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PREMIUM DIFFERENTIATION IN THE UNEMPLOYMENT INSURANCE SYSTEM AND THE DEMAND FOR LABOR

By Rob Alessie and Hans Bloemen

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Premium differentiation in the Unemployment Insurance system and the demand for labor

Rob Alessie[1]

Hans Bloemen[2]

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Abstract

In this study we investigate the effect of the introduction of premium differentiation (experience rating) in the Dutch Unemployment Insurance system on the demand for labor. We formulate a model of labor demand, based on the model by Bentolila and Bertola (1990), in which we distinguish two types of workers: the "young" and the "old". This distinction is made, as one of the major motives for opening the discussion around premium differentiation in the Netherlands is the wish to reduce the inflow of older workers into unemployment. In the model, labor adjustment costs (hiring and firing costs) are linear. The model allows for uncertainty in the business cycle. Premium differentiation is incorporated in the model as a rise in firing costs, accompanied by a decrease in unemployment insurance premium payments. Values for the model parameters are determined to quantify the effect of premium differentiation on the demand for labor in various sectors of the Dutch economy. We compute the effect of premium differentiation on the steady state level of labor demand. We also compute the effect of premium differentiation on the level of profits.

JEL classification: J20, J60, J65

Key words: Unemployment Insurance, premium differentiation, labor demand

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[1] Free University Amsterdam., De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands, and Tinbergen Institute, Email: ralessie@econ.vu.nl.

[2] Corresponding author: CentER Applied Research, Tilburg University, P.O. BOX 90153, 5000 LE Tilburg, The Netherlands. Email: H.G.BLOEMEN@KUB.NL.

1. Introduction

The system of raising premiums for the unemployment insurance that is at present in operation in the Netherlands does not allow for experience rating (or: premium differentiation) at the level of the individual firm. Consequently, a firm which fires a worker, is not directly confronted with the cost of financing the unemployment benefit that the worker will receive. Recently, in the political debate attention has been paid to the possibility of introducing premium differentiation in the Netherlands to finance the unemployment insurance benefits. One of the major motivations for this increased interest is the wish to reduce the inflow of elder workers into the Unemployment Insurance scheme. Elderly who become unemployed have a low probability of re-employment. Their monthly unemployment benefits are relatively high (compared to the benefits of young workers). Moreover, the unemployed elderly have a long entitlement. From a certain age (57.5) on, the elderly unemployed actually can stay on unemployment insurance, without entering social assistance, until the age of 65. It is felt that the unemployment insurance system in the Netherlands sometimes is used as a form of pre-retirement, attractive to both employers and workers. In the political debate, it has been argued that the introduction of premium differentiation at the level of the individual firm creates a disincentive for this practice at the side of the firm.

The aim of the present study is to quantify the effects on the demand for labor of the introduction of premium differentiation in the Netherlands, for various sectors of the Dutch economy. Since experience rating has not yet been introduced in the Netherlands, we cannot estimate the effect of experience rating on employment (see Topel (1983)). Therefore we have designed a simulation model. The point of departure is the labor demand model by Bentolila and Bertola (1990). This model describes the labor demand decision of a firm, which is forward looking and maximizes the expected discounted stream of profits. The firm incorporates uncertain future shocks in the demand for the firm's product. The adjustment cost of labor, the cost of hiring and firing, is linear in the number of workers hired or fired.[3] In the model we distinguish two types of labor, the 'young' and the 'old' workers. The wages, the cost of hiring and firing, and the quit rates differ between the two types of workers.

The introduction of premium differentiation can be modeled as a shift from wage costs to firing costs. A firm will be confronted with higher UI premiums as the result of firing a worker. If, on the contrary, the firm decides not to fire, no (additional) premiums need to be paid. This is different from a system without premium differentiation in which a firm pays (the same) UI premiums irrespective of whether and how many workers are fired.

[3] The nature of the firing costs associated with premium differentiation requires a model in which firing costs are <u>linear</u> in the number of workers to be fired. Nickell (1986) gives an extensive overview of the different shapes of adjustment costs that appear in dynamic models of labor demand.

The higher firing cost as the result of the introduction of premium differentiation has a negative effect on firing.[4] There is a negative effect on hiring as well. A negative effect on hiring will be the consequence of the forward looking behaviour of the firm. A firm that is about to make a hiring decision will incorporate the probability that the newly hired worker may have to be laid off in future, due to a negative business cycle or productivity shock, in which case the firm is confronted with the cost of firing. In the model by Bentolila and Bertola (1990). The formation of the firm's expectations about the future will depend on the variation in firm specific or business cycle shocks and the firm's growth rate, so will the effect of firing costs on the hiring decision. In the model by Bentolila and Bertola (1990), that abstracts from possible equilibrium wage reactions, the decrease in firing is found stronger than the decrease in hiring and therefore the eventual employment effect is positive. Next, there is a negative effect of higher firing costs on the firm's 'efficiency', resulting in a lower profitability. With higher firing costs workers that would otherwise have been laid off will stay in the firm, leading to a less efficient situation in terms of productivity wage ratio.[5]

The higher firing costs go together with lower wage costs, due to the shift from wage costs to firing costs. This will have a positive effect on the employment in the firm, and may compensate for the inefficiency created by the higher firing costs.

The model will be used to calculate the effects of premium differentiation on the average (steady state) level of labor demand for both young and old workers. We determine the relative change in the steady state level of labor demand due to the system of premium differentiation. To be able to quantify the effects of premium differentiation, all model parameters have been chosen on the basis of micro-economic data. The change in the level of profits due to the system of premium differentiation is determined to get an idea of the effects on the efficiency of premium differentiation.

Since the model by Bentolila and Bertola (1990) only addresses the demand side of the labor market, the analysis is partial. In matching models, like the models by Bertola and Caballero (1994) and Millard and Mortensen (1997), an increase in the cost of firing leads to a wage reaction. The interpretation of the wage reaction arising there is that an increase in firing costs leads to a higher insider power of the workers in a firm, as the probability of being fired has decreased. This leads to an upward pressure on the wage, which in turn has a downward pressure

[4] Note that higher firing costs may create an incentive for the firm to try and find other exit routes for workers. Spending more on investment in outplacement is a possibility. These effects will however not be incorporated in the model.

[5] A decreased level of profits may have a negative level on investment. It may be a barrier to create new firms. Apart from the level of profits, the increased risk of the premium fluctuations, resulting in an increased variability in profits, may create a disincentive to invest. The effects on investment will not be modeled by us. Risager and Sørensen (1997) present a labor demand model with firing costs and endogenous investment.

on employment. Therefore, the matching models are a serious alternative for the model of Bentolila and Bertola (1990) to investigate the effects of premium differentiation. Millard and Mortensen (1997) actually use the Mortensen and Pissarides (1994) framework to gain insight in the effects of experience rating. We chose to use the Bentolila and Bertola (1990) framework,[6] as in the matching models mentioned some other simplifications are made. For example, the model by Mortensen en Pissarides (1994) hiring as a result of a positive business cycle shock at the firm level is not incorporated. In Bertola and Caballero (1994) business cycles switch with some probability between two known states characterized by a productivity value.[7, 8] To be able to gain insight in possible wage reactions, we will use, in an admitted ad hoc manner, a wage equation, derived from the matching models, to analyze the sensitivity of the results obtained with the Bentolila and Bertola (1990) model.

In section 2 we give a description of the system of financing the unemployment insurance that is at present in operation in the Netherlands. In section 3 we presented the extended Bentolila and Bertola (1990) model. We discuss how this model will be used in the calculation of the effects of premium differentiation. In section 4 we describe how we determine values for the model parameters. In section 5 the results of the analysis are presented. Section 6 concludes.

2. The Dutch Unemployment Insurance system

In the Dutch Unemployment Insurance system expenditures on unemployment benefits are not charged to individual firms. However, to a certain degree premiums are experience rated at the sectoral level. The unemployment benefits are financed from two sources. The first 26 weeks on unemployment benefit payments are financed from a sector specific fund. Premiums differ between sectors, and are paid by the employers. The benefit payments to individuals who are unemployed for more than 26 weeks are financed by a general fund. Premiums are the same for every employer. Part of the premiums are paid by the employers and the remaining part by the employees.

The eligibility of someone unemployed to unemployment insurance benefits depends on the labor history of the unemployed. If the unemployed has worked at least 26 weeks during the past three quarters, and if the unemployed has been working in the past 5 years at least 52 days

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[6] At the start of this project, we considered doing the calculation both on basis of the Bentolila and Bertola (1990) framework and on the Mortensen and Pissarides (1994) framework. We soon gained the insight that it was over optimistic to do both in one project, so we chose Bentolila and Bertola (1990) for the reasons given.

[7] A similar shock process is used in the labor demand model by Bentolila and Saint-Paul (1992).

[8] A challenging extension of the literature in these type of models would be the combination of the techniques and the shock process in Bentolila and Bertola (1990) with the matching type of model in Bertola and Caballero (1994).

in at least 4 years (the '4 out of 5' requirement), the unemployed is eligible to receive 70% of the past wage. If the '4 out of 5' requirement is not met, but the requirement mentioned before is satisfied, the unemployed is eligible to receive 70% of the minimum wage. The entitlement period depends on the individual labor history, and varies from 6 months for individuals who have had a job for less than 5 years, to 5 years for individuals with a labor history of 40 years or more. For further details of the system of financing unemployment insurance, we refer to Alessie et al. (1999).

3. The model

The model that will be used to simulate the effects of premium differentiation is a supplemented version of the model by Bentolila and Bertola (1990). The model by Bentolila and Bertola (1990) is extended by introducing two types of labor: 'young' and 'old' workers. Considering the ad hoc nature in which we derive this wage response, the analysis with the wage response only deserves the interpretation of a sensitivity analysis on the employment effects derived with the Bentolila and Bertola (1990) model.

3.1 Formulating the model

The model of Bentolila and Bertola (1990) describes the labor demand decision of the firm. Labor ('young' and 'old' workers) is the input factor in the firm's production process. Due to the existence of hiring and firing cost, labor is a quasi-fixed production factor. Capital is assumed to be fixed.[9] The wage cost per worker are given for the firm (a competitive labor market is assumed). On the product market, there is monopolistic competition. The firm optimizes its hiring and firing strategy by maximizing the expected intertemporal profits. Workers may leave the firm by quitting. Constant quit rates are assumed, that may have a different value for the two different types of labor ('young' and 'old' workers). Hiring and firing cost is linear in the number of workers being hired and fired. The hiring and firing cost is allowed to take a different value for the 'young' and 'old' workers. The demand for the firm's product is subject to an uncertain shock process.

The labor demand model incorporates two types of labor, L_{t1} and L_{t2}, indicating the number of young and old workers in the firm, respectively. The production function of the firm is of the Cobb-Douglas type:

$$Q_t = A_t L_{t1}^{\beta_1} L_{t2}^{\beta_2} \qquad (1)$$

[9] Risager and Sørensen (1997) present a labor demand model with firing costs that does incorporate endogenous investment.

