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ABSTRACT

This paper employs MIMIC, an applied general equilibrium model of the Dutch economy, to explore various tax cuts aimed at combating unemployment and raising labor supply. MIMIC combines modern labor-market theories, a firm empirical foundation, and a detailed description of Dutch labor-market institutions. We develop a small aggregate model, which contains the core of MIMIC, namely wage setting, job matching, labor supply, and labor demand. In addition to illustrating the main economic mechanisms in MIMIC, the small model shows the advantages of employing a larger, more disaggregated model that accounts for heterogeneity, institutional details, and more economic mechanisms.

Targeting in-work benefits at the low skilled is the most effective way to cut economy-wide unemployment, but damages the quality and quantity of labor supply. Cuts in social security contributions paid by employers and subsidies for hiring long-term unemployed reduce unskilled unemployment most substantially. Tax cuts in the higher tax brackets boost the quantity and quality of formal labor supply but are less effective in reducing unemployment and in raising unskilled employment and female labor supply.

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1. Introduction

Many European countries suffer from high structural unemployment, especially among the unskilled. Various reforms of labor-market institutions and the tax and social insurance systems have been put forward to fight involuntary unemployment. These proposals include, in addition to reducing social benefits and minimum wages, cutting social insurance premiums and payroll taxes on low-skilled work, introducing wage subsidies for the long-term unemployed, and providing inwork benefits (see Snower and De la Dehesa (1996), Haveman (1996), and Sørensen (1997)). The latter proposals aim to enhance low-skilled employment without seriously damaging the incomes of transfer recipients.

At the same time, the aging of the population implies that the increasing burden of social insurance benefits paid to the elderly must be financed by a relatively small number of workers. Indeed, the rising ratio between the number of inactive people collecting social insurance benefits and the labor force is a more and more important cause for concern. To mitigate this trend, many EU countries aim at stimulating labor supply. Indeed, the low labor-force participation of women and the elderly in many European countries leave substantial scope for raising labor supply. Proposals to raise labor supply include cutting marginal tax rates, reducing tax benefits to households with a non-participating partner, and decreasing early retirement benefits.

This paper employs an applied general equilibrium model, the so-called MIMIC model,[1] to explore various tax policies aimed at combating unemployment and raising the quality and quantity of labor supply. MIMIC describes the Dutch economy and has been developed at CPB Netherlands Bureau for Economic Policy Analysis. MIMIC is designed so as to help Dutch policymakers in investigating the structural labor-market implications of changes in the systems of taxation and social insurance. Hence, the model focuses on adequately describing wage formation, labor supply and demand, and the institutional details of taxation and social insurance. In doing so, the model combines a rich theoretical framework based on modern economic theories, a firm empirical foundation, and an elaborate description of the actual tax and social insurance systems in the Netherlands. The theoretical foundation of the model implies that one can interpret the model results rather easily in terms of rational microeconomic behavior despite the disaggregated nature of the model and its rich institutional detail. This institutional detail makes the model especially relevant for policy making because actual policy proposals typically involve particular details of the tax and social insurance systems.

As an applied general equilibrium model, MIMIC draws on microeconomic theory to derive supply and demand from optimizing behavior by decentralized agents. In modelling the labor market, the model departs from the traditional assumption in most applied general equilibrium models of market clearing. In modelling various labor-market imperfections that give rise to involuntary unemployment, MIMIC employs modern labor-market theories. In particular, it includes elements of wage bargaining, efficiency wages, and costly job matching. In this way, the model describes equilibrium unemployment in terms of the structure of the tax system, minimum wages, and the features of social insurance.

Another distinctive feature of MIMIC is a disaggregated household model aimed at adequately describing the impact of the statutory rates of taxation and social security premiums on labor supply and the income distribution. In particular, the model accounts for heterogeneity in household composition, labor-market status, educational level, wages, and preferences for leisure. Incorporating this heterogeneity allows the model to explore the various trade-offs facing policymakers, including those between equity and efficiency.

MIMIC has a firm empirical basis. Various crucial relationships in the model, including contractual wage formation and the production function, have been estimated from time series data. Furthermore, microeconometric estimates on Dutch labor supply have been used to calibrate the

[1] MIMIC stands for MIcro Macro model to analyze the Institutional Context.

labor supply model. Moreover, income distributions have been calibrated by employing micro data. Finally, MIMIC pays close attention to the institutional details of the tax and social insurance systems.

In recent years, MIMIC has been extended in several directions compared to an earlier version discussed in Gelauff and Graafland (1994). Theoretical extensions aimed at more adequately modelling the effects of high marginal tax rates on the quality and quantity of labor supply in the formal sector. In particular, labor supply of breadwinners and single persons as well as human capital accumulation were endogenized. Furthermore, the informal economy, which consists of the black economy and household production, was included in the model. The empirical foundation of the production function and contractual wage formation has been improved, while the model was calibrated on the basis of a more recent data set for 1993. Finally, to be able to explore specific policies targeted at combatting long-term and unskilled unemployment, the new MIMIC model distinguishes between unskilled and low-skilled labor as well as between short-term and long-run unemployment.

The rest of this paper is structured as follows. Section 2 presents MINI-MIMIC, a small aggregated model that incorporates the core elements of MIMIC, namely wage formation, job matching and labor supply and demand. In order to illustrate the main economic mechanisms in MIMIC, MINI-MIMIC is used to explore a number of tax cuts aimed at reducing unemployment and raising labor supply. By analyzing these tax policies with MINI-MIMIC, we are able to illustrate some of the main mechanisms in MIMIC. Section 3 discusses how MIMIC differs from MINI-MIMIC in incorporating more heterogeneity, disaggregation and economic mechanisms. The MIMIC model is used in section 4 to investigate the structural impact on the labor market of various policies aimed at raising labor supply and reducing unemployment. This section compares these results from MIMIC with those of MINI-MIMIC. This illustrates the value added of the larger MIMIC model. Finally, section 5 concludes.

2 MINI-MIMIC: A core representation of MIMIC

This section develops a small general equilibrium model with similar features as the MIMIC model. As in MIMIC, the key elements of this so-called MINI-MIMIC model are labor supply and demand, wage formation and job matching. In particular, agents operating on the goods and labor markets are firms, households and the public sector (see Table 2.1). On the goods markets, firms set prices and supply goods, which are demanded by households and the public sector. In the open Dutch economy, the terms of trade on the commodity market is endogenous because domestically and foreign produced goods are imperfect substitutes. On the labor market, firms are the demanding agents whereas households supply labor. Wages on the labor market are set through collective bargaining between employers and unions. Together with search costs due to costly job matching, collective bargaining yields an equilibrium rate of unemployment.

-- insert Table 2.1 here --

2.1 Firm behavior

2.1.1 Labor demand

The economy consists of two types of domestic firms. For each type $i = u,s$, a fixed number of N_i symmetric firms produce commodities according to a linear production function $Y_i^j = h_i L_i^j$, where superscript j denotes firm $j = 1...N_i$. The two types of firms differ with respect to the labor skill they adopt in the production process, namely unskilled labor (L_u^j) or skilled labor (L_s^j). The fixed parameter h_i measures the productivity of labor skill i.

Firms set prices on markets that are characterized by monopolistic competition. Profit maximization implies that the output price of firm j of type i, P_i^j, is set as a mark-up over marginal costs:

$$P_i^j = \frac{1}{1-\epsilon_i^j}\frac{Pl_i}{h_i} \qquad i = u,s \qquad j = 1 \ldots N_i \tag{2.1}$$

where Pl_i represents the wage costs of (un)skilled labor (including search costs, see subsection 2.4), and $\varepsilon_i^j \equiv -(\partial P_i^j/\partial Y_i^j)(Y_i^j/P_i^j) > 0$ denotes the negative of the inverse price elasticity of demand for Y_i^j. Profits (Π_i^j)(on account of the mark-up) flow to the owners of the firm, who are residents of the home economy:

$$\Pi_i^j = P_i^j Y_i^j - Pl_i L_i^j \qquad i = u,s \qquad j = 1 \ldots N_i \tag{2.2}$$

Commodities produced by labor skill $i = u,s$ are aggregated into a composite commodity Y_i, with an ideal price index, P_i:

$$Y_i = [\sum_j^{N_i} a_{ij}^{1/\eta}\, Y_i^{j\,(\eta-1)/\eta}]^{\eta/(\eta-1)} \qquad i = u,s \tag{2.3}$$

$$P_i = [\sum_j^{N_i} a_{ij}\, P_i^{j\,1-\eta}]^{1/(1-\eta)} \qquad i = u,s \tag{2.4}$$

where η denotes the substitution elastictity between commodities produced by firms of type $i = u,s$. From (2.3), we derive that the elasticity ε_i^j in the mark-up factor in (2.1) is independent of firm j and type i and inversely related to the substitution elasticity between the different commodities, i.e. $\varepsilon = 1+\eta$. Hence, the mark-up in (2.1) is small if commodities are close substitutes for each other.

Total domestic production (Y) is a CES aggregate of the composite of commodities produced by skilled workers (Y_s) and the composite of commodities produced by unskilled workers (Y_u). The optimal allocation of Y over the two composite commodities -- demanded by domestic households, foreign households and the government -- is derived from maximizing a homothetic CES sub-utility function $Y = g(Y_u,Y_s)$. We thus arrive at the following expression for the optimal allocation between the two composite commodities:

$$\frac{Y_s}{Y_u} = \left(\frac{P_s}{P_u}\right)^{-\phi} \tag{2.5}$$

where ϕ stands for the elasticity of substitution between the two composites. Expression (2.5) can be interpreted as an implicit demand function for skilled and unskilled labor; the demand for Y_u and Y_s implicitly determines the demand for skilled and unskilled labor as a function of the price indices P_u and P_s that are determined by the respective wage rates for skilled and unskilled labor (see (2.1) and (2.4)). The parameter ϕ can thus be interpreted as the substitution elasticity between skilled and unskilled labor.

2.2 Household behavior

2.2.1 Labor supply

The economy is populated by three types of households: skilled households, unskilled households and capitalists. The latter households do not supply labor but receive profit income from their ownership of the domestic firms. The other two household types supply labor. In particular, households of each skill type maximize utility (U_i) subject to a budget constraint and a time constraint, where subscript $i = u,s$ denotes the skill type of the household. Utility features a private consumption bundle (C_i), leisure (V_i) and public consumption (G) as its arguments. This latter variable enters utility in an additively separable way, i.e. $U_i = u(C_i,V_i) + h(G)$. Hence, changes in public consumption do not directly affect private household behavior. The CES function $u(.)$ is homothetic in its two arguments. If a household is not rationed on the labor market, its budget for consumption commodities is determined by labor income, i.e. $(1\text{-}TA_i)W_iS_i = P_cC_i$, where W_i is the

gross wage rate,[2] TA_i denotes the average tax rate on labor income, S_i stands for labor supply, and P_c represents the ideal price index of the consumption bundle. The time endowment is normalized to unity so that labor supply is given by $S_i = 1\text{-}V_i$. Unrestricted optimization yields the following expression for labor supply of each skill type:

$$S_i = 1/[1 + \Delta_i \left(\frac{(1-TM_i)W_i}{P_c}\right)^{-\sigma} \left(\frac{(1-TA_i)W_i}{P_c}\right)] \qquad i = u,s \tag{2.6}$$

where σ denotes the elasticity of substitution between consumption and leisure in household utility, Δ_i depends on the parameters of the utility function and TM_i stands for the marginal tax rate on labor income. Expression (2.6) reveals that a higher average tax rate (TA_i) stimulates labor supply through the income effect while a higher marginal tax rate harms labor supply through the substitution effect. A higher real wage rate (W_i/P_c) raises labor supply if the substitution effect dominates the income effect, i.e. if $\sigma > 1$.

2.2.2 Consumption

Involuntary unemployment implies that some skilled and unskilled households are rationed in their labor supply. The rationed households do not receive wage income but collect unemployment benefits. Aggregate household consumption is restricted by the sum of aggregate after-tax labor income (including the income of those who are employed in the search activities of the employers, see subsection 2.4), income from unemployment benefits, and aggregate profit income (Π):

$$P_c C = \sum_i [(1-TA_i)Pl_i L_i + B_i U_i S_i] + \Pi \tag{2.7}$$

where L_i denotes economy-wide demand for labor type i (excluding labor involved in search activities), B_i represents the (net) unemployment benefit for labor type i, and $U_i \equiv 1\text{-}L_i/S_i$ stands for the unemployment rate of type i. Households spend their entire income on a consumption bundle (C) consisting of two aggregate goods with an ideal price index P_c (see figure 2.1). One aggregate good is a CES aggregate of domestic commodities produced by skilled workers and dommestic commodities produced by unskilled workers (see subsection 2.1.1). The other aggregate good is a composite of imported commodities with an ideal price index P_m. Domestic and foreign commodities are imperfect substitutes. The optimal choice between these two aggregate commodities is derived from optimization of a homothetic CES subutility function, $C = c(C_m, C_y)$, where C_m denotes aggregate private demand for foreign goods and C_y stands for aggregate private consumption of domestically produced goods. The optimal allocation of consumption over the two goods is given by:

$$\frac{C_m}{C_y} = \left(\frac{P_m}{P_y}\right)^{-\kappa} \tag{2.8}$$

where κ denotes the substitution elasticity between the two commodities and P_y stands for the ideal price index of domestic production, Y.

-- insert figure 2.1 here --

2.3 Wage formation

For each skill type, wages are determined by a right-to-manage model in which an employers organization and a trade union of each skill type bargain over wages while employers determine employment. In particular, collective wage bargaining involves the maximization of the following Nash function:

[2] The gross wage, W_i, is smaller than the gross labor costs, Pl_i, because of search costs, see expression (2.18) below.

$$\underset{W_i}{Max}\ \Omega_i = \Lambda_i^{\alpha}\,\Gamma_i^{1-\alpha} \qquad 0 < \alpha < 1 \qquad i = u, s \tag{2.9}$$

where Λ_i and Γ_i denote the utilities of the employers organization and the union, respectively, and α represents the relative bargaining power of the employers organization.

The utility of the employers organization of type $i = u,s$ equals revenues minus wage costs (excluding search costs):

$$\Lambda_i = P_i Y_i - W_i L_i \qquad i = u, s \tag{2.10}$$

The utility of the union of skill type $i = u,s$ depends on the level of employment and the surplus from working, which is the after-tax wage offered by the employer minus the opportunity costs of taking a job (i.e. the reservation wage):

$$\Gamma_i = L_i^{1/2}\,[\,W_i(1 - TA_i) - \hat{W}_i\,]^{1/2} \qquad i = u, s \tag{2.11}$$

where $\hat{W}_i$ represents the reservation wage for skill i. After substituting equations (2.10) and (2.11) into equation (2.9) and deriving the first-order condition for the Nash bargaining solution, we arrive at the following wage equation:

$$W_i = \frac{\dfrac{\chi_1 \hat{W}_i}{1 - TM_i} + \chi_2 P_i h_i}{\dfrac{\chi_1 (1 - TA_i)}{1 - TM_i} + \chi_2} \qquad i = u, s \tag{2.12}$$

where $\chi_1 = \alpha + \tfrac{1}{2}(1-\alpha)/(1-\epsilon)$ and $\chi_2 = \tfrac{1}{2}(1-\alpha)$. Expression (2.12) reveals that the contractual wage strikes a balance between the threat points of both bargaining parties. If the employers organization dominates bargaining (α=1 so that $\chi_2 = 0$), the union is driven back to its threat point and the after-tax wage equals the reservation wage. The contractual wage increases if the union exerts more bargaining power, i.e. if α becomes smaller. Since a wage contract will be concluded only if the maximum after-tax wage offer $((1-TA_i)P_i h_i)$ exceeds the minimum wage claim ($\hat{W}_i$), (2.12) implies that the marginal tax rate unambiguously reduces the wage. At a given average tax rate, a rise in the marginal tax rate implies that the government absorbs a larger share of a wage increase. Hence, increasing wages becomes less attractive for the bargaining parties (see also Hersoug et al., 1986).

Instead of looking for another job on the official labor market, the employee may seek work in the informal sector. Accordingly, the reservation wage $\hat{W}_i$ amounts to a weighted average of the opportunity wage in the official labor market ($\hat{W}_i^o$) and that in the informal sector ($\hat{W}_i^b$):

$$\hat{W}_i = \beta_w \hat{W}_i^o + (1 - \beta_w)\,\hat{W}_i^b \qquad 0 \le \beta_w \le 1 \qquad i = u, s \tag{2.13}$$

The opportunity wage in the official labor market depends not only on the expected wage in other jobs, $\bar{W}_i$, but also on the unemployment benefit because a laid-off employee generally spends some time in unemployment before finding another job:

$$\hat{W}_i^o = U_i B_i + (1 - U_i)(1 - TA_i)\,\bar{W}_i \qquad i = u, s \tag{2.14}$$

where the time spent unemployed before finding an alternative job is assumed to equal the unemployment rate.

