sector which has to hire more researchers to satisfy demand and has to offer higher wages to attract these researchers. Increased final production also raises the demand for medium-skilled who are the closest substitute to the high-skilled workers leaving the final goods sector to the research sector. Real wages and total net real wages are increasing, especially for the high-skilled. There is a strong shift towards net wages in the share of total net disposable income relative to the other income categories.

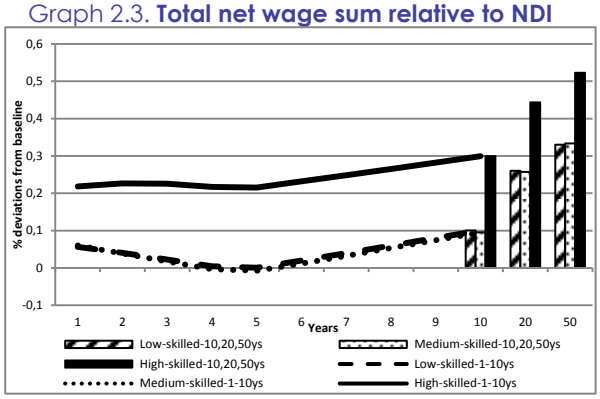
Graph 2.1. **Change in income shares (% of NDI)**



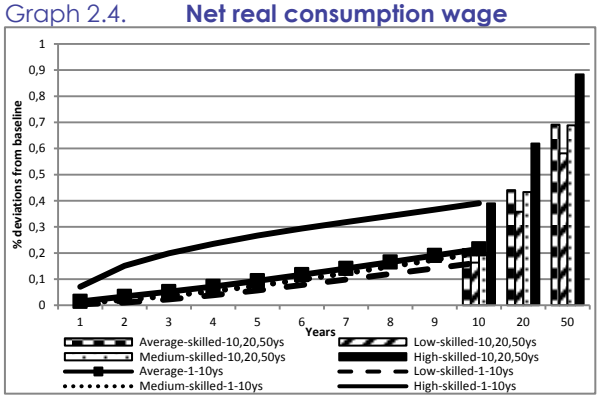
Graph 2.2. **Total net wage sum**



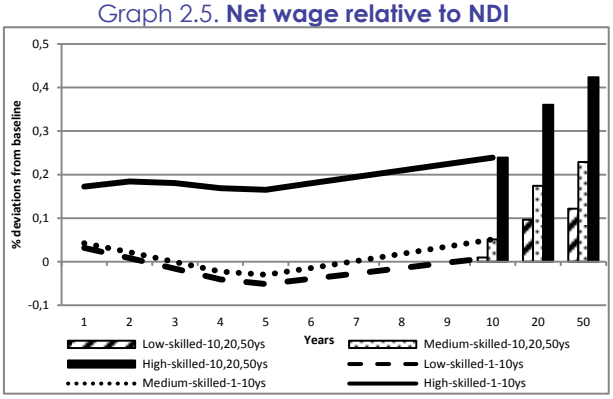
Graph 2.3. **Total net wage sum relative to NDI**



Graph 2.4. **Net real consumption wage**



Graph 2.5. **Net wage relative to NDI**

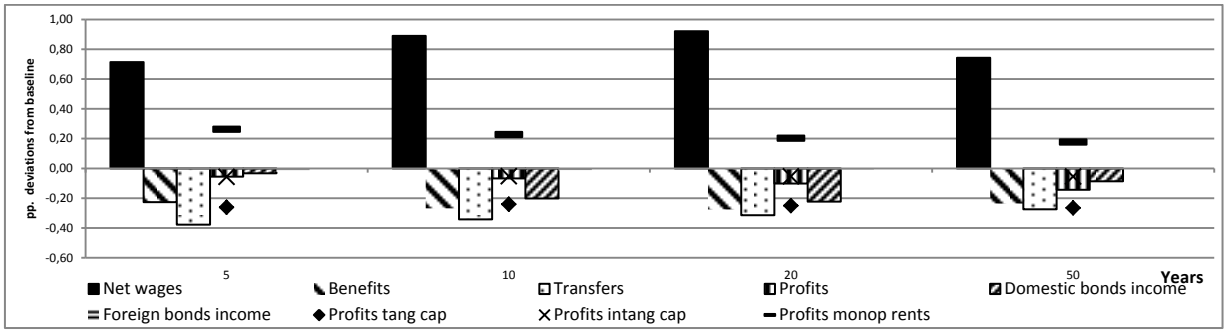


Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.
Source: Commission services

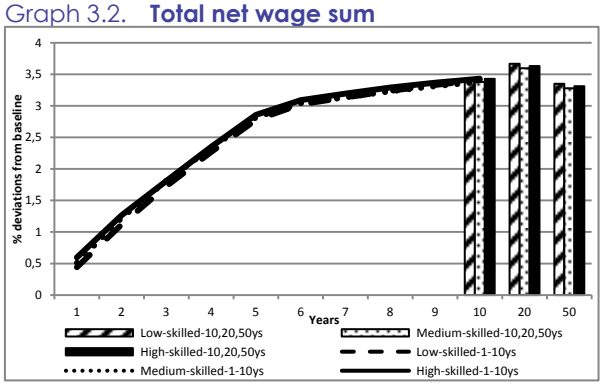
5.2 Tax reforms

Reducing labour income taxes and rasing consumption taxes, in a revenue neutral way, shifts the burden of taxation from labour to all sources of income, including income from financial and non-financial wealth. Such a tax shift redistributes real consumption income from capital owners to wage earners (see Burgert and Roeger, 2014). The scenario simulated corresponds to a 4% of GDP shift from labour to consumption taxes on average. The tax-shift makes returns to labour income more attractive and boosts employment, particularly for the low-skilled, which have a higher wage elasticity. Graph 3 shows that wage income shares are increasing while the shares of other income sources fall. Concerning social transfer income the tax shift is regressive, especially in a situation in which transfer income recipients are not compensated for the increase in the VAT. This adverse effect on benefit recipients is partly alleviated by a positive employment effect which allows unemployed workers into employment. The effects thus depend on how different income groups are compensated for the consumption tax increase. In particular, if unemployment benefits and other transfers are indexed to consumer prices, the positive effects on employment and the wage income share will be smaller, while the transfer and benefit income shares might even increase.

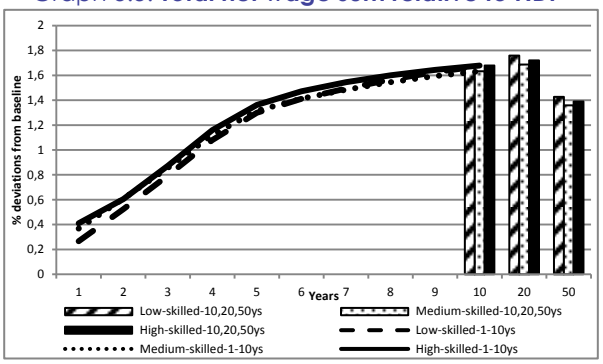
Graph 3.1. **Change in income shares (% of NDI)**



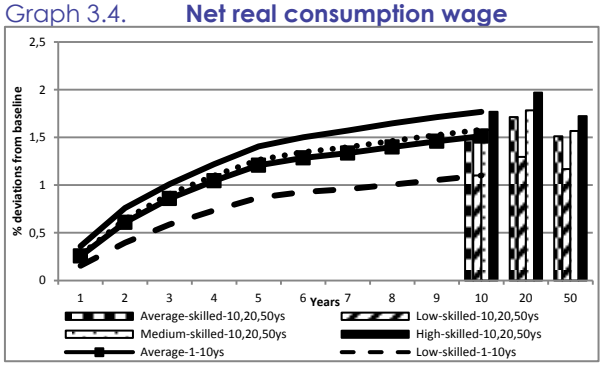
Graph 3.2. **Total net wage sum**



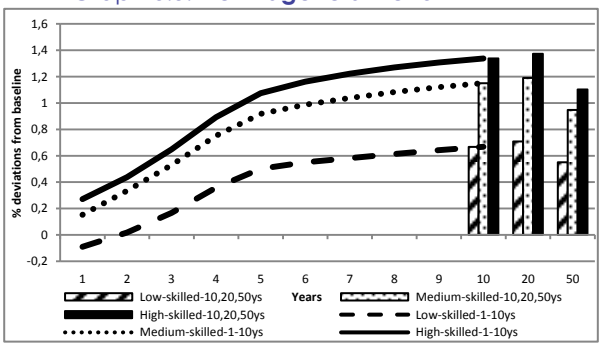
Graph 3.3. **Total net wage sum relative to NDI**



Graph 3.4. **Net real consumption wage**



Graph 3.5. **Net wage relative to NDI**

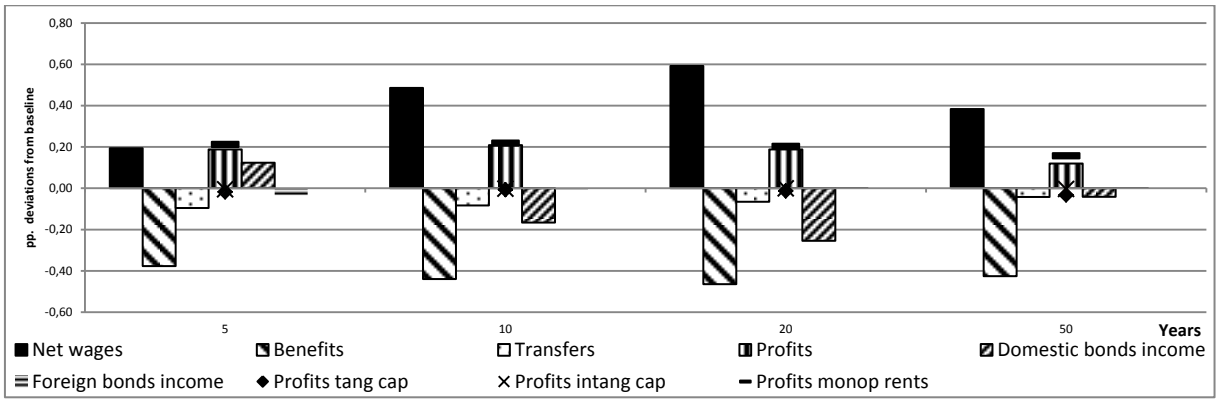


Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.
Source: Commission services

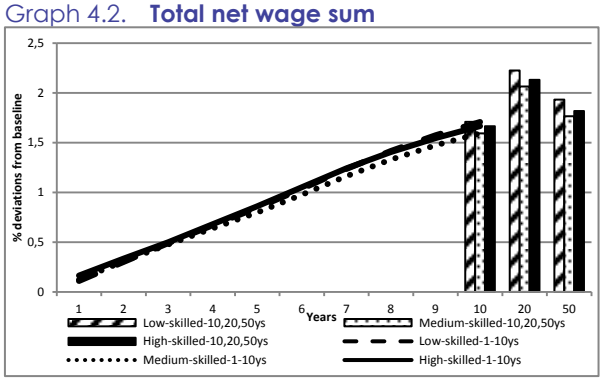
5.3 Unemployment benefit reforms

Benefit reform shifts income from benefits to wages. The initial policy impulse is a reduction in the unemployment benefit replacement rate by 3.5 pp. at the EU level. The main effect is an increase in employment generated by lower wage claims, as can be seen by a reduction of the share of wages in total income (for high and medium skilled for only 4-6 years). (Note this happens despite the fact that the share of benefits is also falling). However in the long run the share of wage income is increasing. This happens entirely because of a decline in benefit income. Income from financial wealth and capital income increases slightly as well, because increased labour supply (lower wages) increases investment in physical capital and intangible assets (entry of new firms). The capital income share rises mostly because of an increase in monopoly rents. This is mostly due to a scale effect, an expansion of output (higher labour input) which reduces the share of fixed costs in production (the model does not assume an increase in the mark up).