The production function gives the production in period *t*, indicated by Q_t, as a function of the labor inputs L_{t1} and L_{t2}. β_1 and β_2 are the labor elasticities of production ($0<\beta_i<1, i=1,2$), and A_t is a factor that influences the marginal productivity of both types of labor.[10] Bentolila and Bertola (1990) assume that it grows with a constant, geometric growth rate ϑ_a. Moreover, Bentolila and Bertola (1990) assume that L_{t1} and L_{t2} are perfect substitutes and that a linear production technology prevails. The specification of the production function in (1) implies that different types of workers influence each others productivity positively. In others words, the firms needs both young and old workers to produce.

The demand for the firm's product Q_t is determined as a function of the price P_t. The firm operates on a product market of monopolistic competition. Consequently, it faces the following demand curve for its product:

$$Q_t = Z_t P_t^{\frac{1}{\mu-1}}, 0<\mu<1 \tag{2}$$

The parameter μ determines the price elasticity. The state of the business cycle is represented by the random variable Z_t. It indexes the position of the direct demand curve. The variable Z_t is assumed to be random. Apart from random shocks due to the business cycle, it may represent firm specific shocks. Conform Bentolila and Bertola (1990), it is assumed to follow a geometric Brownian Motion[11] (see Dixit (1992) for a clear review on Brownian Motions):

$$dZ_t = Z_t \vartheta_z dt + Z_t \sigma_z dW_t \tag{3}$$

The interpretation of equation (3) is that the growth of the firm is characterized by random shocks around a constant growth rate, θ_z, with standard deviation σ_z.

An expression for the revenue function can be obtained by combining the production function in (1) with the inverse of the demand function in (2):

$$P_t Q_t = A_t^{\mu} L_{t1}^{\mu\beta_1} L_{t2}^{\mu\beta_2} Z_t^{1-\mu} \tag{4}$$

Note that the parameter *μ* serves as an exponential weight factor between the systematic part of the revenue function, which consists of the production function, and the random demand factor. If *μ* approaches 1, uncertainty disappears from (4).

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[10] Like Bentolila and Bertola (1990), we assume that capital is a fixed production factor.

[11] W_t is a Wiener process with standard normal increments.

We define the following flow equation for the number of young workers L_{t1}:

$$dL_{t1} = dX_{t1} - \delta_1 L_{t1} - \rho L_{t1} \qquad (5)$$

The change in the number of young workers is represented by dL_{t1}. The change in the number of young workers due to the hiring or firing behaviour of the firm is indicated by dX_{t1}. Each period, a fraction δ_1 of the young workers quits the firm and a fraction ρ will, due to aging, turn into old workers. We define a similar type of flow equation for the old workers:

$$dL_{t2} = dX_{t2} - \delta_2 L_{t2} + \rho L_{t1} \qquad (6)$$

The quit rate of the old workers is represented by δ_2. The flow equation in (6) can also be written as

$$dL_{t2} = dX_{t2} - \delta_2 L_{t2} + \omega_t L_{t2} \qquad (7)$$

with $\omega_t = \rho L_{t1}/L_{t2}$. In order to keep the calculations tractable, we assume that ω_t is constant over time, and we will denote $\omega = \omega_t$ in the sequel. This is like assuming a constant inflow rate into the stock of old workers, instead of a constant outflow rate out of youth. The implication for the quit rates actually is that the 'effective' quit rate for young workers, including the aging process, is $\delta_1 + \rho$, whereas the 'effective' quit rate for old workers is $\delta_2 - \omega$.

The hiring costs for a worker of age group *i* are indicated by H_i. The costs of firing a worker of age group *i* are indicated by F_i. The wage costs of a young and an old worker are represented by w_1 and w_2, respectively. The objective of the firm is the maximization of the expected present value of its cash flow. The following objective function is maximized, subject to the dynamic laws of motion in (5) and (7):

$$E_t\left\{\int_t^{\infty} e^{-r(\tau-t)}\left[(A_\tau L_{\tau 1}^{\beta_1} L_{\tau 2}^{\beta_2})^{\mu} Z_\tau^{1-\mu} d\tau - \sum_{j=1}^{2}\left[w_j L_{\tau j} d\tau + \{\iota(dX_{\tau j} > 0)H_j + \iota(dX_{\tau j} < 0)F_j\} dX_{\tau j}\right]\right]\right\} \qquad (8)$$

In (8), *r* is the discount rate and $\iota(.)$ is the indicator function. The optimization problem leads to the following first order conditions:[12]

$$E_t\left[\int_t^{\infty} (\eta_{\tau i} - w_i) e^{-\lambda_i(\tau - t)} d\tau\right] = -F_i \text{ if } dX_{ti} < 0 \qquad (9)$$

[12] See Nickell (1986) for the derivation of the first order conditions.

$$-F_i < E_t[\int_t^{\infty} (\eta_{\tau i} - w_i) e^{-\lambda_i(\tau - t)} d\tau] < H_i \ if \ dX_{ti} = 0 \qquad (10)$$

$$E_t[\int_t^{\infty} (\eta_{\tau i} - w_i) e^{-\lambda_i(\tau - t)} d\tau] = H_i \ if \ dX_{ti} > 0 \qquad (11)$$

where $\lambda_1 = \delta_1 + \rho + r$ and $\lambda_2 = \delta_2 - \omega + r$.

In (9), (10) and (11), $\eta_{\tau i}$ is the marginal revenue product of labor of age group *i*, in period τ:

$$\eta_{t1} = \beta_1 \mu A_t^{\mu} L_{t1}^{\beta_1 \mu - 1} L_{t2}^{\beta_2 \mu} Z_t^{1-\mu} \qquad (12)$$

$$\eta_{t2} = \beta_2 \mu A_t^{\mu} L_{t1}^{\beta_1 \mu} L_{t2}^{\beta_2 \mu - 1} Z_t^{1-\mu} \qquad (13)$$

The interpretation of the first order conditions in (9), (10) and (11) is straightforward. First of all, note that if firing and hiring costs of both types of workers were equal to zero, the conditions reduce to the well known condition of the standard neoclassical labor demand model, which reads that the marginal revenue product equals the wage. If costs of adjustment are positive, equation (10) implies that if the expected present value of the difference between the marginal revenue product and the wage is not too large, compared to the costs of hiring and firing, the firm will decide neither to hire, nor to fire. Equation (9) implies that if the expected present value of the difference between the marginal revenue product and the wage becomes, due to a shock, too small (negative), compared to the costs of firing, the firm decides to fire. From equation (9) it can be derived that a higher level of firing costs has a negative impact on firing: a larger negative shock than before in the marginal revenue product of labor is needed to induce the firm to firing. Equation (11) implies that if, due to a shock, the expected presented value of the difference between the marginal revenue product and the wage becomes too high, the firm will hire. From (9) and (11) is can also be derived that lower wage costs reduce firing, and have a positive effect on hiring.

Note that the expressions for the first order conditions in (9), (10), and (11) do neither make use of the assumption made about the functional form of the marginal revenue product functions in (12) and (13), nor of the assumption made about the shock process in (3). In order to be able to solve the first order conditions in (9), (10), and (11), the assumption about the stochastic process in (3), as well as the assumptions leading to (12) and (13), need to be used.

3.2 Solving the model

Using (3), (12) and (13), together with the flow equations (5) and (7), it can be shown that the marginal revenue product of labor of type i, η_{ti} follows a regulated geometric Brownian Motion with lowerbound d_i and upperbound u_i. The geometric Brownian Motion process within the bounds can be written as

$$d\eta_{ti} = \theta_i \eta_{ti} dt + \sigma \eta_{ti} dW_t \tag{14}$$

The growth rate θ_i and the variance σ follow from Itô's lemma:

$$\sigma = (1-\mu)\sigma_z \tag{15}$$

$$\theta_1 = \mu\theta_a - (\beta_1\mu - 1)(\delta_1 + \rho) + \beta_2\mu(\omega - \delta_2) + (1-\mu)\theta_z - 1/2\mu(1-\mu)\sigma_z^2 \tag{16}$$

and

$$\theta_2 = \mu\theta_a - \beta_1\mu(\delta_1 + \rho) + (\beta_2\mu - 1)(\omega - \delta_2) + (1-\mu)\theta_z - 1/2\mu(1-\mu)\sigma_z^2 \tag{17}$$

Using the properties of a regulated geometric Brownian Motion, the first order conditions (9), (10) and (11) can be solved. In appendix A more details are provided about the solving of the bounds d_i and u_i.

3.3 Interpretation of the model's hiring and firing process

In continuous time, demand shocks Z_t affect the marginal revenue product of labor (MRPL) of young and old workers. This shock process is described in equation (14) in reduced form. For purposes of interpretation, it is illuminating to recall that (14) results from the demand shock process (3), which affects the MRPL's given in equations (12) and (13).

As long as the MRPL's remain within their bounds (i.e. $d_i < \eta_{ti} < u_i, i = 1,2$), no hires and no fires take place. The demand shock Z_t does affect the values of the MRPL's, by equations (12) and (13), but not the numbers of young and old workers L_{t1} and L_{t2}. Note also that the ratio of the MRPL's is not affected by the shock. Dividing (12) by (13) gives $\eta_{t1}/\eta_{t2} = \beta_1 L_{t2}/(\beta_2 L_{t1})$. The only changes in L_{t1} and L_{t2} are due to quits and greying. This can also be seen by applying Itô's lemma to $y_t := \eta_{t1}/\eta_{t2}$. This shows that $dy_t = (\theta_1 - \theta_2) y_t dt$ and $\theta_1 - \theta_2 = \delta_1 + \rho - (\delta_2 - \omega)$, according to (16) and (17). Thus, the ratio of the MRPL's has a constant, geometric growth rate depending on the quit rates and greying parameters, and it is not affected by the demand shocks. The latter is not surprising since the demand shock affects the firm’s revenues, and is not specific to any of the labor inputs. This holds only as long as the MRPL’s are within the bounds.

Now suppose, for example, that the MRPL of young workers hits the lowerbound d_1 due to a negative demand shock, but the MRPL of old workers remains within its bounds. The MRPL of young workers becomes ‘too low’, and to correct for that the firm fires young workers. According to (12), the MRPL of young workers is raised as the result of the firing. The number of old workers remains the same, but due to the firing of young workers, the MRPL of old workers in (13) is decreased. The ratio of young workers to old workers has declined now due to the shock, and the ratio of the MRPL of young workers to old workers has increased accordingly. This in turn increases the probability that the next time it will be the MRPL of old workers that hits the lower bound at a negative shock. This is an important observation, since it shows that the employer cannot keep on reducing the number of workers of one age category only. There will be one point at which the firm decides to fire workers of the other age category instead.

Summarizing we can say that the ratio of the MRPL of the two age categories, as well as the numbers of workers, are not affected by demand shocks as long as the two MRPL’s both remain within their bounds. They are affected by demand shocks if one of the MRPL’s hits a bound.