The informal labor market, in which no taxes are levied, consists of home production and the black labor market. Informal labor productivity increases with labor productivity in the formal sector (h_i), because technological progress in the formal sector enhances labor productivity also in the informal sector. The informal output price is related to the formal consumer price (P_c) because home production saves on official consumer outlays:

$$\hat{W}_i^b = \gamma\, h_i P_c \qquad i = u, s \tag{2.15}$$

By substituting (2.14) and (2.15) into (2.13) and using the equilibrium condition $W_i = \bar{W}_i$, we arrive at the following wage equation:

$$\log W_i = \log h_i + \log P_i + \log\left[1 + \theta\left(\frac{P_c}{P_i(1 - TM_i)}\right)\right] - \log\left[1 + \frac{\chi_1}{\chi_2}\frac{1 - TA_i}{1 - TM_i}\left[1 - \beta_w(U_i R_i - (1 - U_i))\right]\right] \tag{2.16}$$

for $i = u,s$ where $\theta = (1 - \beta_w)\gamma\, \chi_1/\chi_2$ and $R_i \equiv B_i/(1\text{-}TA_i)W_i$ stands for the replacement rate, defined as the net unemployment benefit as a ratio of the after-tax wage rate. Expression (2.16) implies that, at a given coefficient of progression $(1\text{-}TM_i)/(1\text{-}TA_i)$, a higher tax rate unambiguously increases the wage. Intuitively, taxes raise the relative attractiveness of working in the informal sector, thereby strengthening the bargaining position of the union in the formal sector.[3]

Equation (2.16) reveals that, at a constant coefficient of progression, the same effect on wages is exerted by the various components of the wedge between, on the hand, the after-tax wage deflated by the consumer price and, on the other hand, the gross wage deflated by the producer price.

Another implication of equation (2.16) is that the wage effects of the replacement rate and unemployment rate are related. If unemployment is low, spells of unemployment are only short. Hence, the unemployment benefit level exerts only a small impact on the alternative wage in the official sector. At the same time, the influence of the unemployment rate on wages diminishes with the level of the replacement rate, becoming zero if the replacement rate equals one. A final implication of equation (2.16) is that labor productivity affects wages with a unitary elasticity.

Graafland and Huizinga (1996) estimated equation (2.16) in non-linear form and found that, on average for the sample period, the positive elasticity of the average tax is six times (0.6) as large in absolute value than the negative elasticity of the marginal tax rate (-0.1). The elasticity of the consumer price equals the sum of the elasticities of the marginal and average tax rates, i.e. 0.5. Hence, at constant unemployment and replacement rates, the incidence of a higher tax wedge (by simultaneously increasing average and marginal tax rates) is split equally between employers and employees in terms of, respectively, higher gross wage costs and lower after-tax wages.

2.4 Job matching

In each period, a fixed proportion of the employed, ω, involuntarily quit their job. These job quits give rise to vacancies (Vl_i) which, in a steady-state equilibrium, are equal to:

$$Vl_i = \frac{\omega\, L_i}{z_i} \qquad i = u, s \tag{2.17}$$

where $z_i \equiv Ml_i/Vl_i$ denotes the rate at which vacancies are filled and Ml_i stands for the number of job matches of skill type i.

To fill the vacancies, employers have to acquire new employees through a costly search process of matching vacancies with unemployed workers. Search costs associated with this matching process are related to the ease with which vacancies are filled (z_i) and the labor involved

[3] If the informal sector does not impact the reservation wage (β_w=1 and thus θ=0), taxes affect the wage outcome only through the coefficient of progression $(1\text{-}TM_i)/(1\text{-}TA_i)$. Accordingly, at a constant replacement rate, proportional taxes are fully born by the workers in terms of lower after-tax wages.

in search activities. Wages costs for new employees are thus determined by the gross wage and search costs:

$$Pl_i = W_i\left(1 + \frac{v_i}{z_i}\right) \qquad i = u,s \tag{2.18}$$

where v_i measures the search costs for each new employee.

The matching process between unemployed and vacancies is described by the following Cobb-Douglas function:

$$Ml_i = Vl_i^{1/2}(U_i S_i)^{1/2} \qquad i = u,s \tag{2.19}$$

2.5 Public institutions

Government behavior is largely exogenous. In particular, the government collects public revenues from taxing labor incomes. These revenues are used to finance expenditures on (net) unemployment benefits and public consumption. Public consumption, *G*, features the same composition as private consumption and thus exhibits the same ideal price index, P_c. The government budget is balanced:

$$P_c G = \sum_i \left(TA_i Pl_i L_i - B_i U_i S_i \right) \tag{2.20}$$

The marginal tax rate and the unemployment benefit are uniform for skilled and unskilled labor, i.e. $TM_u = TM_s = TM$ and $B_u = B_s = B$.[4] The average tax rate differs from the marginal tax because the government allows for a tax credit that may differ among household types (F_i). The average tax rate for each type of labor is described by:

$$TA_i = TM - \frac{F_i}{Pl_i L_i} \qquad i = u,s \tag{2.21}$$

The unemployment benefit (*B*) is indexed to average wages in the following way:

$$B = \beta_u R^* W(1 - TA) + (1 - \beta_u) Q W \tag{2.22}$$

where *W(1-TA)* and *W* denote the average after-tax and before-tax wage rates, respectively. Expression (2.22) allows for two alternative indexation rules. If $\beta_u = 1$, net unemployment benefits are indexed to after-tax wages. In that case, the parameter R^* can be interpreted as the fixed average replacement rate. Hence, tax cuts do not affect the average replacement rate. If $\beta_u = 0$, unemployment benefits are indexed to gross wages. In that case, cuts in the average tax burden for workers, *TA*, reduce the average replacement rate, $R \equiv B/W(1-TA) = Q/(1-TA)$.

2.6 The foreign sector

Analogous to consumption of domestic households, the allocation of foreign consumption over domestically produced and foreign produced goods depends on the terms of trade, i.e.:

$$X_y = \left(\frac{P_y}{P_m}\right)^{-\xi} \tag{2.23}$$

where X_y represents demand for domestically produced commodities by foreign countries and ξ denotes the export elasticity. With less than infinite price elasticities for export and import demand, domestic policies may change the terms of trade.

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[4] The uniform unemployment benefit implies that the replacement rate for skilled workers (with a higher than average wage rate) is smaller than that for unskilled workers (with a less than average wage rate).

The market for domestically produced goods is in equilibrium. Hence, aggregate supply of domestic goods (Y) equals aggregate demand for domestically produced goods by domestic households (C_y), the government (G_y) and foreigners (X_y), i.e.:

$$Y = C_y + G_y + X_y \tag{2.24}$$

Balance of payments equilibrium is found by combining the profit equations (2.2), the economy-wide household budget constraint (2.7), the government budget constraint (2.20) and goods-market equilibrium (2.24):

$$\boldsymbol{P}_m(C_m + G_m) = \boldsymbol{P}_y X_y \tag{2.25}$$

where G_m represents the demand by the government for foreign goods.

2.7 Welfare

This section derives the welfare effects of public policies for the different household types, i.e. for skilled and unskilled households and capitalists. Skilled and unskilled households can be either employed or unemployed. The following Bellman equations describe intertemporal welfare for employed and unemployed households (where the index $i = u,s$ has been dropped for notational convenience):

$$r J_E = U_E + \omega [J_{\boldsymbol{B}} - J_E] \tag{2.26}$$

$$r J_{\boldsymbol{B}} = U_{\boldsymbol{B}} + \psi [J_E - J_{\boldsymbol{B}}] \tag{2.27}$$

where r stands for the interest rate and U_i and J_i represent, respectively, the temporal and intertemporal utilities of employed ($i=E$) and unemployed ($i=B$) households. The quit rate ω measures the inflow of employed households into unemployment, while ψ denotes the transition rate from unemployed households into employment. In a steady-state equilibrium, the inflow into unemployment equals the outflow, i.e. $(1-U)\omega = U\psi$. Accordingly, the transition rate of unemployment into employment can be written as $\psi = (1-U)\omega/U$. Solving equations (2.26) and (2.27) for J_E and J_B, we arrive at:

$$r J_E = U_E - \frac{\omega}{\omega + r + \psi} [U_E - U_{\boldsymbol{B}}] \tag{2.28}$$

$$r J_{\boldsymbol{B}} = U_{\boldsymbol{B}} + \frac{\psi}{\omega + r + \psi} [U_E - U_{\boldsymbol{B}}] \tag{2.29}$$

Expression (2.28) reveals that welfare of an employed household is determined by not only its temporal welfare on the job, but also the potential welfare loss if the household becomes unemployed. Similarly, (2.29) reveals that welfare of the unemployed depends on both temporal utility of unemployment and the potential welfare gain from finding a job. If transition rates would be zero, welfare would be measured by temporal utilities alone. If transition rates are large, however, the welfare measures for employed and unemployed households in (2.28) and (2.29) converge, especially if the discount rate is small so that households attach a large weight to future states.[5]

The temporal welfare effects can be derived from the utility functions and the first-order conditions of employed households and unemployed households:

[5] Schluter (1997) adopts a similar welfare measure in the context of a search theoretic framework.

$$\frac{dU_E}{\mu_E} = d\left(\frac{(1-TA)W}{P_c}\right) + \frac{h_G}{\mu_E}dG \tag{2.30}$$

$$\frac{dU_B}{\mu_B} = d\left(\frac{B}{P_c}\right) + \frac{h_G}{\mu_B}dG \tag{2.31}$$

where the Lagrange multipliers μ_i denote the marginal utilities of private income of, respectively, employed households (i=E) and unemployed households (i=B). The left-hand sides of (2.30) and (2.31) measure the monetary equivalents of changes in temporal utilities. The right-hand sides reveal that this monetary value of temporal utility rises with real after-tax income and with public consumption. A similar expression can be derived for the welfare of capitalists, U_P:

$$\frac{dU_P}{\mu_P} = d\left(\frac{\Pi}{P_c}\right) + \frac{h_G}{\mu_P}dG \tag{2.32}$$

where μ_P denotes the marginal utility of private income of capitalists.

2.8 Calibration

MINI-MIMIC is contained in Table 2.2, where symbols are explained in the text. The model is calibrated in a simple way to reflect the major features of the aggregate data of MIMIC in 2018, which is the year in which the simulation results with MIMIC in section 4 are evaluated. The data and parameters are presented in Table 2.3. Aggregate labor supply by skilled households is 5.2 million labor years of which 4.9 million labor years are employed in production. The unemployment rate thus amounts to 5.8% of the skilled labor force. For the unskilled, the unemployment rate is larger; it amounts to 9.5% of the unskilled labor force, which amounts to 2.1 million labor years. Skilled households earn an annual wage income of DFL 265,000 which exceeds the annual income of unskilled households of DFL 180,000. Prices in the base year are normalized to unity. About 50% of all domestically produced goods of DFL 2,500 billion is consumed in the home country; the rest is exported abroad. In the home country, private households consume 60% of GDP, with the rest consumed by the government. The replacement rate for unskilled workers is 0.9 while the replacement rate for skilled workers is substantially lower, namely 0.65. The marginal tax rate in the initial equilibrium is 0.6 while the average tax rate is smaller, namely 0.56 for skilled workers and 0.54 for unskilled workers. Hence, the initial tax system is mildly progressive.

The elasticities of the wage equation are derived from Graafland and Huizinga (1996). In the initial equilibrium, the parameters from Table 2.3 imply wage elasticities of consumption and production prices of 0.5. The wage elasticity of the average tax burden is 0.6 while the wage elasticity of the marginal tax rate is −0.1. The replacement rate and the unemployment rate feature elasticities of 0.3 and −2, respectively. The substitution elasticity between skilled and unskilled labor is derived from estimates of Draper and Manders (1996) and set at 1.5. The export elasticity of −2 is consistent with estimates by Draper (1996). The uncompensated wage elasticity and the income elasticity of labor supply are based on econometric micro research for the Netherlands and set at 0.15 and −0.05, respectively.[6]

-- insert Tables 2.2 and 2.3 here --

[6] See e.g. Theeuwes and Woittiez (1992) and Van Soest (1995).

2.9 Simulation results

Table 2.4 reports the simulation results of three tax cuts of 0.5% GDP, financed by an equivalent ex-ante reduction in public consumption. The model is closed by changes in public consumption. Hence, the ex-post effect on public consumption can be interpreted as the long-run budgetary costs of the tax reduction.

The three experiments reported in Table 2.4 assume that unemployment benefits are indexed to after-tax wages (i.e. $\beta_u = 1$) so that the average replacement rate is constant. These experiments involve:

1. A reduction in the marginal tax rate for all workers;
2. An increase in the tax credit for skilled and unskilled workers with the same abolute amount;
3. An increase in the tax credit for unskilled workers.[7]

If unemployment benefits are indexed to gross wages (i.e. $\beta_u = 0$), tax cuts reduce the replacement rate. Table 2.5 presents the results if this alternative indexation rule holds.

-- insert Tables 2.4 and 2.5 here --

Labor supply
Only the cut in marginal tax rates boosts aggregate labor supply through the substitution effect. All other tax cuts do not affect marginal tax rates on hours worked. Hence, the substitution effect is absent and a positive income effect reduces labor supply. Targeting the tax cuts to the unskilled implies a substantial positive income effect for this group. Accordingly, unskilled labor supply declines substantially in the targeting case (see the third columns of Tables 2.4 and 2.5).

Unemployment
Economy-wide unemployment drops in all cases due to a lower average tax burden. Even if the average replacement rate remains constant (i.e. if benefits are linked to after-tax wages as in Table 2.4) does aggregate unemployment decline. The reason is that, in addition to the replacement rate, the average tax rate enters the wage equation (2.16). This implies that lower taxes are not fully absorbed in higher after-tax wages but partly benefit employers in terms of lower gross wages (so-called real wage resistance).[8] The lower wage costs raise labor demand.

The drop in unemployment is largest if net unemployment benefits are linked to gross rather than net wages. In that case, a lower replacement rate strengthens the wage moderating effect of a lower average tax burden.

The drop in the aggregate unemployment rate is most substantial if tax cuts are targeted at the unskilled (compare the first and second columns with the third columns in Tables 2.4 and 2.5). The main reason is the relatively low wage rate for unskilled labor. This implies that cutting the average tax rate for unskilled labor is relatively cheap in terms of budgetary costs. Another reason is that targeted tax reductions reduce the replacement rate for the unskilled (see below). The wage equation in (2.16) implies that a lower replacement rate is particularly effective at high unemployment rates. Since the unemployment rate for the unskilled exceeds that for skilled

[7] Targeting the low skilled does not raise the marginal tax rates on hours worked because the unskilled are assumed to be targeted on the basis of hourly wages rather than annual incomes. See also sub-sections 4.2.2 and 4.3.3 below.

[8] This contrasts with Layard, Nickell and Jackman (1990) who claim that labor taxes are fully borne by workers in the long run.

workers, tax reductions targeted at the unskilled are relatively effective in cutting unemployment rates.

Unskilled unemployment
Unskilled unemployment declines more substantially than skilled unemployment if only average tax rates are cut while keeping marginal tax rates constant. The reason is threefold. First, a larger tax credit implies a larger drop in the average tax rate of the unskilled than in that of the skilled because the tax credit represents a relatively large share of the relatively low incomes of the unskilled. The larger drop in the average tax rate implies a stronger moderating impact on wage costs (see equation (2.16)). Second, the unskilled unemployed do not fully share in this larger drop in the average tax rate of the unskilled because their unemployment benefits are linked to average wages. Hence, even if benefits are linked to (average) after-tax wages does the replacement rate for unskilled labor decline.[9] If benefits are linked to gross wages, the replacement rate for unskilled labor drops more substantially than the replacement rate for skilled labor because unskilled workers benefit from a larger cut in average tax rates. These effects on the relative replacement rates are much stronger if the cut in the tax credit accrues only to unskilled labor (see the third columns in Tables 2.4 and 2.5). The final reason for the relatively large drop in unskilled unemployment is the high initial unemployment rate of the unskilled. This makes the equilibrium unemployment rate of the unskilled sensitive to reductions in the replacement rate.

