Employment, wage setting, and the multiplier

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Abstract: The calculation of multipliers (output, employment, income) is the core of impact analysis with input-output (IO) models. This is done by applying the standard model (type I) that covers direct and indirect effects or the type II-model that additionally accounts for income/consumption feedbacks. Given this focus of IO modeling on the multiplier, it is remarkable that IO analysis has not contributed to the recent macroeconomic debate on fiscal multiplier heterogeneity. In the macroeconomic literature, this heterogeneity stems from (i) behavioral differences between different groups of consumers or from (ii) downward wage rigidity. The first feature is absent in most macroeconomic IO models, and wages are rigid independently of the state of the economy in type I and type II models. In this paper, a type II model with a wage function in line with Kehoe et al. (1995) is set up. Additional features of the model comprise mark-up pricing, factor substitution between labor and intermediate inputs as well as a simple household demand system. In the wage curve, real wages react to the unemployment rate in booms, but nominal wages are restricted to downward rigidity in recessions. At high unemployment rates, downward wage rigidity allows for large real income and multiplier effects (quantity adjustment). At full employment, demand shocks mainly induce price adjustments. An exemplary model version is applied to 2016 data of the EU 28. The impact of a 1% GDP shock in public consumption is simulated in the base case (2016 data), as well as in a severe recession and in a boom. The model reveals GDP multiplier heterogeneity in line with the recent macroeconomic literature, ranging from 0.3 (boom) to 1.4 (recession). The standard type I and type II model with the same data yield GDP multipliers between 0.95 and 1.6. The GDP multiplier result of the standard type II model even outperforms the multiplier in the recession case and therefore is most probably biased.

Keywords: Macroeconomic input-output modeling, fiscal multiplier, downward wage rigidity

JEL-codes: E62, E12, D58

1. Introduction

Multiplier analysis is the core area of input-output (IO) modeling (s.: chapter 6 in Miller and Blair, 2009). The simple IO model (type I) only includes inter-industry linkages into the multiplier, whereas type II models add an income - consumption loop that leads to large multiplier effects from positive final demand shocks. The IO literature has questioned this traditional concept of IO multipliers by introducing ‘net multiplier’ concepts (Oosterhaven et al., 2003; Miller and Blair, 2009) or by assuming simultaneous negative impulses (financing of public expenditure) of positive final demand shocks (Guerra and Sancho, 2011). Supply constraints from the labor market as defined in wage functions (Kehoe et al., 1995) have also been considered (Cardenete and Sancho, 2012).

Endogenous policy reactions, as in Guerra and Sancho (2011), have always been dealt with in macroeconomic modeling as factors that determine the outcome of demand shocks (monetary policy, public budget constraints). Since the Great Recession (2008/2009), the main issue in macroeconomic policy analysis was defining states of the economy, where monetary policy was ineffective and fiscal policy multipliers would be potentially large (Eggertson, et al., 2019). Heterogenous behavior of agents in reaction to positive demand shocks has been a key explanation for the potential differences in the magnitude of the multiplier. This discussion is based on theoretical concepts and stylized facts about state-dependent multipliers (Leeper et al., 2015; Owyang et al., 2013; Zuibary, 2014), i. e. multipliers that depend on the state of the economy in the boom-bust cycle. One main mechanism in explaining state dependent multipliers is the magnitude of the reaction of consumption to transitory income shocks (Gali et al., 2004). If all households have perfect foresight, ‘Ricardian equivalence’ holds and households do not increase consumption when current government spending increases their current income. Economic booms and busts are then characterized either by different shares of perfect foresight vs. ‘hand to mouth’ consumers (Auerbach and Gorodnichenko, 2012) or by different binding liquidity constraints for saver- and borrower-households (Eggertson and Krugman, 2012).

Another line of research on state dependent multipliers that is followed in this paper, emphasizes the mechanisms of the labor market. The main idea is to attribute the observed heterogeneity in the reaction of consumers to government spending between booms and recessions to downward wage rigidity (Shen and Yang, 2018). In recessions, positive demand shocks lead to less induced wage and price inflation, and therefore rather induce quantity adjustment in employment and real income, which is the mechanism behind the multiplier. Due to nominal downward wage rigidity, the (producer) real wage rate decreases with positive demand shocks in recessions, leading to a labor market equilibrium at higher employment and a lower (producer) real wage rate. This argument resembles the original concept of the ‘employment function’, laid down by Keynes (1936) in chapter 20 (Gali, 2013).

In this paper, the main features of the model of Shen and Yang (2018) are integrated into a macroeconomic IO-model (type II) in order to generate state-dependent multipliers. The extension of the standard type II model proposed here incorporates direct feedbacks from quantities (employment) on wages and output prices like the CGE (Computable General Equilibrium) approach. The main difference to the CGE approach is that no strict macro-closure like fixed savings is introduced, that effectively rules out positive multipliers. Equilibrium in the model set up here is not defined by the base year data, but can imply idle capacities (unemployment), in which case positive demand shocks can lead to multiplier effects. If an economy works at full employment, positive demand shocks mainly lead to positive price adjustments, as in the CGE model. The model presented in this study therefore extends the standard macroeconomic IO model like INFORUM (Almon, 1991; Meade, 2013) or GINFORS (Meyer and Lutz, 2007; Meyer and Ahlert, 2017), where feedbacks from prices on quantities (demand) are a crucial feature, but strong feedbacks from quantities to prices are usually not modeled.

In general, the different models used in the literature (type I, type II, macroeconomic IO, CGE) yield different multiplier values for the same demand shock, according to the model specification, but not according to the state of the economy. Heterogeneity of multipliers therefore is not something that is usually derived as a result from *one* model. The main objective of this paper is to fill this research gap and to contribute to the recent fiscal multiplier debate with an IO modeling approach. A tentative conclusion is that especially the results of the two extremes of the modeling spectrum, i. e. the type II (no price feedbacks) and the CGE model (savings driven investment plus full price feedback), might be biased.

The channel of influence from quantities on prices in the type II model presented here stems from the labor market and works via wage functions as in Kehoe et al. (1995) and Cardenete and Sancho (2012). These two studies integrated the wage function into a CGE model which - in general - does not yield multipliers of demand shocks. Cardenete and Sancho (2012) then show the difference of CGE modeling results between a fully competitive labor market and a labor market with wage rigidity, comprised in the wage function. This is a completely different setting from what is done in this study. The most important extension presented here and the main contribution of this study with respect to the integration of a wage function is the introduction of downward wage rigidity as proposed by Shen and Yang (2018) into a type II model that allows for multipliers of demand shocks. In booms or situations close to full employment, the ‘unemployment parameter’ of the wage function induces wage inflation when employment rises. In large recessions, the same parameter value would *ceteris paribus* lead to falling wage rates but is restricted according to downward wage rigidity. Introducing demand shocks in the model, when this restriction to wages is active leads to an employment increase and an income plus consumption effect. The multiplier effect in recessions with wage rigidity is driven by the mechanism explored in Shen and Yang (2018), i. e. employment and income effects accompanied only by minimal price adjustments. As in Shen and Yang (2018), the fiscal multiplier is always positive, but in situations close to full employment it is dampened by two different impacts on demand and output: (i) real income and consumption are depressed by an increase in the consumer price, and (ii) wage increases lead to substitution of labor by intermediate inputs thereby increasing import demand. The latter effect is absent in Shen and Yang (2018) and most other macroeconomic studies, as they deal with closed economies.

A numerical example version of the model with ten industries and goods is applied to the EU 28 (base year 2016). The demand shock (1% of GDP increase in public consumption) is simulated for the base case of 2016, comparing the traditional type I and type II model with the model developed in this study. Further, starting from the base case, a boom (full employment) and a recession have been simulated via changes in export demand and the same demand shock has been introduced on top of this. The model simulations for different states and model specifications of the European economy reveal a significant variance of GDP multipliers, ranging from 0.27 (boom) to 1.63 (traditional type II model). The range of GDP multipliers between booms and recessions in this study (0.27 to 1.43) is in line with the existing literature (Shen and Yang, 2018; Auerbach and Gorodnichenko, 2012). The GDP multiplier of the standard IO model is always smaller than unity (0.95), but significantly larger than the multiplier in the base case of 2016 (0.71). The highest multiplier is obtained in the type II model, where induced effects are considered and at the same time wage and price adjustments are completely absent.

The paper is organized as follows. In section 2 the quantity and price model of the macroeconomic IO model as well as the labor market specification are laid down. Additionally, the calibration of an exemplary numerical model, based on the EU 28 Supply and Use tables for 2016 is described. In section 3, the simulation results and multipliers for the standard type I and type II version of the model are presented. In section 4, the results and multipliers of the macroeconomic IO model version for the base case (2016), a boom and a recession are shown and discussed, comparing them with the macroeconomic literature. Finally, section 5 draws some conclusions.

2. The macroeconomic IO model

The core of the model applied in this study is a type II model extended with features of a CGE model, as factor substitution, household demand allocation and a labor market (wage setting). The most important characteristic common to a CGE model is the twofold links between the quantity and the price model. One link from prices to quantities works out in the price model, where the price of intermediates is determined by output prices (the IO loop) and in turn determines labor and intermediate input demand. The other link from prices to wages is implemented in private consumption, where total consumption is defined as a function of real disposable income, i. e. nominal disposable income deflated by the consumer price. The allocation of total consumption to the different goods is guided by a demand system with Cobb-Douglas preferences. The main link back from quantities to prices stems from the labor market. The nominal price of labor is determined via a wage schedule, depending on the actual to the equilibrium rate of unemployment (Kehoe et al., 1995) with a full pass through of the consumer prices into wages.