3.4 A steady state solution for the demand of labor

From the equation (12) and (13), the numbers of young and old workers can be expressed in the marginal revenue products of both types of labor:

$$L_{t1} = [\beta_1^{1-\beta_2\mu} \beta_2^{\beta_2\mu} \mu A_t^{\mu} Z_t^{1-\mu} \eta_{t1}^{\beta_2\mu-1} \eta_{t2}^{-\beta_2\mu}]^{1/(1-\mu(\beta_1+\beta_2))} \tag{18}$$

$$L_{t2} = [\beta_1^{\beta_1\mu} \beta_2^{1-\beta_1\mu} \mu A_t^{\mu} Z_t^{1-\mu} \eta_{t1}^{-\beta_1\mu} \eta_{t2}^{\beta_1\mu-1}]^{1/(1-\mu(\beta_1+\beta_2))} \tag{19}$$

Note that evaluating (18) and (19) in the lower bounds d_1 and d_2 for η_{t1} and η_{t2}, generates upper bounds for L_{t1} and L_{t2}, since $-\beta_i\mu<0$ and $\beta_i\mu-1<0, i=1,2$. Similarly, evaluating (18) and (19) in the upper bounds u_1 and u_2 for η_{t1} and η_{t2}, yields lower bounds for L_{t1} and L_{t2}.

The equations (18) and (19) serves as a basis for determining the steady state (average) labor demand level for young and old workers. Now first note that the processes for employment of both types of workers, L_{t1} and L_{t2}, are nonstationary. However, the expressions for the marginal revenue product of labor of both types of workers, (12) and (13), define a cointegrating relation between (the logarithms of) A_t, Z_t, L_{t1} and L_{t2}. Therefore (conform Bentolila and

Bertola (1990)), for the current levels of A_t and Z_t a conditional steady state mean value of L_{t1} and L_{t2} can be computed. For this purpose, the steady state density function of the regulated Brownian Motion η_{ti} is used to average the labor demand equations (18) and (19) over η_{t1} and η_{t2}. The result will be an average level of labor demand, conditional on the values of A_t and Z_t. The steady state density function of a regulated Brownian Motion η_{ti} with lowerbound d_i and upperbound u_i, growth rate θ_i and standard deviation of the increments equal to σ, is given by

$$g_i(\eta_i) = \frac{(\gamma_i - 1)\eta_i^{\gamma_i - 2}}{u_i^{\gamma_i - 1} - d_i^{\gamma_i - 1}}, d_i < \eta_i < u_i \tag{20}$$

with $\gamma_i = 2\theta_i/\sigma^2$. In integrating over (18) and (19), we account for the fact that η_{t1} and η_{t2} are correlated, and actually follow from the same underlying random shock process Z_t. We use Monte Carlo integration for this. We denote the distribution function of the density function in (20) by $G_i(\eta_i)$. We generate random variables η_{ir}, $r=1,...,R$, $i = 1, 2$, (with R indicating the number of drawings used in the Monte Carlo integration) for the Monte Carlo integration by first drawing random variables v_r, $r=1,...,R$ from the uniform distribution on the interval (0,1), and then transforming them into random variables η_{1r} and η_{2r}, $r = 1,...,R$, by means of the transformation $v_r = G_i(\eta_{ir})$, $i = 1,2$, $r = 1,...,R$. Note that we use the same underlying random drawings of random variables v_r, $r=1,...,R$ for generating random numbers η_{1r} and η_{2r}, $r = 1,...,R$. Thus, we incorporate the dependence between the two processes.

We calculate the steady state levels of labor demand for various systems of financing the unemployment benefits. Note that the relative difference in labor demand levels between various systems of financing benefits does not depend on the value of A_t and Z_t.

3.5 Regularity conditions

The parameters have to satisfy certain regularity conditions to ensure a well-behaved optimization problem. The value function in (8) is bounded if the following conditions is satisfied:

$$\frac{\mu\theta_a}{1-\mu(\beta_1+\beta_2)} + \frac{(1-\mu)\theta_z}{1-\mu(\beta_1+\beta_2)} < r \tag{21}$$

To ensure a finite value for the integrand in (9), (10) and (11), the following condition must hold for both types of labor ($i = 1,2$):

$$\lambda_i > \theta_i \qquad (22)$$

The regularity conditions in (21) and (22) are a straightforward extension of the regularity conditions in Bentolila and Bertola (1990).

Table 1: The parameters of the simulation model

Sector	Gross yearly earnings per employee		Number of employees		quit rates		greying parameter ρ	growth in turnover	uncertainty in demand: standard deviation in employment
	young (<50)	old (>= 50)	young (<50)	old (>= 50)	young (<50)	old (>= 50)			
1. Agriculture, Tobacco	44646	56430	16	2	4.1	7.3	1.8	1.8	14.5
2. Construction	60197	77242	28	3	3.4	11.0	2.4	4.9	26.0
3. Wood-, furniture industry	60197	77242	22	2	3.5	11.0	2.4	4.9	34.3
4. Publishing, printing and reproduction industry	61805	88828	23	3	7.9	19.5	2.6	2.9	10.5
5. Basic and fabricated metal products ,electro industry	61417	83516	33	5	3.7	11.2	2.5	2.9	12.4
6. Retail trade and repair	29023	42059	28	3	6.0	10.8	2.5	3.8	25.8
7. Harbour, inland navigation, fishing	79129	109158	41	3	5.9	18.1	1.4	5.0	24.7
8. Other transportation	57356	71764	43	5	8.6	7.9	2.2	5.0	20.3
9. Hotels and restaurants	27282	32490	18	1	10.9	8.3	2.7	6.4	16.8
10. Health care	43781	58156	97	12	6.1	12.8	2.3	1.2	6.6
11. Government services	36696	49191	98	13	1.1	7.6	4.7	1.6	6.6
12. Banking, Insurance, wholesale tradensportation	68573	110324	186	4	5.1	12.1	2.8	6.9	21.0
13. Employment Agencies	28852	47996	106	2	3.0	0.0	0.0	1.2	54.2
14. Other manufacturing	50024	60808	64	9	4.0	10.7	1.9	2.9	1204.0

Greying parameter (ρ) =the transition probability that the employee is ‘old’ (i.e. at least 50 years old) in year t+1 given that he/she is ‘young’ (less than 50 years) in year t

4. Determination of the parameters

The model which has been presented in the previous section, contain the following parameters:

1. Quit rates of the young and old employees[13]: δ_1 and δ_2.
2. 'Greying parameter': ρ
3. Hiring costs: H_1 and H_2.
4. Firing costs: F_1 and F_2.
5. Gross yearly earnings of the young and old employees: w_1 and w_2.
6. The number of young and old employees: L_1 and L_2.
7. The mark-up factor (cf. Equation (2)): μ.
8. Expected growth in the turnover (and its standard deviation); These statistics will be used to derive the parameters $\mu\theta_a+(1-\mu)\theta_z$ en σ_z.
9. The interest rate: r.
10. The parameters of the Cobb-Douglas production function (1): β_1 and β_2
11. The parameter which indicates the share of the surplus of the match between the worker and the employer that is assigned to the worker according to the wage bargaining rule (see appendix B): ζ.

In the empirical analysis the private sector has been split up in the following 14 sub-sectors (cf. Table 1). The sector classification is on based the way the UI scheme has been implemented: fourteen organizations ('bedrijfsverenigingen') are responsible for this and they cover different sectors of the economy.

In order to simulate the effects of premium differentiation (experience rating), we have to choose values for all the parameters mentioned above. In most cases the choice of these parameters is based on Dutch survey data and on aggregated macro-economic time series. However, some parameters are chosen without calling on such data. For instance, we assume in the simulations that the interest rate r and the mark-up factor μ are equal to 7.5% and 0.6 respectively. The estimate of μ is taken from Burda (1987) (Bertola end Bentolila (1990) have used the same estimate). We have assumed that the values of the parameters β_1 en β_2 of the Cobb-Douglas production function are equal to 0.33. This choice of these parameter values is based on a study by Schroer en Stahlecker (1997). On the basis of studies by Holmlund and Zetterberg (1991) and Graafland and Huizinga (1996) we have decided to fix the value of ζ to be equal to 0.2. Notably, the chosen values of the parameters discussed in this paragraph are not sector

[13] In this paper 'old employees' are those who are at least 50 years old.

specific.

The OSA labor demand survey, the Socio-Economic Panel (SEP), the Yearly Research into Employment and wages (JWL) and the quarterly accounts of Statistics Netherlands have been used by us most frequently in order to estimate some key parameters. The OSA labor demand panel is a longitudinal panel survey which has been conducted bi-annually from 1988 on by the Organization of Strategic Labor Market Research (OSA). The surveys concern both firms in the private sector (at the establishment level) and government bodies. Only those organizations (firms or government bodies) have been sampled which have at least 10 employees. In this study we only make use of the 1994 wave of the OSA labor demand survey. The 1994 wave of the OSA labor demand survey contains 2247 firms in the private sector and 476 government bodies. In this study we have only selected the firms in the private sector. Since the OSA labor demand survey is not entirely representative, the OSA has constructed sample weights (for more information about e.g. the sampling frame of the OSA labor demand survey, see Hassink (1996)). Evidently, we have used the sampling weights in the computation of summary statistics. In this study the OSA Labor demand survey has been used to estimate the quit rates, the hiring costs, the 'greying parameter (see below), business cycle uncertainty (cf. Table 1), and the number of young and old employees (cf. Table 1).

The Socio-Economic Panel (SEP) is a survey administered by Statistics Netherlands for a panel of approximately 5,000 households. The SEP is representative of the Dutch population, excluding those living in special institutions such as nursing homes. The first survey was conducted in April 1984. The same households were interviewed in October 1984 and then twice a year (in April and October) until 1989. Since 1990 the survey has been conducted once a year in May. In the October interview, information is collected on socio-economic characteristics, income and labor market participation. In this study we have made use of the following waves of the SEP: 1989 till 1993. In this study the SEP has mainly been used to estimate the quit rates, the hiring and firing cost, and the 'greying parameter (see below). Aggregated information from the Yearly Research into Employment and Wages (JWL) and the quarterly accounts of Statistics Netherlands have been used to estimate Gross yearly earnings per employee (see table 1) and the growth in turnover (see table 1) respectively (see Alessie et al. (1999) for more details).

The 'greying parameter' is defined as the transition probability that the employee is 'old' (i.e. at least 50 years old) in year t+1 given that he/she is 'young' (less than 50 years) in year t. The lay-off rate is the transition probability that an employee in year t has received an UI benefit in year t+1.[14] The quit rate is equal to 1 minus the lay-off rate, the 'greying parameter' and the probability that the employee stays with the same employer. The quit rates and the 'greying

[14] The estimates of the lay-off rates are only used to determine the quit rates and not in the simulations.

parameter' have been estimated by using survey data from the OSA labor demand survey and the Socio-Economic Panel survey. The sector specific estimated quit rates are presented in table 1. Details about the determination of the quit rates can be found in appendix C.