Employment
The cut in marginal tax rates boosts employment through both the channel of higher labor supply and the channel of lower unemployment. The other tax cuts reduce both labor supply and unemployment. However, the decline in unemployment dominates the fall in labor supply. Hence, employment expands in all cases. The expansion in aggregate employment is strongest if marginal tax rates are reduced (the first columns of Tables 2.4 and 2.5) or if tax cuts are targeted at the unskilled (the third columns of Tables 2.4 and 2.5). With lower marginal tax rates, higher labor supply accounts for a substantial part of the expansion in employment. With targeting the unskilled, lower unemployment explains the substantial increase in employment. This suggests a trade-off between raising labor supply and cutting unemployment. Cutting marginal tax rates stimulates labor supply but targeting tax cuts at the unskilled reduces unemployment most.

Unskilled employment
Unskilled employment rises most substantially if tax cuts are targeted at the unskilled, even though unskilled labor supply declines most sharply in this case. Hence, also here, a trade-off emerges between stimulating labor supply and fighting unemployment. Nevertheless, targeting the unskilled raises unskilled employment as the positive employment effects on account of lower unemployment dominate the negative employment effects associated with lower labor supply.

Skilled employment
Skilled employment rises most if marginal tax rates are cut and is broadly unaffected if tax cuts are more targeted at the unskilled. In the latter experiments, aggregate labor productivity declines due to substitution away from skilled towards unskilled labor.

Welfare
The tax cuts raise the incomes of all agents if unemployment benefits are linked to net wages so that also the unemployed benefit from the tax cuts. If the unemployment benefits are linked to gross wages, in contrast, wage moderation reduces the incomes of the unemployed. Intertemporal welfare of the unemployed may nevertheless rise. Indeed, the transition rate from unemployment

[9] The *average* replacement rate does not change in this case.

into employment is large compared to the quit rate and the discount rate. Hence, unemployment spells are only short and future incomes are important for welfare. As a direct consequence, higher incomes of the employed raise the intertemporal welfare of the unemployed. This positive welfare effect for the unemployed is reinforced by the lower unemployment rate which raises the inflow into employment. Tables 2.4 and 2.5 reveal that intertemporal private welfare for the unemployed increases, even if the incomes of the unemployed are indexed to gross wages. The private welfare gains for employed and unemployed households should be weighed against the loss in public welfare on account of lower public consumption.

3. The MIMIC model

Compared to MINI-MIMIC developed in section 2, MIMIC incorporates more institutional detail, economic mechanisms, disaggregation, and heterogeneity. These extensions make MIMIC more suited for analyzing actual policy proposals in the Netherlands. Furthermore, more disaggregation and heterogeneity allow a for better empirical foundation of several parts of the model, such as the labor supply, labor demand and production. Incorporating these extensions, however, implies that not all parts in MIMIC are fully consistent with each other. To illustrate, behavioral equations in the matching model are derived from utility functions that differ from the underlying labor-supply model. This section discusses how MIMIC extends MINI-MIMIC in describing firm behavior, household behavior, wage determination, job matching, and public institutions.

3.1 Firm behavior

MIMIC involves more disaggregation in the commodity markets (sub-section 3.1.1) and in the input structure of firms (sub-section 3.1.2) than MINI-MIMIC. Furthermore, it models both the demand for black labor (sub-section 3.1.3) and on-the-job training (sub-section 3.1.4). Finally, firms in MIMIC exert some monopsony power in setting wages and employ a minimum productivity standard in selecting employees. These features are discussed in, respectively, section 3.3 on wage determination and section 3.4 on job matching.

3.1.1 Disaggregation in commodity markets

MIMIC contains six firm sectors: the exposed sector, the sheltered sector, the construction sector, the medical sector, the mining sector (mainly natural gas), and the residential sector (i.e. the exploitation of real estate). The exposed and the sheltered sectors are the largest sectors. The sheltered sector supplies labor-intensive services facing little competition from abroad. It includes trade, banking and insurances and other private services. The exposed sector consists of capital-intensive industries subject to intense foreign competition. This sector includes manufacturing, agriculture, and transport.

The markets on which the firms in the exposed and sheltered sectors operate feature monopolistic competition. In particular, various market segments exist. Within each market segment, a large number of symmetric domestic firms compete. Each firm produces an unique good, which is a close, but imperfect, substitute for goods produced by other domestic firms competing on the same market segment. In the exposed sector, also foreign firms operate on these market segments. However, within any market segment, a commodity supplied by a domestic firm is a closer substitute for the output of another domestic firm than for the output of a foreign firm. This reconciles small observed profit margins of 5 to 10% with relatively low price elasticities of import and export demands.[10] Figure 3.1 presents the nesting structure of the demands for the outputs of the firms in the sheltered and exposed sectors.

[10] Most estimates for Dutch export and import elasticities are in the order of 2.

-- insert figure 3.1 here --

Using a CES function to describe this nesting structure of demand and assuming that the number of market segments is so large that the market share of a single market segment can be neglected, we arrive at the following expression for the negative of the inverse own-price elasticity of demand, ε:

$$\epsilon = \frac{1}{\sigma_d + (\sigma_m - \sigma_d)\, s_d + (\sigma_s - \sigma_m)\, s_m} \tag{3.1}$$

where s_d denotes the market share of the individual firm in total domestic output on a particular market segment and s_m represents the market share of the individual firm in total output on a market segment. The substitution elasticity between outputs of domestic firms within a market segment is denoted by σ_d, that between outputs of domestic and foreign firms by σ_m, and that between various market segments by σ_s.

The own-price elasticity is an important determinant of pricing decisions. In particular, profit maximizing firms set prices as a mark-up on marginal costs:

$$P_y = \frac{1}{1 - \epsilon}\, MC \tag{3.2}$$

where MC and P_y stand for the marginal costs per unit of output and the output price, respectively. The model is calibrated in such a way that the mark-ups are in line with empirical information on profit rates.

3.1.2 Disaggregation in input structure

Firms produce their firm-specific output by using five inputs: intermediaries, capital,[11] unskilled labor, low-skilled labor, and high-skilled labor.[12] The transformation process is described by a CES neo-classical production function, which exhibits constant returns to scale. The substitution elasticities between the various inputs are based on recent empirical estimates by Draper and Manders (1996). In particular, the substitution elasticity between capital and the composite of labor inputs equals 0.15 in the exposed sector and 0 in the other sectors. The substitution elasticity between the three labor types is 1.1 in the exposed sector, 2.0 in the sheltered sector and the construction sector, and 1.5 in the medical sector.

Cost minimization yields input demands as a function of output and marginal input costs. In minimizing costs, firms take prices of non-labor inputs as given. Labor costs, C_l, are given by:

$$C_l = \sum_j W_j L_j + \nu \bar{W}_j Vl_j + \tfrac{1}{2}\alpha_w L_j \frac{(W_j - \hat{W}_j)^2}{\hat{W}_j} \tag{3.3}$$

where W_j denotes the wage rate of a worker (with average labor productivity) of labor type j, L_j employment of labor type j, Vl_j the number of vacancies of labor type j, $\nu \bar{W}_j$ search costs per vacancy of labor type j, and $\hat{W}_j$ the contractual wage of labor type j. A bar over a particular variable denotes the economy-wide average of that variable. Search costs are proportional to the average gross wage of the particular labor type, $\bar{W}_j$, which is exogenous to the firm, and the number of vacancies posted by the employer, Vl_j, which is given by:

$$Vl_j = (dL_j/dt + \omega_j L_j) \,/\, z_j \tag{3.4}$$

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[11] The cost of capital depends on the interest rate. The Netherlands is a small open economy in world capital markets. Hence, the interest rate is fixed.

[12] Compared to MINI-MIMIC, unskilled labor is disaggregated into low-skilled labor and unskilled labor. These latter categories amount to, respectively, 11% and 18% of the labor force.

where ω_j stands for the average quit rate of workers of type j and z_j denotes the rate at which vacancies for type j are filled. This specification implies that marginal labor costs, which are an important determinant of labor demand, increase if search costs rise because vacancies are open for a longer time. The rate at which vacancies are filled depends on the relative wage offered by the employer:

$$z_j = (W_j / \bar{W}_j)^{\beta} \bar{z}_j \tag{3.5}$$

where W_j represents the wage offered by the firm and $\bar{z}_j \equiv Ml_j/Vl_j$ denotes the average rate at which vacancies for type j are filled, where Ml_j is the number of successful job matches.

3.1.3 Demand for black labor

For each skill type, firms in the sheltered sector and the construction sector can hire labor from the black market. This black labor combines with formal labor of the corresponding labor type in an additional nest of the CES-production function. The elasticity of substitution between black and formal labor is set at 2, which is based on empirical evidence in Baartmans et al. (1986).

Furthermore, firms may pay formal labor in part informally, i.e. without reporting the wages to the tax authority. Firms determine this informal labor (L_c) by trading off lower taxes against a potential penalty for fraud. This yields the following optimal demand for informal labor (L_c):

$$L_c = \bar{L}_c \frac{(\tau_m)^e}{\Delta} \tag{3.6}$$

where τ_m denotes the marginal burden of collective levies (i.e. taxes and social security premiums) on employers, Δ depends on the potential penalty on tax evasion, and $\bar{L}_c$ is a scaling parameter. In absence of empirical evidence, the elasticity of informal labor with respect to the marginal tax is based on best-guess values and set at 1.0 for unskilled workers, 0.5 for low-skilled workers and 0.3 for high-skilled workers.

3.1.4 On-the-job training

A high marginal tax rate on employers reduces on-the-job training that firms undertake. In particular, if the firm invests in the human capital of its workers, employees are likely to claim part of the return to these investments in terms of a higher after-tax wage rate. A high marginal tax burden for the employer makes such wage increases expensive. We set the elasticity of on-the-job training with respect to the marginal tax rate of the employer equal to 0.2, which corresponds to the elasticity of training activities by households (see below).

On-the-job training raises the stocks of human capital. In particular, human capital may raise the productivity of workers within their own skill. Moreover, by acquiring more skills, some households may move from their initial skill towards a higher skill level, i.e. an unskilled worker may become low skilled while a low-skilled worker may become high skilled. On average, the rate of return to on-the-job training is set at 8%, which is a rather modest value compared to the available empirical evidence for the Netherlands.[13]

3.2 Household behavior

Compared to the households in MINI-MIMIC, MIMIC's household sector is more disaggregated and accounts for more heterogeneity (sub-section 3.2.1). Furthermore, households demand labor-intensive services on the black labor market and save part of their income (sub-section 3.2.2). They

[13] See e.g. Teeuwes et al. (1985) and Groot and Mekkelholt (1995).

feature heterogeneous preferences for leisure (sub-section 3.2.3), supply labor on the black market (sub-section 3.2.4), and are engaged in off-the-job training (sub-section 3.2.5).

3.2.1 Disaggregation

MIMIC distinguishes 40 types of households in order to adequately describe labor supply and explore the income distribution. In particular, MIMIC distinguishes couples, single persons, single parents, pensioners and students. To model the specific labor supply behavior of those close to retirement, people aged between 55 and 65 years are represented by a separate household type. Couples consist of a so-called breadwinner (i.e. the individual with the highest personal income) and a partner (i.e. the adult with the lowest personal income). Couples are subdivided into families with children and families without children. Individuals within each household may differ with respect to their skill level and their job status (i.e holding a job in the formal sector or collecting a social benefit). Figure 3.2 presents an overview of the household types in MIMIC.

-- insert figure 3.2 here --

For each household type, MIMIC employs class-frequency income distributions based on micro data to describe the distribution of gross incomes. These income distributions are important determinants of the efficiency costs of high marginal tax rates: the more people are concentrated in a particular income range, the higher become the efficiency costs of high marginal rates in this income range. By applying the corresponding statutory tax and premium rates to gross incomes, MIMIC determines net incomes and the average and marginal tax rates that determine labor-supply decisions.[14]

3.2.2 Consumption demand

In optimizing utility, households first determine how to optimally allocate their income over saving and various consumption commodities, while taking labor supply as given. Consumption consists of three categories: labor-intensive services from the formal market, labor-intensive services from the black market, and other consumption from the formal market.[15] In the CES utility structure, labor intensive services are first aggregated before combining with other consumption from the formal market to yield total consumption. The elasticity of substitution between labor-intensive consumption and other consumption equals 1.1 (see Eijgenraam and Verkade, 1988). The elasticity between labor-intensive services from the formal market and the black market is set at 2 (see e.g. Baartmans et al., 1986). The division of income over saving and consumption follows from optimizing an intertemporal utility function (see Boone (1998)). The intertemporal elasticity of substitution is based on Draper (1994) and set at 0.85.

3.2.3 Labor supply

In the second step of the optimization procedure, labor supply S is selected from a limited set of discrete options.[16] In particular, single persons can select four options: a full-time job, a part-time job of 40% or 80% of a full-time equivalent, or a job that amounts to 120% of a full-time equivalent. Breadwinners can choose between 80%, 100% and 120% of a full-time equivalent. Partners of breadwinners may opt for non-participation and a part-time job of 30%, 50% or 80% of a full-time equivalent. For each of the discrete choices an individual faces, utility is determined by:

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[14] For a more elaborate description, see chapter 3 in Gelauff and Graafland (1994).

[15] This structure is similar to Frederiksen et al., 1995.

[16] Empirical evidence for both the Netherlands and other countries suggests that hours worked do not exhibit smooth continuous patterns but rather are concentrated at discrete points (see, e.g., Woittiez (1990) and Van Soest et al. (1990)).

$$G = U(Y, V) - \psi \left| S - \bar{S} \right| \tag{3.7}$$

where Y represents real household income that is allocated to consumption and saving. Leisure V in the unconstrained optimum can be derived from the time constraint:

$$V = 1 - S - T \tag{3.8}$$

where the time endowment is normalized to unity and T denotes the time spent on off-the-job training activities (which is exogenous at this stage of the optimization process). The autonomous preference for labor supply (S) varies between households and follows from a continuous probability density function. Optimal labor-supply behavior of each households strikes a balance between, on the one hand, minimizing the loss associated with deviations from the autonomous preference ($\bar{S}$) and, on the other hand, the highest possible utility from $U(.)$. The uniform probability density function of $\bar{S}$ is determined such that the model reproduces micro data on Dutch labor supply. The calibration of the parameter ψ and the substitution elasticity between leisure and consumption ensure that the model reproduces labor-supply elasticities estimated in the empirical literature for the Netherlands. In particular, the uncompensated wage elasticity of labor supply by partners is set at 1.0, single persons feature a corresponding elasticity of 0.25 and most breadwinners of around 0.1. Older breadwinners, who may change their retirement decisions in response to changes in wages, feature a somewhat higher elasticity of 0.15. The income elasticities of labor supply are smaller than the wage elasticities, namely 0.2 for partners, 0.05 for single persons and almost zero for breadwinners.[17]

3.2.4 Informal labor supply

In the next step of the optimization procedure, the following extended utility function determines the allocation of overall labor supply (S) across the formal labor market and the black labor market (S_z):

$$Z = G(.) - \delta^{\beta_z} S_z \tag{3.9}$$

The supply of black labor, S_z, is a discrete choice and amounts to 20% of a full-time equivalent. The optimal choice between formal and black labor trades off higher subutility G(.) from the option with black labor (because black wages typically exceed after-tax wages in the formal labor market) against the moral cost associated with supplying black labor, measured by the parameters δ and β_z. The latter parameter is heterogeneous across households and is taken from a continuous uniform probability density function. Only households with a small β_z, i.e. those who face a low moral costs of supplying black labor, choose the option with 20% black labor supply. The density function of β_z is such that the model reproduces the size of the black economy in the Netherlands, which is estimated at about 3% of GDP. The parameter δ is set to reproduce an uncompensated wage elasticity of black labor supply of 0.75 found by Koopmans (1994).

Apart from labor in the underground sector, households can be involved also in a second type of informal labor, namely housekeeping activities. Time spend on housekeeping activities is modeled as a fixed fraction of leisure. We adopt the time allocation survey of SCP (1995) for the calibration of these fractions. Housekeeping yields household production, which is a perfect substitute for the consumption of labor-intensive services. Compared to the supply of black labor-intensive services, household production represents a larger part of the informal economy.