The model is comparative static and describes an open economy. Gross fixed capital formation and exports are not explicitly modelled but held exogenously fixed. Import prices are also fixed and in a CGE context could be regarded as the numeraire. Public consumption is the policy variable for the simulations. Imports are endogenous via import shares of users (intermediate and final). These import shares are fixed by good for final users and are defined as the technical coefficients of imported use for industries. These latter are endogenous, depending on the substitution between labor and intermediates.

The matrices and vectors that constitute the IO model are:

(i) the supply table (industries * goods) $\mathbf{V}$ with column sum equal to the vector of output by goods, $\mathbf{q}(\mathbf{g})$. The row sum of this matrix is defined as the vector of output by industries, $\mathbf{q}$,

(ii) the domestic use table for intermediates (goods * industries) $\mathbf{U}^{d}$ with row sum equal to the vector of output by goods, $\mathbf{q}(\mathbf{g})$, and

(iii) the imports use table for intermediates (goods * industries) $\mathbf{U}^{im}$ with row sum equal to the vector of intermediate imports by goods.

(iv) the matrices of final demand $\mathbf{F}^{d}$ and $\mathbf{F}^{im}$ (goods * final demand components), comprising domestic (d) and imported (im) goods.

Total imports **im** are the sum of intermediate and final imports. The supply and use tables are converted into coefficients matrices for setting up the IO model. The 'market shares matrix' **D** is derived by dividing the matrix elements of **V** through the column sum, **q**(**g**). An element $q_{ji}/q(g)_i$ of this matrix **D** defines the participation of industry *j* in the production of good *i*. This matrix links the output by industries **q** to the output by goods **q**(**g**): **q** = **D q**(**g**). Note that applying the 'market shares matrix' **D** implies the assumption of 'industry technology', i. e. each good of an industry is produced with the same unique technology of this industry. The domestic 'technical coefficients matrix' $\mathbf{B}^d$ is derived by dividing the domestic use table $\mathbf{U}^d$ through the vector of total output by industries, **q**. The elements x^d_{ij}/q_j of $\mathbf{B}^d$ define the domestic input *i* in the production of one unit of industry *j*, therefore they determine domestic intermediate demand $\mathbf{x}^d$ as a function of output by industries **q**: $\mathbf{x}^d = \mathbf{B}^d\ \mathbf{q}$. Additionally, an imported 'technical coefficients matrix' $\mathbf{B}^{im}$ exists, that is derived from the import use matrix, $\mathbf{U}^{im}$. The vector of final demand **f** is the sum of the following components: private consumption (**cp**), capital formation (**cf**), stock changes (**st**), exports (**ex**) and government consumption (**cg**): **f** = **cp** + **cf** + **st** + **ex** + **cg**. Total imports **im** are given by: $\mathbf{cp}^{im} + \mathbf{cf}^{im} + \mathbf{st}^{im} + \mathbf{ex}^{im} + \mathbf{cg}^{im} + \mathbf{x}^{im}$, where $\mathbf{x}^{im}$ is the imported intermediate demand ($\mathbf{x}^{im} = \mathbf{B}^{im}\ \mathbf{q}$). Total intermediate demand **x** is the sum of $\mathbf{x}^d + \mathbf{x}^{im}$. Value added is defined as the sum of the following row vectors (industry dimension): (i) wages **W**, (ii) profit (gross operating surplus) **Π**, and (iii) net taxes in production, $\mathbf{T_q}$.

In the standard type I model, final demand and value added are the exogenous variables. In the model applied in this study, the final demand components are aggregated into two vectors: private consumption (**cp**) and other final demand (**f* = cf** + **st** + **ex** + **cg**). The latter is treated as exogenous, while the former is endogenous in terms of total consumption, *CP*. It is a function of real disposable household income *YD*/*PC*, which is directly linked to **W** and a share of **Π** (distributed profits) as in a traditional SAM. The consumer price *PC* is determined in the price model-part.

In the price model, nominal coefficients per unit of real output (**w**, **p** and $\mathbf{t_q}$) are defined, which determine wages (**W**), profits (**Π**) and net taxes ($\mathbf{T}_q$). The identity for nominal GDP holds from the demand ($GDP = \mathbf{i'q} - \mathbf{i'x} = \mathbf{i'f} - \mathbf{i'im}$) as well as from the income ($GDP = \mathbf{Wi} + \mathbf{\Pi i} + \mathbf{T_q i}$) side with **i** as the (column) summation vector. Real GDP in simulations is calculated from the demand side by (**i'f** – **i'im**), but could be alternatively derived as real value added, which is not explicitly calculated in the model.

2.1. The quantity model

Given the definitions in the last section, the quantity model can be solved for output by industries and by goods. The final demand vector without private consumption (**f***) is exogenous and can be shocked in order to analyze multiplier effects.

The two main equations of the quantity model are:

$$\mathbf{q} = \mathbf{D}\,\mathbf{q}(\mathbf{g}) \tag{1}$$

$$\mathbf{q}(\mathbf{g}) = \mathbf{B}^{\mathrm{d}}\mathbf{q} + \mathbf{cp}^{\mathrm{d}} + \mathbf{f}^{*\mathrm{d}} \tag{2}$$

In (2) the domestic part of the final demand categories has been directly plugged in. That has been derived by subtracting the import components from **cp** and **f***. Substituting (1) into (2) gives the solution of the model that can be used to calculate multiplier effects of shocks in (real) domestic final demand:

$$\mathbf{q}(\mathbf{g}) = \left[\mathbf{I} - \mathbf{B}^{\mathrm{d}}\mathbf{D}\right]^{-1}\left(\mathbf{cp}^{\mathrm{d}} + \mathbf{f}^{*\mathrm{d}}\right) \tag{3}$$

The vector of private consumption of domestic goods is the matrix product of the vector of quantity shares $\mathbf{s}_{\mathrm{cp}}^{\mathrm{d}}$ of domestic goods and total private consumption, *CP*:

$$\mathbf{cp}^{\mathrm{d}} = \mathbf{s}_{\mathrm{cp}}^{\mathrm{d}}CP \tag{4}$$

The quantity shares comprise domestic and imported products, $\mathbf{s}_{\mathrm{cp}}^{\mathrm{d}}$ and $\mathbf{s}_{\mathrm{cp}}^{\mathrm{im}}$. Given these quantity shares, the consumer price can be written as a function of the (row) vectors of domestic and import prices ($\mathbf{p}^{\mathrm{d}}$ and $\mathbf{p}^{\mathrm{im}}$):

$$PC = \mathbf{p}^{\mathrm{d}}\mathbf{s}_{\mathrm{cp}}^{\mathrm{d}} + \mathbf{p}^{\mathrm{im}}\mathbf{s}_{\mathrm{cp}}^{\mathrm{im}} \tag{5}$$

The preferences of households are Cobb-Douglas and consumers maximize their utility according to the utility function:

$$u(CP) = \prod_{i=1}^{d+m} CP^{i^{\gamma^i}} \tag{6}$$

where CP^i is a domestic or imported consumption good *i* ($CP^{d,i}$ or $CP^{im,i}$) and the restriction of the Cobb-Douglas specification: $\Sigma\gamma^j = 1$. An element of the vectors $\mathbf{s}_{\mathrm{cp}}^{\mathrm{d}}$ and $\mathbf{s}_{\mathrm{cp}}^{\mathrm{im}}$ is therefore either given as $s_{cp}^{d,i} = \frac{\gamma^i}{p^{d,i}}$ or $s_{cp}^{im,i} = \frac{\gamma^i}{p^{im,i}}$. As import prices only change exogenously, this is equivalent to define the quantity shares for imported consumption goods as equal to γ^j.

Total private consumption is endogenized in a Social Accounting Matrix (SAM)-model. The difference is that the link between income generated in value added and the flows between the household sector and the other institutional sectors are not integrated into an extended matrix system, but are added to the equation system that is solved in loops (see: Kratena, 2017). Private consumption depends on real disposable income *YD*/*PC*, where *YD* is the sum of wages, **i**'**W**, the share (s_Y) of distributed profit **i**'**Π** (with **i**' as the transposed unity vector), government transfers Tr_g minus taxes, T_Y, and net foreign transfers, Tr_f. Defining the row vectors of value added-coefficients for wages as **w** and for profit with **π**, and relating $(Tr_g - T_Y)$ to $(\mathbf{i'W} + s_Y\,\mathbf{i'\Pi})$ via a net income tax rate t_Y, nominal disposable income can be expressed in terms of the output vector:

$$YD = (\mathbf{p}_\mathrm{L}\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 - t_Y) + Tr_f \tag{7}$$

In (7) the row vector **w** has been decomposed into the product of the two elements p_L (price of labor) and λ (labor coefficient), and these products constitute the new row vector $\mathbf{p}_\mathbf{L}\boldsymbol{\lambda}$. Employment L can then be expressed as $L = \boldsymbol{\lambda}\mathbf{q}$. Real private consumption becomes a function of output and prices:

$$CP = c_Y\left[(\mathbf{p}_\mathrm{L}\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 + t_Y) + Tr_f\right]/PC \tag{8}$$