Table 2: Size and composition of the hiring cost in the private sector						
Sector	Recuitment cost	Cost of settling into a new job		Cost of keeping open a vacancy	hiring cost total	
		<50 jr	>=50 jr		<50 jr	>=50 jr
1. Agriculture, Tobacco	323	8500	10744	720	9544	11787
2. Construction	584	10763	13810	1202	12549	15596
3. Wood-, furniture industry	1846	13391	17183	1064	16301	20093
4. Publishing, printing and reproduction industry	2071	9696	13935	6521	18287	22527
5. Basic and fabricated metal products ,electro industry	1297	11908	16193	3496	16701	20986
6. Retail trade and repair	411	4854	7035	467	5732	7912
7. Harbour, inland navigation, fishing	3156	10184	14049	5815	19155	23020
8. Other transportation	568	4485	5612	1830	6884	8011
9. Hotels and restaurants	97	2601	3098	5862	8560	9056
10. Health care	2212	6480	8608	3825	12517	14644
11. Government services	1587	9599	12868	183	11369	14638
12. Banking, Insurance, wholesale trade, transportation	2846	11614	18685	14377	28838	35909
13. Employment Agencies	967	3913	6509	50	4930	7526
14. Other manufacturing	2616	9436	11470	8476	20528	22562

In order to determine the hiring costs, it has been assumed that the hiring costs consist of the following 3 components: 1) Cost of advertising and recruiting; 2) Cost of settling into the job;

3). Cost of keeping open a vacancy. Information on the cost of advertising and recruiting is obtained directly from the OSA labor demand survey.[15] The cost of settling into the new job has been derived by multiplying two variables: 1) the time of settling into the job, and 2) the earnings of an employee with seniority of less than 2 years. The outcome of this multiplication is multiplied by a weight factor of 0.5, to express that new workers are productive for only half their working time during the period of settling into the job. In the sensitivity analysis we vary this factor of 0.5.

The average time of settling into the job has been estimated by using the information from the

[15] Details on the question asked to survey respondents with respect to cost of advertising and recruitment are found in appendix C.

OSA labor demand survey. (See appendix C for the details). Data on the average earnings of a 'new employee' (an employee with less than 2 years tenure) stems from the Yearly Research into Employment and Wages (JWL) (see Statistics Netherlands (1994) and Statistics Netherlands (1996)). In the computation of the average cost of settling into a new job it has been assumed that a new employee is only productive for 50%.

The cost of keeping open a vacancy is defined as the product of 1) average duration of a vacancy, and 2) the net value added per worker -gross earnings per employee. The average duration of a vacancy is determined with information from the OSA labor demand survey. See appendix C for more details. Data on the net value added (against factor cost) per worker and the gross earnings per employee are taken from the National accounts (see Statistics Netherlands (1997)). The size and composition of hiring cost are presented in table 2.

Firing cost

In order to derive the total firing cost, we first calculate the firing cost in absence of experience rating (premium differentiation). The most important component of the firing cost is the severance pay. An employee receives severance pay when he/she fired through mediation of the cantonal judge. An employer could also fire employees by applying for a permission of the Regional Labor Office (Regionaal Bureau van de Arbeidsvoorziening (RBA)). In principle, the employee does not receive any severance pay if the RBA approves the application of the employer. However, one should realize that the RBA needs a lot of time to judge the application and that the RBA only approves the application under rather strict conditions. Therefore, it could be more attractive for both the employee and employer to ask for the judgement of the cantonal judge. Hassink, Reitsma, and Roorda (1998) find that cantonal judges handle 33 percent of the firing cases. This percentage has been used in the calculation of the sector- and age-specific average severance pay.

In most cases, the cantonal judge uses the so-called ABC-formula in order to assess the severance pay. According to the ABC-formula the severance pay is equal to the product of a) gross monthly earnings, b) 'weighted tenure'. The variable 'weighted tenure' is calculated as follows: the 'tenure years' before age 40 have a weight of 1, the 'tenure years' between age 40 and 50 a weight of 1.5, and 'tenure years' of over age 50 a weight of 2 (see Hassink, Reitsma, and Roorda (1998)). In order to assess the average severance pay, we have used data from the SEP to estimate the age-specific average value of the variable 'weighted tenure', and data from the JWL. According to the SEP data, the average 'weighted tenure' of the young employees (<50) is equal to 7.7 years and that of the 'old employees' (>=50 years) 19.3 years. In these calculations we have proxied the variable 'weighted tenure'. For the employees younger than 50, we have taken taken the unweighted tenure and for the old employees we have multiplied the unweighted tenure by a factor 1.5. In table 3 we present the average severance pay by sector and age.

The total firing cost is equal to the sum of average severance pay and the cost of premium differentiation. To determine the firing costs due to premium differentiation, we first determined the discounted sum of unemployment benefit payments to individuals. For this, we used data from the LISV.[16] The available data contain records of individuals for whom, in a given year[17] entitlement to unemployment insurances benefits ended. It contains information about their monthly unemployment insurance benefit and the number of months they have been unemployed. We have taken the discounted sum[18] of monthly unemployment benefits over the period of unemployment. The average over individuals has been determined. The data contain information about the age of the individual, so we could determine the discounted sum of benefits for different age groups. Table 4 shows the costs of unemployment benefits per worker. The cost of unemployment benefits for the unemployed aged 50 years or older are for most sectors 3 to 4 times higher than the costs of unemployed individuals younger than 50.

Table 3: Severance pay by age and sector

Sector	ABC-formula		ABC-formula times factor 0,33	
	young (<50)	old (50+)	young (<50)	old (50+)
1. Agriculture, Tobacco	23944	110474	7902	36456
2. Construction	31820	149042	10500	49184
3. Wood-, furniture industry	31820	149042	10500	49184
4. Publishing, printing and reproduction industry	32107	168446	10595	55587
5. Basic and fabricated metal products ,electro industry	32082	159246	10587	52551
6. Retail trade and repair	15664	82859	5169	27344
7. Harbour, inland navigation, fishing	42268	212841	13948	70238
8. Other transportation	30798	140660	10163	46418
9. Hotels and restaurants	14845	64532	4899	21296
10. Health care	23606	114464	7790	37773
11. Government services	20474	100184	6756	33060
12. Banking, Insurance, wholesale trade and transportation	35139	206361	11596	68100
13. Employment Agencies	15912	96621	5251	31886
14. Other manufacturing	26981	119721	8904	13356

[16] LISV stands for 'National Institute for Social Insurances' (Landelijk Instituut Sociale Verzekeringen).

[17] We had data available for the years 1992-1995.

[18] Discounting took place on basis of a monthly discount rate which is the equivalent of the yearly discount rate of 7.5%, that we chose before.

The extent in which the costs of unemployment benefits in table 4 will be part of the firing costs depends on the particular system of premium differentiation that will be introduced. For example, if only half of the costs of unemployment benefit payments are charged to the individual firm, the firing costs per worker will only be half the amount of the costs listed in table 4. But even in a system of complete premium differentiation, the firing costs may differ from the figures in table 4. In the system of premium differentiation at present in operation in the Netherlands for disability insurances,[19] for practical reasons the costs of the benefits are charged to the firm with a lag of two years. Assuming the same practice in the unemployment insurance system, this implies that the costs of benefits in table 4 need to be discounted to account for the time lag.

Table 4: The costs of unemployment benefits per worker

Sector	Total costs for workers aged < 50	Total costs for workers aged >= 50
1. Agriculture, Tobacco	12607	29171
2. Construction	16585	36639
3. Wood-, furniture industry	17317	62301
4. Publishing, printing and reproduction industry	20791	83445
5. Basic and fabricated metal products, electro industry	19015	97419
6. Retail trade and repair	19480	56272
7. Harbour, inland navigation, fishing	19142	137564
8. Transportation	16849	49944
9. Hotels and restaurants	14559	28245
10. Health care	30242	64905
11. Government services	10003	28727
12. Banking, Insurance, wholesale trade	20187	70645
13. Commercial employment agencies	13397	46374
14. Other manufacturing	19531	89279

Source: LISV

The benefit ratio

To calculate the effects of premium differentiation, we also need to look at the effects on unemployment insurance premiums in different sectors. For this purpose, we need data about the benefit ratio in different sectors. The benefit ratio is defined as the ratio of the total

[19] This system is known under the name PEMBA ('Premiedifferentiatie en Marktwerking Bij Arbeidsongeschiktheidsverzekeringen').

unemployment insurance expenditures, divided by the total wage bill.[20] LISV collects the information on the total unemployment insurance payments in each sector as well as on the sectors' total wage bill. We use this information to determine the benefit ratio in each sector. We do not have information about benefit ratios at the firm level within sectors. In the computations, the point of departure will be the average firm in a sector with the benefit ratio equal to the benefit ratio in the sector, and firing costs per worker equal to firing costs in the average sector.

In determining the effects of premium differentiation, we will assume a direct relationship between the premium and the benefit ratio. For example, we will assume that in a system of complete premium differentiation the premium for a firm in a given sector is equal to the benefit ratio in that sector. In a system of premium differentiation in which half of the benefit payments are charged to the individual, the premium consists of half of the benefit ratio at the sectoral level plus half of the benefit ratio, undifferentiated by sector. Notably we abstract from a number of practical reasons why unemployment insurance premiums in a system of premium differentiation will not only determined by the benefit ratio. Even in a system of complete premium differentiation, there will always be something like a base premium to raise premium revenues for unemployment benefit payments that cannot be charged to a specific firm, for example the benefits that have to be paid to the former workers of a firm that went bankrupt.

Table 5 shows the benefit ratio (unemployment insurance expenditures expressed as a percentage of the wage bill) for the various sectors in the Dutch economy. The first column of table 5 shows the benefit ratio for each sector. The final row contains the undifferentiated benefit ratio. Sector with a benefit ratio above the undifferentiated number are sectors with above average UI premiums. The benefit ratio is highest in the sector of commercial employment agencies, which is closely related to the nature of the activities in the sector, namely bringing firms and workers together for a fixed term labor contract. The second column shows the differentiated benefit ratio per sector, based on only the benefit payments to individuals who are unemployed for at most 6 months.[21] Recall that at present there is premium differentiation at the sectoral level in the Netherlands, based on the unemployment benefit expenditures for the first six months of unemployment. The premium in a given sector in the present system will therefore

[20] A benefit ratio can be determined at various levels of aggregation. It can be determined at the level of the individual firm, or at the sectoral level. We have not the information to determine the benefit ratio at the level of individual firms. We can, however, compute the benefit ratio at the sectoral level. We will assume throughout that for the 'average' firm in a sector the benefit ratio is equal to the sector benefit ratio.

[21] More precisely, it is the total amount of unemployment insurance expenditures in a given year in a sector to individuals who are unemployed for at most 6 months, divided by the total wage bill in the sector. This means that for individuals who initially are unemployed less than six months in the given year, but for whom the length of the unemployment spell increases to over six months during the year, only part of the benefit expenditures are added in the calculation of the benefit ratio.

be based on the sector specific benefit ratio in the second column of table 5, increased with the undifferentiated premium of 3.8% in the fourth column of table 5, which shows the benefit ratio based on unemployment insurance expenditures to individuals who are unemployed for more than 6 months.