3.2.5 Off-the-job training

A separate intertemporal model (see De Mooij, 1997) endogenizes the time spent on training activities by employed workers (denoted by T in expression (3.8)). Higher future wages due to training are traded off against the opportunity cost of training, as measured by current wage

[17] See footnote 6.

income foregone. The intertemporal model yields the following steady-state relationship between training activities and employment in the formal economy (L_f):

$$T = \eta L_f \tag{3.10}$$

Intuitively, if labor supply becomes more attractive, also other activities aimed at raising these labor incomes are encouraged.[18]

In the calibration of the model, the return on off-the-job training is set at 8%, which is equivalent to the return to on-the-job training. A Dutch survey on the allocation of time (see SCP (1995)) indicates that, as a ratio to labor time, men spent more time on training than women do. In most households with two adults, men are the breadwinner. Accordingly, breadwinners in MIMIC feature a larger η than partners do.

3.3 Wage formation

On the formal labor market, MIMIC distinguishes between contractual wages (sub-section 3.3.2), which are determined in collective negotiations between employers and unions, and incidental wages (sub-section 3.3.3), which are set by individual employers based on the tightness of the skill-specific labor markets. The distinction between contractual and incidental wages is important because social benefits are linked to contractual, rather than incidental, wages. Hence, higher incidental wages reduce the replacement rate.

3.3.1 The black labor market

The black labor market is perfectly competitive. On this market, household demand for black labor-intensive services and firm demand for black labor are confronted with household supply of black labor.

3.3.2 Contractual wages

Contractual wages in the Netherlands are determined mainly through collective bargaining at the industry level. Since both skill-specific and macro-economic factors play a role, the wage equation (2.16) is specified both on the macro-economic level and for the three skill types. The macro wage equation adopts macro-aggregates for the average tax rate, the marginal tax rate, the replacement rate and unemployment. Skill-specific aggregates are used in the skill-specific wage equations. Based on Graafland and Lever (1996),[19] the macro and skill-specific wage equations carry equal weights in determining the contractual wage for a specific skill. The elasticities of the wage equation correspond to those in MINI-MIMIC.

3.3.3 Incidental wages

The wage structure among skills is further modified by a skill-specific, so-called incidental, wage component. The employer can use this incidental wage component, which is defined as the difference between the wage offered by the firm and the contractual wage determined by collective bargaining (see subsection 3.3.2), to minimize search costs. The incidental wage can be interpreted as an efficiency wage associated with hiring costs. In setting incidental wages, the employer thus exerts some monopsony power.

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[18] This relationship assumes that the marginal tax rate on income from additional labor supply coincides with the marginal tax rate on income from higher hourly wages (due to additional training). If wage subsidies are based on hourly wages, however, these two marginal tax rates may differ. In that case, the parameter η involves the ratio between the complement of the marginal tax rate on hourly wages and that on annual labor income.

[19] They find that sector-specific variables account for 50% of the total impact on wages while economy-wide factors account for the other 50%.

Minimization of labor costs (3.3) subject to (3.4) and (3.5) implies that incidental wages are set as a mark-up over the contractual wage. This mark-up rises with the tightness of the labor market as reflected in the ratio between vacancies and employment.

3.4. Matching on the labor market

MIMIC introduces heterogeneity in the matching process (sub-section 3.4.1). This heterogeneity allows MIMIC to model the adverse impact of high minimum wage costs and high reservation wages on the efficiency of matchings process. In particular, low-productivity matches may fail because they do not meet the minimum productivity standard of the employer (sub-section 3.4.2) or the reservation wage of the unemployed (sub-section 3.4.3). The behavior of the unemployed is described in terms of the reservation wage and the search intensity (sub-section 3.4.3), which allows MIMIC to describe the specific features of the long-term unemployed (sub-section 3.4.4).

3.4.1 Heterogeneous matchings

On the formal labor market, unemployed workers of each skill meet firms that search for appropriate employees with those skills. A matching function describes the number of matches, Ml_j, for each type of labor:

$$Ml_j = Co_j \, fm_j \tag{3.11}$$

where Co_j denotes the number of contacts between employers and the unemployed while fm_j stands for the share of these contacts resulting in successful matchings. The number of contacts follows from a Cobb-Douglas contact function, which features constant returns to scale:[20]

$$Co_j = \gamma_j Vl_j^{\theta} \, (s_j \, U_j)^{1-\theta} \tag{3.12}$$

where Vl_j represents the number of vacancies, s_j the search intensity of the unemployed, U_j unemployment, and γ_j a mismatch parameter, which reflects the mismatch due to differences between vacancies and unemployment in terms of skill, work experience and location.[21]

The share of contacts that results in an agreement depends on the acceptance rate of the employers and the unemployed. For a contact to result in a successful match, the productivity of the job match must exceed both the reservation wage of the unemployed and the minimum productivity standard of the employer (see below). The productivity of an individual job-worker combination is matchspecific. In view of the heterogeneity of reservation wages and productivity, the average acceptance rate is modelled as a CES function of the shares of contacts acceptable to employers (fe_j) and the unemployed (fu_j):

$$fm_j = (fe_j^{-\lambda} + fu_j^{-\lambda})^{-1/\lambda} \tag{3.13}$$

3.4.2 The minimum productivity standard

The search and selection strategy of employers involves the number of vacancies (discussed in sub-section 3.1.2 above) and a minimum productivity standard determining the fraction of matches that is acceptable to the employer. Under the assumption that individual workers of type j are perfect substitutes, the minimum productivity standard is derived from the condition that marginal labor costs per efficiency unit must be the same for workers with different labor productivities:

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[20] This specification does not incorporate the distinction between the short-term and long-run unemployed (see below).

[21] The parameter θ in the contact function is based on the estimation results in van Ours (1991), while the mismatch parameter is calibrated so as to reproduce data on average unemployment duration.

$$he_j = \frac{hn_j Wm}{W_j\left(1 + \frac{v}{z_j}(\omega_j + r - \frac{\frac{d}{dt}(\bar{W}_j/z_j)}{\bar{W}_j/z_j}) + \frac{1}{2}\alpha_w \frac{(W_j - \hat{W}_j)^2}{W_j}\hat{W}_j\right)} \quad (3.14)$$

where he_j denotes the minimum productivity standard for labor type j while hn_j and W_j represent the average productivity index and wage level of all new employees of type j. *Wm* stands for the sector-specific effective minimum wage.[22] Marginal labor costs include wage and search costs (see expression (3.3)). Equation (3.14) implies that a higher effective minimum wage decreases the number of candidates whose productivity is acceptable to the employer. This raises vacancy duration, thereby boosting search costs for employers, and thus depressing labor demand.

The productivity of an individual job-worker combination of type j is match-specific. It follows from a lognormal distribution with standard deviation sd_j, which is based on micro data of the wage distribution for each type of labor, and an average productivity that is normalized at 1. The share of contacts that is acceptable to the employer can thus be defined as:

$$fe_j = 1 - G((\log he_j)/sd_j + 0.5sd_j) \quad (3.15)$$

where G is the cumulative distribution function of the standard normal distribution.

3.4.3 The behavior of the unemployed

Unemployed persons are drawn randomly from the pool of labor supply. A separate model akin to the search model of Pissarides (1990) is developed to model the behavior of the unemployed in terms of two endogenous variables, namely the search intensity and the reservation wage.[23] This model applies to a representative unemployed worker of each skill and thus abstracts from heterogeneous preferences for leisure. In raising search intensity, the unemployed trade off the loss of leisure against the increased probability of moving into the employed state. The employed state yields more life-time utility than the unemployed state does because of higher income in work and because the unemployed may feel rejected and socially isolated. The optimal search intensity increases in the average transition rate into employment (because it raises the marginal return on search) and decreases in the replacement rate (which decreases the difference in life-time utility between the employed and unemployed states).

The second variable describing the behavior of the unemployed is the reservation wage, which is the wage at which an unemployed job seeker is indifferent between the employed and unemployed states. The reservation wage rises with both the unemployment benefit and the average transition rate into employment. Together with the lognormal wage distribution of job offers, the reservation wage determines the acceptance rate of the unemployed (i.e. the share of contacts that is acceptable to unemployed job seekers).

A higher replacement rate thus exacerbates the mismatch on the labor market by lowering search intensity and raising the reservation wage. This pushes up incidental wages, thereby raising unemployment in equilibrium.

3.4.4 Short- and long-term unemployment

Long-term unemployed typically differ from short-term unemployed in their search behavior, reservation wage and productivity. MIMIC therefore distinguishes between short- and long-term unemployment by using a steady-state flow model for job matches akin to Holmlund and Linden

[22] This wage may differ from the statutory minimum wage because the lowest wage scales in the Netherlands, which are agreed upon in collective wage agreements, generally exceed the official minimum wage.

[23] Chapter 4 in Gelauff and Graafland (1994) and Jongen and Graafland (1998) discuss the modeling of the behavior of the unemployed in more detail.

(1993).[24] In particular, the long-term unemployed are less productive than the short-term unemployed because they lost some human capital during their prolonged period of unemployment. If they find a job, the long-term unemployed face some (exogenous) probability to restore their human capital. The long-term unemployed take this benefit of entering work into account and hence feature a relatively low reservation wage. This is consistent with empirical evidence (see e.g. Van den Berg (1990) and Devine and Kiefer (1991)). Accordingly, rather than the reservation wage, the minimum effective productivity standard determining the acceptance rate of the employer mainly restricts the number of successful matches for the long-term unemployed. For the short-term unemployed, in contrast, a relatively high reservation wage is the most important barrier to successful job matches. As a relatively large number of long-term unemployed are unskilled, the minimum effective productivity standard amounts also to the most important restriction in the job-matching process of the unskilled.

Search intensity falls over the unemployment spell because the probability of finding a job declines as the unemployed lose some human capital during prolonged unemployment. Hence, the long-term unemployed search less intensively for a job than the short-term unemployed do. This is in accordance with empirical findings of Layard et al. (1991) and Van Aalst and Hermsen (1994). Hence, although the long-term unemployed feature a rather low reservation wage, their employment perspectives are worse than those of the short-term unemployed because of their relatively low productivity and the associated low search intensity. Hence, transition rates into employment are lower for long-term unemployed than for short-term unemployed. Also this is in line with empirical studies, which typically report true duration effects (see e.g. Kerckhoffs et al. (1994), Van Opstal and Van de Pol (1991), and Groot (1990)).[25] The model is calibrated so as to conform closely to the observed transition rates between the various states and to the main empirical findings on search intensity and the reservation wage.

3.5 Public institutions

MIMIC contains several public institutions, including the Dutch personal income tax system in 1998. The personal income tax features a tax-free allowance of about DFL 8.600 and three tax brackets (see Figure 3.3). A partner whose labor income remains below the tax-free allowance can transfer the tax-free allowance to the breadwinner. The rate in the first bracket is about 36% in 1998. The tax rate in the second tax bracket is 50% and has to be paid on incomes above about DFL 55.000. The marginal rate in the third tax bracket, which amounts to 60%, is paid on incomes above DFL 115.000. Workers benefit from a special earned-income tax deduction, which amounts to 12% of labor income with a maximum of around DFL 3.100. VAT in the Netherlands imposes a low rate on necessary goods (6%) and a high rate for other goods (17½%). Other public institutions in MIMIC include employee and national social insurance schemes,[26] the employers and employees contributions to employee social insurances, the statutory minimum wage (which is linked to the average contractual wage rate), social assistance (which is linked to the statutory minimum wage), and a number of policy instruments targeted at specific groups, such as the long-term unemployed and the unskilled.

-- insert figure 3.3 here --

[24] A detailed description of this model can be found in Jongen and Graafland (1998).

[25] Part of the decline in the transition rate is explained by heterogeneity in the composition of the unemployed. MIMIC captures part of this effect through heterogeneity in skill types.

[26] Employee insurances apply only to working people and cover employment risks, namely unemployment, disability, and sickness. Benefits depend on previously earned wages. All residents are entitled to national social insurance, which involves family allowances, disability benefits for the handicapped, special health costs, and a basic pension. In contrast to benefits from employee insurances, benefits from national social insurance are not related to previously carned wages.

3.6 The model as a whole[27]

Figure 3.4 provides an overview of the most important relationships between labor-market institutions and the functioning of the labor market in MIMIC. In particular, it summarizes how taxes and social benefits affect labor demand and supply, the process of wage formation and the job-matching process.

A number of parameters in MIMIC are calibrated so that the model reproduces Dutch data for the base year 1993. Elasticities in the wage equation and the production function are estimated. Most other elasticities are derived from the literature. For elasticities that suffer from a weak empirical basis, sensitivity analysis has been employed. This analysis suggests that most simulation results are quite robust (see Nieuwenhuis and Boone, 1998).

-- insert figure 3.4 here --

4. Cutting taxes in MIMIC

This section employs the MIMIC model to investigate the long-run effects of a number of tax cuts.[28] Just as in the experiments with MINI-MIMIC in sub-section 2.9, the ex-ante (i.e. before behavioral responses have been taken into account) reduction in tax revenues is 0.5% of GDP (3.5 billion guilders). A cut in public consumption balances the government budget ex post, i.e. after the effects of the behavioral responses on the public budget have been taken into account. Hence, the required cut in public consumption reflects the impact of behavioral responses on the public budget. In particular, if the reduction in public consumption is less than the ex-ante cut in revenues of 0.5% of GDP, behavioral responses help to mitigate the budgetary costs.

This section consists of three parts. The first part explores cuts in personal income taxes. The second part turns to cuts in social security contributions paid by employers. Finally, the third part investigates various forms of an Earned Income Tax Credit (EITC). These in-work benefits are aimed at increasing the reward of work in general and of low-skilled work in particular.

4.1 Personal income taxation

4.1.1 Cutting marginal tax rates

The detailed modelling of the personal tax system allows MIMIC to explore the labor-market effects of various parameters of the Dutch tax system. The first three columns of Table 4.1 contain the long-run effects of cuts in each of the three tax brackets of the Dutch personal income tax (see sub-section 3.5). These tax cuts reduce both marginal and average tax rates. Hence, they resemble the cut in the marginal tax rate explored in the stylized model in section 2 (see the first column of Table 2.4).

-- insert Tables 4.1 and 4.2 here --

Labor supply

All three tax cuts boost aggregate labor supply (in hours) because the substitution effect dominates the income effect. The composition of additional labor supply, however, differs. In particular, a lower tax rate in the first bracket raises especially labor supply of partners. This is because partners tend to work part-time jobs with relatively low (annual) labor incomes. Hence, their marginal labor income is typically subject to the tax rate in the first bracket. A cut in this tax rate therefore

[27]The foreign sector in MIMIC is similar to that in MINI-MIMIC.

[28] A new long-run equilibrium is established after approximately 20 simulation periods.

encourages partners to work longer hours, especially in view of the relatively large uncompensated wage elasticity of partner's labor supply.

Breadwinners and older workers tend to earn higher labor incomes than partners do. Indeed, the incomes of many of these workers fall in the second or third tax bracket. A lower tax rate in the first bracket reduces the average tax rate without affecting the marginal tax rate of those who fall in the second or third bracket. The inframarginal character of the tax cut in the first bracket for many breadwinners explains why such a cut barely affects aggregate labor supply of breadwinners and older workers; the income effect is relevant for all breadwinners and older workers while the substitution effect applies only to those workers whose marginal labor income falls in the first bracket.

In contrast to tax cuts in the first bracket, tax cuts in the second and third brackets are effective in stimulating labor supply of breadwinners and older workers. Although these groups feature relatively low labor-supply elasticities, the impact of tax cuts in the higher tax brackets on aggregate labor supply (in hours) is substantial because breadwinners, single persons and elderly account for a large share of aggregate labor supply (in hours). Indeed, compared to tax cuts in the first bracket, tax cuts in the second and third brackets reduce the average marginal tax rate (i.e. the marginal tax rate averaged over the various workers) substantially more (see Table 4.1).

Tax cuts in the higher brackets discourage partners to supply labor because the income effect rather than the substitution effect mainly impacts the labor supply of partners. In particular, by raising the incomes of breadwinners, the tax cuts in the higher brackets reduce partners' labor supply through the channel of higher household incomes. At the same time, the substitution effect is not important because only few partners earn sufficiently high incomes to be marginally taxed in the second or third brackets.

These simulations illustrate the added value of the extensive labor-supply model of MIMIC, which accounts for heterogeneity in preferences and wages, incorporates the actual Dutch tax system, and explicitly models labor supply of partners. The incorporation of the actual income distribution and the institutional detail of the Dutch tax system allows MIMIC to determine to what extent cuts in particular tax brackets are (infra)marginal. Furthermore, the explicit modelling of labor-supply behavior of partners and breadwinners modifies the predictions from aggregate models. To illustrate, tax cuts in the first brackets are more inframarginal and thus reduce marginal tax rates substantially less than tax cuts in the higher brackets do. Nevertheless, MIMIC indicates that tax cuts in the first bracket are not substantially less effective in stimulating aggregate labor supply. The reason is that tax cuts in the first bracket reduce marginal tax rates of partners -- the group featuring the most elastic labor supply.