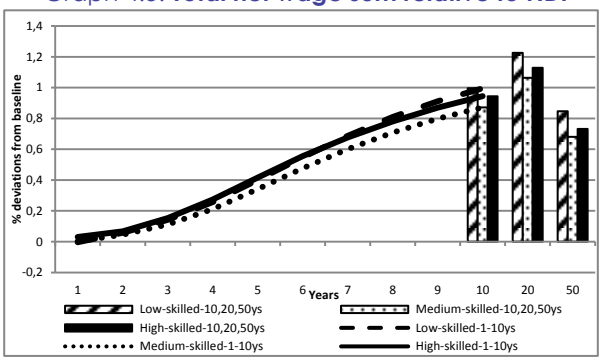
Graph 4.1. **Change in income shares (% of NDI)**



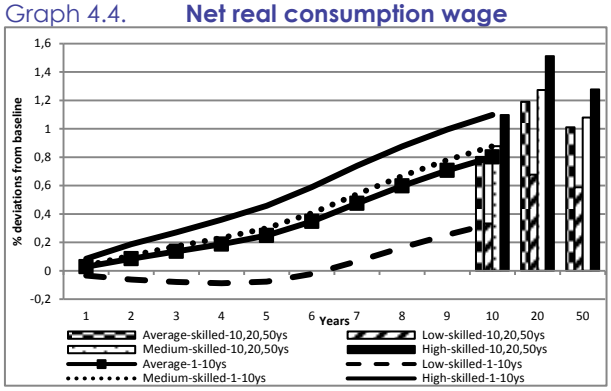
Graph 4.2. **Total net wage sum**



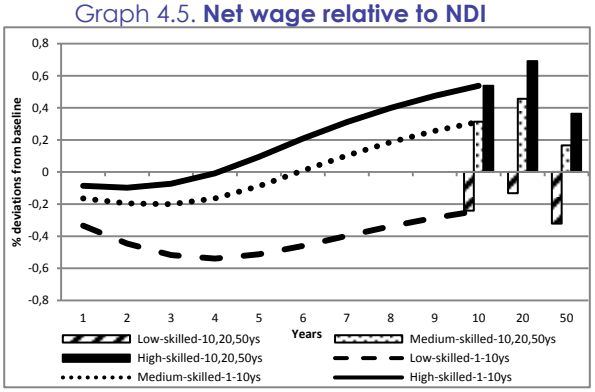
Graph 4.3. **Total net wage sum relative to NDI**



Graph 4.4. **Net real consumption wage**



Graph 4.5. **Net wage relative to NDI**



Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

Source: Commission services

5.4 Labour market participation reforms

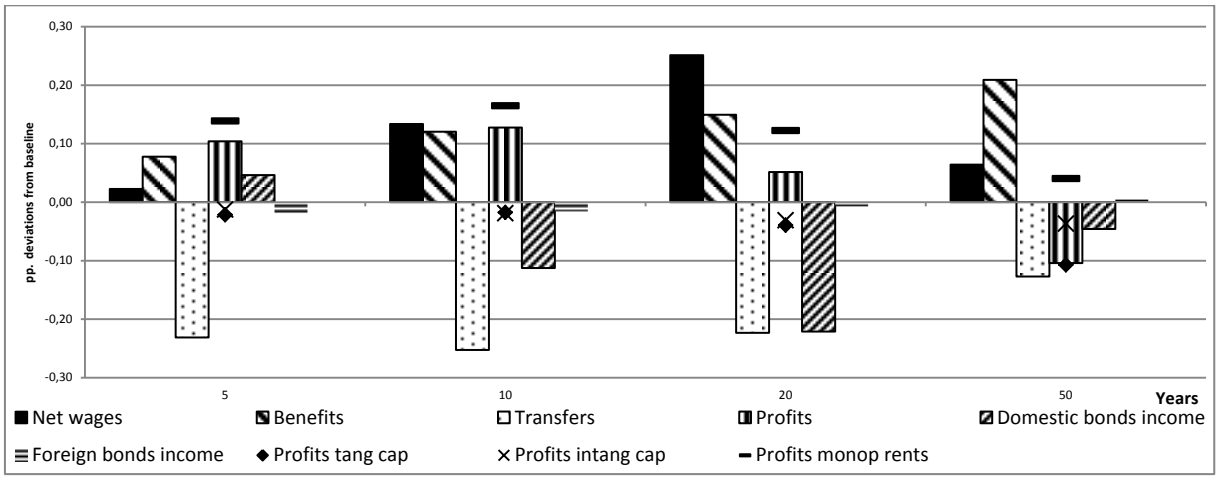
5.4.1 Female participation

This reform consists of an overall increase in labour supply across all skill categories, closing the gap with best performance in terms of female participation per skill group. As the gaps are largest for lower qualified workers, the reform is biased toward higher participation of this group. On average the increase in the female labour force participation rate amounts to 4.5 pp.. This increase in labour supply is accompanied by clear trade-offs. Total wage income is increasing, however this is generated by an increase in employment at a lower wage rate. The unemployment benefit share also increases, as low skilled workers have a higher probability of being unemployed. Profit income share is higher mostly because the rent component increases, due to the increase in output which reduces the share of fixed costs in production. These increases in income shares are at the expense of transfer income, which is only indexed to inflation in these scenarios. We also run an alternative scenario of this reform allowing for an endogenous decline of mark-ups in response to an increase in monopoly rent (see Graphs 5b). In this case the rent component of profit income share falls more sharply in the medium term while the real wage share increases in the long run.[13]

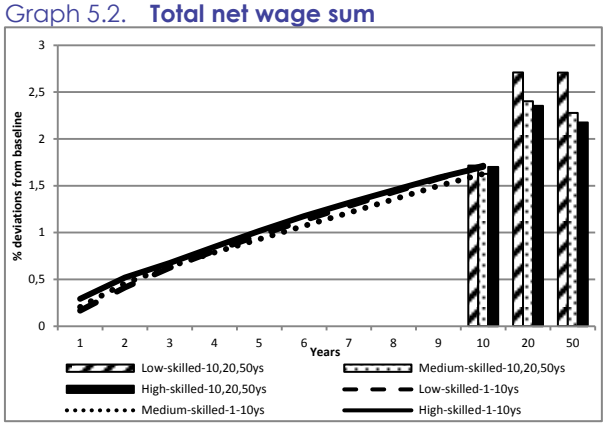
[13] In this scenario we endogenize services mark-ups, (mup_t^Y) in order to mimic the endogenous entry of new firms via the return of monopoly rents (*m.rent*) towards their baseline level $(\overline{m.rent})$, i.e. mark-ups decline in response to an increase in monopoly rents: $mup_t^Y = mup_{t-1}^Y - \gamma(m.rent - \overline{m.rent})$, where $\gamma > 0$.

Graph 5. Increase in female participation - without entry

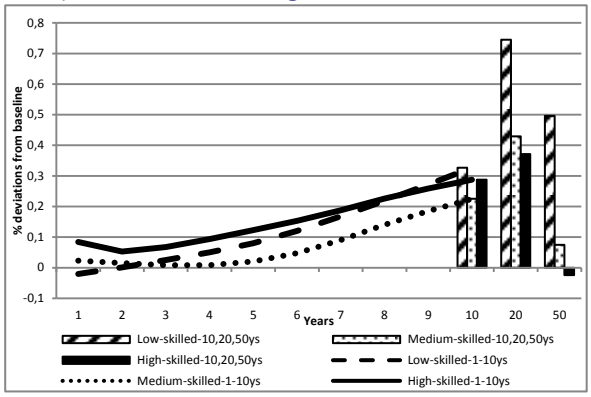
Graph 5.1. **Change in income shares (% of NDI)**



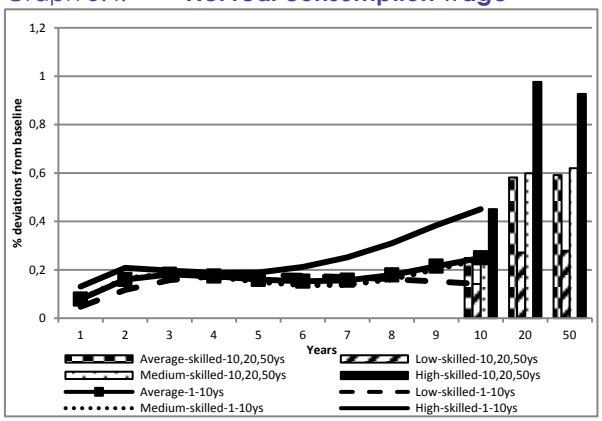
Graph 5.2. **Total net wage sum**



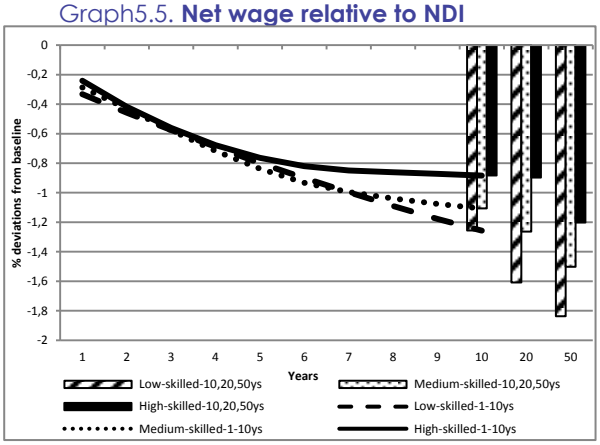
Graph 5.3. **Total net wage sum relative to NDI**



Graph 5.4. **Net real consumption wage**



Graph5.5. **Net wage relative to NDI**

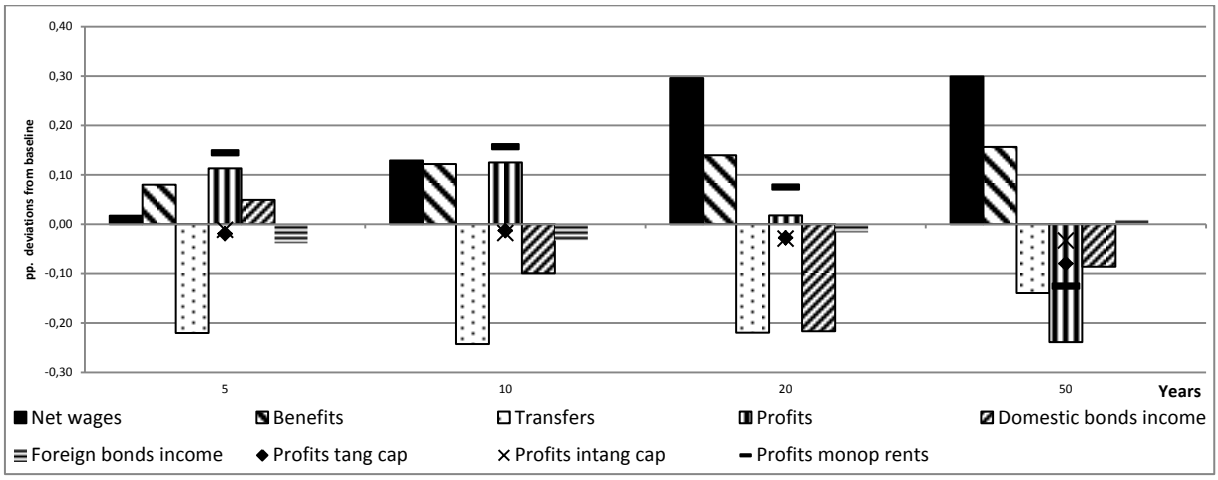


Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years., the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