Table 5: The benefit ratios (in %)			
Sector	Benefit ratio	Benefit ratio, based on UI expenditure for first 6 months of unemployment	Benefit ratio, based on UI expenditures to individuals unemployed for more than 6 months
1. Agriculture, Tobacco	9.4	4.6	4.7
2. Construction	8.8	4.3	4.4
3. Wood-, furniture industry	5.0	1.8	3.2
4. Publishing, printing and reproduction industry	5.4	1.7	3.7
5. Basic and fabricated metal products, electro industry	5.5	1.5	4.0
6. Retail trade and repair	6.9	2.4	4.6
7. Harbour, inland navigation, fishing	10.8	2.3	8.5
8. Transportation	4.0	1.5	2.5
9. Hotels and restaurants	9.2	4.7	4.5
10. Health care	3.8	1.0	2.8
11. Government services	11.3	7.0	4.3
12. Banking, Insurance, wholesale trade	4.1	1.6	2.5
13. Commercial employment agencies	12.9	7.1	5.7
14. Other manufacturing	6.1	1.9	4.2
Undifferentiated	5.8	2.0	3.8

Source: LISV, 1995

5. Results

Premium differentiation will be modeled as a shift from wage costs to firing costs: firing costs are increased, whereas wage costs are lower due to a decrease in unemployment insurance premiums. The effects of premium differentiation will be presented in two steps. In this way we hope to get a clearer view of the different impacts that the increase in firing costs and the decrease in wage costs have on the hiring and firing behaviour of firms.

We present the results for one variant of premium differentiation. We will assume throughout that half of the unemployment insurance expenditures due to the firing of workers will be charged to the individual firm. This choice has been made as in the political debate arguments are put forward in favour of restricting the degree of premium differentiation. Restricting the degree of premium differentiation decreases the financial risks run by individual firms. In the political debate it is felt moreover that the firms cannot be held fully responsible for the total unemployment benefit expenditures to workers fired, as these are also influenced by the individual search effort of the unemployed. This means that the increase in the firing cost that will be used in the simulations to determine the effect of premium differentiation is equal to half the amount of the cost of unemployment benefits per workers from table 4. In addition, this amount will be discounted for two years for the reason described in section 4.

First, we increase the firing costs of both types of labor. The increase in firing costs has a negative effect on firing, which in terms of the model in section 3, emerges as a decrease in the lower bound of the marginal product of labor. In section 3.3 we described the relation between the lower bounds of the marginal revenue product of labor for both types of workers, and the upperbounds on labor demand (following from (18) and (19)). Due to this relation, the upper bounds for the demand for labor for both types of workers increases due to an increase in firing cost. The increase in firing cost has a negative effect on hiring, which is shown by an increase in the upper bounds of the marginal revenue product of labor for both types of workers. Using the relation between the upper bounds of the marginal product of labor and the lower bounds for the workers, the lower bounds for both types of workers decrease.

By changing only the lower bounds of the marginal revenue products of labor of both types in the Monte Carlo integration, while keeping the upper bounds constant, we can separate the effect of the increase in firing costs on the average demand of labor due to a change in firing behaviour. By doing the reverse (changing the upper bounds of the marginal revenue product of labor of both types, while keeping the lower bounds constant) we can determine the change in the average level of labor demand due to a change in hiring behaviour. The total effect, which is the sum of the two separate effects, is obtained by changing both the upper and the lower bounds. Note that only changing firing costs, while keeping wage costs constant, gives a conservative view of the effects of premium differentiation on the demand for labor: apart from having to pay firing costs in case of firing, it is as if the firm continues paying premiums according to the existing system of financing unemployment insurances. The only reason to presenting the analysis in various steps is to gain insight in what is going on. The simulations we do by only increasing the firing cost are directly comparable with the analysis performed by Bentolila and Bertola (1990).

In the second step, we decrease the wage costs with the differentiated part of the unemployment insurance premium, based on the benefit ratio calculations in table 5. Note that in this case, the financing of benefits of the laid off workers who are unemployed at the moment of a switch from one system to another is ignored. In this respect we act as if the firm is in a situation without former laid off workers on unemployment benefits, and the firm is only to decide about hiring and firing at present and in the future.

In section 5.1 the effects on the steady state level of labor demand due to an increase in the firing costs are presented. In section 5.2 we present the effects of an increase in firing costs and a decrease in wage costs. Section 5.3 shows the results of sensitivity analysis, including the wage reactions. In section 5.4 we simulate the effects of premium differentiation on the firm's efficiency and on the average level of profits.

5.1 Increasing the cost of firing

Table 6: Premium differentiation based on half of the unemployment insurance expenditures: Relative changes (in %) in the steady state level of labor demand due to an increase in firing costs

	Due to change in firing behaviour		Due to change in hiring behaviour		Total effects		Total
Sector	young	old	young	old	young	old	employment
1. Agriculture, Tobacco	0.6	1.6	-0.8	-0.4	-0.1	1.2	0.0
2. Construction	1.6	1.8	-1.7	-1.3	-0.1	0.5	0.0
3. Wood-, furniture industry	2.9	4.6	-2.0	-2.2	1.0	2.4	1.1
4. Publishing, printing and reproduction industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5. Basic and fabricated metal products, electro industry	1.0	3.8	-0.4	-0.7	0.5	3.1	0.9
6. Retail trade and repair	4.1	6.4	-3.5	-3.2	0.6	3.2	0.9
7. Harbour, inland fishing and navigation	1.6	2.2	-1.6	-2.0	0.0	0.2	0.0
8. Transportation	0.6	1.2	-0.7	-0.6	-0.1	0.7	-0.1
9. Hotels and restaurants	0.7	3.1	-0.4	-1.4	0.3	1.7	0.4
10. Health care	0.8	3.4	0.0	0.0	0.8	3.4	1.1
11. Government services	0.2	0.7	0.0	0.0	0.2	0.7	0.2
12. Banking, insurance, wholesale trade	0.8	2.0	-0.9	-1.4	-0.1	0.6	-0.1
13. Commercial employment agencies	4.6	5.5	-2.7	-2.2	1.9	3.3	2.0
14. Other manufacturing	1.2	4.9	-0.4	-0.8	0.8	4.2	1.2
Total	1.5	2.7	-1.0	-0.7	0.5	2.0	0.6

Table 6 shows for each sector the effects of an increase in firing costs, due to premium differentiation based on half of the unemployment insurance expenditures for the 14 different sectors. It gives the relative changes (in %) in the steady state level of labor demand for young and old workers due to the increase in the costs of firing. The final column ('total employment') has been obtained as the weighted average of the effects for young and old workers, weighted by the average numbers of young and old workers in a firm in the given sector. Similarly, the row 'total' gives an average of the results over all of the sectors. It shows that the increase in firing costs generally leads to an increase in the demand for labor of young workers that is attributed to a decrease in firing of 1.5%, whereas it leads to a decrease in the demand for labor, due to a decrease in hiring, of 1%. This results in a total increase in the demand for young workers of 0.5%. For old workers the demand for labor increases by 2%. This is the result of a positive effect of 2.7% due to a decrease in firing and a negative effect of 0.7% due to a decrease in hiring. Weighting the effects for young and old workers leads to a total increase of employment in the firm of 0.6%. Looking at sectoral differences, we see that the relative effects on the demand for labor are largest in the commercial employment agencies. The demand for young workers increases by 1.9%, whereas the demand for old workers increases by 3.3%. From table 1 we know that the uncertainty in this sector is the largest amongst all the sectors. Moreover, the quit rates and growth rates are among the lowest of all sectors (see table 1). Bentolila and Bertola (1990) note that the demand for labor notably increases if the variance is high, quit rates are low and the growth rate is low.[22] The effects of the increase in firing costs on labor demand are almost zero in the publishing, printing and reproduction sector. Looking at table 1, we see that this sector has relatively high quit rates, especially for workers of age 50 or older.[23] For some sectors we see a slightly negative effect on the demand for young workers (agriculture, construction, transportation and banking). We have checked what was going on here and found that the upper bound of labor increased more than the lower bound decreased (in absolute levels), as expected according to Bentolila and Bertola (1990), but we also found that in these sectors the marginal productivity of old workers, according to the values generated by the model, is relatively high as compared to the marginal productivity of young workers.[24] Given that the impact of the marginal productivity of old workers on the demand for labor of young workers is decreasing according to (18), and given that the marginal product of labor is on average closer to the higher bound (see the discussion in Bentolila and Bertola (1990)), the negative effect of

[22] These factors are mentioned explicitly by Bentolila and Bertola (1990) on page 393 as factors that increase the employment increasing effect of an increase in the firing costs.

[23] In the early nineties, a compulsory early retirement scheme has been introduced in this sector (see "Vervroegde uittreding in CAO's", report by the Dutch ministry of Social Affairs and Employment, 1990, Dienst Collectieve Arbeidsvoorwaarden, Reeks studies van CAO's).

[24] Note that the values of β_i is assumed to be the same for young and old workers.

the increase in firing costs in the hiring of old workers, apparently obtains so much weight in the determination of the demand for labor of young workers, that it dominates, and causes the (small) negative effect in the sectors mentioned.

5.2 Increasing the costs of firing and decreasing the wage costs

In this section we analyze the effects of premium differentiation by increasing the costs of firing, while decreasing the wage costs, due to a reduction in the unemployment insurance payments. Before we present the results, we go back to the specification of the labor demand functions in (18) and (19). The form of these labor demand functions is the result of the specification of the Cobb-Douglas type of production function in (1), together with the demand function in (2). To be able to solve the model in the first place, these type of (multiplicative, geometric) functional forms need to be used (see also Bentolila and Bertola (1990)). A serious drawback of the specification is that it places a restriction on the range of values of the wage elasticity of the demand for labor. This can most easily be seen if we replace the marginal revenue products in (18) and (19) by the wage costs per worker. This coincides with the case in which hiring and firing costs are absent.[25] The wage elasticity of the demand for labor, due to an increase in the wages of both old workers and young workers is for both types of labor equal to

$$e = -\frac{1}{1 - \mu(\beta_1 + \beta_2)} \tag{32}$$

Given that $0<\mu<1$ and $0<\beta_i<1$ the elasticity in (32) is always smaller than -1, which implies a fairly large wage reaction on the demand for labor. For the specific parameter values we chose, the wage elasticity is -1.66.[26] The own wage elasticity is -1.33 and the cross wage elasticity is -0.33.[27]

The effects of an increase in the firing costs and a decrease in the wage costs can be found in table 7.

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[25] Hamermesh (1986) interprets this as the long run demand for labor function.

[26] In the model of Bentolila and Bertola, the wage elasticity is -2.5 if μ = 0.6.

[27] For the purpose of comparison, we mention that in the JADE (1997) model, a labor demand model for the Dutch economy by the Dutch Central Planning Bureau, that is based on CES production functions, two sectors are distinguished: the ‘sheltered’ sector and the ‘exposed’ sector. The wage elasticity of labor demand in the sheltered sector is equal to -0.93, while the elasticity for the exposed sector is equal to -0.82. The JADE model makes a distinction between workers with a high and a low education. The elasticities given here are a weighted average of the elasticities for high and low educated workers. The weights used are the numbers of high and low educated workers. This information was provided to us by the CPB.