Black labor supply and training

All three tax cuts reduce the size of the black economy. Supply of black labor declines because lower marginal income taxes make formal labor supply more attractive. Firm demand for black labor decreases because formal wage costs fall on account of a lower average tax burden. This encourages firms to hire formal rather than informal labor. Tax cuts in the higher brackets are most effective in combatting the black economy because these tax cuts reduce the marginal tax rates most.

The lower marginal tax rate also raises the marginal return on training activities. Accordingly, human capital and labor productivity increase. As a result, the expansion of production exceeds the rise in employment. These results contrast with the corresponding results of MINI-MIMIC, which abstracts from endogenous accumulation of human capital.

Unemployment

The income tax cuts reduce equilibrium unemployment for two main reasons. The first, which also operates in MINI-MIMIC, is the drop in the average tax burden which moderates contractual wages (see wage equation (2.16)). The lower marginal tax wedge produces upward wage pressure.

However, the positive elasticity of the average tax burden in wage equation (2.16) substantially exceeds the absolute value of the negative elasticity of the marginal tax burden. Hence, the overall effect of the tax cut is to moderate wages, thereby reducing equilibrium unemployment. Cutting taxes in the first bracket is most effective in reducing unemployment because it combines the decline in the average tax burden (the magnitude of which is similar for tax cuts in each of the three brackets) with the smallest decline in the marginal tax rate.

The second factor explaining the decline in unemployment is the lower replacement rate; workers tend to benefit more from lower marginal rates of personal income tax than transfer recipients do because the incomes of workers tend to exceed those of transfer recipients. This is especially so for tax reductions in the second bracket of the income tax. The tax rate in the third bracket exerts only a relatively small effect on the replacement rate because this income range is largely irrelevant for unemployed persons. MINI-MIMIC, which contains neither an actual income distribution nor the institutional detail of the Dutch tax system, does not capture how changes in statutory tax rates impact replacement rates.

Employment

The three tax cuts raise aggregate employment through the channels of both lower unemployment and higher labor supply. In fact, all tax cuts generate a similar increase in aggregate employment. However, the composition of the employment gains differs. A tax cut in the first bracket is most effective in reducing unemployment and in raising employment for the unskilled, low skilled and partners. The other tax cuts are somewhat more effective in boosting aggregate labor supply (in hours) and high-skilled employment and in combatting the black economy. Just as the results from MINI-MIMIC, these MIMIC simulations thus reveal a trade-off between cutting unemployment and raising formal labor supply. In MIMIC, however, the trade-off is less sharp than in MINI-MIMIC. This is because cuts in the first bracket, although cutting marginal tax rates less substantially than cuts in higher brackets, are still quite effective in stimulating aggregate labor supply because these tax cuts reduce marginal tax rates for partners, which feature relatively elastic labor supply (see above).

Long-run income effects

Table 4.2 contains the long-run impact on average real disposable incomes of various types of households. Compared to tax cuts in the higher brackets, cutting taxes in the first bracket benefits transfer recipients and partners more. This is because these groups tend to earn lower incomes than breadwinners and older workers do. These latter groups benefit more from tax cuts in the higher brackets. These latter tax cuts may even reduce the incomes of benefit recipients because social benefits are linked to average contractual wages, which decline on account of wage moderation.

4.1.2 Introducing a tax credit

This sub-section explores the effects of introducing a tax credit (see the fourth column in Table 4.1). Partners who do not earn sufficient labor income to fully use the tax credit can transfer the tax credit to the breadwinner. The tax credit is thus in fact refundable for households with non-participating partners. Hence, this tax credit reduces the average tax burden but leaves the marginal tax burden unaffected, even for partners with small part-time jobs. The tax credit applies to both transfer recipients and workers. It is thus similar to the across-the-board credit analyzed in MINI-MIMIC (see the second column of Table 2.4).

Formal labor supply declines because the tax credit exerts only income effects on labor supply. The black economy expands although the marginal tax rate and thus the allocation of labor between the formal and informal sectors remains constant. Black consumption rises because the lower average tax burden raises the demand for consumption commodities from not only the formal but also the informal sector. Hence, not only the formal private sector, but also the informal sector grows.

Unemployment declines despite an increase in the average replacement rate. The unemployed benefit relatively more from a tax credit than those in work because the unemployed typically collect lower incomes than the employed. The main reason for lower equilibrium unemployment is that the lower average tax burden together with the constant marginal tax burden moderates contractual wages (see equation (2.16)).

To summarize, a lower average tax rate at a constant marginal tax rate reduces both labor supply and unemployment. On balance, aggregate employment expands. The main difference with the cuts in tax brackets is thus that labor supply falls.

These MIMIC results are broadly consistent with the corresponding results from MINI-MIMIC. However, the drop in unemployment and the associated rise in employment are smaller in MIMIC, in part because MIMIC accounts for the positive impact of the tax credit on the replacement rate.

4.2 Lower taxes for employers

Table 4.3 explores three alternative ways to reduce the tax burden on employers. The first two columns analyze two ways to cut social security contributions (SSC) paid by employers, namely an across-the-board reduction in the rate of SSC and a targeted reduction of SSC for unskilled workers. A third experiment involves a two-year subsidy for firms that hire a long-term unemployed person.

-- insert Tables 4.3 and 4.4 here --

4.2.1 Across-the-board reductions of employers' SSC

The first column of Table 4.3 shows the effects of an across-the-board cut in the rate of SSC paid by employers. Cuts in the rate of SSC reduce the average tax rate more than the marginal tax rate, thereby raising the coefficient of progression. This is because the contributions are paid only on labor incomes up to DFL 80.000. Indeed, the impact of the cut in the SSC rate on the marginal tax rate and hence on the labor market is quite similar to a weighted average of a reduction in the tax rate in the first bracket (explored in sub-section 4.1.1) and an across-the board tax credit (explored in sub-subsection 4.1.2). In terms of MINI-MIMIC, this experiment thus combines elements from the cut in marginal tax rates (the first column of Table 2.4) with elements from the across-the-board tax credit (the second column of Table 2.4). Indeed, the MIMIC results closely resembles a weighted average of these two experiments with MINI-MIMIC.

The lower SSC burden directly reduces labor costs. Accordingly, employment for all types of labor expands while unemployment falls. Workers succeed in collecting part of the SSC cut in the form of higher net wages (see the income effects in Table 4.4). In particular, employees raise their wage claims in contractual wage formation as the higher profit margin raises the rents that are bargained over. Moreover, incidental wages rise as firms try to attract more applicants to fill the increasing number of vacancies. Also recipients of social security benefits gain (see Table 4.4) because of the institutional link between benefits and gross contractual wages. Higher wages mildly stimulate labor supply because the substitution effect dominates the income effect.

4.2.2 Targeted SSC cut

In order to enhance the employability of low productivity workers, the SSC cut can be targeted at unskilled labor. This sub-section investigates a targeted SSC cut for low-skilled labor, which amounts to DFL 2,500 for full-time workers who earn an hourly wage up to 120% of the statutory minimum wage. The SSC cut is reduced proportionally for workers who work less hours than 36

hours a week.[29] It is phased out linearly between hourly wages of 120% and 180% of the statutory minimum wage. The phasing out of the cut raises the marginal tax rates on higher hourly wages in this range. However, it does not raise the marginal tax rate on hours worked because the SSC cut is based on hourly wages and hence increased proportionally for workers who work longer hours. This targeted tax cut is thus similar to the targeted tax credit for unskilled labor explored in MINI-MIMIC (see the third column of Table 2.4), which reduces the average tax burden only on unskilled labor without raising the marginal tax rate on hours worked.

A comparison between the first and second columns of Table 4.3 reveals that a targeted SSC cut is more effective in raising employment than an across-the-board SSC cut, especially as far as unskilled employment is concerned. The cut in SSC for unskilled workers boost the demand for these workers through substitution towards unskilled labor. Moreover, lower labor costs at the minimum wage level facilitate job matching. In particular, the lower wage costs reduce the minimum productivity standards due to minimum wage scales. Accordingly, an increasing number of unskilled unemployed, which often feature rather low productivities, meet the minimum productivity standards of employers. In this way, they become employable because the minimum productivity standard is the most restrictive factor in determining the overall acceptance rate for the unskilled (see sub-section 3.4).

The matching process is facilitated further by a reduction in the replacement rate for unskilled workers. Just as in MINI-MIMIC (with benefits linked to gross wages), this replacement rate drops because backward shifting of the tax cut boosts net wages collected by the unskilled; since social benefits are linked to average contractual wages in the economy as a whole, the higher relative wages of the unskilled widen the gap between income from unskilled work and unemployment benefits. The lower replacement rate moderates reservation wages and raises the search intensity of the unemployed.

The targeted SSC cut suffers from a number of drawbacks. First, by gradually reducing the tax allowance, the marginal tax rate on increases in hourly wages rises. Accordingly, increasing the net hourly wage is rather expensive because it substantially raises SSC. The high marginal tax burden on higher hourly wages harms the incentives for employers to train unskilled employees. Accordingly, the productivity level of unskilled workers drops. Indeed, Table 4.3 reveals that production rises less than employment, which reflects the loss in human capital of the unskilled. Moreover, private consumption rises less than under an across-the board cut in SSC. Furthermore, less on-the-job training hampers the upgrading of unskilled workers into low-skilled labor. Since unskilled workers face a higher replacement ratio than low skilled workers do, this tends to mitigate the decline in the average replacement ratio, thereby moderating the employment gains.

Another disadvantage of a high marginal tax burden for employers is that it stimulates substitution between formal labor and informal labor. In particular, a high marginal tax burden encourages firms to pay additional wage income above the formal minimum wage in an informal fashion.[30]

These two drawbacks of a targeted SSC cut are not captured by the stylized model in section 2. Another difference between MIMIC and MINI-MIMIC is that aggregate labor supply in MIMIC remains constant while it declines in MINI-MIMIC. The reason is that MIMIC accounts for the impact of the SSC cut on the incentives of partners with low hourly wages to enter the labor force.

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[29] The Dutch government recently introduced a reduction in employer's SSC that is structured similarly: the so-called SPAK (SPeciale AfdrachtsKorting). The maximum SSC cut is DFL 3,660 per year for a full-time worker earning the minimum wage.

30 In addition, firms face an incentive to overstate the number of hours worked. The MIMIC simulations abstract from this incentive.

4.2.3 Subsidies for hiring long-term unemployed

Snower (1994) proposes marginal labor subsidies for hiring the long-term unemployed. In this way, the funds currently used for paying passive unemployment benefits are diverted towards recruitment subsidies for the long-term unemployed. We analyze the impact of a hiring subsidy for an employer who hires a worker who has been unemployed for more than two years. The annual subsidy amounts to DFL 15,000, which corresponds to 100% of the social assistance level in the Netherlands, and applies to the first two years of the employment contract.

The simulation results presented in the third column of Table 4.3 indicate that the hiring subsidy for long-term unemployed is more effective in fighting unskilled unemployment than the other policies analyzed here.[31] Indeed, the cut in labor costs for long-term unemployed, which typically are unskilled and feature low productivity, is substantial during the first two years of employment. As a result, the minimum productivity standard for the long-term unemployed falls. This substantially raises the efficiency of the matching process because the minimum productivity standard (and thus the acceptance rate of the employer) is the most restrictive factor in determining the overall acceptance rate for the long-term unemployed (see sub-section 3.4).

In contrast to the targeted cut in SSC, the marginal labor subsidy does not raise the marginal tax rate for the employer. Accordingly, it neither stimulates the black economy nor harms the incentives to accumulate human capital. Instead, long-term unemployed who find a job are able to restore some of the human capital they lost during prolonged unemployment.

Despite the substantial decline in unskilled unemployment, the results are less favorable than Snower (1994) maintains. In particular, the fall in public consumption indicates that, in contrast to what Snower suggests, the hiring subsidy does not pay for itself. A major reason is the large dispersion in the productivity distribution for the long-term unemployed, implying that only a relatively small part of the long-term unemployed becomes employable. Moreover, the average productivity of the long-term unemployed is rather low. Hence, enhancing the employability of the long-term unemployed is rather expensive. Another factor limiting the employment impact is that part of the subsidy is shifted backwards to the employees, thereby containing the decline in wage costs. Finally, the higher transition rate of long-term unemployment into employment crowds out opportunities of short-term unemployed to find a job, thereby moderating the impact on the overall unemployment rate.

4.3 Earned Income Tax Credit

Table 4.5 contains the long-term effects of introducing various forms of a tax credit that applies only to workers -- the so-called Earned Income Tax Credit (EITC). In several EU countries, this instrument is increasingly perceived as an attractive instrument to combat unemployment by raising the return to low-skilled work.

-- insert Tables 4.5 and 4.6 here --

4.3.1 A flat EITC

The first column of Table 4.5 contains the impact of a flat EITC of 500 guilders per year (corresponding to about 1% of the median gross wage). This EITC resembles the uniform tax credit from skilled and unskilled workers (not applying to transfer recipients) in MINI-MIMIC (see the second column of Table 2.5).

This non-refundable EITC reduces the marginal tax rate on small part-time jobs so that partners find it more attractive to enter the labor force. Accordingly, the participation rate (i.e. labor supply in persons) increases. The income effect reduces labor supply of other groups, thereby offsetting higher labor supply of partners. As a result, aggregate labor supply (in hours) remains constant.

[31] Jongen and Graafland (1998) discuss these results in more detail.

Unemployment declines substantially. The reason is that the EITC accrues only to those in work and hence reduces the replacement rate. The lower replacement rate enhances job matching by reducing the reservation wage and by encouraging the unemployed to search more intensively for a job. Moreover, it moderates contractual wages. This wage moderation reduces the incomes from transfers recipients (see Table 4.6) because social benefits are linked to gross wages.

The comparison between the across-the-board tax credit (explored in sub-section 4.1.2) and an EITC identifies a trade-off between cutting unemployment and raising transfer incomes. Whereas the EITC succeeds in cutting unemployment more than an across-the-board credit, it is less effective than an across-the-board tax credit in protecting the incomes of the unemployed. The probability of finding a job rises, however, so that a number of previously unemployed will experience a substantial rise in their income.

Comparing the results from MIMIC and MINI-MIMIC, we observe that the fall in unskilled unemployment is smaller and the fall in skilled unemployment larger in MIMIC. This is because wages are negotiated on a more central level in MIMIC. Hence, the decline in the replacement rate for unskilled workers moderates unskilled wages costs relatively more in MINI-MIMIC and skilled wage costs relatively more in MIMIC.

In MIMIC, the decline in the replacement rate, which results from targeting tax cuts at workers only instead of at both workers and transfer recipients, exerts a larger effect on equilibrium unemployment than in MINI-MIMIC (compare the difference between the second columns of Table 2.4 and 2.5 with the difference between the fourth column of Table 4.1 and the first column of Table 4.5). This is because the replacement rate in MIMIC affects not only wage formation but also job matching through the reservation wage and the search intensity of the unemployed.

The labor-supply effects differ between MIMIC and MINI-MIMIC. Whereas MINI-MIMIC shows a decline in aggregate labor supply, MIMIC predicts that the participation rate rises while labor supply in hours remains constant. The more positive labor-supply effects in MIMIC are due to the elaborate labor supply model, which accounts for partners' labor supply and heterogeneous preferences for leisure. In particular, an EITC stimulates those partners who are indifferent between non-participation and working a small job to join the labor force. Thus, reducing tax rates on low annual incomes can be effective in raising aggregate labor supply, even though such tax cuts do not affect marginal tax rates for most workers and harm labor supply through the positive income effects.

4.3.2 A targeted EITC based on annual labor incomes

The second column of Table 4.5 explores the impact of an EITC that focusses on raising the reward to low-skilled work. The EITC analyzed here depends on annual labor income of an individual.[32] It amounts to 20 % of annual labor income of the individual in a phase-in range up to the statutory minimum wage (DFL 30,000) and stays at DFL 1,200 in a flat range up to incomes of about DFL 36,000 (120 % of the minimum wage). Subsequently, the EITC is phased out linearly between annual labor incomes of DFL 36,000 and DFL 54,000 (i.e. 180 % of the minimum wage).