The vector of private consumption of domestic goods can be directly written as in a SAM multiplier model:

$$\mathbf{cp}^\mathrm{d} = \mathbf{s}_\mathrm{cp}^\mathrm{d}\left\{c_Y\left[(\mathbf{p}_\mathrm{L}\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 + t_Y) + Tr_f\right]/PC\right\} \tag{9}$$

The equations (7), (8) and (9) comprise the specification of the SAM (type II model) as described in the model used in this study, where the loops are solved via the solution of the linear equation system comprising all equations. Alternatively, the type II model (without wage and price interactions) could also be written in an extended matrix system (s.: Miller and Blair, 2009, chapter 6), defining the household row vector **y** as $\mathbf{y} = (\mathbf{p}_\mathrm{L}\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 + t_Y)$ and the household column vector as in equation (4):

$$\begin{matrix}\mathbf{q}(\mathrm{g}) \\ \mathbf{yd}\end{matrix} = \begin{bmatrix}\mathbf{B}^\mathrm{d}\mathbf{D} & \mathbf{c} \\ \mathbf{y} & \mathbf{0}\end{bmatrix}\begin{pmatrix}\mathbf{q}(\mathrm{g}) \\ \mathbf{yd}\end{pmatrix} + \begin{pmatrix}\mathbf{f}^{*\mathrm{d}} \\ \mathbf{0}\end{pmatrix} \tag{10}$$

The sum of the household account is **yd**, which besides the income generated in production (**y**) also contains the other income sources and deductions (transfers and taxes). In analogy, the vector of exogenous final demand $\mathbf{f}^{*\mathrm{d}}$ also contains consumption out of these income sources, i. e. $\mathbf{s}_\mathrm{cp}^\mathrm{d} c_Y Tr_f$.

The standard Leontief model, where all final demand **f** is exogenous, is simply given by:

$$\mathbf{q}(\mathbf{g}) = \left[\mathbf{I} - \mathbf{B}^\mathrm{d}\mathbf{D}\right]^{-1}\mathbf{f} \tag{11}$$

The total quantity model part of the macroeconomic IO model is made up of the following equations that are solved as a recursive system:

$$\mathbf{q}(\mathbf{g}) = \left[\mathbf{I} - \mathbf{B}^\mathrm{d}\mathbf{D}\right]^{-1}\left(\mathbf{cp}^\mathrm{d} + \mathbf{f}^{*\mathrm{d}}\right) \tag{3}$$

$$\mathbf{q} = \mathbf{D}\,\mathbf{q}(\mathbf{g}) \tag{1}$$

$$\mathbf{cp}^\mathrm{d} = \mathbf{s}_\mathrm{cp}^\mathrm{d}\left\{c_Y\left[(\mathbf{p}_\mathrm{L}\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 + t_Y) + Tr_f\right]/PC\right\} \tag{9}$$

$$s_{cp}^{d,i} = \frac{\gamma^i}{p^{d,i}} \quad ; \quad s_{cp}^{im,i} = \frac{\gamma^i}{p^{im,i}} \tag{12}$$

Final demand $\mathbf{f}^{*d}$ and foreign transfers Tr_f are exogenous and consumption demand not only depends on the income generated in production $(\mathbf{p}_L\boldsymbol{\lambda}\mathbf{q} + s_Y\boldsymbol{\pi}\mathbf{q})(1 + t_Y)$ as in the traditional type II model, but also on the feedback from the price side via $PC = \mathbf{p}^d\mathbf{s}_{cp}^d + \mathbf{p}^{im}\mathbf{s}_{cp}^{im}$. The allocation of total consumption across goods ($\mathbf{s}_{cp}^d$ and $\mathbf{s}_{cp}^{im}$) in turn depends on relative prices, $p^{d,i}$.

2.2. The price model

The price model is solved for domestic goods prices ($\mathbf{p}^d$) and output prices ($\mathbf{p}$), for exogenously given import prices ($\mathbf{p}^{im}$). All vectors in the price model are row vectors. The 'market shares matrix' is used to transform output prices by industry into goods prices:

$$\mathbf{p}^d = \mathbf{p}\,\mathbf{D} \tag{13}$$

The output prices by industry are determined by mark-up pricing, combined with a unit cost function of labor and intermediate inputs. The mark up μ is levied upon marginal cost, i. e. the cost of labor and intermediates combined in the fixed aggregate input coefficient $\mathbf{b}_{LM}$ with the corresponding composite price $\mathbf{p}_{LM}$:

$$\mathbf{p} = \boldsymbol{\mu}\mathbf{p}_{LM}\mathbf{b}_{LM} + \mathbf{t}_q \tag{14}$$

The cost of the input bundle of intermediate inputs and labor input per unit of output is equal to $\mathbf{b}_{LM} = \boldsymbol{\lambda} + \boldsymbol{i}'\mathbf{B}^d + \boldsymbol{i}'\mathbf{B}^{im}$. The sum of the second and the third term is the total intermediate input vector per unit output, $\mathbf{m} = \boldsymbol{i}'\mathbf{B}^d + \boldsymbol{i}'\mathbf{B}^{im}$. The (row) vector $\mathbf{b}_{LM}$ is assumed to be constant. Applying a CES cost function with constant returns to scale, the composite price, p_{LM} for industry j is:

$$p_{LM,j} = \left(d_{L,j}p_{L,j}^{1-\sigma_j} + (1 - d_{L,j})p_{M,j}^{1-\sigma_j}\right)^{1/(1-\sigma_j)} \tag{15}$$

The CES function has become the main workhorse in CGE modeling (Burfisher, 2017), as it is more flexible than Cobb-Douglas in the sense that it allows different own price elasticity values than – 1. The factor demand equations in industry j with substitution elasticity σ_j are:

$$s_{L,LM,j} = d_{L,j}\left(\frac{p_{LM,j}}{p_{L,j}}\right)^{\sigma_j} \quad ; \quad s_{M,LM,j} = (1 - d_{L,j})\left(\frac{p_{LM,j}}{p_{M,j}}\right)^{\sigma_j} \tag{16}$$

The nominal factor shares ($d_{L,j}$) are kept constant in the comparative setting of this model. The $s_{L,LM}$ and $s_{M,LM}$ are the real shares within the L,M – bundle, so that the aggregate IO coefficients are defined as:

$$\boldsymbol{\lambda} = \mathbf{s}_{L,LM}\,\mathbf{b}_{LM} \quad ; \quad \boldsymbol{i}'\mathbf{B}^d + \boldsymbol{i}'\mathbf{B}^{im} = \mathbf{m} = \mathbf{s}_{M,LM}\,\mathbf{b}_{LM} \tag{17}$$

The total input coefficient (per output) $\mathbf{b}_{LM}$ is constant, whereas the factor input shares within this total input (equation (16)) are flexible and change according to changes in the factor prices (vectors $\mathbf{p}_L$ and $\mathbf{p}_M$). That, in turn, changes the input coefficients $\boldsymbol{\lambda}$ and $\mathbf{m}$. The latter is the row vector of the column sums of the domestic and the import technical coefficients matrix, as defined in (17). The structure within these matrices is constant and defined by 'use structure' matrices $\mathbf{S}_{\mathrm{M}}^{\mathrm{d}}$ and $\mathbf{S}_{\mathrm{M}}^{\mathrm{im}}$. Each element of these matrices is defined as the share of intermediate input of good i in industry j (x_{ij}) in total intermediate inputs of industry j (x_j). The use structure matrices are applied for integrating the IO loop in the price model:

$$\mathbf{p}_{\mathrm{M}} = \mathbf{p}^{\mathrm{d}}\mathbf{S}_{\mathrm{M}}^{\mathrm{d}} + \mathbf{p}^{\mathrm{im}}\mathbf{S}_{\mathrm{M}}^{\mathrm{im}} \tag{18}$$

The price of labor $\mathbf{p}_L$ is determined in the labor market model (see section 2.3) and the price of intermediate inputs $\mathbf{p}_M$ via equation (18).

The domestic use structure matrix $\mathbf{S}_{\mathrm{M}}^{\mathrm{d}}$ is further applied for the feedback of the change in the total intermediate input coefficient $\mathbf{m}$ on the technical coefficients-matrix $\mathbf{B}^d$. Note that each technical coefficient b_{ij}^d can be defined as the product of an element of matrix $\mathbf{S}_{\mathrm{M}}^{\mathrm{d}}$ with the total input coefficient $\mathbf{m}$: $b_{ij}^d = s_{ij}^d m_j$.

The total price model is then made up of the following equations that are solved as a recursive system:

$$p_{LM,j} = \left(d_{L,j}p_{L,j}^{1-\sigma_j} + (1-d_{L,j})p_{M,j}^{1-\sigma_j}\right)^{1/(1-\sigma_j)} \tag{15}$$

$$\mathbf{p} = \boldsymbol{\mu}\mathbf{p}_{\mathrm{LM}}\mathbf{b}_{\mathrm{LM}} + \mathbf{t}_{\mathrm{q}} \tag{14}$$

$$\mathbf{p}^{\mathrm{d}} = \mathbf{p}\,\mathbf{D} \tag{13}$$

$$\mathbf{p}_{\mathrm{M}} = \mathbf{p}^{\mathrm{d}}\mathbf{S}_{\mathrm{M}}^{\mathrm{d}} + \mathbf{p}^{\mathrm{im}}\mathbf{S}_{\mathrm{M}}^{\mathrm{im}} \tag{19}$$

$$\boldsymbol{\pi} = \mathbf{p} - \mathbf{p}_{\mathrm{LM}}\mathbf{b}_{\mathrm{LM}} - \mathbf{t}_{\mathrm{q}} \tag{20}$$

$$PC = \mathbf{p}^{\mathrm{d}}\mathbf{s}_{\mathrm{cp}}^{\mathrm{d}} + \mathbf{p}^{\mathrm{im}}\mathbf{s}_{\mathrm{cp}}^{\mathrm{im}} \tag{5}$$

In (20), the profit coefficient per unit of output is derived as the difference between the output price and the unit cost for labor and intermediates. The aggregate price of private consumption (equation (5)) feeds back to the quantity model, into equation (9). The output prices p^d determine the allocation of total consumption across goods, according to equation (12).