Table 7: Premium differentiation based on half of the unemployment insurance expenditures: Relative changes (in %) in the steady state level of labor demand due to an increase in firing costs and a decrease in wage costs.								
	Due to change in firing behaviour		Due to change in hiring behaviour		Total effects		Total employ ment	Relative change in wage costs
Sector	young	old	young	old	young	old		
1. Agriculture, Tobacco	2.1	6.5	3.4	0.8	5.5	7.3	5.7	-3.5
2. Construction	4.2	6.1	1.1	0.1	5.3	6.2	5.4	-3.2
3. Wood-, furniture industry	5.3	7.7	-0.6	-1.3	4.7	6.4	4.9	-2.2
4. Publishing, printing and reproduction industry	0.0	0.0	3.4	3.4	3.4	3.4	3.4	-2.1
5. Basic and fabricated metal products, electro industry	1.7	6.7	2.3	0.1	4.0	6.8	4.4	-2.1
6. Retail trade and repair	5.8	9.8	-1.1	-2.0	4.8	7.8	5.0	-2.6
7. Harbour, inland fishing and navigation	3.1	2.8	0.9	1.2	4.0	4.0	4.0	-2.5
8. Transportation	1.4	4.1	1.9	0.2	3.3	4.3	3.4	-2.1
9. Hotels and restaurants	1.7	7.2	4.5	0.7	6.1	8.0	6.3	-3.5
10. Health care	1.5	6.3	2.5	0.6	4.1	6.9	4.4	-1.9
11. Government services	1.7	7.2	6.0	1.5	7.7	8.6	7.8	-4.5
12. Banking, insurance,wholesale trade	1.5	4.4	1.6	-0.2	3.2	4.2	3.2	-2.1
13. Commercial employment agencies	11.5	13.4	-1.2	-1.3	10.3	12.1	10.4	-4.6
14. Other manufacturing	2.0	8.3	2.6	0.2	4.6	8.4	5.1	-2.3
Total	3.3	6.3	2.0	0.5	5.3	6.9	5.4	-2.9

The final row shows the average effects. For the young workers, the demand for labor increases with 5.3%: 3.3% of this increase is due to a change in firing behaviour, and 2% due to a change in hiring behaviour. For young workers, the negative effect on hiring that was found in table 6 is more than compensated by the decrease in wage costs. For old workers, the demand for labor increases by 6.9%. A comparison with table 6 shows that 2.0% of this increase is due to the increase in firing costs, whereas the remaining 4.9% must be due to the decrease in wage costs. For old workers, we now see a small positive impact on the hiring behaviour of the firm. The increase in total employment is 5.4%. Looking at the sectoral differences, we see the smallest increase in the demand for labor in the banking sector. Note that in publishing sector, the decrease in the wage costs mainly influences the hiring behaviour, as due to the relatively large quit rates, firing is apparently not an issue for the average firm in this sector. It is also interesting to note the asymmetry between old and young workers with respect to hiring and firing in e.g. the sectors health care and government services. Both these sectors are characterized by a fairly low uncertainty (see table 1). For old workers, the decrease in wage costs has the largest influence on the firing behaviour, whereas for young workers, the effect on the hiring behaviour is largest. The effect on the demand for labor is largest in the sector of commercial employment agencies, which experiences the largest increase in firing costs, and the largest relative decrease in wage costs.

For completeness, we included in appendix D a table with the effects on labor demand if we compute the effects on labor demand due to the decrease in wage costs using external wage elasticities.[28] Table D1 shows an increase in the demand for labor of young (old) workers by 3.0% (4.5%). This is more than 2 percent lower than the results in table 7.

5.3 Sensitivity analysis and the effects of wage reactions

The effects of premium differentiation on labor demand presented in the previous subsection, were all obtained with given values of the parameters. Moreover, the effects of a possible upward pressure on wages have not been taken into consideration. In this section we analyze the sensitivity of the results with respect to the values of the model parameters. As a base specification we take the average results from the last line of table 7. We will show how these results are affected by changes is the model parameters. Moreover, we show how the results change if we take wage reactions into account.

First of all we look at a change in hiring costs. In section 4 we assumed that one of the components of hiring costs was the 'cost of settling into the job'. In estimating this cost, the assumption has been made that a new employee is only productive for 50%. We replace this assumption by assuming that during 'the time of settling into the job' the new worker is not productive at all. Thus, we increase the hiring costs. The results of this exercise are found in table 8. On the first row of table 8 ('base') we repeat the results from table 7 (final line). The second row shows the effects of premium differentiation on the demand for labor if the hiring costs are higher. Quantitatively, there is hardly any difference with the base results.

Next, we increase the parameter μ from 0.6 to 0.8. A priori is is hard to tell what is the effect of an increase in this parameter. By (18) and (19) is influences the relative and total effects of the marginal revenue products of both types of labor on the average demand for labor. Note that μ influences the model outcomes through many canals. By (32), it influences the wage elasticity. The increase in μ leads to a higher sensitivity of labor demand with respect to the wage. Therefore, the effect of the decrease in wage cost will be higher. The parameter μ also

[28] For the elasticities we use value from the JADE model by the CPB, mentioned before.

affects the growth rates of the marginal revenue product of both types of labor, as well as the variance around this growth rate. According to (15), this variance gets smaller. From the analysis in Bentolila and Bertola (1990) it is known that the variance notably affects the marginal effect of firing costs on the hiring decision. A higher variance increases this effect. Finally, μ affects the growth rates of the marginal revenue product of labor processes according to (16) and (17). In table 8 we see that notably the firing behaviour is most affected by the increase in μ. The positive effect on average labor demand due to the decrease in firing cost and the increase in wage costs has become larger. For both young and old workers the additional effect is almost 2%. The positive effect on hiring due to the decrease in wage cost has increased as well. Taken together, the increase in the demand for labor of young (old) workers is 2.5% (2.6%) higher than in the base specification. From this we draw the conclusion that results are fairly sensitive with respect to the value of the parameter μ.

In the base specification the assumption was made that firing costs that are not due to the costs of unemployment benefits (i.e. the firing costs that have to be paid irrespective of whether or not there is a system of premium differentiation) are equal to one third of the so called 'ABC formula'. We computed the effects of premium differentiation if we increased these firing to 50% as well as 100% of the ABC formula. We see from table 8 that the increase in firing costs due to premium differentiation has a smaller decreasing effect on hiring if the ABC part of the firing costs is higher. This is consistent with Bentolila and Bertola (1990) who discuss that a higher level of firing costs decreases the marginal effect of firing costs on the hiring decision. There is no such thing like a decreasing marginal effect of firing costs on the firing decision. This is due to the fact that firing costs per worker are linear. The eventual effect of an increase in firing costs on the firing behaviour depends on the shape of the functions in (18) and (19). For young workers we see that the marginal effect of firing costs is hardly effected by the increase of the basic firing costs. If the ABC formula is included in the firing costs for only 0.33%, the increase in the demand of labor for young workers due to the change in firing behaviour is 3.3%. If it is included for 50% or 100%, this increase is 3.3% and 3.4%, respectively. For old workers we actually see an increase in the marginal effect of firing costs. Combining effects on hiring and firing, we conclude that higher basic firing costs increase the positive effects on the demand for labor of premium differentiation. Considering the fact that these basic firing cost were made three times as large, the effect is not that large: the increase in total employment is 0.6% points higher.

The variance parameter for the different sectors has been increased by 10%. A higher variance increase the chance that due to a shock the firing bound will be hit. A higher variance will therefore increase (in abolute value) the marginal effect of firing costs on the hiring decision. This will have a negative effect on the demand for labor. A higher variance will also increase the marginal effect of an firing costs on the firing decision, which leads to a positive effect on the average level of labor demand. In table 8 we see that the demand of labor for both young and old workers remains unchanged. An additional employment increasing effect attributed to the firing behaviour is compensated by an additional employment decreasing effect due to a change in the hiring behaviour.

Next, we reduced growth rates by dividing them by 2. A lower growth rate also increases the probability that the firing bound is being hit. The effects of premium differentiation on the demand for labor hardly change due to the change in the growth rate. In table 8 we see that there is a slight (additional) increase in the demand for labor that is attributed to a change in firing behaviour.

Finally, the interest rate is increased from 7.5% to 10%. Note that the interest rate also influences the value of discounted costs of benefits, and therefore reduces the firing costs due to premium differentiation. The increase in firing costs due to premium differentiation is therefore somewhat smaller if the interest rate is higher. As the interest rate discount future events, and the increase in firing costs due to premium differentiation affects the hiring decision only through expectations with respect to the future, the hiring decreasing effect of an increase in firing costs will be smaller the larger is the interest rate. To explain the effect of a lower interest rate on the firing decision, we look at the first order condition (9). Before, we noted that firing costs due to premium differentiation get smaller due to discounting. But the left hand side of (9), the discounted sum of productivity-wage differences, is suppressed (in absolute value) even more, since here discounting takes place over the entire, infinite, future, whereas discounting of benefit payments only takes place over the average period of unemployment. Therefore, the effect on the firing decision of an increase in firing costs, due to premium differentiation, increases, as the increase in firing costs get a relatively higher weight. The results of these considerations can be found in table 8. For young (old) workers the increase in the demand for labor now is 5.7% (8.1%), whereas before it was 5.3% (6.9%).

Next, we consider the impact of wage reactions on the demand for labor. We analyse what are the effects on the demand for labor of young and old workers if, apart from the decrease in wage costs due to the decrease in unemployment insurance payments, there is an upward effect on wages due to insider power. These wage effects are computed using a wage equation derived in the context of a matching model, based on Bertola and Caballero (1994) and Millard and Mortensen (1997). The derivation of this equation is described in appendix B. In table 7, which incorporates the decrease in wage costs only, wage costs decrease on average by 2.9%. Once we incorporate the upward wage pressure due to insider power, the average decrease in wage costs is only 1.5%. The implications for the demand for labor are shown in table 8. Due to premium differentiation, the demand for labor of young workers increases with 3.2%. Without the insider wage reaction, we found an increase of 5.3%. The demand for labor of old workers now increases with 4.2%. The increase was 6.9% in the absence of insider power wage reactions. Total employment increases with 3.3%, whereas we found an increase in total employment of 5.4% before.

Table 8: Sensitivity analysis on the effects of premium differentiation based on half of the unemployment insurance expenditures (increase in firing costs and decrease in wage costs).

	Due to change in firing behaviour		Due to change in hiring behaviour		Total effects		Total
Analysis	young	old	young	old	young	old	employment.
Base	3.3	6.3	2.0	0.5	5.3	6.9	5.4
Settling time 100% inproductive	3.2	6.3	2.1	0.6	5.3	7.0	5.4
mu = 0.8	5.2	8.2	2.5	1.3	7.8	9.5	7.9
100% ABC formula	3.4	6.9	2.4	1.0	5.8	7.9	6.0
50% ABC formula	3.3	6.5	2.1	0.7	5.4	7.2	5.6
variance +10%	3.6	6.5	1.7	0.4	5.3	6.9	5.5
growth rate halfed	3.5	6.6	1.8	0.6	5.4	7.2	5.5
interest rate = 10%	3.6	7.5	2.1	0.6	5.7	8.1	5.9
insider power wage reaction	2.8	4.5	0.4	-0.2	3.2	4.2	3.3

5.4 Effects of premium differentiation on profits

In the debate around premium differentiation, often the argument is brought forward that introducing premium differentiation will lead to a loss in the firms' profits. The higher cost of firing induces firms to maintain the working relation with workers that in the absence of premium differentiation would have been laid off. Thus, inefficiency is created. However, in this argumentation the decrease in wage cost due to a decrease in unemployment insurance premiums is left out of consideration. To gain insight in the effects of premium differentiation on the firms' profits the model described in section 3 will be used to determine the quantitative effects of premium differentiation on profits.