The EITC reduces the marginal tax burden on small part-time jobs, thereby encouraging partners to join the labor force. Accordingly, the participation rate increases. However, the average length of the work week falls. Only partners raise their average labor supply (in hours) because many partners fall in the phase-in range of the EITC. Breadwinners and singles, in contrast, reduce their labor supply because of a positive income effect and, to the extent that they fall in the phase-out range, a negative substitution effect associated with a higher marginal tax rate. On balance, the reduction in labor supply on account of the substitution effect in the phase-out range

[32] Hence, this EITC differs from the EITC implemented in the US, which depends on family income and the number of children in a family.

and the income effect dominates the positive effect on the participation rate. Hence, aggregate labor supply (in hours) drops.

The high marginal tax rate in the phase-out range reduces the incentives for training. Indeed, the human capital index falls because a larger part of wage increases due to productivity gains accrues to the government in the form of a lower EITC. Accordingly, compared to the flat EITC, the targeted EITC exerts smaller positive effects on production and consumption. The higher marginal tax rate in the phase-out range also boosts informal activities.

Compared to the fixed EITC, the targeted EITC is more effective in reducing the replacement rate for low-paid work. Accordingly, unemployed search more intensely for a job and reduce their reservation wage, thereby facilitating job matching. Furthermore, the lower replacement rate weakens the bargaining position of the unions in collective bargaining. Hence, contractual wages fall. Through all these channels, unemployment declines. Unemployment for the unskilled falls by 1.3 percentage points, which compares to a drop of 0.8 percentage points with a flat EITC.

The comparison between the flat and targeted EITC reveals once again a trade-off between, on the one hand, raising labor supply and, on the other hand, fighting unemployment. In particular, by widening the income gap between low labor incomes and social benefits, a targeted EITC is more effective in fighting unemployment. However, by reducing the income gap between low and high labor incomes, this EITC yields lower labor supply than a flat EITC does.

4.3.3 A targeted EITC based on hourly wages

If the objective is to reduce the number of unskilled who collect unemployment benefits, the targeted EITC explored above suffers from the disadvantage that it accrues also to part-time workers with high hourly wages but low annual incomes. This is relevant especially in the Netherlands, which features the highest share of part-time work of all OECD countries. Hence, in the Dutch policy discussion, a targeted EITC that depends on hourly wages rather than annual incomes has been proposed. Workers who earn the hourly minimum wage and hold a full-time job are eligible for the full EITC. The credit is reduced proportionally for workers who work less than a full-time job. It gradually drops also with the level of the hourly wage rate.

By reducing the credit for part-time workers, the EITC for full-time workers who earn an hourly wage up to 120 % of the statutory minimum wage can be more than doubled to DFL 2,500. The phase out range runs up to an hourly wage of 180% of the minimum wage.[33] This EITC is thus phased out in the same way as the targeted SSC cut, which is also based on hourly wages. Just as the targeted SSC cut, this targeted EITC does not raise the marginal tax rate on hours worked in the phase-out range. In MINI-MIMIC, it resembles the tax credit targeted at low-skilled workers (see the third column of Table 2.5), which reduces the average tax burden only on unskilled labor without raising the marginal tax rate on hours worked.

Labor supply

This EITC reduces the marginal tax burden only on part-time jobs with low hourly wages. Hence, the effect on the participation rate is smaller than in the previous experiment. The higher marginal tax rate in the phase-out range applies only to higher hourly wages and not to higher labor incomes on account of more hours worked. Accordingly, labor supply (in hours) drops only on account of the income effect. Both the effects on participation and labor supply (in hours) are thus smaller (in absolute value) than in the previous experiment. On balance, the positive effect on participation rate and the negative labor supply effect associated with the income effect cancel out. Consequently, aggregate labor supply (in hours) is unaffected.

[33] The Dutch cabinet included a very similar EITC in its recent white paper on the future of the Dutch tax system.

Human capital

The marginal tax rate on higher hourly wages in the phase-out range is higher than in the previous experiment because the maximum credit is twice as large. This harms the incentives to accumulate human capital. Hence, compared to an EITC that depends on annual incomes, an EITC that depends on hourly wages does less harm to the quantity of labor supply but more harm to the quality of labor supply.

Another drawback of this variant of the EITC is that it relies on additional information (namely the number of hours worked in the formal sector) that is vulnerable to fraud. Indeed, the black economy expands substantially.

Unemployment

This EITC reduces the replacement rate for unskilled workers more substantially than the other EITCs explored above. Through skill-specific wage formation, this decline in the replacement rate for unskilled work reduces gross unskilled wages, thereby boosting demand for unskilled labor. Moreover, the lower replacement rate stimulates search and lowers the reservation wage, thereby facilitating the matching process for unskilled labor. Accordingly, the unemployment rate for the unskilled and the low skilled drops more substantially than under the EITCs analyzed above.

Trade-offs

The comparison between an EITC that depends on annual incomes and an EITC that depends on hourly wages reveals a trade-off between two objectives of the Dutch government, namely between, on the one hand, increasing the participation rate of partners and, on the other hand, reducing the unemployment rate for the low skilled. An EITC that depends on annual incomes advances the first objective while an EITC that depends on hourly wages is more effective in cutting low-skilled unemployment.

Another trade-off involves the quality versus the quantity of labor supply. Compared to an EITC that depends on annual incomes, an EITC that depends on hourly wages enhances the quantity of labor supply (in hours) but harms its quality (in terms of human capital).

Comparison with MINI-MIMIC

Targeting the tax cuts at the unskilled is somewhat less effective in cutting aggregate unemployment in MIMIC than in MINI-MIMIC, although in MIMIC the lower replacement rate for the unskilled enhances job matching by reducing the reservation wage and raising the search intensity of unskilled jobseekers (see above). There are two reasons for this. The first reason is that wage formation in MIMIC occurs more on the macro-economic level.[34] Cutting the average tax burden and the average replacement rate is more expensive than cutting the corresponding variables for unskilled labor. Moreover, cutting the average replacement is less effective in moderating average wages because average unemployment is smaller than unskilled unemployment (see wage equation (2.16), which implies that cuts in the replacement rate moderate wages more substantially at high unemployment rates).

The second reason why targeting is less effective in MIMIC is that MIMIC accounts for the adverse impact of targeting on human capital accumulation. Hence, targeting implies that more workers remain unskilled. Since unskilled workers feature the highest replacement rates, the higher share of unskilled workers raises the average replacement rate, thereby putting upward pressure on equilibrium unemployment.

[34] This explains also why unskilled unemployment declines less and skilled unemployment more in MIMIC than in MINI-MIMIC.

4.3.4 Targeting the EITC

The last two columns of Table 4.5 show the effects of two EITC's (based on hourly wages) that are phased out more rapidly than the previous experiment, namely, between 115% of the minimum wage and 150% of the minimum wage (the fourth column) or between the minimum wage and 130% of the minimum wage (the fifth column). The advantage of more targeting is that the maximum credit for people who earn the minimum wage rate can be larger, thereby cutting the replacement rate of the unskilled more substantially. The disadvantage is that the marginal tax rate in the phase-out range increases more sharply and the (larger) decline in the replacement rate applies to less persons.

A moderately targeted version of the EITC (in the fourth column of Table 4.5) is slightly more effective in reducing the aggregate unemployment rate than the most targeted EITC (in the fifth column of Table 4.5). Also compared to the less targeted EITC (in the third column of Table 4.5), the moderately targeted EITC is more effective in reducing the aggregate unemployment rate. This suggests that an inverse U-shaped curve describes how the effectiveness of the EITC in cutting unemployment varies with the degree of targeting. Hence, moderately targeting the EITC seems the most effective way to reduce the overall unemployment rate.

4.3.5 Targeted SSC cut versus targeted EITC

A comparison between the targeted cut in SSC paid by employers (see sub-section 4.2.2) with a similar targeted EITC (see sub-section 4.3.3) reveals that the SSC cut is more effective in fighting unemployment among the unskilled but less effective in reducing aggregate unemployment. The SSC cut enhances the efficiency of the matching process primarily through lower minimum wage costs. This substantially reduces unskilled unemployment because the minimum productivity standard is the most restrictive factor in the matching process for the unskilled.

The EITC improves the matching process primarily through a lower replacement rate reducing the reservation rate of the unemployed. A lower reservation wage is less important for the matching process of the unskilled than a lower minimum productivity standard. However, a lower replacement rate also moderates wages in collective bargaining. This makes the targeted EITC more effective in reducing aggregate unemployment. The substantial decline in the replacement rate produced by the EITC is associated with a decline in the current incomes of transfer recipients. In case of a targeted SSC, in contrast, benefit recipients are better off because gross wages (to which benefits are linked) rise rather than fall.

Just as in MINI-MIMIC, a targeted EITC reduces aggregate unemployment more substantially than a targeted SSC cut does because a targeted EITC directly reduces the replacement rate. However, MIMIC differs from MINI-MIMIC in that a targeted SSC cut is more effective in fighting unskilled unemployment than a targeted EITC. The reason is wage bargaining on the macro level together with the important role of a high minimum productivity standard in inhibiting matching of unskilled jobs.

5. Conclusions

5.1 Policy conclusions

The simulations with MIMIC reveal several trade-offs between various objectives. These objectives include cutting unemployment in general and low-skilled unemployment in particular, stimulating the participation of women in the labor force, raising the quality and quantity of labor supply, and establishing an equitable income distribution, including a reasonable income level for those dependent on social benefits.

Indeed, these objectives imply different priorities for how tax cuts should be structured. In particular, cutting unemployment primarily requires widening the gap between labor incomes and transfer incomes in unemployment. Stimulating labor-force participation of women calls for

widening the gap between, on the one hand, after-tax incomes of households with two partners who are active on the formal labor market and, on the other hand, after-tax incomes of households with a non-participating partner. Such a larger income gap encourages the latter partner to start participating in the labor force so that the latter households turn into the former households. Raising the quantity and quality of labor supply in the formal economy calls for widening the income differentials between low formal labor incomes and high formal labor incomes.

The most effective way to fight economy-wide unemployment are in-work benefits. These benefits widen the gap between after-tax income from work and net transfer income, thereby raising the reward to work compared to relying on social benefits. This moderates wage costs, reduces reservation wages and encourages search of jobseekers. The wage moderation reduces social benefits because these benefits are linked to (gross) wages.

Targeting in-work benefits at the low skilled is the most effective way to cut economy-wide unemployment. This is because the gap between labor income and transfer income is smallest for low-skilled workers. Hence, widening this small gap produces the largest pay-off in terms of reducing unemployment. However, by decreasing the gap between low and high labor incomes through a more progressive tax system for workers, a targeted EITC reduces the hours of labor supplied. This trade-off between cutting unemployment and raising labor supply (in hours) can be mitigated by linking the EITC to hourly wages rather than annual incomes and by reducing the EITC proportionally for small part-time jobs. Doing so, however, raises the marginal tax burden on hourly wage increases, thereby discouraging the accumulation of human capital and stimulating the black economy. Moreover, the lower benefits to small part-time jobs do not help to raise the labor-force participation of women. This is in contrast to an EITC targeted at low annual incomes which, together with tax cuts in the first tax bracket, exerts the strongest positive impact on female labor-force participation of all policies explored in this paper. This points to a trade-off between targeting tax cuts at small part-time jobs of partners or at full-time jobs of breadwinners and singles earning low hourly wages.

Tax cuts in the higher tax brackets are most effective in raising the quantity and quality of formal labor supply (in hours). Indeed, these policies widen the after-tax income differentials between low and high labor incomes by reducing marginal tax rates. However, cuts in higher tax brackets are less effective in reducing unemployment (by widening the income gap between being in work and collecting unemployment benefits), raising low-skilled employment, and stimulating female labor supply.

5.2 Modelling conclusions

As in MINI-MIMIC, all tax cuts in MIMIC raise employment and reduce unemployment. Moreover, a cut in marginal and average rates both boosts labor supply and reduces unemployment. Furthermore, a refundable tax credit increases employment even though it reduces labor supply.

The MIMIC simulations, however, differ in important respects from the simulations with MINI-MIMIC. The differences between the results from MINI-MIMIC and MIMIC illustrate the added value of working with a larger model that accounts for more heterogeneity (in terms of wages, preferences, job matching, household types, long- and short-term unemployed), more economic processes (matching, black economy, training, mobility between skills), and more institutional detail, which allows one to explore more policy measures (e.g. subsidies for the long-term unemployed, cuts in particular tax brackets). Furthermore, by using micro data on income distributions, the large model is more appropriate to explore the impact of specific tax proposals on the economy through its impact on the marginal and average tax burdens and replacement rates. This makes the model more relevant for policy analysis than MINI-MIMIC. The large model is especially useful when combined with MINI-MIMIC because this allows for a better understanding of the main driving forces behind the economic effects of tax policies.

An important priority for future research is further strengthening the empirical base of the MIMIC model. Some of the recent extensions of the model, including human capital accumulation, suffer from a rather weak empirical basis. Indeed, only little empirical evidence is available for several important parameters.

Another priority is to better model active labor-market policies that tailor to the needs of vulnerable individuals by employing more information on the earning capacities of specific individuals. Finally, MIMIC will be used to explore the welfare implications of tax reforms and to derive optimal tax policies.

References

Aalst, M. van de and H. Hermsen, 1994, Work after job search: behavior of the unemployed and their probability to find a job (in Dutch), Ministry of Social Affairs and Employment, Research Memorandum 333, The Hague

Baartmans, K., F. Meyer and A. van Schaik, 1986, *Houserepair and the informal sector* (in Dutch), University of Delft

Berg, G.J. van den, 1990, Search behavior, transitions to non-participation and the duration of unemployment, *The Economic Journal*, 100, pp. 842-865

Boone, J., 1998, A simple dynamic optimization model to determine household's saving, mimeo, CPB

Devine, T.J. and N.M. Kiever, 1991, *Empirical labor economics*, Oxford University Press, Oxford

Draper, D.A.G., 1994, Savings, pension rights and taxation, *De Economist*, Vol. 142, no.2, pp. 171-92

Draper, D.A.G., 1996, The export market (in Dutch: De exportmarkt), CPB Research Memorandum no. 130, The Hague.

Draper, D.A.G. and A.J.G. Manders, 1996, Structural changes in the demand for labor, Research Memorandum, no. 128, CPB

Eijgenraam, C.J.J. and E.M. Verkade, 1988, *Beta, a multisector model for the Dutch Economy* (in Dutch), Occasional Paper 44, CPB

Frederiksen, N.K, P.R. Hansen, H. Jacobsen and P.B. Sørensen, 1995, Subsidising consumer services: effects on employment, welfare and the informal economy, *Fiscal Studies* 16, pp. 271-293.

Gelauff, G.M.M. and J.J. Graafland, 1994, *Modelling Welfare State Reform*, North Holland

Graafland, J.J. and F.H. Huizinga, 1996, Taxes and benefits in a non-linear wage equation, Research Memorandum, no. 125, CPB

Graafland, J.J. and M.H.C. Lever, 1996, Internal and external forces in sectoral wage formation: Evidence from the Netherlands, *Oxford Bulletin of Economics and Statistics* 58, pp. 241-52

Groot, W., 1990, The effects of benefits and duration dependence on re-employment probabilities, *Economics Letters* 32, pp. 371-76

Groot, W. and E. Mekkelholt, 1995, The rate of return to investments in on-the-job training, *Applied Economics* 27, pp. 173-181.

Haveman, R., 1996, Reducing poverty while increasing employment: a primer on alternative strategies, and a blueprint, OECD Economic Studies, no. 26, 1996/1.

Hersoug, T., K.N. Kjaer and A. Rødseth, 1986, Wages, taxes and the utility-maximizing trade union: a confrontation on Norwegian data, *Oxford Economic Papers* 38, pp. 37-51

Holmlund, B., Linden, J., 1993, Job Matching, Temporary Public Employment, and Equilibrium Unemployment, *Journal of Public Economics*, 51, pp.329-343, North-Holland.

Jongen, E.L.W and J.J. Graafland, 1998, Vouchers for the long-term unemployed: a simulation analysis with MIMIC, Research Memorandum 139, CPB, The Hague

Kerckhoffs, C., C. de Neuburg and F. Palm, 1994, The determinants of unemployment and jobsearch duration in the Netherlands, *De Economist*, 142, pp. 21-42

Koopmans, C.C., 1994, Direct measurement of hidden labour, *Applied Economics* 26, pp. 575-581.