The technical coefficients in matrix $\mathbf{B}^d$ and $\mathbf{B}^{im}$ are endogenous, according to equation (17) and this represents another feedback from the price model to the quantity model (equation (3)).

2.3. The labor market

In chapter 20, Keynes (1936) sets up the concept of an 'employment function' as an alternative to the neoclassical model of the labor market (see also: Gali, 2013). This alternative framework starts with the observation that union wage bargaining leading to nominal downward wage rigidity prevails in economic reality and therefore supply and demand of labor are not balanced by direct changes in the real wage rate, as the neoclassical theory suggests. With fixed nominal wage rates, the relationship between the employment level and the real wage rate is indirectly determined by prices and not directly in the labor market. The modeling of the labor market in this study closely follows the interpretation of Keynes' employment function by Gali (2013) and the specification of downward nominal wage rigidity (DNWR) laid down by Schmitt-Grohé and Uribe (2016). The basic idea is combining two regimes, one being a wage curve as in Kehoe et al. (1995) or Cardenete and Sancho (2012) and the other one a nominal downward rigid wage schedule. The economy is either at full employment or in a recession and wages are either flexible, reacting to the utilization of labor supply or downward rigid, depending on the lagged wage rate. The wage mechanism can be expressed via the slackness condition (Shen and Yang, 2018):

$$(w - \gamma w_0)\left(\overline{L^S} - L\right) = 0 \qquad (21)$$

In the comparative static framework of this study, instead of using the lagged wage rate, the wage rate of the base case, w_0, is applied. In the case of full employment, the second term is zero, as labor supply L^S exactly matches labor demand L via the flexible wage mechanism. In the case of DNWR with $\gamma \geq 1$, the wage rate cannot fall below the level of the base case and the first term is zero. Labor supply is endogenous in other studies (Gali, 2013 and Shen and Yang, 2018), whereas it is fixed in this study and in (21) has been adjusted for the fact that full employment, defined as $\left(\overline{L^S} - L\right) = 0$ still implies a small positive rate of unemployment. Actual labor supply is L^S and the actual unemployment rate is defined as $\frac{L^S - L}{L^S}$. The labor input *per unit of output* in this study depends on the wage rate, but aggregate labor demand also depends on the level of output and therefore aggregate effective demand.

The dis-continuous wage function is defined as:

$$log(w_j) = \begin{cases} \alpha_{w,1} + \alpha_{w,2} log(PC) + \alpha_{w,3}\left(\frac{ur}{ur^*}\right) & ; \text{when } w_j > w_{j,0} \\ \gamma \log(w_{j,0}) & ; \text{when } w_j < w_{j,0} \end{cases} \qquad (22)$$

with $\alpha_{w,2} = 1$ and $\gamma = 1$. Equation (22) therefore can be seen as defining the consumer real wage rate as a function of the utilization of labor supply with fully downward rigid wages. In the case of a recession, equation (22) can be recalibrated for $\alpha_{w,3}$ by inverting the equation and using the DNWR restriction:

$$\alpha_{w,3} = \frac{[\gamma \log(w_{j,0}) - \alpha_{w,1} - \alpha_{w,2} log(PC)]}{\left(\frac{ur}{ur^*}\right)} \quad (23)$$

Plugging this new parameter value into the wage equation then leads to a new wage setting schedule that can be used in the model for simulations of demand shocks.

2.4. Empirical application of the model

The comparative-static macroeconomic IO model used in this study as a numerical example is based on the 2016 Supply/Use tables (source: EUROSTAT) for the EU28 countries and deals with the EU 28 as one single economy. The data for the components of nominal disposable household income (taxes, social contributions and transfers) have been taken from Sectoral Accounts within National Accounts of EUROSTAT. The share of profits, that accrues to households (s_Y), the average propensity of consumption (c_Y) and the *net* income tax rate (net of public transfers to households, c_Y) are directly derived from these data. The substitution elasticity between labor and intermediates (σ^j) is based on estimation results for a large scale European macroeconomic IO model (Kratena et al., 2017). It is below unity (0.75) for all industries, except for the public sector, where the potential for outsourcing is higher. The equilibrium unemployment rate is the NAWRU from the AMECO database and the parameter $\alpha_{w,3}$ is set equal to - 0.20.

>>>> *Table 1: Model parameters (EU 28)*

Kehoe et al. (1995) use a logarithmic specification of the wage function with $\left(\frac{1-ur}{1-ur^*}\right)^{\frac{1}{\beta}}$ as the unemployment term and set β equal to 1.5, when calibrating the model to data for Spain in that period. Their specification is also not directly comparable to this study, as it works on the level of wages and unemployment by skill level. If, nevertheless, their parameter value is applied to the semi-logarithmic specification used here, it would give a value of -0.1, which is below the average parameter of -0.15 that has been found as a robust result in empirical applications of the Blanchflower and Oswald (1994) wage function. The parameter in Kehoe et al. (1995) gives a 0.75% increase in the wage rate by skill level for a 1% decrease in the unemployment rate by the same skill level. This wage reaction is uniform across the range of unemployment rates. In this study, the wage reaction is dis-continuous, as for high rates of unemployment, DNWR is binding. Therefore, the parameter value of $\alpha_{w,2}$ is set equal to -0.2, which is the upper range of estimation results with the wage curve. That, in turn, yields a range of 1.9% to 2.1% wage increase for a 1% decrease in the unemployment rate at low levels of unemployment. For high unemployment levels, DNWR is binding, according to equation (22) and (23). Over the whole range of unemployment rates considered (6% to 15%), the average wage increase for a 1% decrease in the unemployment rate is 1% and therefore slightly higher than in Kehoe et al. (1995).

3. Multipliers in type I and type II models

The model has been used for simulations of a 1% of GDP shock in public consumption. In a first step, this demand shock has been simulated, applying the standard type I and type II model from the literature, as defined in equation (11) and (10), respectively. The calculation of GDP at constant prices is in all simulation exercises derived from the demand side:

$$GDP = \mathbf{i}'(\mathbf{cp} + \mathbf{f}^{*}) - \mathbf{i}'\left(\mathbf{B}^{\mathrm{im}}\mathbf{q}\right) - \mathbf{i}'\left(\mathbf{cp}^{\mathrm{im}} + \mathbf{f}^{*\mathrm{im}}\right) \tag{24}$$

The standard type I model (Leontief model) of an open economy necessarily yields a GDP multiplier smaller than unity. The specification of the type II model could be thought of as a ‘Keynesian equilibrium’ as defined in Carlin and Soskice (2018), where the zero lower bound of the interest rate is binding and inflation is stable at zero as well. Wage and price feedbacks from demand shocks are therefore ruled out in both model specifications.

Figure 1, 2 and 3 show the GDP, output and employment multiplier of the demand shock. The GDP multiplier of the Leontief model is close to unity, as the EU 28 are a large and relatively closed economy. Integrating the income/consumption feedbacks magnifies the GDP multiplier to a value of 1.63. The gross output multiplier is even magnified more than the GDP multiplier, the employment multiplier slightly less (Figure 2 and 3). The gross multiplier effect rises from 1.5 (type I model) to 2.9 in the type II model. The employment effect in the Leontief model for the EU 28 amounts to 2.6 mill. of jobs, which *ceteris paribus* would have decreased the unemployment rate by 1.1 percentage points. For the employment effect of the type II model (almost 4 mill. of jobs) the corresponding decrease in the unemployment rate would have been 1.7 percentage points. From the parameterization of the wage curve in section 2.4 one could conclude that - in a situation close to full employment - the partial wage inflation effect of these reductions in the unemployment rate would be 2% to 3.5%. These expected partial effects on wages are magnified by price-wage feedbacks in a full model, as will be shown in the next section.

>>>>> *Figure 1: GDP multipliers of a 1% GDP shock in public consumption (EU 28)*

>>>>> *Figure 2: Gross output multipliers of a 1% GDP shock in public consumption (EU 28)*

>>>>>> *Figure 3: Employment multipliers (1.000 jobs) of a 1% GDP shock in public consumption (EU 28)*

The important difference between type I and type ÍI model results in an IO context does not only concern the aggregate results, but in particular the industry results. The feedback from income generated in production expansion towards private consumption induces output in other industries than those directly affected by the demand shock. Figure 4 reveals that by showing the difference in industry results for gross output. Those industries that are directly affected by the demand shock (Public Administration, Education and Health), do not expand their production much more in the type II model result than in the Leontief model result. The opposite holds for the other industries, especially energy and services.