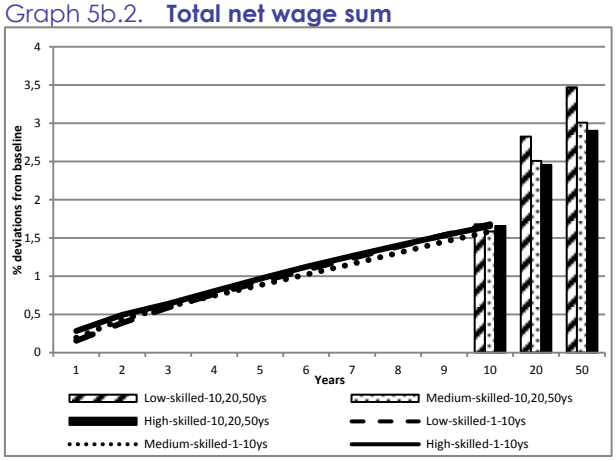
Source: Commission services

Graph 5b. Increase in female participation - with entry

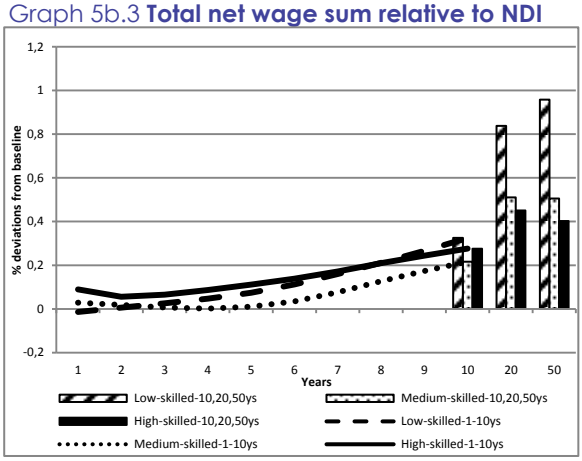
Graph 5b.1 **Change in income shares (% of NDI)**



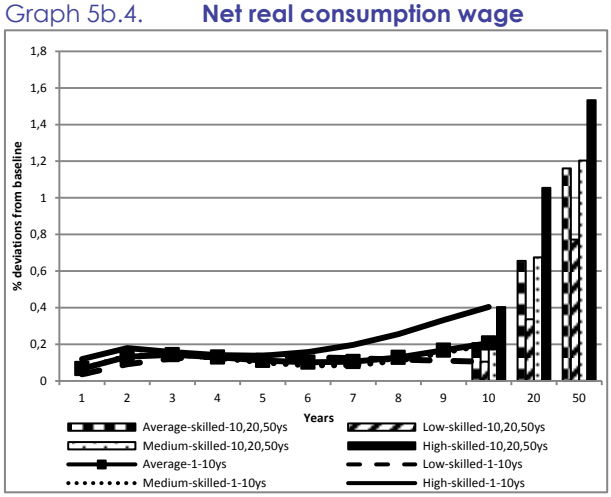
Graph 5b.2. **Total net wage sum**



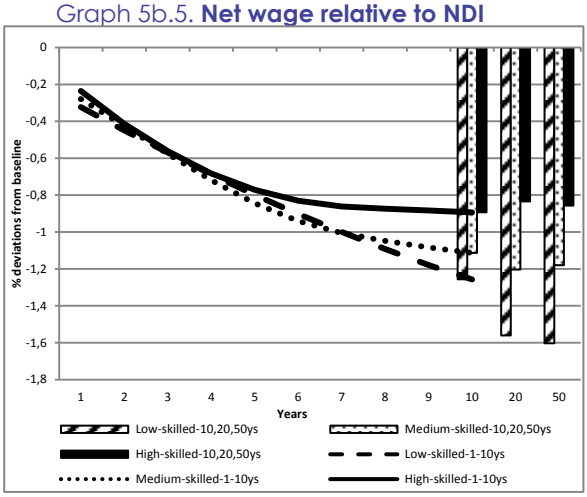
Graph 5b.3 **Total net wage sum relative to NDI**



Graph 5b.4. **Net real consumption wage**



Graph 5b.5. **Net wage relative to NDI**



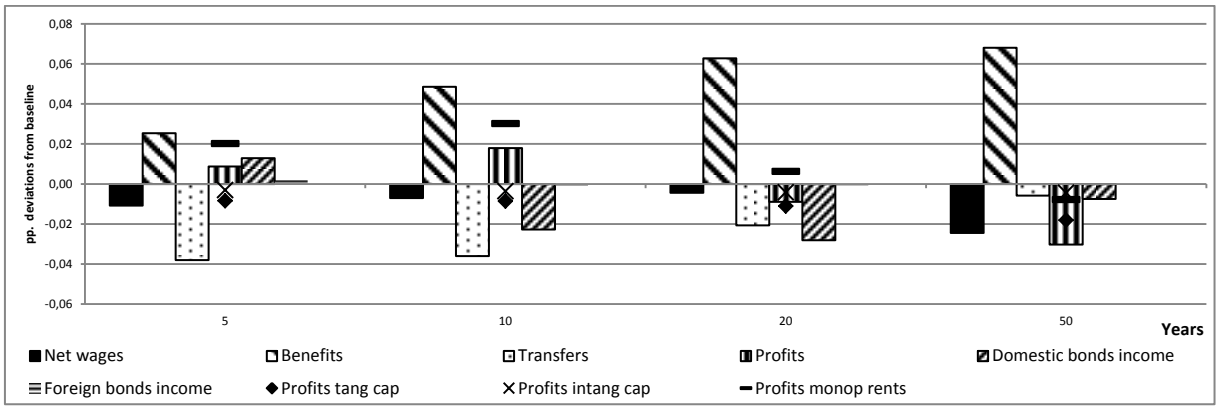
Note: The first graph shows the change of income shares in pp. deviation after 5, 10, 20 and 50 years, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

Source: Commission services

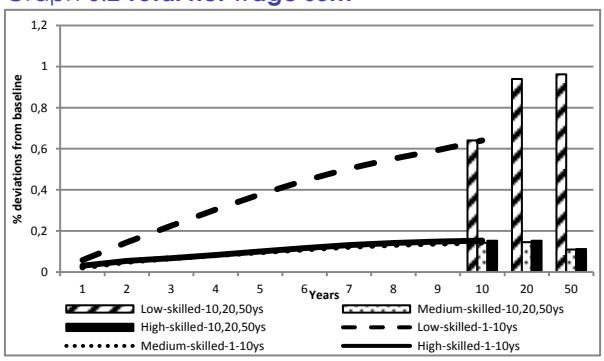
5.4.2 *Low-skilled participation*

In contrast to the previous scenario, this is an increase of the low skilled (male) labour force participation rate, by around 4.2 pp. at the aggregate EU-level. There is a clear trade off between higher employment and lower relative wages. The income of medium and high skilled workers is not affected much by this participation shock for low-skilled workers. Wage income as a share of total income is reduced, while the main other income shares, in particular the share of benefit income, increase. This is due to the fatc that higher low skilled participation also increases entitlements to benefits, as this skill group has a higher risk of unemployment.

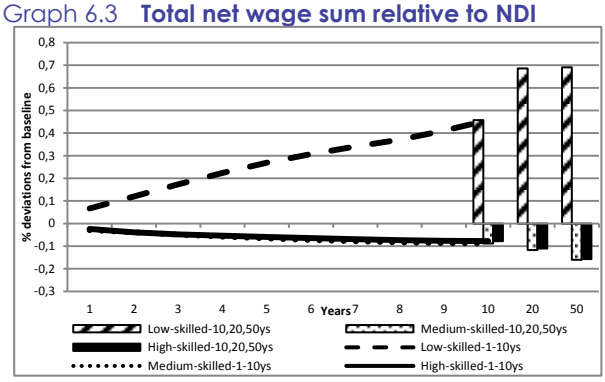
Graph 6.1 **Change in income shares (% of NDI)**



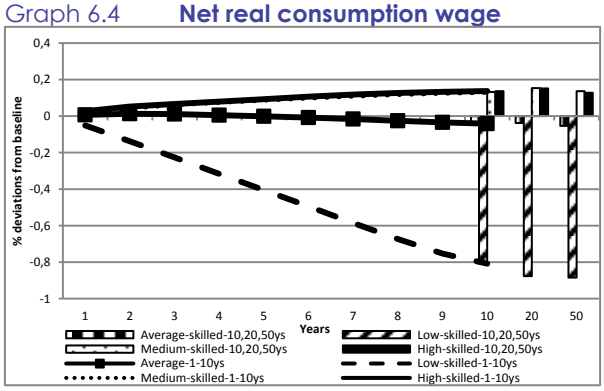
Graph 6.2 **Total net wage sum**



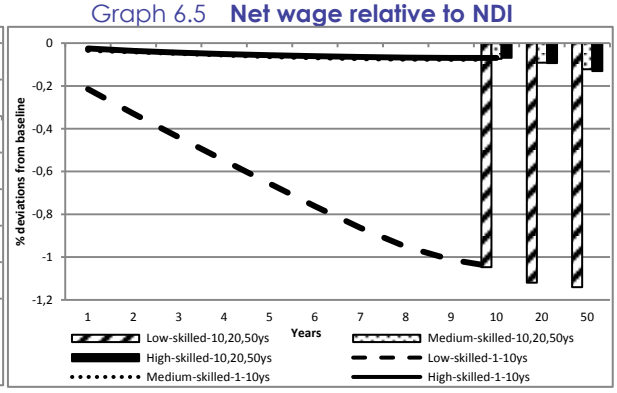
Graph 6.3 **Total net wage sum relative to NDI**