Layard, R., S. Nickell and R. Jackman, *Unemployment*, Oxford University Press, Oxford

Mooij, R.A. de, 1997, Taxation and human capital accumulation (in Dutch), *Maandschrift Economie*, no. 61, pp. 224-240.

Nieuwenhuis, A. and J. Boone, 1998, Tax policy and the labor market: a sensitivity analysis with an AGE model, CPB Research Memorandum, forthcoming.

Ours, J.C. van, 1991, The efficiency of the Dutch Labour market in Matching Unemployment and Vacancies, *De Economist*, 139, pp. 358-378.

Pissarides, C.A., 1990, *Equilibrium Unemployment Theory*, Basil Blackwell, Oxford.

SCP, 1995, Time allocation survey, Social and Cultural Studies 22, Social Cultural Planning Bureau, Rijswijk

Schluter, G., 1997, On the performance of social benefit systems, *Economic Journal* 107, pp. 489-502.

Snower, D.J., 1994, Converting unemployment benefits into employment subsidies, *AEA Papers and Proceedings*, Vol. 84, pp. 65-70

Snower, D.J, and G. de la Dehesa, 1996, *Unemployment policy: Government options for the Labour Market*, CEPR and Cambridge University Press, Cambridge.

Soest, A. van, 1995, Structural models of family labor supply, a discrete choice approach, *Journal of Human Resources*, Vol. 30, pp. 63-88

Soest, A. van, I. Woittiez and A. Kapteyn, 1990, Labour supply, income taxes and hours restrictions in the Netherlands, *Journal of Human Resources*, Vol. 25, pp. 517-88

Sørensen, P.B., 1997, Public finance solutions to the European unemployment problem, *Economic Policy*, October.

Theeuwes, J, C.C. Koopmans, R. van Opstal and H. van Reijn, 1985, Estimation of optimal human capital accumulation parameters for the Netherlands, *European Economic Review*, pp. 233-257.

Theeuwes, J.J.M. and I. Woittiez, 1992, Advising the minister on the elasticity of labour supply, Research Memorandum 92.06, Leiden University

Woittiez, I., 1990, *Modelling and empirical evaluation of labour supply behavior*, dissertation

Table 2.1 Markets and agents in MINI-MIMIC

	goods market		labor market	
	quantity	price	quantity	price
firms	supply	setting	demand	bargaining
households	demand	taking	supply	bargaining
government	demand	taking		

Figure 2.1: The utility tree in MINI-MIMIC

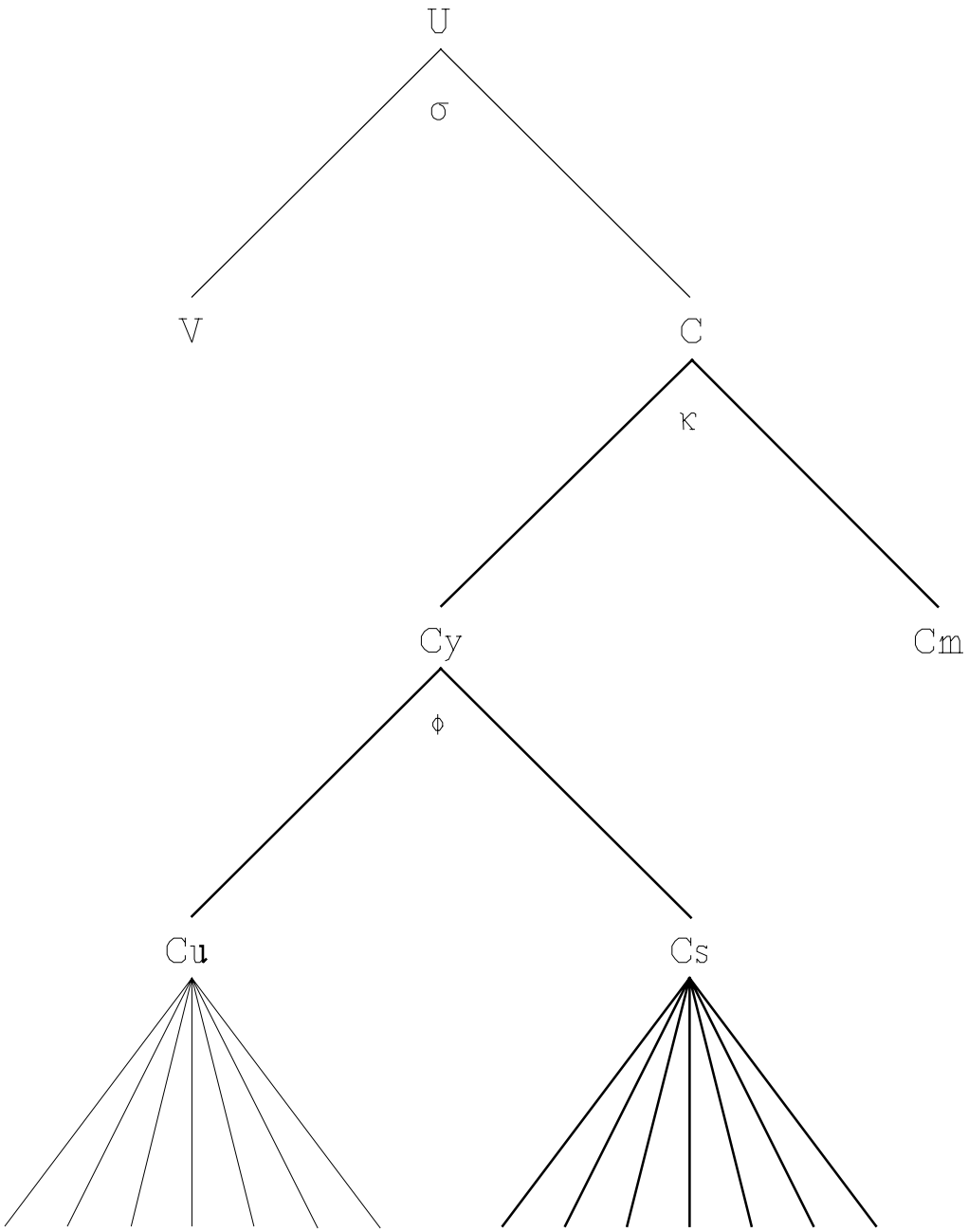

Table 2.2: MINI-MIMIC

Individual firms (for skill type $i = u,s$ and firm $j = 1...N_i$)

Profits $$\Pi_i^j = P_i^j Y_i^j - Pl_i L_i^j \quad (1)$$

Production $$Y_i^j = h_i L_i^j \quad (2)$$

Price equation $$P_i^j = \frac{1}{1 - 1/\eta} \frac{Pl_i}{h_i} \quad (3)$$

Aggregates (for skill type $i = u,s$)

Production $$Y_i = [\sum_j^{N_i} a_{ij}^{1/\eta} Y_i^{j\,(\eta-1)/\eta}]^{\eta/(\eta-1)} \quad (4)$$

Ideal price index $$P_i = [\sum_j^{N_i} a_{ij} P_i^{j\,1-\eta}]^{1/(1+\eta)} \quad (5)$$

Economy-wide aggregates

Profits $$\Pi = \sum_i \sum_j^{N_i} \Pi_i^j \quad (6)$$

Domestic production $$Y = [b^{1/\phi} Y_s^{(\phi-1)/\phi} + (1-b)^{1/\phi} Y_u^{(\phi-1)/\phi}]^{\phi/(\phi-1)} \quad (7)$$

Optimal commodity mix $$\frac{Y_s}{Y_u} = \left(\frac{P_s}{P_u}\right)^{-\phi} \quad (8)$$

Ideal price index $$P_y = [bP_s^{1-\phi} + (1-b)P_u^{1-\phi}]^{1/(1-\phi)} \quad (9)$$

Individual households (for skill type $i = u,s$)

Utility $$U_i = [d^{1/\sigma} C_i^{(\sigma-1)/\sigma} + (1-d)^{1/\sigma} V_i^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)} \quad (9)$$

Notional labor supply $$S_i = 1/[1 + \Delta_i \left(\frac{(1-TM_i)W_i}{P_c}\right)^{-\sigma} \left(\frac{(1-TA_i)W_i}{P_c}\right)] \quad (10)$$

Household aggregates

Aggregate household budget constraint

$$P_c C = \sum_i [(1 - TA_i) Pl_i L_i + B U_i S_i] + \Pi \tag{11}$$

Optimal consumption mix

$$\frac{C_m}{C_y} = \left(\frac{P_m}{P_y}\right)^{-\kappa} \tag{12}$$

Wage formation (per skill type $i = u,s$)

Wage equation

$$\begin{aligned} \log W_i &= \log h_i + \log P_i + \log\left[1 + \theta \frac{P_c}{P_i (1 - TM_i)}\right] \\ &- \log\left[1 + \frac{\chi_1}{\chi_2} \frac{1 - TA_i}{1 - TM_i} [1 - \beta_w (U_i R_i - (1 - U_i))]\right] \end{aligned} \tag{13}$$

Search costs

$$Pl_i = W_i \left(1 + \frac{v_i}{z_i}\right) \tag{14}$$

Unemployment rate

$$U_i \equiv 1 - \frac{L_i}{S_i} \tag{15}$$

Public sector

Government budget constraint

$$P_c G = \sum_i [TA_i Pl_i L_i - B U_i S_i] \tag{16}$$

Unemployment benefits

$$B = \beta_u R^* W (1 - TA) + (1 - \beta_u) Q W \tag{17}$$

Foreign sector

Exports

$$X_y = \left(\frac{P_y}{P_m}\right)^{-\xi} \tag{18}$$

Equilibrium on the goods market

$$Y = C_y + G_y + X_y \tag{19}$$

Aggregates

$$W = \frac{W_u L_u + W_s L_s}{L_u + L_s} \qquad TA = \frac{Pl_u L_u TA_u + Pl_s L_s TA_s}{Pl_u L_u + Pl_s L_s}$$

Table 2.3 Calibration of MINI-MIMIC

Labor-market data

$S_s = 5.2$	$L_s = 4.9$	$U_s = .058$	$W_s = 265$	$Pl_s = 297$
$S_u = 2.1$	$L_u = 1.9$	$U_u = .095$	$W_u = 180$	$Pl_u = 193$

National accounts

$Pl_sL_s = 1455$	$Y = 2500$	$X_y = 1250$	
$Pl_uL_u = 367$	$C = 1523$		
$\Pi = 678$	$G = 977$		

Institutional data

$TM = 0.60$	$F_s = 57$
$TA_s = 0.56$	$F_u = 23$
$TA_u = 0.54$	$R_s = 0.65$
$TA = 0.55$	$R_u = 0.90$

Parameters

$\eta = 5.0$	$\kappa = 1.5$	$\beta_w = 0.94$	$r = 0.1$
$\phi = 1.5$	$\sigma = 4.0$	$\omega = 0.05$	
$\Delta_s = 10.9$	$\gamma = 0.29$	$\upsilon = 0.15$	
$\Delta_u = 9.7$	$\alpha = 0.97$	$\xi = 2.00$	

Table 2.4 Three tax cuts in MINI-MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP (unemployment benefits indexed to *net* wages).

	(1)	(2)	(3)
	percentage changes		
Wage costs	−0.2	−0.1	−0.3
- Skilled	−0.2	0.0	0.0
- Unskilled	−0.3	−0.3	−1.1
Gross wage rate	−0.6	−0.5	−0.8
- Skilled	−0.5	−0.4	0.1
- Unskilled	−0.6	−0.8	−3.6
Net wage rate	1.0	0.9	0.6
- Skilled	1.0	0.9	0.1
- Unskilled	0.8	1.0	2.8
Production price	−0.2	0.0	−0.1
Consumption price	−0.1	0.0	0.0
Private consumption	1.1	0.7	0.6
Exports	0.4	0.1	0.2
Imports	0.1	0.0	0.0
Production	0.4	0.1	0.2
Employment	0.4	0.2	0.5
- Skilled	0.4	0.1	0.0
- Unskilled	0.6	0.5	1.7
Labor supply	0.2	−0.1	−0.3
- Skilled	0.2	−0.1	0.0
- Unskilled	0.2	−0.2	−0.9
Ratios	*absolute changes*		
Unemployment rate	−0.2	−0.3	−0.7
- Skilled	−0.2	−0.2	0.0
- Unskilled	−0.4	−0.6	−2.4
Replacement rate	0.0	0.0	0.0
- Skilled	0.0	0.0	0.3
- Unskilled	0.1	−0.1	−2.0
Average tax rate[a]	−0.7	−0.6	−0.6
- Skilled	−0.7	−0.6	0.0
- Unskilled	−0.7	−0.9	−3.0
Marginal tax rate[a]	−0.7	0.0	0.0
Welfare	*percentage changes*		
Real after-tax private income			
Skilled worker	1.1	0.9	0.1
Unskilled worker	0.9	1.0	2.8
Unemployed	1.1	0.9	0.6
Capitalist	0.3	0.1	0.0
Intertemporal welfare			
Skilled worker	1.2	1.0	0.1
Unskilled worker	1.0	1.1	2.9
Skilled unemployed	1.3	1.1	0.2
Unskilled unemployed	1.0	1.1	3.0
Public welfare			
Public consumption[b]	−0.4	−0.5	−0.3

[a] Weighted average tax rate on hourly wages
[b] Closure rule, in % of GDP

(1) Reduction in the marginal tax rate
(2) Increase in the tax credit for all workers
(3) Increase in the tax credit for unskilled workers

Table 2.5 Three tax cuts in MINI-MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP (unemployment benefits indexed to *gross* wages).

	(1)	(2)	(3)
	percentage changes		
Wage costs	−0.3	−0.2	−0.4
- Skilled	−0.2	0.0	0.0
- Unskilled	−0.6	−0.5	−1.3
Gross wage rate	−1.0	−0.9	−1.2
- Skilled	−0.8	−0.6	−0.1
- Unskilled	−1.3	−1.5	−4.5
Net wage rate	0.7	0.7	0.3
- Skilled	0.9	0.8	−0.1
- Unskilled	0.2	0.5	2.5
Production price	−0.2	−0.1	−0.1
Consumption price	−0.1	0.0	−0.1
Private consumption	1.1	0.8	0.6
Exports	0.5	0.2	0.3
Imports	0.1	0.0	0.1
Production	0.6	0.2	0.3
Employment	0.6	0.3	0.6
- Skilled	0.5	0.1	0.1
- Unskilled	1.1	0.9	2.0
Labor supply	0.2	−0.2	−0.3
- Skilled	0.2	−0.2	0.0
- Unskilled	0.1	−0.3	−1.1
Ratios	*absolute changes*		
Unemployment rate	−0.5	−0.5	−0.9
- Skilled	−0.3	−0.3	−0.1
- Unskilled	−0.9	−1.1	−2.9
Replacement rate	−1.2	−1.1	−1.1
- Skilled	−1.2	−1.0	−0.7
- Unskilled	−1.1	−1.2	−3.3
Average tax rate[a]	−0.7	−0.7	−0.7
- Skilled	−0.7	−0.6	0.0
- Unskilled	−0.7	−0.9	−3.3
Marginal tax rate[a]	−0.7	0.0	0.0
Welfare			
Real private income		*percentage changes*	
Skilled worker	1.0	0.8	−0.1
Unskilled worker	0.4	0.5	2.6
Unemployed	−0.8	−0.8	−1.1
Capitalist	0.4	0.1	0.1
Intertemporal welfare			
Skilled worker	1.0	0.8	−0.1
Unskilled worker	0.3	0.5	2.6
Skilled unemployed	1.1	0.9	−0.1
Unskilled unemployed	0.3	0.5	2.6
Public welfare			
Public consumption[b]	−0.3	−0.4	−0.2

[a] Weighted average tax rate on hourly wages
[b] Closure rule, in % of GDP

(1) Reduction in the marginal tax rate
(2) Increase in the tax credit for all workers
(3) Increase in the tax credit for unskilled workers

Table 4.1 Economic effects of four cuts in the personal income tax according to MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP.