>>>>> *Figure 4: Output effects (in %) of a 1% GDP shock in public consumption, Type I and type II model, (EU 28)*

These induced output effects mainly benefit industries with higher labor productivity and lower vale added-intensity than the directly affected public industries. That explains why the magnification effect of the multiplier in the type II model is larger for gross output than for GDP and employment.

4. Multipliers in booms and recessions

The same 1% of GDP shock in public consumption has been simulated with the macroeconomic IO model laid down above. The model is composed of the equations (1), (3), (9) and (12) of the quantity model, the equations (5), (13), (14), (15), (17), (19) and (20) of the price model, and of the wage setting schedule (equation (22)). These equations are complemented by the definitions of employment with $L = \boldsymbol{\lambda}\mathbf{q}$ and of the unemployment rate with $ur = \frac{L^S - L}{L^S}$. The feedbacks and links between the model parts include: (i) employment and therefore the unemployment rate are determined in the quantity model (for given $\boldsymbol{\lambda}$) and the unemployment rate feeds back into wage setting, (ii) factor intensities, goods prices and the aggregate consumer price are determined in the price model and feed back to wage setting and to different variables in the quantity model (technical coefficients, value added coefficients, real disposable income, private consumption by good), and (iii) the price of labor is determined by wage setting and fits back to the price model (factor substitution) and to the quantity model (value added coefficients).

In a first simulation, the demand shock is introduced in the model calibrated with the base year data (2016). The simulations for a recession and a boom start from the base year situation and introduce an exogenous shock to export demand that results in full employment for the boom-case and in about 14% (historical maximum) for the recession case. Full employment is defined by the NAWRU for 2016 from the AMECO database and equals 8.0%. In the base year, the actual rate of unemployment is 8.8% and therefore relatively close to full employment. Figure 1 shows the heterogeneity of GDP multipliers for these three different states of the economy: 0.71 for the base case, 1.43 for a recession and 0.27 for a boom. That corroborates the recent macroeconomic literature on fiscal multiplier heterogeneity. The GDP multiplier in a recession is five times larger than in a boom and double the multiplier in the base year 2016. As the unemployment rate in 2016 is close to full employment, these results clearly reveal the non-linearity of the full model feedbacks. The gross output multiplier with a value of 2.6 is also largest in a recession (Figure 2), but the differences are less pronounced than for the GDP multiplier. That is due to the differences in the value added-intensity of those industries that are affected by indirect and induced effects. These differences also are the cause for the gross output multiplier being higher (1.76) in the base case 2016 than in the type I model (1.5), which does not hold for the GDP multipliers (0.71 vs. 0.95). The employment multiplier in the recession (3.3 mill. of jobs) is close to the employment multiplier in the type II model and is negligible in the boom-case. For the base-case the employment multiplier is still 1.3 mill. of jobs and half of the employment multiplier of the type I model. These differences in the employment impact resemble the potential of forcing the unemployment rate down (Figure 5). In the recession-case, the unemployment rate is depressed by 1.4 percentage points, whereas in both other cases, only small (0.6 percentage points in the base case) or zero (boom-case) reductions in the unemployment rate can be achieved. This is because the starting point, when the demand shock is introduced, is already close to the NAWRU in both other cases.

>>>>Figure 5: Unemployment rates and NAWRU of a 1% GDP shock in public consumption, EU 28

That is a first indication for the mechanisms postulated in Shen and Yang (2018), namely that the differences in the potential of job creation without feedbacks from the price side determine the heterogeneity in income and consumption effects. The alternative view to multiplier heterogeneity motivates the differences in consumption reaction with differences in household behavior (expectations) and in the financial environment between booms and busts (Auerbach and Gorodnichenko, 2012; Eggertson and Krugman, 2012). The results presented here clearly show that differences in consumption reaction can be motivated along the line of arguments of Shen and Yang (2018). This can be seen from the macroeconomic results, shown in Table 2 and in Figures 6 to 8. The heterogeneity in the impact on real disposable income and consumption between the three cases is considerable, being the impact in the boom (0.6%) less than half of the impact in the recession (1.4%). This, in turn, is fully triggered by the consumer price effects, which are much larger in the base case and in the boom (5.6% and 8.3%, respectively) than in the recession (1.4%). The rise in nominal disposable income is driven by the higher wage rate and by higher profits due to mark-up pricing, of which 35% accrues to disposable income. This aspect is overseen in some Keynesian models (e.g. Carlin and Soskice, 2018 and Ravn and Sterk, 2016), that work with the Kaleckian feature that all profits are saved and consumption only stems from wages.

Another result of Shen and Yang (2018) is also confirmed by the results in Table 2, namely the difference in the impact on the (producer) real wage rate. The increase in the real wage rate induced by the demand shock is largest in the boom (1.6%) and only 0.3% in the recession. The model simulations do not yield a decrease of the real wage rate with employment creation in a recession, as theoretical New Keynesian models like Gali (2013) suggest. This could only be achieved with a cyclical component in the mark-up. The main result of the model is that as in Shen and Yang (2018), the multiplier of public expenditure is always positive and always has a positive real wage effect, though both the multiplier and the real wage effect are close to zero in a boom. Positive multiplier effects are also a main difference to CGE modeling results. Cardenete and Sancho (2012) present gross output multipliers by industry from their simulations with the CGE model with the integrated wage function and compare it to the multipliers by industry from the type I (Leontief) model for the Andalusian economy. A comparison of their results with the results presented here is therefore not directly possible. Calculating an unweighted average of their multipliers across industries gives a multiplier of 1.95 from the type I model and of 0.12 from the CGE model with the wage function. The comparable gross output multiplier values from this study are 1.5 for the type I model and 1.2 for the boom-case. Taking into account the larger difference between the type I model result and the CGE model result in Cardenete and Sancho (2012), their results indicate that the built-in ‘crowding out – bias’ of a CGE model where investment is savings driven significantly depresses the multiplier. Wage rigidity seems to play a smaller role, as their average gross output multiplier for a CGE model with a competitive labor market is -0.22 and not so different from the multiplier with rigid wages.

>>>>Table 2: Macroeconomic effects of a 1% GDP shock in public consumption (EU 28)

>>>>>Figure 6: Income, consumption and output effects (in %) of a 1% GDP shock in public consumption (EU28)

The heterogeneity in consumption impacts for the three different states of the economy and their contribution to differences in impacts on output can be observed in Figure 7 and 8. Figure 6 shows a picture of similar differences in income, consumption and gross output effects and slightly larger differences in GDP effects, especially between the boom- and the recession-case. The higher heterogeneity in GDP effects compared to consumption effects is due to large differences in the reaction of imports. In all three cases, imports rise significantly, with a maximum of 7% in the case of booms. This is due to the price induced changes in factor intensities of labor and intermediate inputs (Table 3). The lowest effects are observed in the case with the lowest price effects, i. e. in the recession-case. In the other two scenarios, where domestic prices and wages rise considerably while import prices are unchanged, substitution effects between labor and intermediates are the consequence. The factor share of intermediates rises by 0.6% on average in the boom-case, which translates into changes in the matrices of technical coefficients $\mathbf{B}^{d}$ and $\mathbf{B}^{im}$, as defined in equation (17). That leads to larger IO linkages for home made goods as well as for imported goods. This, in turn, could be another reason for the observed phenomenon that gross output multipliers are relatively large in all three cases, compared to the type I model.

>>>>Figure 7: Final demand and GDP effects (in %) of a 1% GDP shock in public consumption (EU 28)

>>>>Figure 8: Final demand and GDP, contribution to effects (in %) of a 1% GDP shock in public consumption (EU 28)

>>>>Table 3: Factor intensity changes (in %) of a 1% GDP shock in public consumption (EU 28)

Larger coefficients for imported inputs, especially in the recession-case, lead to higher total import shares (imports/demand) at the level of goods. These changes can be set in relation to the change in relative domestic prices (in relation to import prices) in order to calculate *implicit* price elasticities that can be seen as equivalent to the 'Armington elasticities' usually applied in CGE models (Burfisher, 2017). That yields almost identical values for all three cases, ranging from 0.72 (Manufacturing) to 0.95 (Mining) and of 0.86 on average. These values are slightly smaller than unity and therefore smaller than empirically estimated 'Armington elasticities' (Turner, et al., 2012).

The import effects in percentage points seems to be more important for the multiplier from Figure 7. That does not consider the differences in the level of the different components of GDP. Therefore, in Figure 8 the contribution of the components in percentage points to the total GDP impact in % is provided. In such a framework, the differences in influence between final demand and imports on GDP diminish. Here it must be further noted, that the whole difference in final demand in the comparative static framework of this study only stems from private consumption. In a dynamic macroeconomic IO model (e. g. Kratena et al., 2017) further effects might stem from accelerator mechanisms in the investment behavior of firms.

>>>>Table 4: Output effects (in %) of a 1% GDP shock in public consumption (EU 28)

The changes in final demand plus the factor substitution effects trigger the impacts on gross output by industry (Table 4). Compared to the gross output results from the type II model, the macroeconomic IO model almost yields the same impacts in the recession case. The main exception is the mining industry, where the substitution towards intermediates induces large effects on import shares. This same effect in the mining industry can also be observed in the boom-case. In all other industries, except the directly affected public industries, the gross output effect is less than half of the effect in the recession-case.