Graph 6.4 **Net real consumption wage**



Graph 6.5 **Net wage relative to NDI**



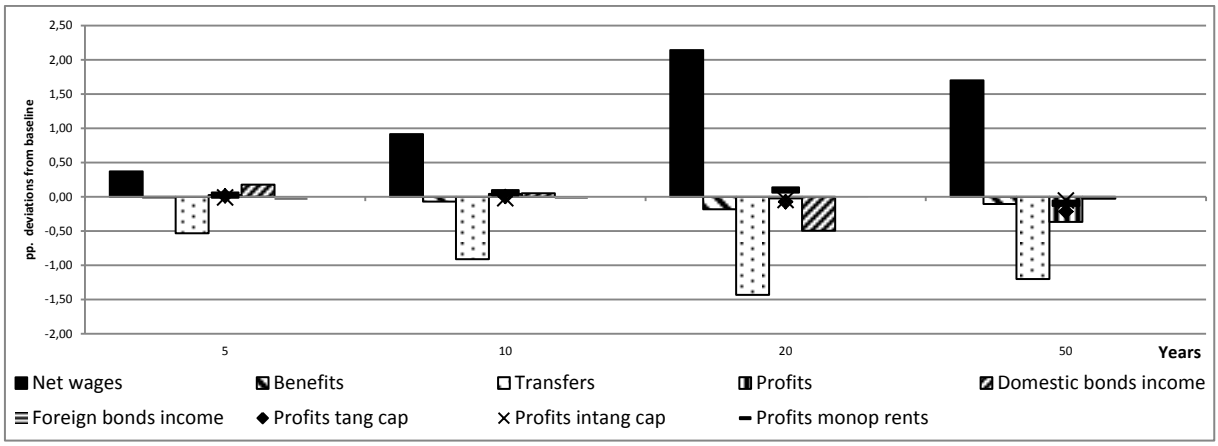
Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs show the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

Source: Commission services

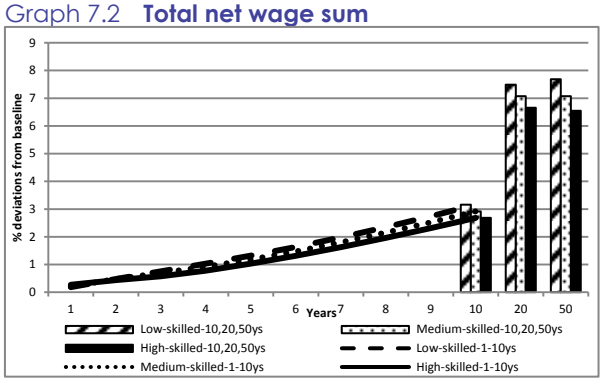
5.4.3 Older workers participation

The final participation scenario is related to the 55-65 age group. Here the simulated reform is an increased in the participation arte for this age group by 2 pp. Higher labour force participation (lower early retirement) implies a decline in transfer (pension) payments, and Graph 7 shows a more favourable wage income share development, while other income than transfers are little affected.

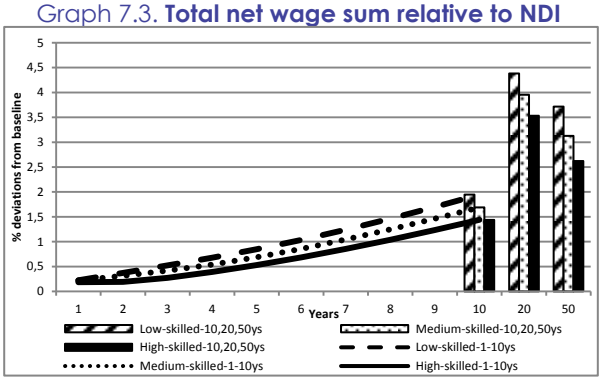
Graph 7.1. **Change in income shares (% of NDI)**



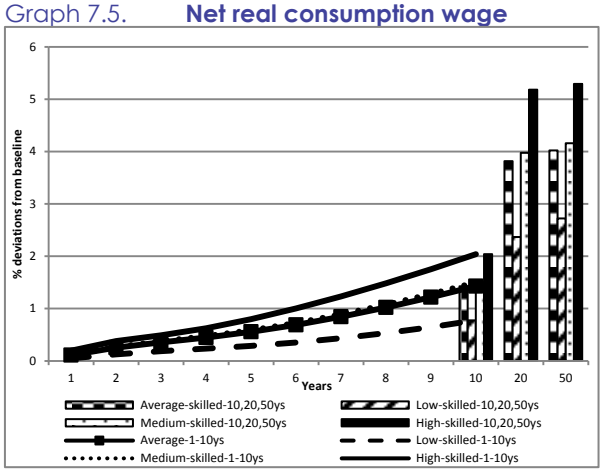
Graph 7.2 **Total net wage sum**



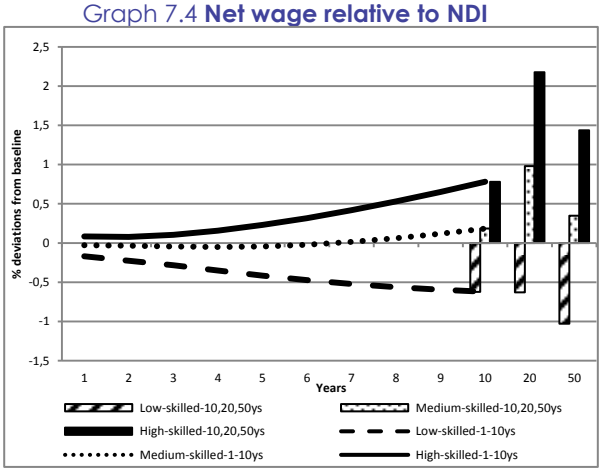
Graph 7.3. **Total net wage sum relative to NDI**



Graph 7.5. **Net real consumption wage**



Graph 7.4 **Net wage relative to NDI**



Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.
Source: Commission services

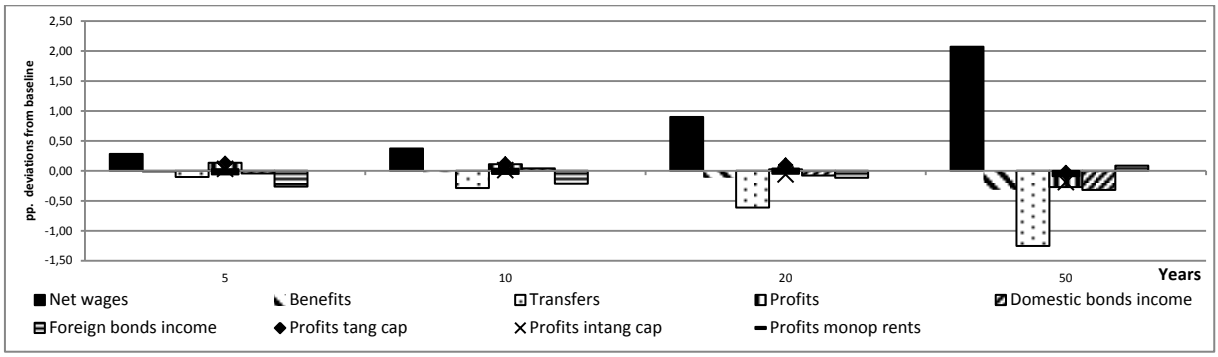
5.5 Education reforms

5.5.1 Increasing the share of high-skilled

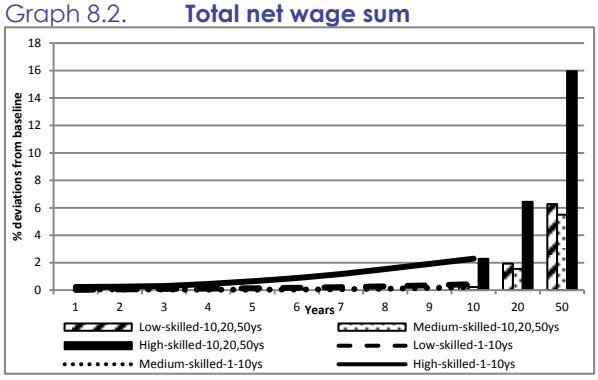
Changes in education and their effects on the quality of the labour force can be captured in the model as changes in the skill composition. Thus, in this exercise human capital investment is modelled as changing the relative weights of the different skill categories. The first type of education reform we consider is an increase in the share of high skilled by 2.2 pp. and a corresponding decline in the share of medium-skilled. There is a direct productivity effect from this as high skilled workers are more productive, but this shift in skill shares is introduced very gradually to capture the fact that this can only be brought about through education and training and will take time. As these reforms will have costs, the higher costs of tertiary education (compared to benchmark spending on this) are also taken into account. Higher supply of high skilled workers increases the supply of intangible capital and leads to entry of new firms. This increases the share of intangible capital income. For the high skilled there are clear trade offs as an increase in high skilled workers is associated with a decline in their real wage (Graph 8). However, there is a tendency towards an increase in the relative wage share of high skilled. This is explained by a secular increase in the demand for high skilled workers which depends on the elasticity of substitution between the three skill-types in the production function (see equation 26). The consensus estimate of the elasticity of substitution between skilled and unskilled labour is between 1.0 and 2.0 (Katz and Autor, 1999). Acemoglu and Autor (2011) recently updated the seminal reference of this elasticity parameter by Katz and Murphy (1992, "KM" hereafter). While KM estimated that the elasticity of substitution between skilled and unskilled labour is about 1.4, Acemoglu and Autor (2011) argues for somewhat higher estimates in the range of 1.6-1.8 using an extended data sample of KM (from 1963 to 2008 as opposed to 1968-1987). In the simulation exercise we used the middle value of this range, $\mu=1.7$. Note that an elasticity of $\mu<1$ could result in a simultaneous decline of high-skilled real wages and relative wage shares after an increase in their population share (See Graph 8.b.). In this case, the overall increase in the wage share is smaller than that with a higher elasticity. In either case, other income shares fall. The decline in the transfer income share is explained by the absence of wage indexation of transfers.

Graph 8. Increase in share of high-skilled

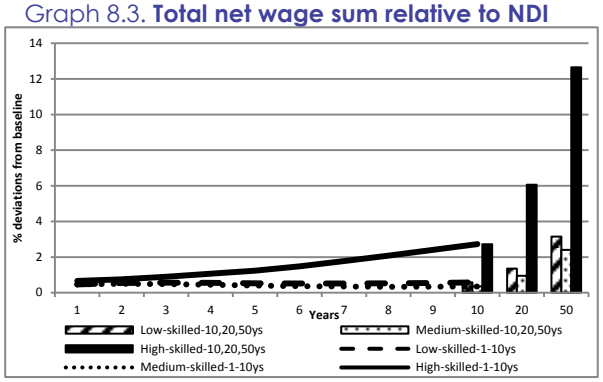
Graph 8.1. **Change in income shares (% of NDI)**