	1	2	3	4
Prices		**percentage changes**		
Wage costs	−0.4	−0.3	−0.2	−0.1
−unskilled	−0.6	−0.3	−0.2	−0.2
−low skilled	−0.4	−0.2	0.0	−0.1
−high skilled	−0.3	−0.3	−0.3	−0.1
Production price	−0.4	−0.4	−0.3	−0.1
Consumption price	−0.3	−0.3	−0.2	−0.1
Volumes				
Private consumption	1.3	1.3	1.3	0.9
Exports	0.6	0.6	0.5	0.2
Imports	0.5	0.6	0.5	0.2
Production	0.8	0.8	0.7	0.2
Employment	0.6	0.6	0.5	0.1
−unskilled	0.8	0.5	0.3	0.1
−low skilled	0.7	0.5	0.1	0.1
−high skilled	0.6	0.7	0.6	0.1
Labor supply (persons)	0.1	0.1	0.0	−0.1
Labor supply (hours)	0.2	0.2	0.3	−0.1
−breadwinners	0.0	0.2	0.4	0.0
−partners	0.7	0.0	−0.3	−0.4
−single persons	0.2	0.4	0.2	−0.2
−55+	0.1	0.4	0.8	−0.1
Black labor (hours)	−0.2	−1.1	−1.9	0.4
Human capital (index)	0.1	0.1	0.1	0.0
Ratios		**absolute changes**		
Unemployment	−0.3	−0.2	−0.1	−0.1
−unskilled	−0.4	−0.3	−0.2	−0.2
−low skilled	−0.3	−0.2	−0.1	−0.2
−high skilled	−0.2	−0.2	−0.1	−0.1
Average replacement ratio	−0.1	−0.4	−0.1	0.3
−unskilled	−0.2	0.0	0.3	0.3
−low skilled	−0.1	−0.3	0.1	0.3
−high skilled	0.0	−0.8	−0.4	0.3
Average tax burden[a]	−0.7	−0.7	−0.6	−0.4
Marginal tax burden[a]	−0.7	−1.9	−2.1	0.0
Government consumption[b]	−0.3	−0.3	−0.3	−0.5

[a] Weighted average of micro tax burdens of the employed.
[b] Closure, in % of GDP.

(1) Reduction in the first tax bracket (by 1,2% points)
(2) Reduction in the second tax bracket (by 6.9% points)
(3) Reduction in the third tax bracket (by 24,6% points)
(4) Introduction of a general tax credit (of 250 guilders)

Table 4.2 Income effects of four reductions in the personal income tax according to MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP.

	1	2	3	4
Real disposable incomes	**percentage changes**			
Breadwinners employed	0.8	1.2	1.4	0.6
Breadwinners with benefit	0.7	0.1	0.1	1.0
Partners employed	2.2	0.3	−0.3	0.7
Partners with benefit	1.0	−0.4	−0.3	1.6
Single persons employed	1.2	1.2	0.3	0.6
Single persons with benefit	0.8	0.0	−0.2	1.4

(1) Reduction in the first tax bracket (by 1.2% points)
(2) Reduction in the second tax bracket (by 6.9% points)
(3) Reduction in the third tax bracket (by 24,6% points)
(4) Introduction of a general tax credit (of 255 guilders)

Table 4.3 Economic effects of three reductions in the tax burden on employers according to MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP.

	(1)	(2)	(3)
Prices		**percentage changes**	
Wage costs	−0.2	−0.8	0.2
−unskilled	−0.4	−2.7	−1.5
−low skilled	−0.2	−0.8	0.8
−high skilled	−0.2	−0.4	0.6
Production price	−0.4	−0.4	−0.4
Consumption price	−0.2	−0.3	−0.3
Volumes			
Private consumption	1.1	0.7	0.9
Exports	0.5	0.6	0.6
Imports	0.4	0.3	0.4
Production	0.6	0.6	0.7
Employment	0.4	0.8	1.1
−unskilled	0.6	3.2	6.1
−low skilled	0.4	0.6	0.7
−high skilled	0.4	0.5	0.4
Labor supply (pers.)	0.1	0.1	0.1
Labor supply (hours)	0.1	0.0	0.1
−breadwinners	0.0	−0.1	0.0
−partners	0.2	0.2	0.3
−single persons	0.1	−0.1	0.1
−55+	0.0	−0.1	0.0
Black labor(hours)	−0.1	2.3	0.0
Human capital (index)	0.1	−0.2	0.1
Ratios		**absolute changes**	
Unemployment	−0.2	−0.6	−0.6
−unskilled	−0.4	−2.0	−4.1
−low skilled	−0.2	−0.5	−0.4
−high skilled	−0.2	−0.3	−0.2
Share long term unemployment	−1.2	−3.2	−6.5
Average replacement ratio	0.0	−0.3	−0.5
−unskilled	0.0	−0.5	2.0
−low skilled	0.0	0.2	−0.2
−high skilled	0.0	0.0	−0.2
Average tax burden[a]	−0.5	−0.5	−1.0
Marginal tax burden[a]	−0.2	2.5	−0.3
Government consumption[b]	−0.3	−0.1	−0.2

[a] Weighted average of micro burdens of employees.
[b] Closure, in % GDP.

(1) Reducing the burden of social security premiums on employers
(2) Reducing the burden of social security premiums on employers for unskilled workers
(3) Introducing a subsidy for firms for hiring long-term unemployed

Table 4.4 Income effects of three reductions in the tax burden on employers according to MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP.

	1	2	3
Real disposable incomes	**percentage changes**		
Breadwinners employed	0.8	0.2	0.6
Breadwinners with benefit	0.7	0.4	0.9
Partners employed	1.2	0.3	0.8
Partners with benefit	0.8	0.4	1.6
Single persons employed	0.9	0.4	0.6
Single persons with benefit	0.8	0.4	1.0

(1) Reducing the burden of SSC on employers
(2) Reducing the burden of SSC on employers for unskilled workers
(3) Introducing of a subsidy for firms for hiring long-term unemployed

Table 4.5 Economic effects of five in-work tax cuts according to MIMIC, financed by an ex-ante reduction in public consumption by 0.5% GDP.

	(1)	(2)	(3)	(4)	(5)
Prices		**percentage changes**			
Wage rate	−0.5	−0.7	−1.0	−1.0	−1.0
−unskilled	−1.0	−1.7	−2.8	−3.8	−5.4
−low skilled	−0.5	−1.0	−1.2	−1.0	−0.7
−high skilled	−0.3	−0.4	−0.6	−0.6	−0.5
Production price	−0.5	−0.3	−0.6	−0.7	−0.6
Consumption price	−0.4	−0.2	−0.4	−0.5	−0.4
Volumes					
Private consumption	1.2	0.7	0.8	0.9	0.8
Exports	0.8	0.4	0.8	0.9	0.8
Imports	0.6	0.2	0.4	0.4	0.3
Production	0.9	0.4	0.9	1.0	0.9
Employment	0.8	0.7	1.2	1.3	1.2
−unskilled	1.4	2.4	3.9	5.1	5.7
−low skilled	0.9	1.0	1.1	0.8	0.5
−high skilled	0.6	0.3	0.8	0.8	0.8
Labor supply (pers.)	0.5	1.6	0.2	0.2	0.2
Labor supply (hours)	0.0	−0.3	0.0	0.0	0.0
−breadwinners	−0.1	−0.2	−0.2	−0.2	−0.2
−partners	0.7	0.9	0.7	0.9	1.1
−single persons	−0.2	−1.2	−0.1	0.0	0.0
−55+	−0.1	−0.5	−0.1	−0.2	−0.2
Black labor (hours)	0.2	0.6	2.0	2.6	2.8
Human capital (index)	0.1	−0.3	−0.4	−0.3	−0.3
Ratios		**absolute changes**			
Unemployment	−0.5	−0.7	−0.8	−0.9	−0.8
−unskilled	−0.8	−1.3	−1.7	−2.0	−2.1
−low skilled	−0.5	−0.8	−0.9	−0.9	−0.8
−high skilled	−0.4	−0.6	−0.7	−0.7	−0.6
Replacement ratio	−0.7	−0.5	−1.3	−1.6	−1.3
−unskilled	−1.2	−2.7	−5.0	−7.0	−5.4
−low skilled	−0.7	0.0	−0.5	−0.3	0.0
−high skilled	−0.6	0.0	−0.5	−0.6	−0.5
Average burden[a]	−0.9	−1.1	−0.9	−0.9	−0.9
Marginal burden[a]	−0.2	1.2	1.8	1.6	1.6
Government consumption[b]	−0.2	−0.2	−0.1	−0.1	−0.1

[a] Weighted average of micro burdens on hours worked of employees
[b] Closure, in % of GDP

(1) A uniform tax credit for workers
(2) An EITC for low annual wage incomes, phased out between 120%-180% of minimum wage
(3) An EITC for low hourly wage rates, phased out between 120%-180% of the minimum wage
(4) An EITC for low hourly wage rates, phased out between 115%-150% of the minimum wage
(5) An EITC for low hourly wage rates, phased out between 100%-130% of the minimum wage

Table 4.6 Income effects of five in-work tax cuts according to MIMIC, financed by an ex-ante reduction in public consumption of 0.5% GDP.

	(1)	(2)	(3)	(4)	(5)
Real disposable incomes	**percentage changes**				
Breadwinners employed	0.8	−0.2	0.5	0.5	0.5
Breadwinners with benefit	−0.2	−0.7	−0.6	−0.6	−0.6
Partners employed	3.7	6.4	0.5	0.5	0.8
Partners with benefit	−1.1	−4.3	−1.0	−0.9	−0.9
Single persons employed	1.2	0.2	1.4	1.4	1.5
Single persons with benefit	−0.2	−0.9	−0.5	−0.4	−0.5

(1) Uniform tax credit for workers
(2) EITC for low anual incomes, phased out between 120%-180% of the minimum wage
(3) EITC for low hourly wages, phased out between 120%-180% of the minimum wage
(4) EITC for low hourly wages, phased out between 115%-150% of the minimum wage
(5) EITC for low hourly wages, phased out between 100%-130% of the minimum wage

Figure 3.1 Output market structure in MIMIC

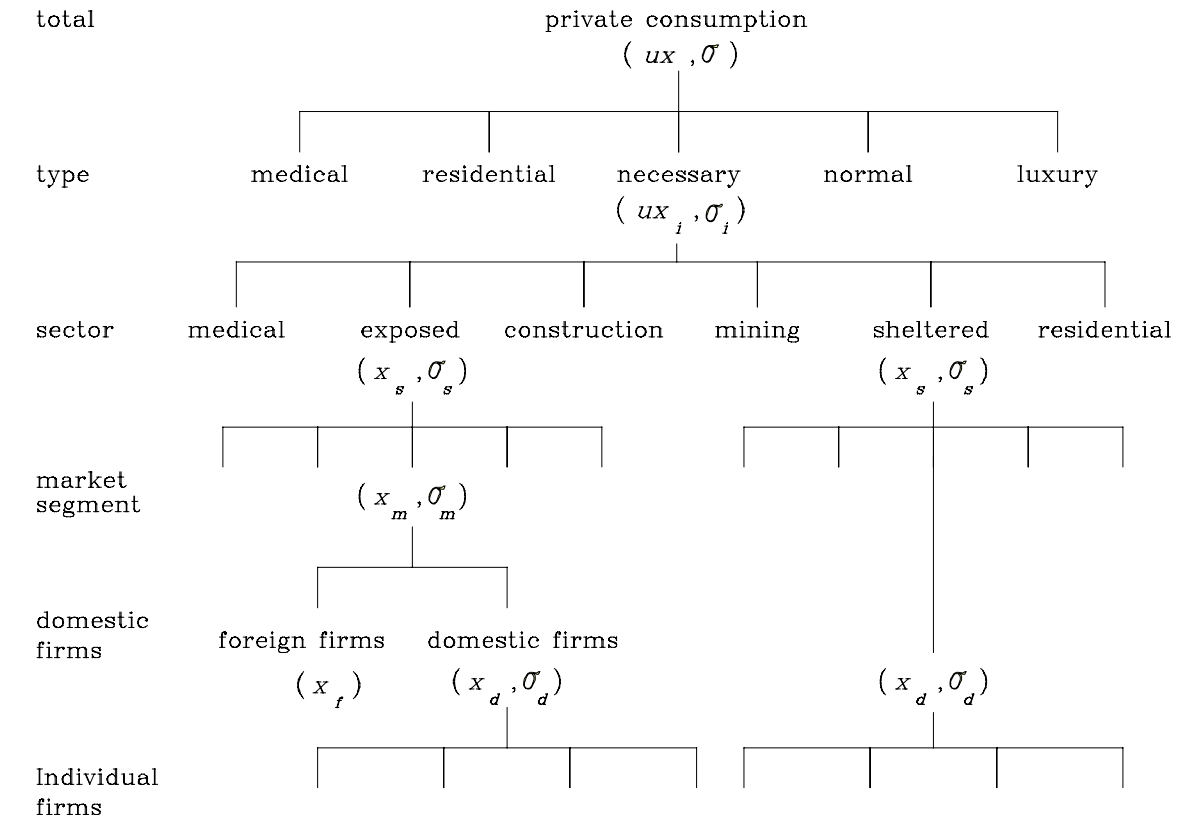

Figure 3.2 Household types in MIMIC

- Household type
    - Single persons, younger than 55
    - Families with children
    - Families without children
    - Families in which one partner receives a social benefit
    - One-parent families
    - Persons between 55 and 65
    - Students
    - Aged persons (over 65 years)

- Skill type (for each household type)
    - High skilled
    - Low skilled
    - Unskilled

- Benefit type
    - Unemployment insurance benefit
    - Disability benefit
    - Social assistance benefit

Per household type

- Time participating on the formal labor market
    - not participating (partners only)
    - 30 percent participation (partners only)
    - 40 percent participation (single persons only)
    - 50 percent participation (partners only)
    - 80 percent participation
    - full-time participation (not for partners)
    - 120 percent participation (not for partners)

Figure 3.3 The income tax rates in 1998 in the Netherlands

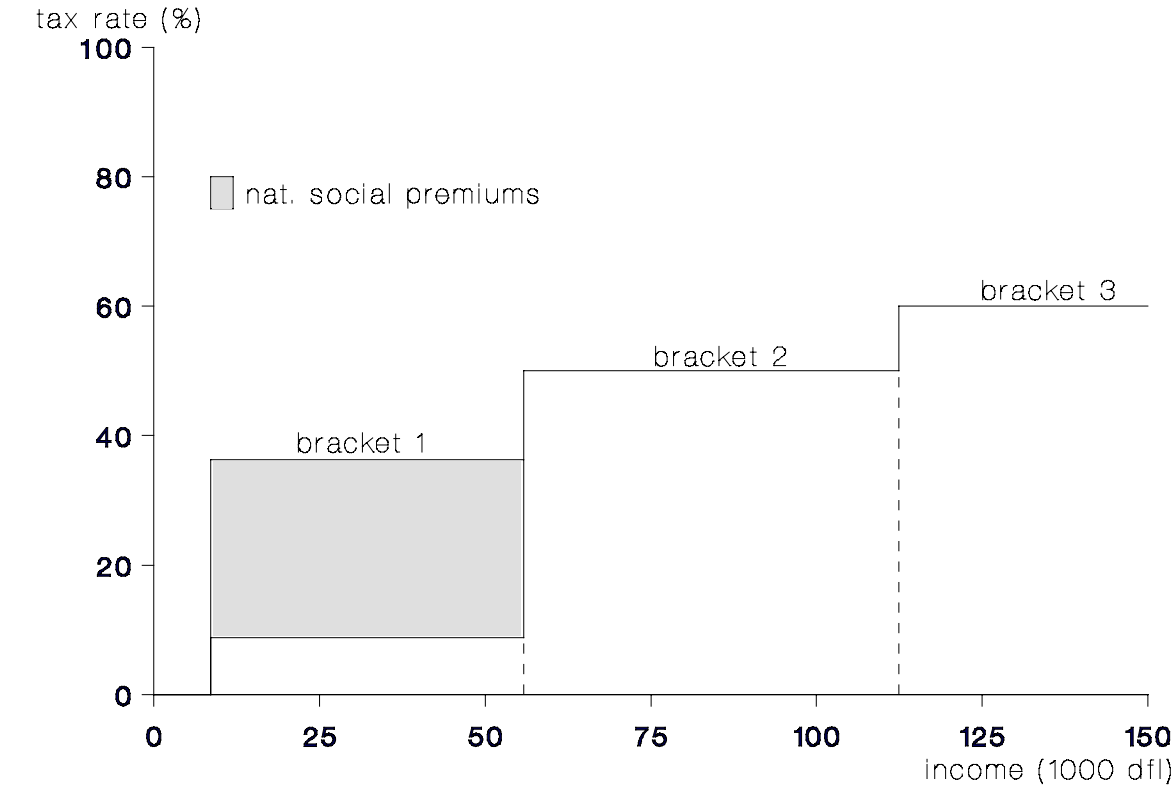

Figure 3.4 Main links in the MIMIC model