5. Conclusions

The objective of this paper was establishing a simple comparative-static macroeconomic IO model with price feedbacks, that allows for large multiplier effects of demand shocks in recessions and small multipliers in booms. A similar multiplier heterogeneity is also demonstrated with different model specifications (type I and II) and from results with a CGE modeling approach (Cardenete and Sancho, 2012), incorporating a similar wage function as in this paper. The purpose of the theoretical analysis and of the numerical example was to show that multiplier heterogeneity can be derived from *one* model depending on the state of the economy and needs not to depend only on model specifications.

This study thereby attempts to contribute to the recent fiscal multiplier debate within an IO framework. One line in this debate attributes the difference in the reaction of consumers to government spending between booms and recessions to the different shares of household types,

i. e. ‘Ricardian equivalence’ vs. ‘hand-to-mouth’ consumers as in Auerbach and Gorodnichenko (2012) or ‘savers’ vs. ‘borrowers’ (with potential liquidity constraints) as in Eggertson and Krugman (2012) or in Eggertson et al. (2019). Another line of research that has been followed here attributes the observed heterogeneity in the reaction of consumption to demand shocks to downward wage rigidity (Shen and Yang, 2018). In recessions, positive demand shocks only lead to small wage inflation, so that quantity adjustment in employment and real income dominates. This mechanism has been built into a macroeconomic IO model with endogenous private consumption, factor substitution between labor and intermediates and a dis-continuous wage function.

A main result of model simulations for a 1% of GDP public consumption shock is that the difference in reaction of private consumption to this stimulus between recessions and booms can be fully attributed to almost zero wage reactions in recessions and high wage reactions in booms. This result clearly corroborates the theoretical model of Shen and Yang (2018). Another simulation result reveals large differences in impacts on imports, driven by factor substitution between labor and (imported) intermediate inputs. This result exceeds the theoretical model of Shen and Yang (2018), who work with the model of a closed economy.

Besides the simulations with the macroeconomic IO model, the same demand shock has also been simulated with the type I (Leontief) model and with the standard type II model that does not incorporate price feedbacks from demand shocks. The GDP multipliers are 0.95 for the type I model and 1.63 for the type II model. For the gross output multiplier, the corresponding values are 1.5 and 2.9.

The macroeconomic IO model gives a GDP multiplier of 1.4 and a gross output multiplier of 2.6 from the same demand shocks in a severe recession with an unemployment rate of 14.2%. The recession result for the multiplier therefore is still below the type II model result. Using the standard type II model without price feedbacks for multiplier analysis most probably overestimates the multiplier, except in severe recessions. The GDP multiplier in a boom (close to full employment) is 0.3, and the gross output multiplier 1.2. Two important conclusions that can be drawn from the results are: (i) the range of GDP multipliers (0.3 to 1.4) is in line with the macroeconomic literature on state-dependent multipliers, and (ii) the heterogeneity of gross output multipliers is lower than the heterogeneity of GDP multipliers. Results from other studies, using the same wage function, but applying a CGE model (Cardenete and Sancho, 2012) show gross output multipliers close to zero. This is due to the negative multiplier bias of CGE models based on the closure rule (savings driven investment).

The employment multipliers of the type II model and the recession-case are equally similar as the gross output and GDP multipliers, whereas the employment multiplier is almost zero in the case of a boom. That resembles the fact that employment cannot be further increased at full employment and an attempt only leads to wage and price inflation. The opposite holds in the recession: a large potential of employment increase exists at the cost of almost zero wage inflation effects. This mechanism is the ultimate reason for the differences of the private consumption impact of demand shocks.

The focus of this study is theoretical and a modest application was carried out just with a small static model, calibrated to a base year. Other important shortcomings are that the endogeneity of final demand only refers to private consumption (as in the type II model), external trade is only modeled in a very limited sense and substitution in private consumption is very restrictive (Cobb Douglas preferences). One natural extension of the work therefore is the integration of the wage function presented here into a dynamic macroeconomic IO model, like INFORUM (Almon, 1991; Meade, 2013), GINFORS (Meyer and Lutz, 2007; Meyer and Ahlert, 2017) or FIDELIO (Kratena et al., 2017).

Another important extension that intrudes itself is the introduction of heterogeneity across households. As Kim et al. (2015) have shown, differentiating groups of households with different behavior and consumption structures serves to explain large changes in the structure of the economy. In the setting of the model presented here, one would expect that also the aggregate short-run multipliers would be more diverse with demand shocks affecting different household groups in a different way. This could as well facilitate including the other modeling mechanisms in private consumption, that are highlighted in the macroeconomic debate (‘Ricardian equivalence’ vs. ‘hand-to-mouth’ or ‘savers’ vs. ‘borrowers’) and the issues linked to that, like uncertainty and liquidity constraints. Finally, compared to the macroeconomic models that have been used for the analysis of fiscal multiplier heterogeneity, what is completely missing here is the financial sector and the interplay between monetary and fiscal policy. This might lead to another potential extension by combining the model presented here with ‘financial’ IO models (flows of funds, financial SAM, etc.).

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Table 1: Model parameters (EU 28)

s_Y	0.353
t_Y	0.142
c_Y	0.835
σ_j	
Agriculture	0.75
Mining	0.75
Manufacturing	0.75
Electricty, gas, water	0.75
Construction	0.75
Trade	0.75
Transport	0.75
Public Administration	1.2
Education, health	1.2
Other Services	0.75
ur^*	0.080
$\alpha_{w,3}$	-0.20

Figure 1: GDP multipliers of a 1% GDP shock in public consumption (EU 28)

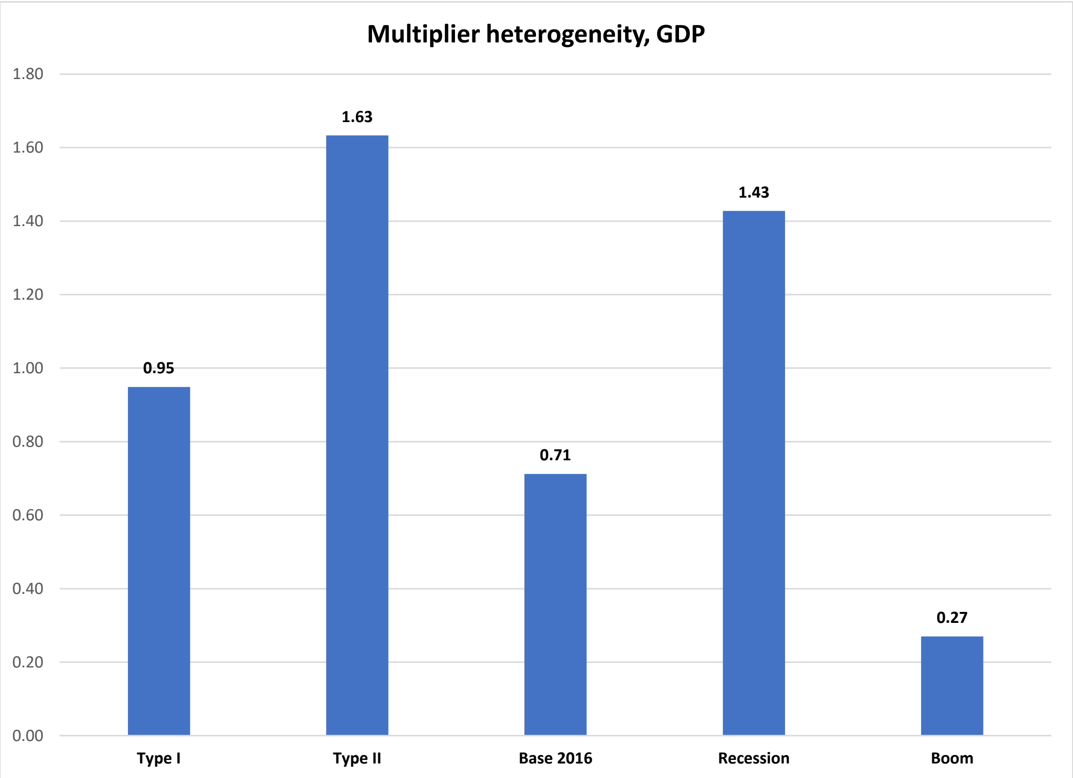

Figure 2: Gross output multipliers of a 1% GDP shock in public consumption (EU 28)