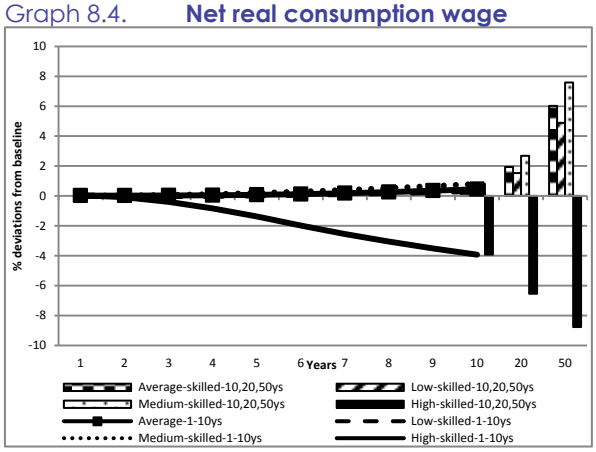
Graph 8.2. **Total net wage sum**



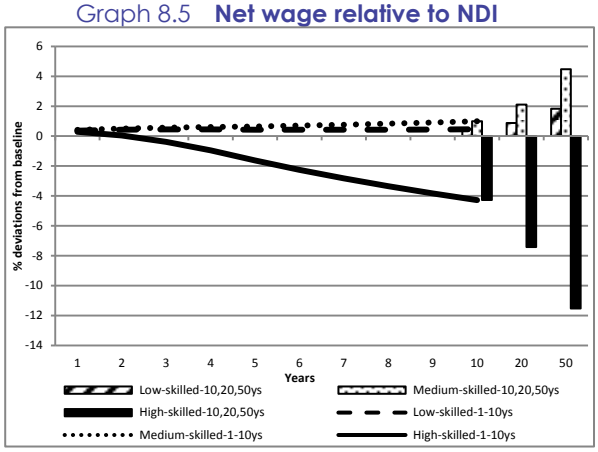
Graph 8.3. **Total net wage sum relative to NDI**



Graph 8.4. **Net real consumption wage**



Graph 8.5 **Net wage relative to NDI**

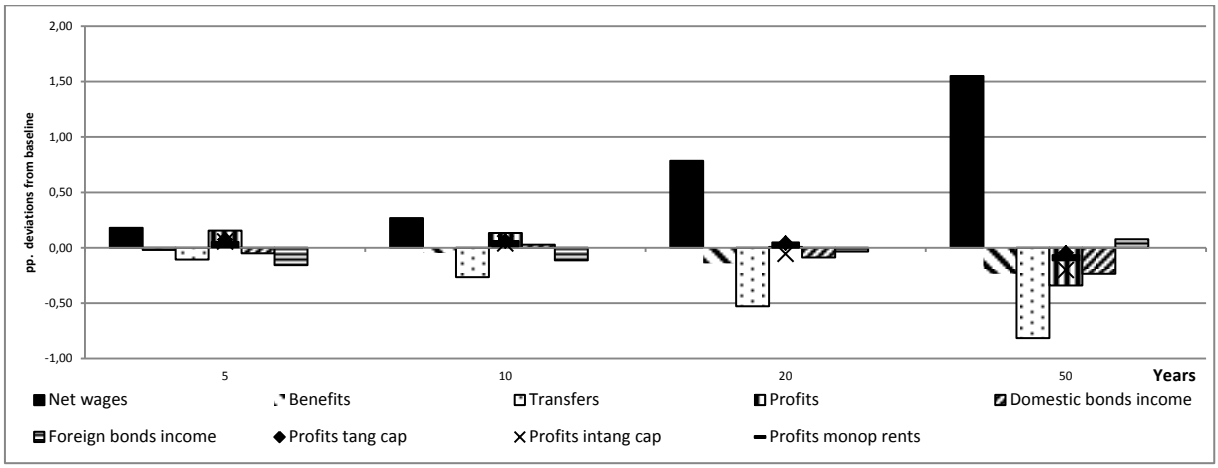


Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

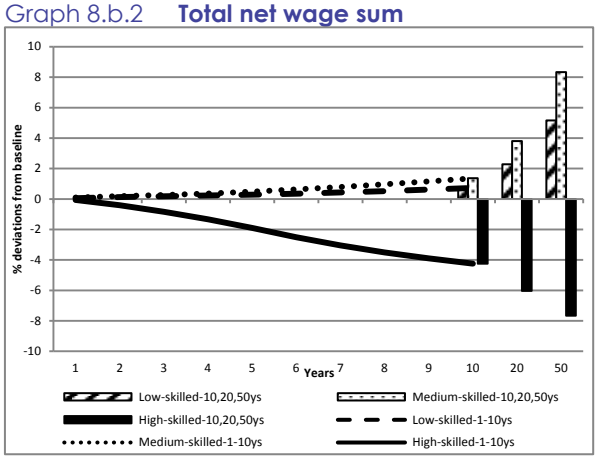
Source: Commission services

Graph 8.b. Increase in share of high-skilled – low elasticity

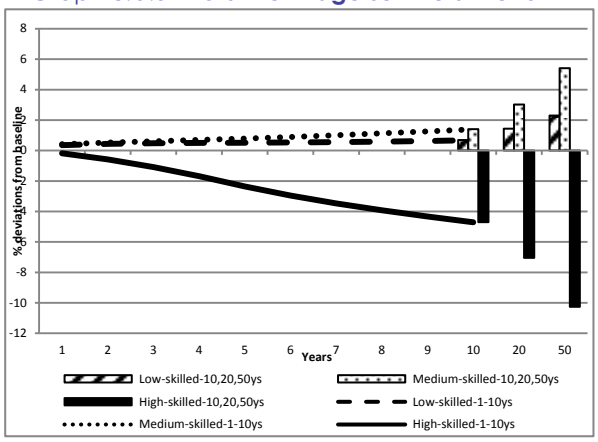
Graph 8.b.1 **Change in income shares (% of NDI)**



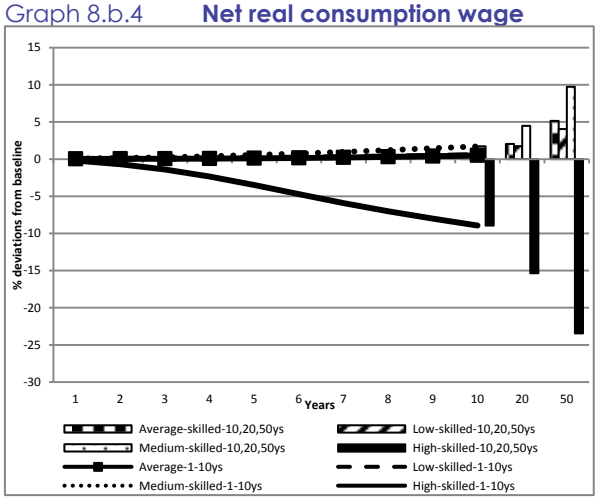
Graph 8.b.2 **Total net wage sum**



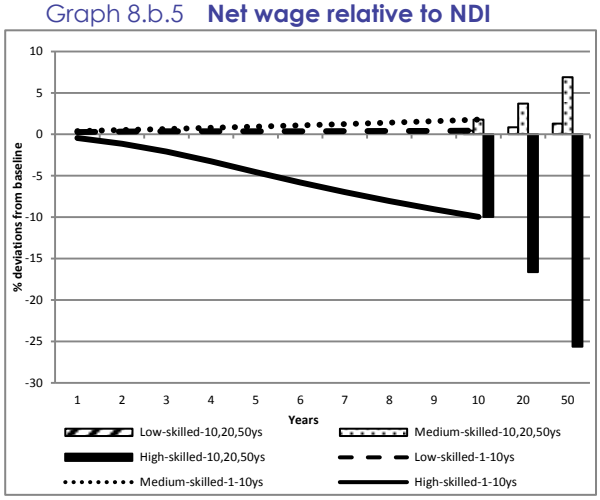
Graph 8.b.3 **Total net wage sum relative to NDI**



Graph 8.b.4 **Net real consumption wage**



Graph 8.b.5 **Net wage relative to NDI**



Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

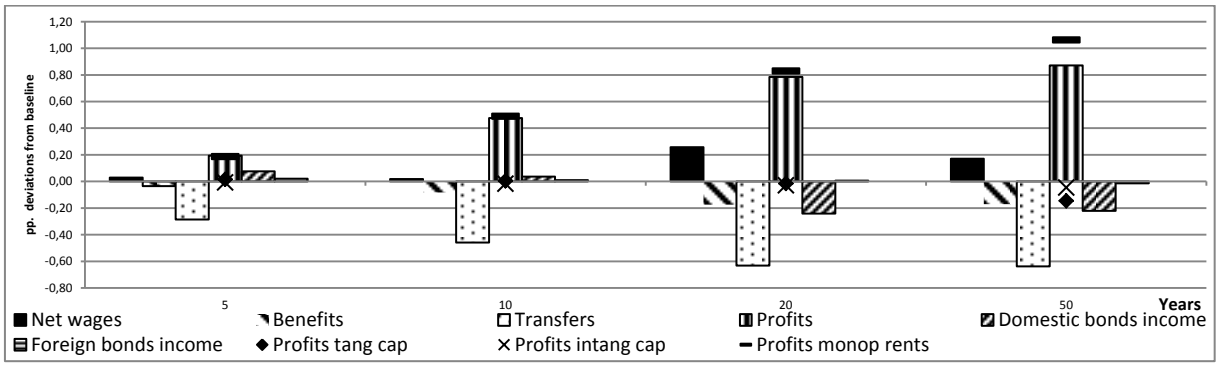
Source: Commission services

5.5.2 *Increasing the share of medium-skilled*

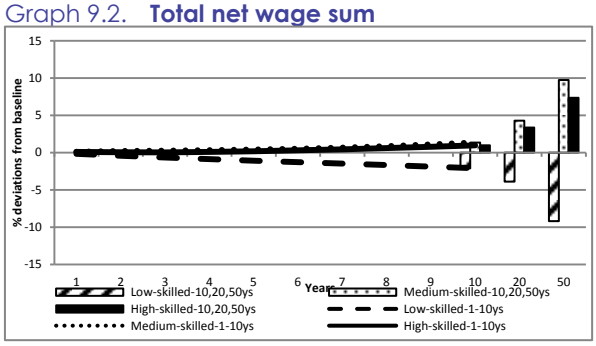
The second human capital investment reform we consider is an increase in the share of medium skilled workers, as a shift from low skilled (Graph 9). The increase of the average skill level in the economy (reducing the proportion of low-skilled) is modelled as a gradual change, accounting for the substantial lags in achieving that objective, including lags in reforming the education system and the gradual passing through of new cohorts onto the labour market. The reform cost is modelled as an increase in education-related expenditure. In this reform the share of medium-skilled increases by 12.4 pp. on average in the EU. Again, we see a trade off between employment expansion and wage decline for the medium skiled, and for the low skilled the opposite and an increase in their wages, Also in this case the reform increases the capital share in total income. The latter result depends crucially on the assumption of no entry. When we allow for entry (through a mark-up reduction which responds endogenously to the rents following the same equation as in footnote 4 with the female participation rate shock) the increase in the profit share is much reduced (see Graph 9.b).