The determination of the steady state solution for the demand for labor, as described in section 3.3, is not sufficient to determine the level of profits, since for the latter the determination of the cost of adjustment is required. To determine the cost of adjustment, we will simulate the regulated Brownian motion of the processes for the marginal revenue product of both types of labor, η_{ti}, ($i = 1, 2$).[29] Thus, we simulate the numbers of hires and fires, and we are consequently

[29] We do this in the following way. First, we generate starting values for the marginal revenue product of labor processes. We determine starting values by drawing 1000 random numbers from the steady state distribution of the marginal revenue product of each type of labor. That is, we draw random numbers from the distribution in (21), in the same way as described in section 3.3. Next, we simulate the regulated Brownian motion process in (14), with bounds d_i and u_i, for the 1000 different starting values for a period of one year. We simulate the Brownian motion, approximating the continuous time process by discrete time intervals of length 1/120. That is to say, we

able to simulate the cost of adjustment. We repeat this procedure, using the same starting values for the marginal revenue product of labor each time, for the case without premium differentiation, the case with higher firing cost due to premium differentiation, and the case with both higher cost of firing and lower wage cost due to premium differentiation.

In the absence of any cost of adjustment, firms maximize the difference between revenues and wage cost. The existence of adjustment cost will lead to a lower level of the difference between revenues and wage cost. Therefore we will consider any decrease in the difference between revenues and wage cost as a measure for the loss in efficiency incurred.

The consequence is that if only the increase in firing cost, resulting from the introduction of premium differentiation, were considered, we expect a negative effect on profits and on the efficiency measure. Given the nature of the firm's optimization problem, the difference between revenues and wage cost should decrease due to an increase in firing cost.[30]

Table 9 shows the effect on profits of an increase in firing cost, accompanied by a decrease in wage cost, due to the introduction of premium differentiation. There are only three sectors in which we find a negative effect on the difference between revenues and wage cost. These are the 'wood and furniture industry' (-1%), the 'retail and repair' sector (-0.5%), and the 'commercial employment agencies' (-1%). In all the other sectors the decrease in the wage cost per worker due to the decrease in unemployment insurance premiums is more than enough to compensate for the loss in efficiency due to the higher cost of firing. The effects on total profits are found in the final column of table 12. Now there are only two sectors with a decrease in profits. These are the 'wood and furniture industry', with a decrease in profits of almost 1%, and the 'commercial employment agencies' for which profits decrease by almost 3%.

simulate 1000 times 120 periods of 1/120 year. (We experimented with a further refinement of the increments, by using steps of 1/200 year. This did not seriously influence the outcomes). For each of the 1000 simulated paths for the marginal product of labor, we determine how often the marginal revenue product of each type of labor hits the bounds and how large an adjustment of any of the types of labor is needed to keep the marginal revenue of products within their bounds.

[30] The calculation of the revenues is based on the average of the evaluation of the revenue function in (4) on basis of the 1000 drawings for the steady state labor demand levels. Total wage cost are calculated on basis of the steady state levels of labor demand as well. We calculated the effect of an increase in firing cost, ignoring the decrease in wage cost, and we found negative effects on profits in every sector. We find that this is the case in all sectors but the publishing sector, where the effect on profits is zero. In most of the sectors, the decrease in the difference of revenues and wage cost is rather small. There are only four sectors in which this decrease is 1% or larger. In the 'other manufacturing' sector we find a decrease of 1%, in the 'retail trade and repair' sector the decrease is 2%, whereas a decrease of 2.3% is found in the 'wood and furniture' industry. The largest decrease of 3.6% takes place among the 'commercial employment agencies'.

Table 9: Premium differentiation based on half of the unemployment insurance expenditures: Relative changes (in %) in the profits as a result of an increase in firing costs and a decrease in wage costs.		
Sector	revenues-wage cost	profits
1. Agriculture, Tobacco	2.0	2.4
2. Construction	1.7	2.6
3. Wood-, furniture industry	-1.0	-0.8
4. Publishing, printing and reproduction industry	1.4	0.6
5. Basic and fabricated metal products, electro industry	0.6	0.8
6. Retail trade and repair	-0.5	0.7
7. Harbour, inland fishing and navigation	1.4	1.5
8. Transportation	1.2	0.9
9. Hotels and restaurants	1.8	1.4
10. Health care	0.9	1.2
11. Government services	3.0	3.5
12. Banking, insurance,wholesale trade	1.1	1.1
13. Commercial employment agencies	-1.0	-2.9
14. Other manufacturing	0.5	0.6

6. Conclusions

We have simulated the effect on labor demand of premium differentiation in the Dutch unemployment benefit system. For this purpose, we adapted the labor demand model by Bentolila and Bertola (1990) by introducing two types of workers, the 'young' and the 'old', who have different wages, a different hiring and firing cost, and different quit rates. For the parameters, numerical values have been determined for 14 sectors of the Dutch economy. For each of the sectors we determined the effect on the steady state level of the demand for labor if half of the unemployment expenditures are charged to the individual firms. The system of premium differentiation has been modeled by a shift from wage cost to firing cost. For all sectors we find an increase in the demand for labor of both young and old workers. The relative increase in the demand for labor is higher for old workers than for young workers.

The model is not an equilibrium model, and consequently wage reactions are ignored. However, we performed a sensitivity analysis by deriving (in an ad hoc way) a wage reaction from an equilibrium model wage equation. The steady state level of labour demand still increases, but the increase is smaller. A sensitivity analysis for the remaining model parameters shows no large shifts in the quantitative results, except for the parameter of the demand equation.

We also simulated the effect of premium differentiation on the profits. In general, an increase in the cost of firing will decrease the profitability of firms, but since the increase in the cost of firing due to premium differentiation is accompanied by a decrease in wage cost, the effect on profits is not clear a priori. We found that for two of the sectors the average level of profits decreased. For the remaining twelve sectors an increase in profits was found.

Several interesting topics are left unattended and are subjects for future research. We have already noted that the present model is not an equilibrium model. Extending the model to an equilibrium model, without simplifying the model in other dimensions, like the shock process, is a difficult but challenging task. The effect of the 'risk' of premium differentiation on investment or opening and closing of firms is something that we have to keep in mind as well in interpreting the positive effect on labor demand.

Appendix A. Solving the bounds of the MRPL

For this, use can be made of lemma 1 in Bentolila and Bertola (1990). If a proces η_{ti} follows a regulated geometric Brownian Motion of the form $d\eta_{it}=\theta_i\eta_{it}dt+\sigma\eta_{it}dw_t$ with lowerbound d_i and upperbound u_i, the following equality holds:

$$E_0\left(\int_0^{\infty}\eta_{ti}e^{-\lambda_i t}dt\right)=\frac{\eta_{0i}}{\lambda_i-\theta_i}+A_i\eta_{0i}^{\alpha_{i1}}+B_i\eta_{0i}^{\alpha_{i2}}=f_i(\eta_{0i};u_i,d_i,\theta_i,\sigma,\lambda_i) \qquad \text{(A1)}$$

with

$$A_i=\frac{1}{\lambda_i-\theta_i}\frac{u_{i1}^{\alpha_{i2}}d_i-u_i d_i^{\alpha_{i2}}}{\alpha_{i1}[u_{i1}^{\alpha_{i1}}d_i^{\alpha_{i2}}-u_i^{\alpha_{i2}}d_i^{\alpha_{i1}}]} \qquad \text{(A2)}$$

$$B_i=\frac{1}{\lambda_i-\theta_i}\frac{u_i d_i^{\alpha_{i1}}-u_i^{\alpha_{i1}}d_i}{\alpha_{i2}[u_{i1}^{\alpha_{i1}}d_i^{\alpha_{i2}}-u_i^{\alpha_{i2}}d_i^{\alpha_{i1}}]} \qquad \text{(A3)}$$

α_{i1} and α_{i2} in (A1) are the roots of the following characteristic equation:

$$-\frac{1}{2}\sigma^2\alpha^2-(\theta_i-\frac{1}{2}\sigma_i)\alpha+\lambda_i=0 \qquad \text{(A4)}$$

Combining the first order conditions in (9) and (11) with the result in (A1) delivers a system of equations from which the lower and upper bounds, d_i and u_i, of the process for the marginal revenue product of labor η_{ti} can be solved numerically:

$$f_i(d_i;u_i,d_i,\theta_i,\sigma,\lambda_i)=\frac{w_i}{\lambda_i}-F_i \qquad \text{(A5)}$$

$$f_i(u_i;u_i,d_i,\theta_i,\sigma,\lambda_i) = \frac{w_i}{\lambda_i} + H_i \quad \text{(A6)}$$

Appendix B. A wage equation with insider power

The model used in the simulations is a labor demand model. The wage is treated as given for the firm. Therefore, the model is not able to describe wage reactions. One of the issues that we want to address is the influence of higher firing costs on the wage through insider effects. As noted in the introduction, extending a labor demand model to a matching model seems hardly possible without making additional simplifying assumptions. Mortensen and Millard (1997) and Bertola and Caballero (1994) present a matching model in which wage reactions are incorporated. We use their models as a background for the determination of a wage equation in order to approximate the effects of increased firings costs on the wage of workers. The analysis with this wage equation is rather ad hoc, and therefore we want to stress that its main function is to perform a sensitivity analysis on the results that are obtained with the model by Bentolila and Bertola (1990), which abstracts from any wage reactions.

We use the analysis by Bertola and Caballero (1994) to derive a wage equation. In their model, a wage equation is derived assuming specific processes for the marginal revenue product of labor and productivity shocks. It can be shown that the derivation of this wage equation can easily be extended to general forms for the marginal revenue product of labor and for general shock processes.[31] In deriving the wage equation according to the analysis by Bertola and Caballero (1994), we use the wage bargaining rule by Millard and Mortensen (1997), as this rule correctly incorporates firing costs.

Let V_t denote the value function of the firm, W_t the value of a worker, and Ω_t the value[32] of an unemployed. For simplicity, we drop the distinction between different types of workers at the moment. The wage bargaining rule, based on Millard and Mortensen (1997) is given by[33]

$$\zeta[V_t+F] = (1-\zeta)[W_t-\Omega_t] \quad \text{(B1)}$$

[31] Details can be obtained from the authors on request.

[32] $\Omega_t = B_t + U_t$, with B_t the expected present value of the benefit income received during the unemployment spell, and U_t the expected present value of search.

[33] For simplicity, the subscript of firing costs F has been dropped.