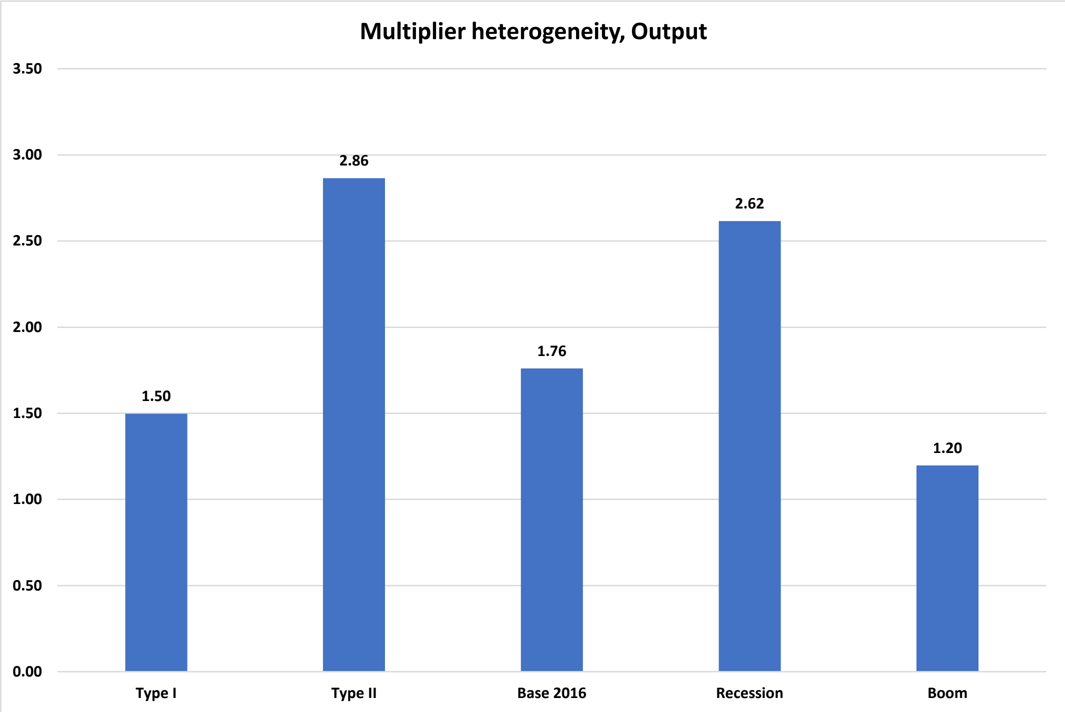

Figure 3: Employment multipliers (1.000 jobs) of a 1% GDP shock in public consumption (EU 28)

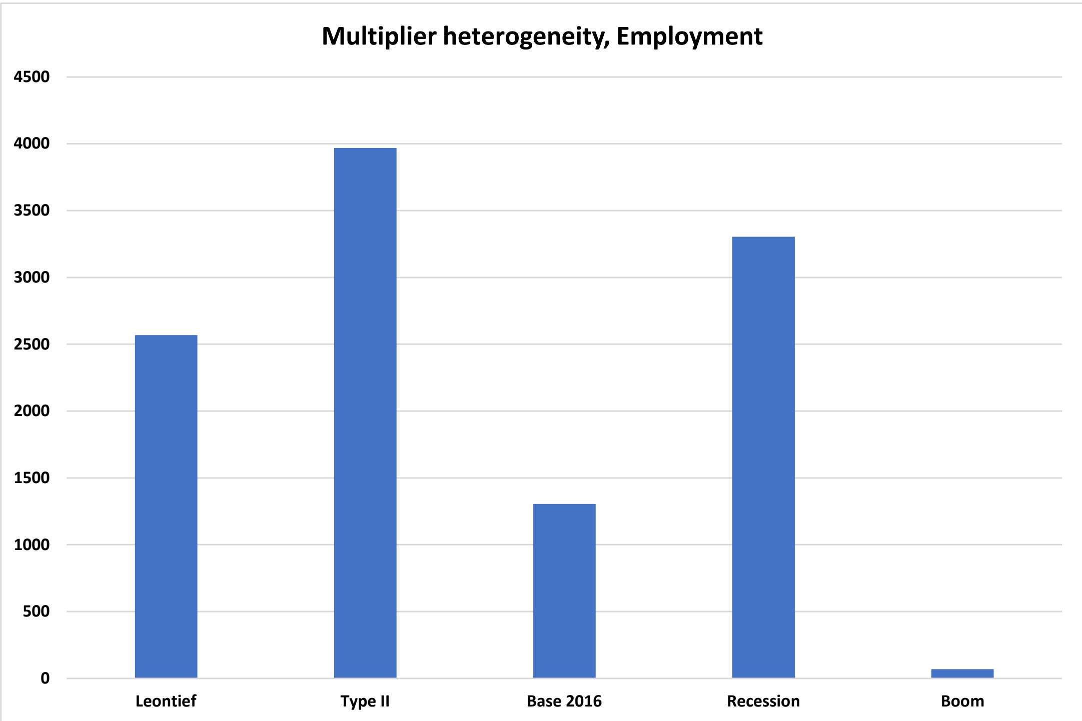

Figure 4: Output effects (in %) of a 1% GDP shock in public consumption, Type I and type II model, (EU 28)

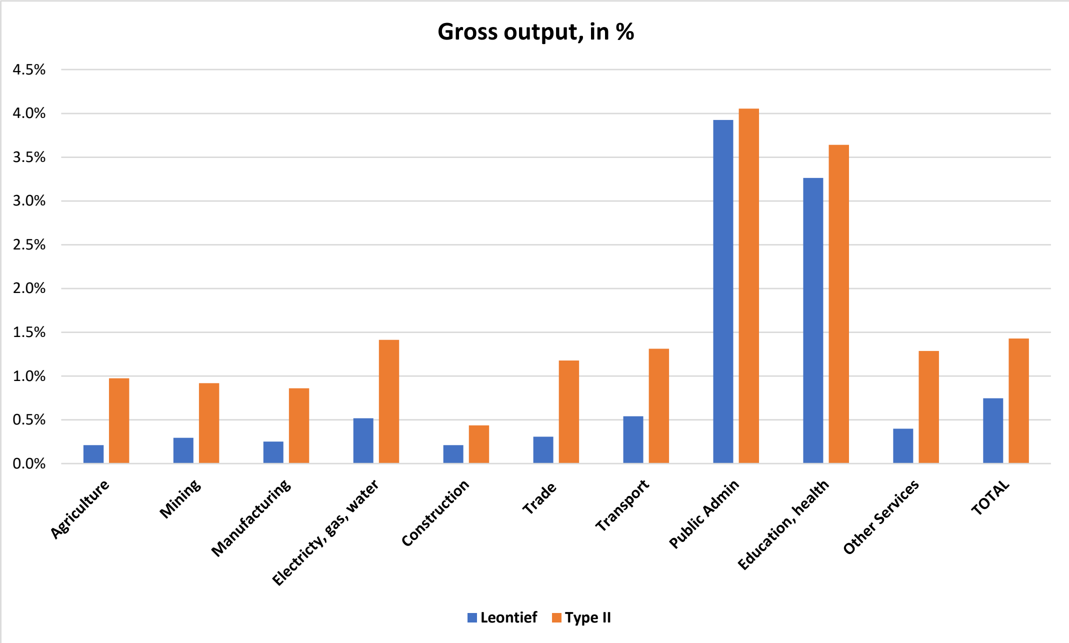

Figure 5: Unemployment rates and NAWRU of a 1% GDP shock in public consumption, EU 28

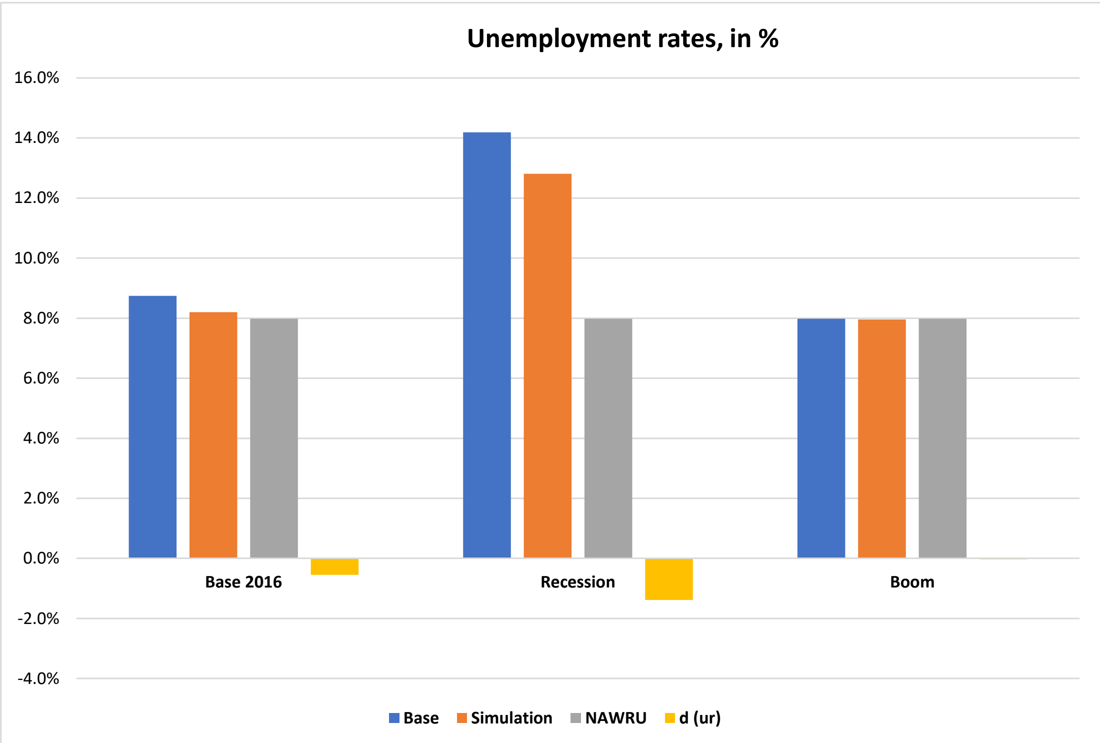

Table 2: Macroeconomic effects of a 1% GDP shock in public consumption (EU 28)

	Base 2016	Recession	Boom
Wage rate	6.9%	1.8%	10.2%
Producer real wage	1.1%	0.3%	1.6%
Consumer prices	5.6%	1.4%	8.3%
Real disp. income	0.9%	1.4%	0.6%
Private Consumption	0.9%	1.4%	0.6%
Imports	5.1%	2.1%	7.0%
GDP	0.7%	1.5%	0.3%
Gross output	0.9%	1.4%	0.6%