Graph 9. Increase in share of medium-skilled "without entry"

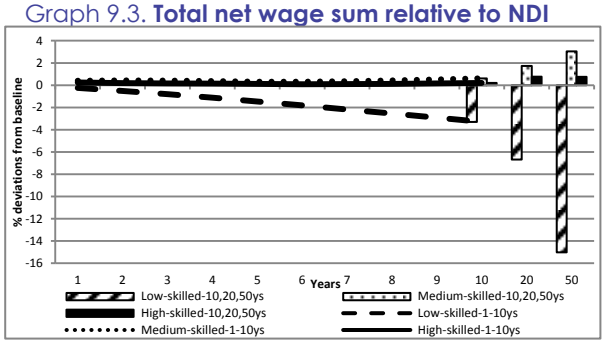
Graph 9.1. **Change in income shares (% of NDI)**



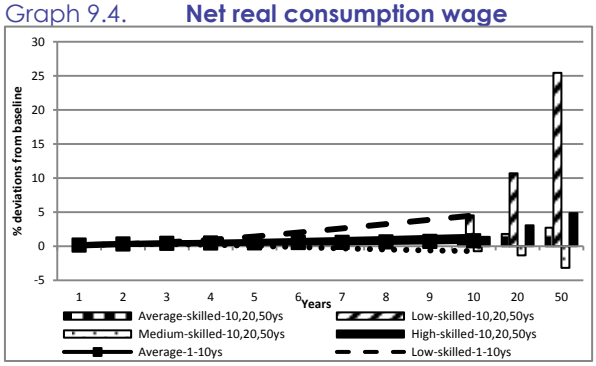
Graph 9.2. **Total net wage sum**



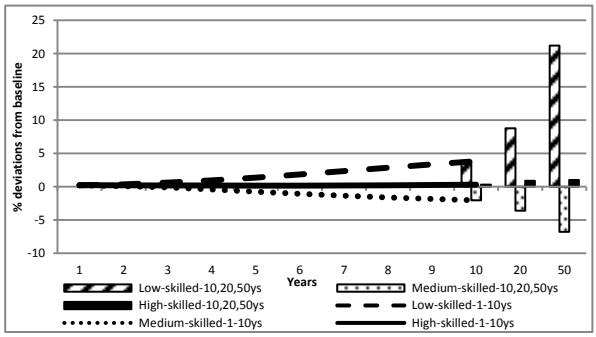
Graph 9.3. **Total net wage sum relative to NDI**



Graph 9.4. **Net real consumption wage**



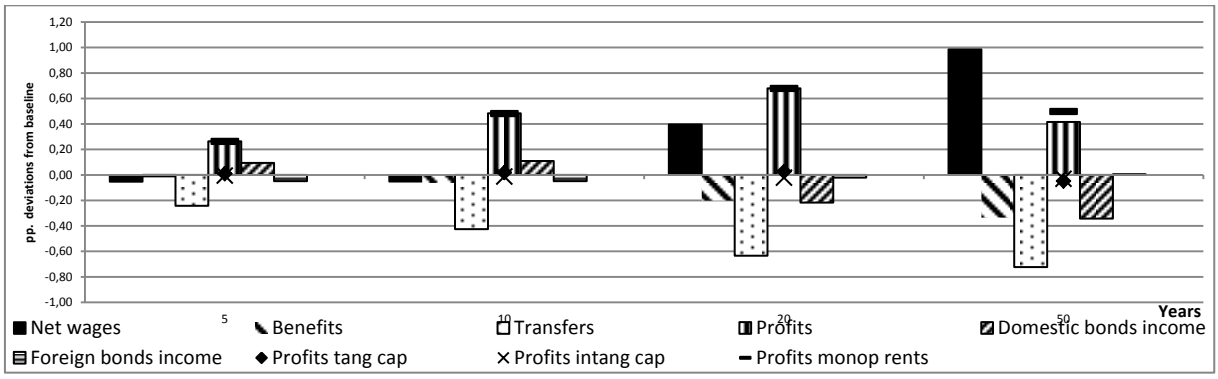
Graph 9.5. **Net wage relative to NDI**



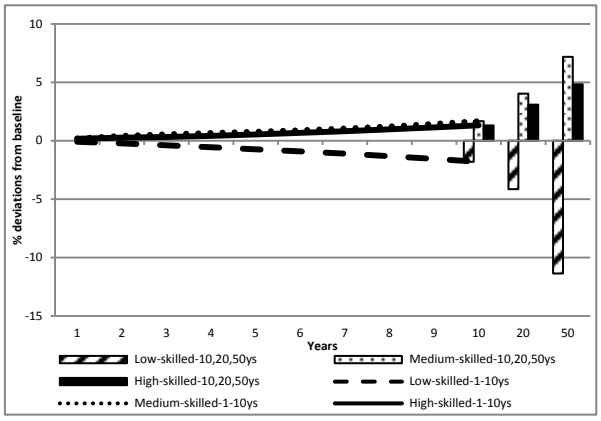
Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.
Source: Commission services

Graph 9.b Increase in share of medium-skilled - "with entry"

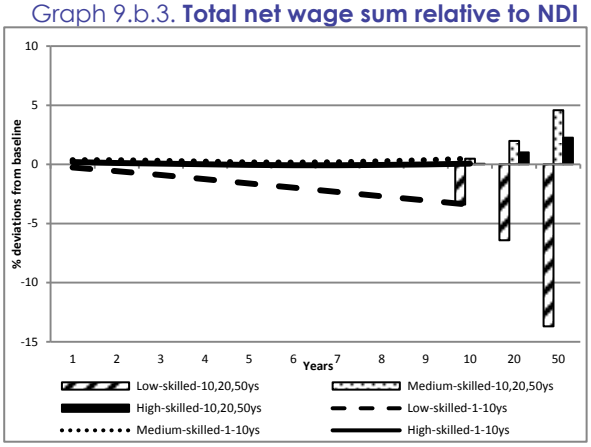
Graph 9.b.1. **Change in income shares (% of NDI)**



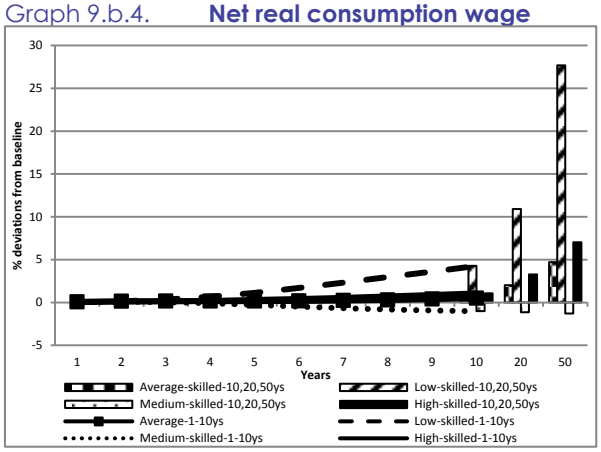
Graph 9.b.2. **Total net wage sum**



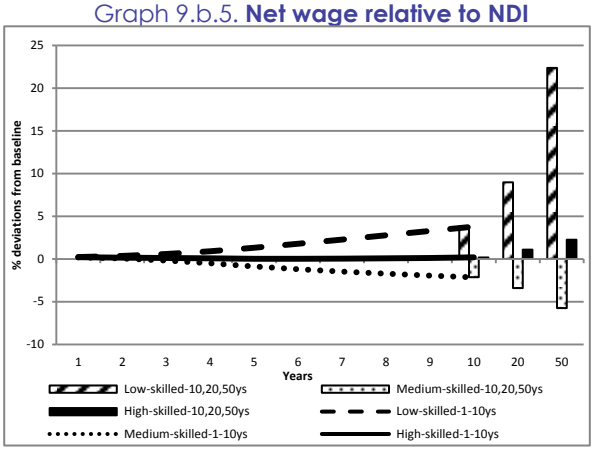
Graph 9.b.3. **Total net wage sum relative to NDI**



Graph 9.b.4. **Net real consumption wage**



Graph 9.b.5. **Net wage relative to NDI**

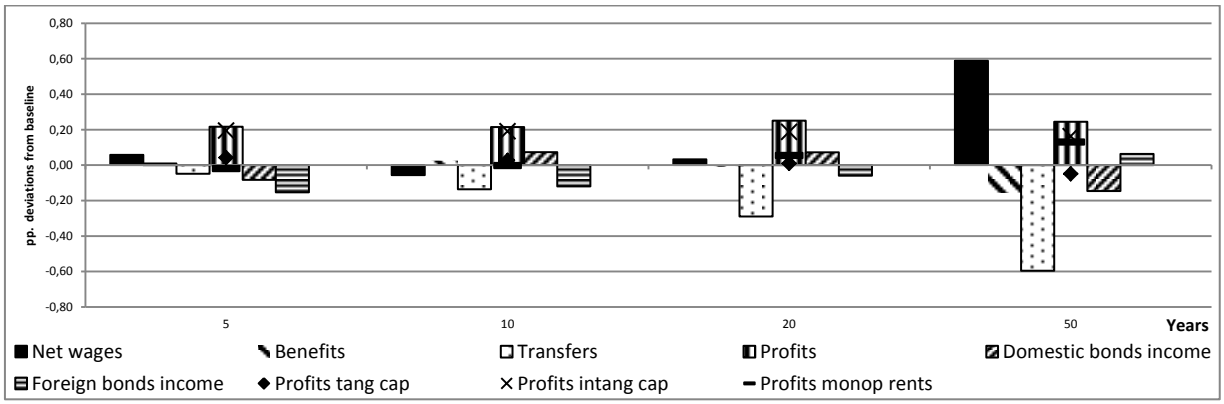


Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.
Source: Commission services

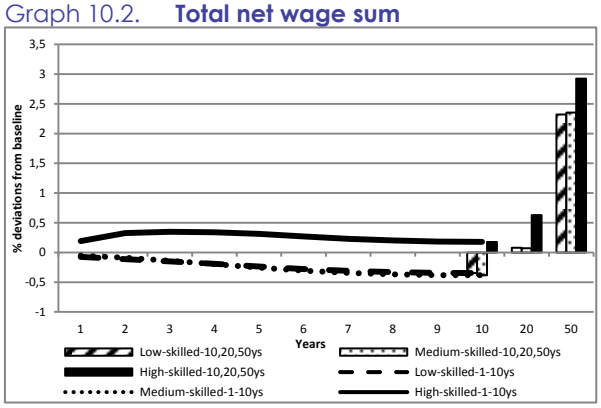
5.6 Innovation subsidies

The innovation subsidy considered in this final scenario is a tax credit for R&D spending. This tax credit raises R&D, and, as Graph 10 shows, this mostly benefits high skilled workers and income from intangible assets. High skilled wages increase relative to other skills. The increase in income shares for wage income and intangible capital is mainly at the expense of transfer income (not indexed to wages). The skill premium increases because of an increase for high skilled workers (increase of R&D). Since higher R&D increases intangible assets, income from intangibles increases. There is also a direct effect on income from intangibles from the R&D subsidy.