Bertola and Caballero (1994) assume that the wage is a function of the number of workers l_t: $w_t = f(l_t)$. Define $\phi_t(l_t)$ as $f'(l_t)l_t + w_t$, the derivative of total wage costs with respect to the number of workers l_t. Let the employer tax be denoted by τ_e and the worker tax by τ_w. Following Bertola and Caballero (1994),[34, 35] we arrive at the following differential equation in terms of the wage function $f(l_t)$:

$$[(1-\tau_w)(1-\zeta)+\zeta(1+\tau_e)]f(l) = rU + \zeta[\eta + rF] - \zeta(1+\tau_e)f'(l)l \tag{B2}$$

Assuming that the functional form for η is provided by (12) or (13), the differential equation can easily be solved. The wage equation that we derived for the wage of worker type *i* is given by:

$$w_i = \frac{(1-\zeta)r[U_i + B_i] + \zeta r F_i}{(1-\tau_w)(1-\zeta) + (1+\tau_e)\zeta} + \frac{\zeta \eta_i}{(1-\tau_w)(1-\zeta) + \zeta(1+\tau_e)\beta_i} \tag{B3}$$

In (B3) the value function of an unemployed of age group *i* is represented by $U_i + B_i$, in which B_i is the discounted sum of the expected benefit receipts, and U_i is the value of searching (the expected present value of the job to be found). In a system of complete premium differentiation, B_i is equal to F_i. In systems with a restricted degree of premium differentiation, F_i will be less than B_i. The bargaining power of the workers is represented by the parameter ζ.

We are aware of the fact that we cannot really interpret the wage equation (B3) as an equilibrium wage. For example, we will not be able to determine changes in the expected unemployment duration, that may affect the value function for unemployed, given by $U_i + B_i$, since unemployment duration is not determined in a one-sided model. The wage equation will be used for the purpose of a sensitivity analysis, to determine how higher firing costs may lead to an upward wage reaction, and what the consequences are for the demand of labor.

The value of unemployment, which enters the wage equation (B3), is not determined inside the model described in section 3. In the simulations, the value of the unemployment benefits B_i is determined by the cost of unemployment benefits per worker, given in table 4. We approximate the value of search, U_i, as the discounted value of an infinite stream of wages. Thereby the implicit assumption is made that the individual worker does not incorporate the risk of layoff in determining the value of a job. We approximate U_i by

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[34] In (B2) Bertola and Caballero (1994) assume $\tau_e = \tau_w = 0$, and $\eta = \eta_g - \sigma l$. In their notation: $\zeta = \beta$.

[35] (B2) is the equivalent to the second unnumbered equation between equations (16) and (17) in Bertola and Caballero (1994).

$$U_i = \frac{(1+r)^{-T_i+1}}{r} w_i \qquad \text{(B4)}$$

in which T_i represents the average unemployment duration of a worker of age group *i*. For the latter, the values in the final two columns of table 4 can be used. The equation (B3) and (B4) can be combined to determine the value of the wage w_i.

Appendix C. Details about the determination of the parameters

Quit rates and 'greying parameter'

We start with the determination of the quit rates and the 'greying parameter'. The OSA Labor Demand survey and the SEP have been used for this purpose. To start with, we have merged 2 consecutive waves of the SEP (1989-1990, 1990-1991, 1991-1992, 1992-1993). Then we have computed the yearly transition rates from the labor market status 'work at the end of year t' to the following labor market positions at the end of year t+1, t=1989,...,1992:[36]

1) same job as at the end of year t
2) new job at the end of year t+1, and UI benefit recipient in year t+1
3) new job at the end of year t+1, and no UI benefit recipient in year t+1
4) military service
5) unemployed (UI benefit recipient)
6) student
7) 'working in the household'
8) (early) retirement
9) Disability benefit recipient
10) volunteer
11) other
12) aging (becoming 50 during year t+1)

The labor market status 'aging' is introduced in order to compute the 'greying parameter' ρ. The lay-off rate is equal to probability that an individual who was employee at the end of year t, has

[36] Everyone who becomes 50 during year t+1, is assigned to the group 'aging' irrespective of the labor market position at the end of year t+1 (same job, unemployed,etc.). Given this assignment rule, the 12 labor market position are mutually exclusive.

received an UI benefit during year year t+1 (cf. Labor market positions 2 and 5). As we have said before, the quit rate is equal to 1 minus the lay-off rate, the ‘greying parameter’ and the probability that the employee stays with the same employer (cf. labor market status 1).
The quit rates are computed both for the group of young employees and for the group old employees (50+).

There is a problem with the quit rates which are estimated only on the basis of information from the SEP. No distinction can be made between internal and external job mobility. In our simulation model internal job mobility is not considered as a ‘quit’. In order to correct for this problem, we have computed the external job mobility rate on basis of the OSA labor demand survey. The remaining components of the quit rate are estimated using SEP data. In Alessie et al. (1999) it has been explained how the age specific external job mobility rate has been estimated from the OSA labor demand survey. The sector specific estimated quit rates are presented in table 1.

Hiring costs

The hiring costs consist of the following 3 components:

I. Cost of advertising and recruiting;
II. Cost of settling into the job;
III. Cost of keeping open a vacancy.

ad I. The cost of advertising and recruiting is estimated on basis of the following question which has been asked to the respondents of the OSA labor demand survey:

“Could you give an estimate of the cost, which your organization faces when it recruits and selects a new employee?
It only concerns cost for advertisement, examination, medical and psychological tests and for retaining an external (employment) agency.

The cost per ‘new’ employee are about NLG..... .”

ad II. The cost of settling into the new job has been derived using the following equation:

$$Cost\ settling\ into\ a\ job = (time\ of\ settling\ into\ the\ job) * (earnings\ of\ an\ employee\ with\ seniority\ of\ less\ than\ 2\ years) * 0.5.$$

The average time of settling into the job has been estimated by using the following question which has been asked to the respondents of OSA labor demand survey:[37]

"Could you indicate what the average time is which an new employee needs to settle into the most common job?

1. Less than 1 week
2. Between 1 week and 1 month
3. Between 1 month tot 1 year
4. More than 1 year"

Data on the average earnings of a 'new employee' (an employee with less than 2 years tenure) stems from the Yearly Research into Employment and Wages (JWL) (see Statistics Netherlands (1994) and Statistics Netherlands (1996)). In the computation of the average cost of settling into a new job it has been assumed that a new employee is only productive for 50%.

ad III. The cost of keeping open a vacancy is computed as follows:

average duration of a vacancy*(net value added per worker -gross earnings per employee).

Estimates of the average duration of a vacancy are based on the following question present in the OSA labor demand survey:

"How many vacancies does your organization have at the moment?"
"Please indicate per duration class the number of vacancies which are open at the moment"

1. Number of vacancies with duration 0-1 months
2. Number of vacancies with duration 1-3 months
3. Number of vacancies with duration 3-6 months
4. Number of vacancies with duration 6-12 months
5. Number of vacancies with duration of more than 1 year

[37] The formulation of the question only allows for a bracket response. For each bracket we have assigned the following values for the time of settling into the job (expressed in months: 0,125, 0,625, 6 en 15,5 months. These numbers have been derived by assuming that the time of settling into the job is exponentially distributed, and by estimating the parameters of this distribution by using the data of the OSA labor demand panel.

"What is the most important reason that the vacancy is not filled?"[38]

1. Long recruiting procedure
2. We have consciously delayed the recruiting procedure
3. Difficulties with filling the vacancy
4. Other reason, namely. ......"

We assume that firms which have consciously delayed the recruiting procedure, do not face costs associated with unfilled vacancy. Data on the net value added (against factor cost) per worker and the gross earnings per employee are taken from the National accounts (see Statistics Netherlands (1997)). The size and composition of hiring cost are presented in table 2

[38] This question is only asked to those firms which has at least one vacancy with a duration of at least 3 months.

Appendix D. Results with alternative wage elasticities

Table D1: Premium differentiation based on half of the unemployment insurance expenditures: Relative changes (in %) in the steady state level of labor demand due to an increase in firing costs and a decrease in wage costs								
	Due to change in firing behaviour		Due to change in hiring behaviour		Total effects		Total employment	Relative change in wage costs
Sector	young	old	young	old	young	old		
1. Agriculture, Tobacco	0.8	4.3	1.8	-0.2	2.6	4.1	2.8	-3.5
2. Construction	2.5	4.1	0.3	-0.6	2.8	3.6	2.9	-3.2
3. Wood-, furniture industry	3.8	6.0	-0.9	-1.6	2.9	4.4	3.1	-2.2
4. Publishing, printing and reproduction industry	0.0	0.0	1.6	1.6	1.6	1.6	1.6	-2.1
5. Basic and fabricated metal products, electro industry	1.0	5.4	1.2	-0.5	2.2	4.8	2.6	-2.1
6. Retail trade and repair	4.5	8.1	-1.7	-2.5	2.9	5.6	3.2	-2.6
7. Harbour, inland fishing and navigation	2.3	2.3	-0.3	-0.2	2.0	2.1	2.0	-2.5
8. Transportation	0.6	2.9	0.9	-0.5	1.6	2.4	1.7	-2.1
9. Hotels and restaurants	0.7	5.5	2.7	-0.4	3.4	5.0	3.6	-3.5
10. Health care	0.8	5.3	1.7	0.0	2.6	5.3	2.9	-1.9
11. Government services	0.2	5.0	4.0	0.0	4.2	5.0	4.3	-4.5
12. Banking, insurance, wholesale trade	0.9	3.4	0.8	-0.8	1.7	2.6	1.7	-2.1
13. Commercial employment agencies	7.4	9.0	-1.3	-1.4	6.1	7.6	6.2	-4.6
14. Other manufacturing	1.2	6.9	1.6	-0.6	2.9	6.4	3.3	-2.3
Total	2.0	4.9	1.0	-0.3	3.0	4.5	3.1	-2.9

In this appendix we present the effects of the increase in firing cost and the decrease in wage cost, based on external elasticities, obtained from the JADE (1997) model from the Central Planning Bureau (CPB). In the JADE (1997) model, a labor demand model for the Dutch economy by the Dutch Central Planning Bureau, that is based on CES production functions, two sectors are distinguished: the 'sheltered' sector and the 'exposed' sector.[39] The wage elasticity of labor demand in the sheltered sector is equal to -0.93, while the elasticity for the exposed sector is

[39] Using our sector definition, the following sectors belong to the 'exposed' sector: 1. Agriculture and Tobacco, 4. Publishing, Printing and Reproduction industry, 5. Basic and fabricated metal products, electro industry, , 7. Harbour, inland navigation and fishing, 8. Other transportation. All the other sectors belong to the 'sheltered' sector.

equal to -0.82.[40] The JADE model contains no suggestions for the cross value of the cross wage elasticity and therefore we assume that the ratio between the own wage elasticity and the cross wage elasticity from the Cobb-Douglas specification is maintained. This leads to a cross elasticity of -0.21 in the exposed sector and -0.23 in the sheltered sector. These wage elasticities imply much smaller wage reactions than the wage elasticity implied by the Cobb-Douglas specification. In table D1 are the results of using the JADE elasticities to calculate the effect of the change in the wage costs on the demand for labor. Note that, by the first order conditions (9), (10) and (11), a given relative change in the wage leads to the same relative change in the average marginal revenue product of labor, so we can replace the Cobb-Douglas wage elasticity, by the JADE elasticities, even in the presence of adjustment costs. To be still able to split up the labor demand reaction to the change in the wage costs in an effect that can be attributed to a change in hiring behaviour and in an effect due to a change in firing behaviour, we still split up the change in the average marginal revenue product due to a change in the upper bound and due to a change in the lower bound.

[40] The JADE model makes a distinction between workers with a high and a low education. The elasticities given here are a weighted average of the elasticities for high and low educated workers. The weights used are the numbers of high and low educated workers. This information was provided to us by the CPB.

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