Figure 6: Income, consumption and output effects (in %) of a 1% GDP shock in public consumption (EU28)

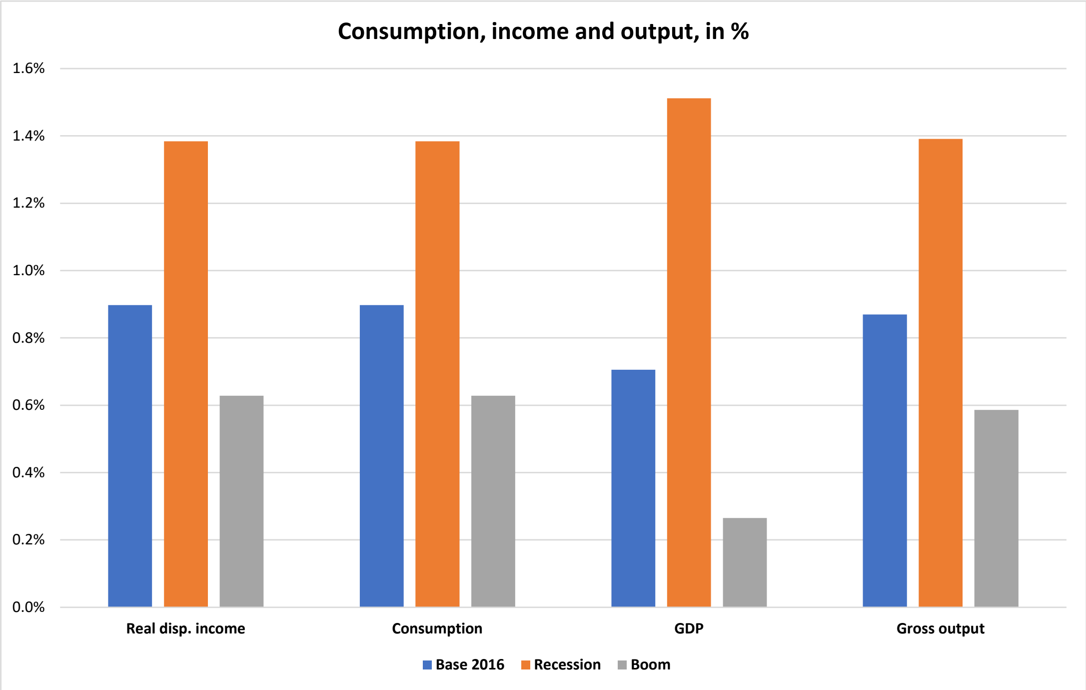

Figure 7: Final demand and GDP effects (in %) of a 1% GDP shock in public consumption (EU 28)

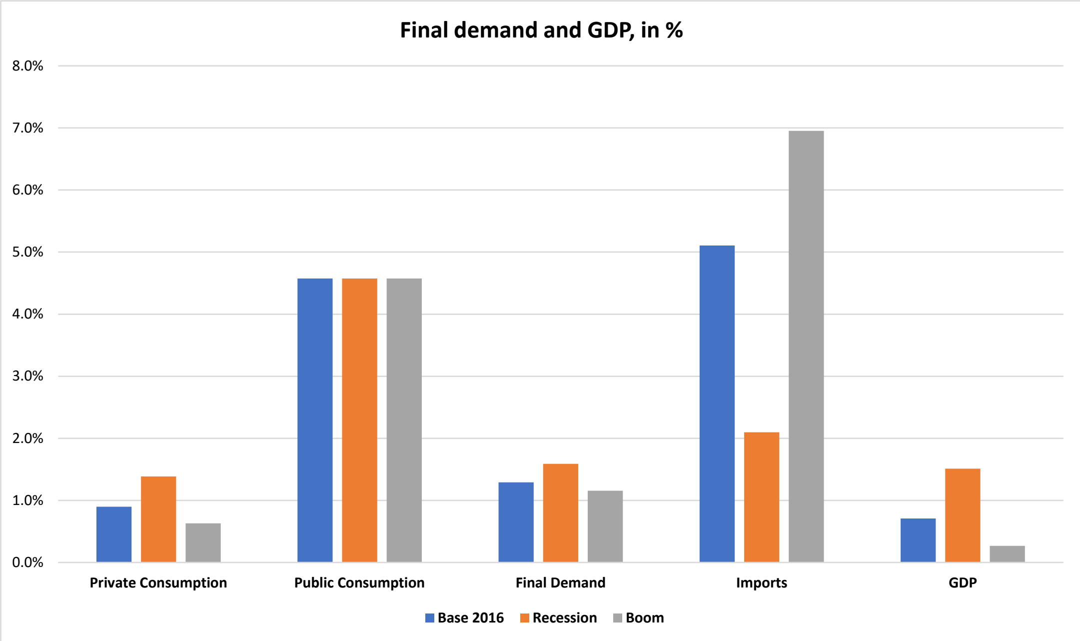

Figure 8: Final demand and GDP, contribution to effects (in %-points) of a 1% GDP shock in public consumption (EU 28)

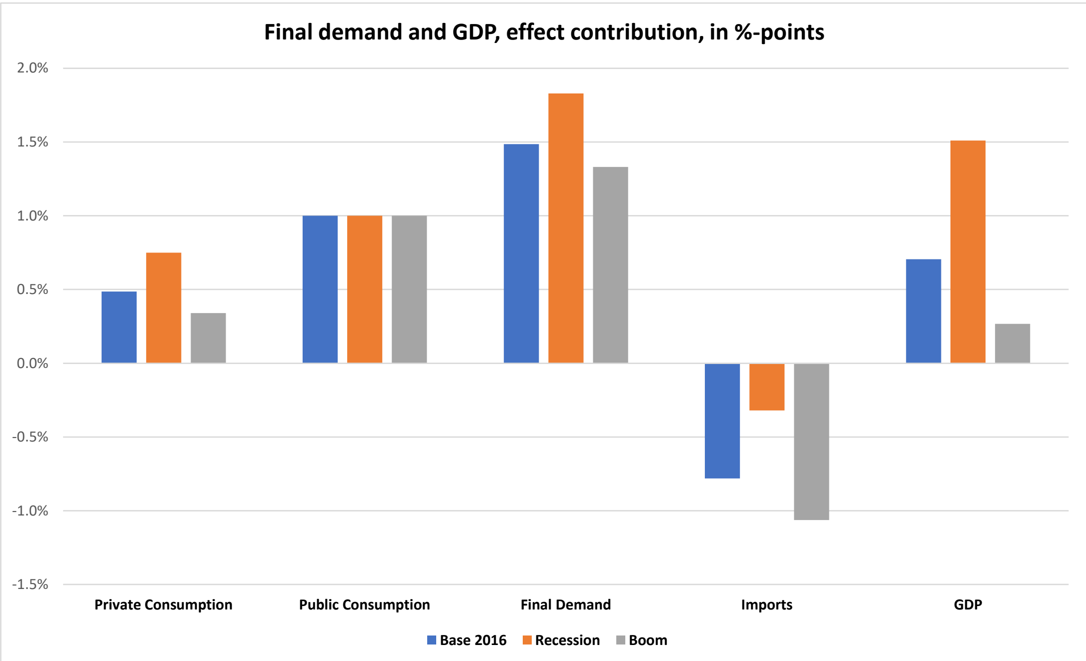

Table 3: Factor intensity changes (in %) of a 1% GDP shock in public consumption (EU 28)

Intermed./Output	Base 2016	Recession	Boom
Agriculture	0.2%	0.1%	0.3%
Mining	0.3%	0.1%	0.4%
Manufacturing	0.3%	0.1%	0.5%
Electricty, gas, water	0.2%	0.1%	0.3%
Construction	0.3%	0.1%	0.4%
Trade	0.4%	0.1%	0.5%
Transport	0.3%	0.1%	0.5%
Public Administration	0.9%	0.2%	1.3%
Education, health	0.9%	0.2%	1.2%
Other Services	0.4%	0.1%	0.5%
Labor/Output	Base 2016	Recession	Boom
Agriculture	-1.0%	-0.3%	-1.5%
Mining	-1.1%	-0.3%	-1.6%
Manufacturing	-1.3%	-0.3%	-1.9%
Electricty, gas, water	-1.2%	-0.3%	-1.7%
Construction	-0.8%	-0.2%	-1.1%
Trade	-0.5%	-0.1%	-0.8%
Transport	-0.9%	-0.2%	-1.2%
Public Administration	-0.6%	-0.2%	-0.8%
Education, health	-0.7%	-0.2%	-1.0%
Other Services	-0.5%	-0.1%	-0.7%

Table 4: Output effects (in %) of a 1% GDP shock in public consumption (EU 28)

Gross Output	Type II	Recession	Boom
Agriculture	1.0%	0.9%	0.0%
Mining	0.9%	-2.3%	-18.2%
Manufacturing	0.9%	0.8%	0.0%
Electricty, gas, water	1.4%	1.4%	0.9%
Construction	0.4%	0.4%	0.4%
Trade	1.2%	1.1%	0.4%
Transport	1.3%	1.3%	0.5%
Public Administration	4.1%	4.1%	4.0%
Education, health	3.6%	3.6%	3.3%
Other Services	1.3%	1.2%	0.4%
TOTAL	1.4%	1.4%	0.6%