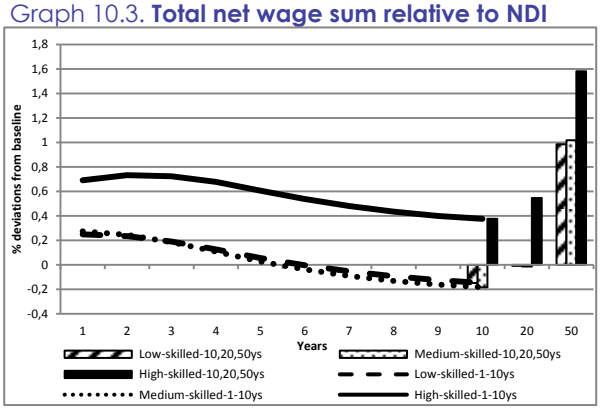
Graph 10.1. **Change in income shares (% of NDI)**



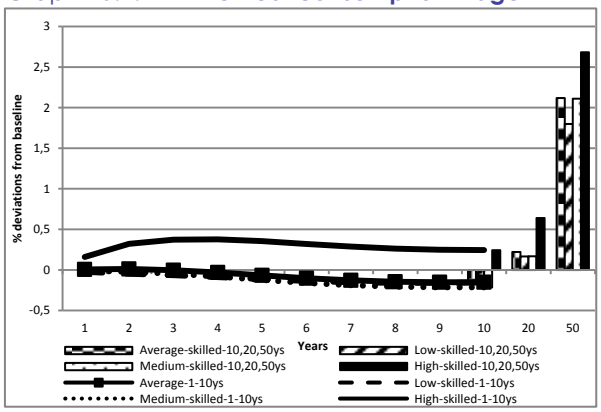
Graph 10.2. **Total net wage sum**



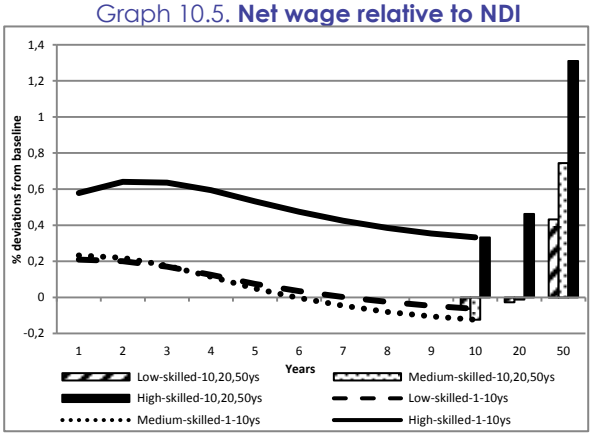
Graph 10.3. **Total net wage sum relative to NDI**



Graph 10.4. **Net real consumption wage**



Graph 10.5. **Net wage relative to NDI**



Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

Source: Commission services

5.7 Structural Reforms 1.0 vs. 2.0 (benefit reforms, raising participation rates and education reforms)

Labour market reforms have predominantly been focused on reforms which aim at increasing the employment rate of low skilled workers (benefit reductions, increasing female labour force participation, and pension reform (increasing elderly labour force participation)). More recently there have been calls for a stronger focus on reforms which aim at raising the skill level of the labour force (increasing the share of high and medium skilled workers via spending on education, and innovation subsidies). It is argued that such labour market reforms linked to human capital improvements and innovation tend to be more acceptable as they are perceived as being more fair.[14] This set of labour reforms is labelled reforms 2.0.

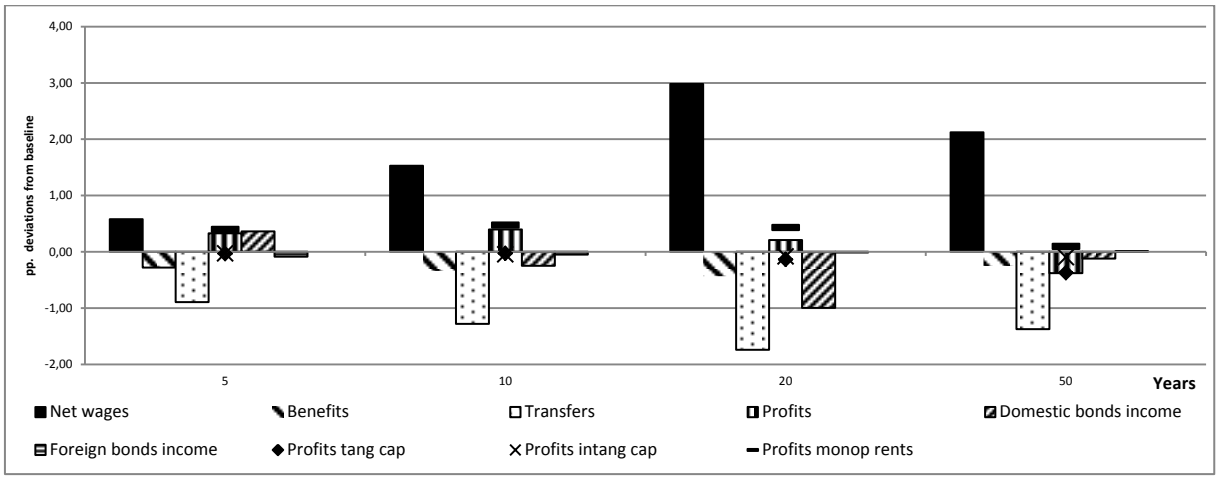
As a way of summarising the results, we group our structural reforms into two sets of reforms. The first set, which we label 1.0, aims at increasing the employment rate and combine the effects of benefit reductions, increasing female labour force and increasing elderly labour force participation (Graph 11 below). The second type of reforms, labelled as labour market reforms 2.0, merge the effect of reforms that increase the share of high and medium skilled workers via spending on education, and also includes innovation subsidies (Graph 12).

While the first group of reforms lead to a significantly larger increase in the wage share, at least in the short-medium run, in the long run the wage share increases more under reforms 2.0. However, it takes longer before the benefits of human capital investment become apparent. Under the first group of reforms, there is also a decline in the transfer share, which is to a large extent due to pension reforms, which raise the participation of elderly workers, and reduce the number of pension recipients. The reforms 2.0, with their focus on innovation and human capital improvements, have a stronger positive impact on the profit share, in particular for intangible capital.

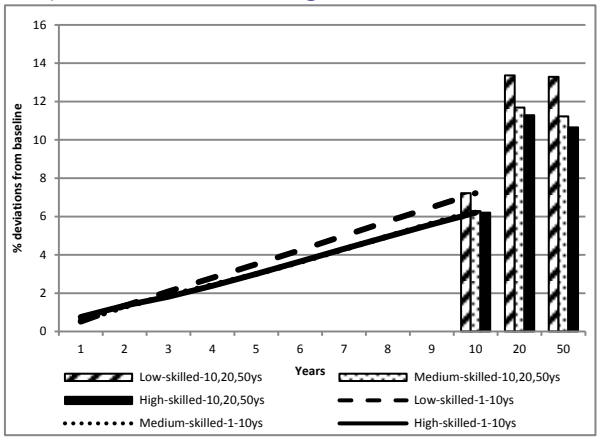
[14] See the speech by Commissioner P. Moscovici "Structural reforms 2.0: for a stronger and more inclusive recovery": http://europa.eu/rapid/press-release_SPEECH-16-2124_en.htm?locale=en

Graph 11 Labour market reforms 1.0

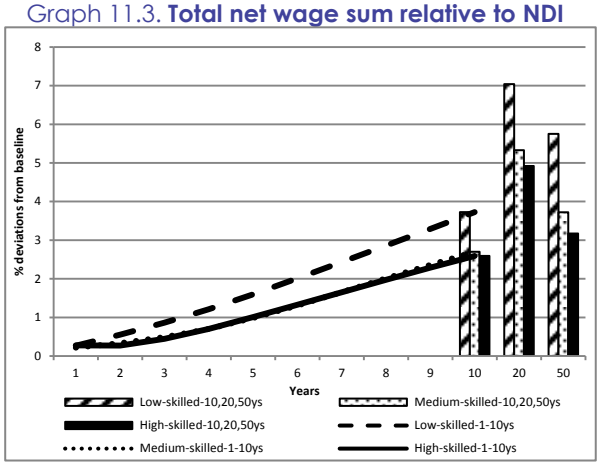
Graph 11.1. **Change in income shares (% of NDI)**



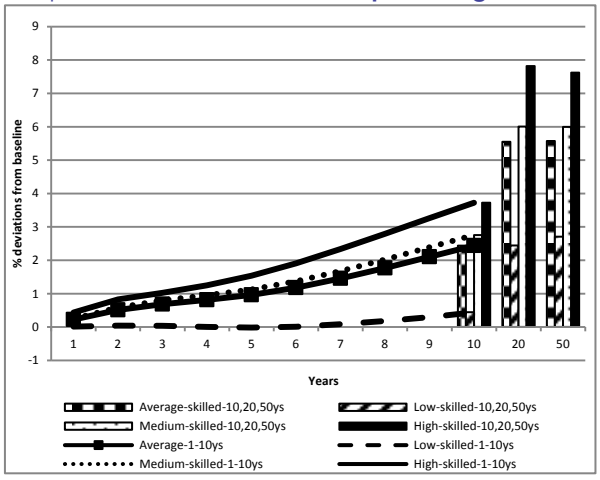
Graph 11.2. **Total net wage sum**



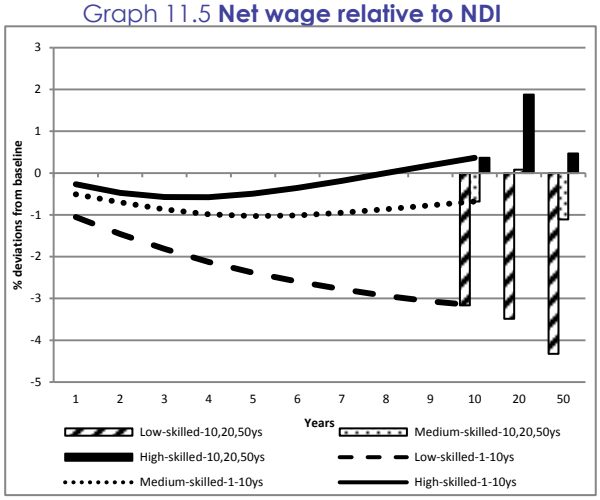
Graph 11.3. **Total net wage sum relative to NDI**



Graph 11.4 **Net real consumption wage**



Graph 11.5 **Net wage relative to NDI**

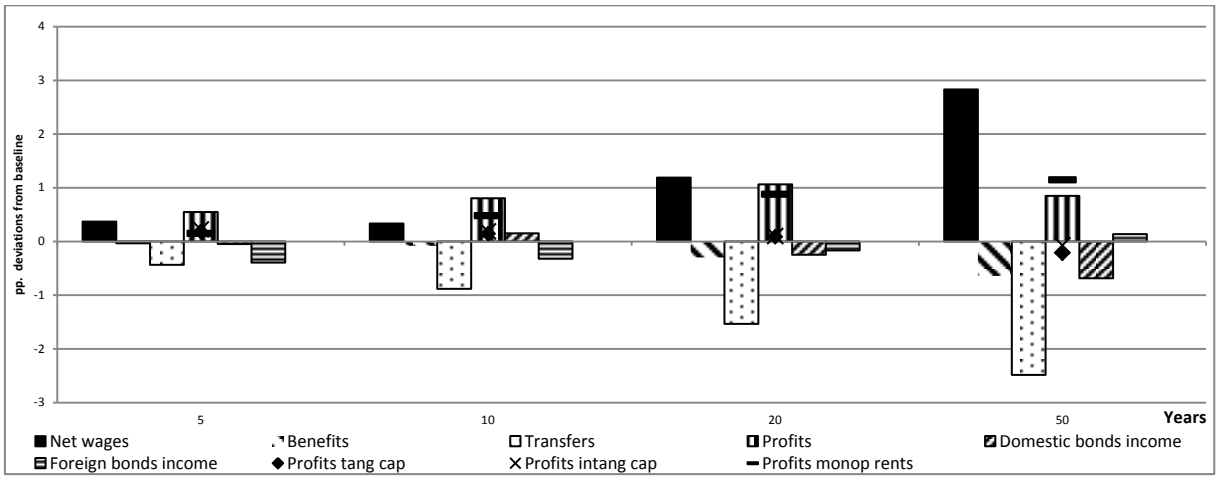


Note: The first graph shows the change of income shares in pp. deviation, the second and third graphs shows the deviation of total net wages alone and in % of net disposable income respectively (GDP deflated). The fourth graph shows the consumption price deflated net wages while the last graph presents the GDP deflated net wages relative to net disposable income. Deviations from baselines.

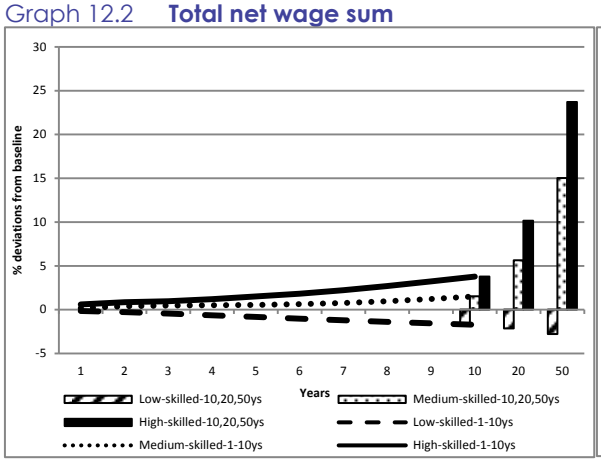
Source: Commission services

Graph 12 Labour market reforms 2.0

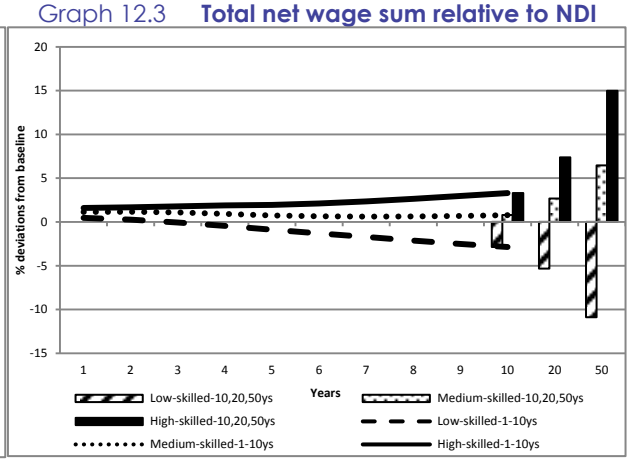
Graph 12.1. **Change in income shares (% of NDI)**



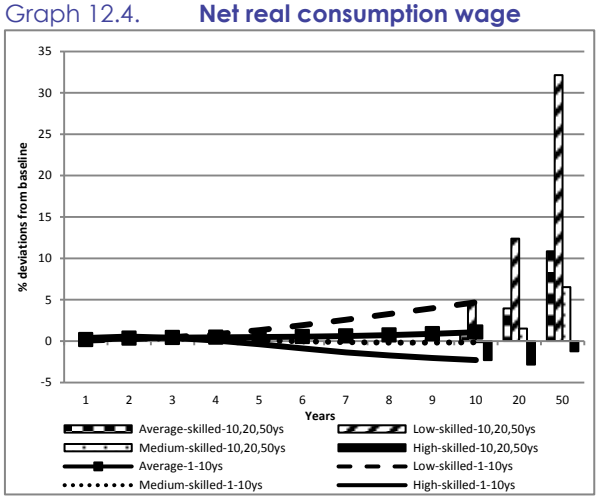
Graph 12.2 **Total net wage sum**



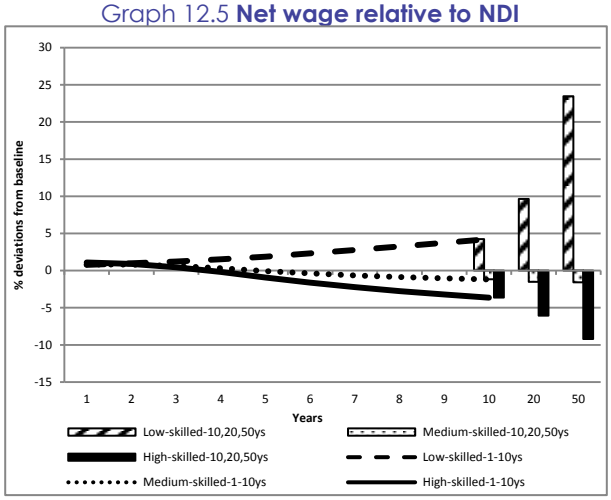
Graph 12.3 **Total net wage sum relative to NDI**



Graph 12.4. **Net real consumption wage**



Graph 12.5 **Net wage relative to NDI**



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Source: Commission services

6. Conclusions

This paper looks at the distributional impacts of a comprehensive set of structural reforms, using an endogenous growth model which is calibrated on each EU member state. Our analysis is based on previous research which traces income gaps to differences in structural indicators across EU member states and identifies reforms which close the income gap by 50% in the long run. This analysis provides realistic quantitative measures for the order of magnitude of reforms needed to significantly close the income gap towards best performing countries in the EU. The set of reforms is comprehensive and ranges from goods market reforms (reducing service sector mark ups, reducing entry barriers) to a broad set of labour market reforms. The labour market reforms can be grouped into reforms which aim at increasing the employment rate of low skilled workers (benefit reductions, increasing female labour force participation, increasing elderly labour force participation) and reforms which aim at raising the skill level of the labour force (increasing the share of high and medium skilled workers via spending on education, innovation subsidies). The two sets of labour reforms can be labelled reforms 1.0 and 2.0 respectively.

Our analysis shows the trade off between an increase in employment of a particular group and the income of the average group member compared to income per capita. In general reforms which aim at increasing the employment rate of low skilled workers are associated with a fall of wages relative to income per capita. This effect can be decomposed into wage distribution effects across skill groups but the overall increase in the supply of labour also affects the distribution between wage earners and other income categories, especially capital owners. Capital owners generally benefit from labour market reforms, not only in the form of an absolute increase in capital income but also in the form of an increasing share in total income. The reason why this is happening is a scale effect in combination with limited entry into the final goods production sector. The relative increase in the capital income share associated with labour market reforms can only be substantially reduced if we allow for entry in the goods market. This suggests that labour market reforms combined with existing goods market rigidities can lead to suboptimal distributional effects.

Labour market 2.0 type of reforms, which raise human capital, reduce the wage gap between low and medium/high skilled workers. Increasing the share of medium skilled workers has a particularly strong positive effect on the wage of low skilled workers. However, here a distributional conflict arises between wage earners and transfer recipients. In the simulations presented here it is assumed that transfer income is indexed to inflation, therefore reforms which also increase productivity increase the gap between wage and transfer income earners. It needs to be checked to what extent an indexation of transfers to productivity changes this picture. The results on capital income are similar as in the case of 1.0 reforms, with a relative increase in the capital income share and thus a potentially suboptimal distributional outcome, if entry in the goods market remains restricted.

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Appendix - Calibration

We calibrate our model in a multicountry setting for the four Southern euro area member states, the rest of the euro area and the rest of the world. We select behavioural and technological parameters for the individual countries such that the model can replicate important empirical ratios such as labour productivity, investment, consumption to GDP ratios, the wage share, the employment rate and the R&D share, given a set of structural indicators describing market frictions in goods and labour markets, tax wedges and skill endowments. Most of the variables and parameters are taken from available statistical or empirical sources from the literature and the remaining parameters are tied down by the mathematical relationship of the model-equations. (For further details see Roeger et al (2008), Varga et al (2014)).

Goods Market:
We identify the intermediate sector as the manufacturing sector and the final goods sector as the aggregate of all remaining market sectors. The manufacturing sector resembles the intermediate sector along various dimensions. First, this sector is more R&D and patent intensive, second, a large fraction of manufacturing supplies innovative goods (in the form of investment goods but also innovative consumer goods). Final goods sectors, including services, on the other hand are typically not subject to large (patented) innovations but rely on organisational changes possibly in relation to new technologies supplied by the manufacturing sector. Also the two sectors differ in the degree of competition, with manufacturing showing smaller mark ups compared to final goods sectors. Our calibration of mark ups is based on Roeger (1995) and Canton and Thum-Thysen (2015). Using the most recent EU KLEMS databank the average mark-up for manufacturing is 10%, while for final goods/service sector it is around 17% in the Euro Area. Concerning entry barriers we rely on estimates provided by the *Doing Business Database*.

Knowledge production technology:
Empirical evidence on output elasticities has been provided by Bottazzi and Peri (2007) and Pessoa (2005). The growth rate of ideas was obtained from Pessoa (2005) with the assumption of a 5% obsolescence rate. In our model the R&D elasticity of research labour (λ) is determined by the wage cost share in the total R&D spending. We rely on Bottazzi and Peri (2007) to calibrate the knowledge elasticity parameters w. r. t. domestic and foreign knowledge capital. The authors do not estimate directly φ and ω, only the ratio between these coefficients and λ. These estimates together with the long-run growth rate of intangible capital (from equation A20) and λ pin down the corresponding elasticities.

Labour market and the skill composition of the labour force:
We rely on Ratto et al. (2009) to calibrate the adjustment parameters of the labour market. Labour force is disaggregated into three skill-groups: low-, medium- and high-skilled labour. We define high skilled workers as that segment of labour force that can potentially be employed in the R&D sector, i.e. engineers and natural scientists. Our definition of low-skilled corresponds to the standard classification of ISCED 0-2 education levels and the rest of the labour force is considered as medium-skilled. Data on skill-specific population shares, participation rates and wages are obtained from the Labour Force Survey, SES, and the Science and Technology databases of EUROSTAT. The elasticity of substitution between different labour types (μ) is one of the major parameters addressed in the labour-economics literature. We rely on Acemoglu and Autor (2011) which updated the seminal reference for this elasticity parameter by Katz and Murphy (1992, "KM" hereafter). While KM estimated that the elasticity of substitution between skilled and unskilled labour is about 1.4, Acemoglu and Autor (2011) argues for somewhat higher estimates in the range of 1.6-1.8 on the extended data sample of KM (from 1963 to 2008 as opposed to 1968-1987). We take 1.7 as our baseline value. The efficiency units are restricted by the labour demand equations which imply a relationship between wages, skill-specific population and employment ratios, and efficiency units. In our baseline calibration low-skilled wages are obtained from the annual earnings of employees with low educational attainment (ISCED 0-2) irrespective of their occupation. High-skilled wages are approximated by the annual earnings of scientists and engineers with tertiary educational attainment employed as professionals or associate professionals in physical, mathematical, engineering, life science or health occupations (ISCO-08 occupations 21, 22, 31, 32). Earnings data of employees with tertiary educational attainment not working as scientists and engineers and employees with medium educational attainment (ISCED 3-4) irrespective of their occupation are taken to calculate wages for our medium-skilled in the model.

Fiscal, monetary and trade variables:
We use EUROSTAT for the breakdown of government spending into consumption, investment and transfers and we use effective tax rates on labour, capital and consumption to determine government revenues. In addition we use estimates of R&D tax credits from OECD (2015c). Monetary policy parameters are adopted from Ratto et al. (2009) while the bilateral trade data is obtained from the EUROSTAT/COMEXT database.