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The Israeli Labor Market:

A Framework for Policy Analysis

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Abstract

The paper studies an optimizing policymaker in a model of the labor market with search costs and matching frictions. We assume that the policymaker cares both about unemployment and about match asset values, which are part of firms' market value. This set up allows us to explore the tradeoffs between the unemployment rate and firms' asset values.

We show that even when the policymaker cares about unemployment, optimization may lead the economy towards a steady state with a relatively high rate of unemployment.

Key words: macroeconomic policy, labor market frictions, business cycles, Beveridge curve, the natural rate of unemployment.

JEL Classification: E24, E32.

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1 Introduction

The importance of the role of labor market frictions in analyzing the rate of unemployment and labor market flows is increasingly recognized. In this context, much attention has been given to differences in 'the natural rate of unemployment' across countries (for example, Europe and the U.S.). It has been argued that government policy may have an effect on the equilibrium unemployment rate through the implementation of certain policies, for example through different tax or UI policies. However, the factors that influence the policymaker decisions were not thoroughly examined. This paper studies the policymaker optimal decisions using a model with search costs and matching frictions. We show that even if a policymaker cares about unemployment, optimization may lead the economy towards a steady state with a relatively high rate of unemployment.

Much of the existing analysis in this framework examined policy measures without discussing preferences or the key tradeoffs facing policymakers. The main innovation of this paper is to study a policymaker who sets measures in order to maximize an objective function under a budget constraint and taking into account the optimal behavior of private agents. We assume that the policymaker cares both about unemployment and about match asset values, which are part of firms' market value. This set up allows us to explore the tradeoffs between the unemployment rate and firms' asset values. The model focuses on the steady state, as does most of the literature,[2] and is calibrated and simulated with reference to structural estimates of the Israeli labor market.

The purpose of the analysis is twofold. First, we examine the impact of the policymaker's

[1] We thank the Sapir Center for financial support. Any errors are our own.

[2] See the survey by Mortensen and Pissarides (1999a). Some important contributions are the analyses of Millard and Mortensen (1997), Mortensen and Pissarides (1999b) and Pissarides (1998, 2000 chapter 9).

preferences, in particular the relative disutility of unemployment, on the labor market. The idea is to give both qualitative answers (identify the mechanisms that are in operation when the relative disutility of unemployment changes) and quantitative answers (show by how much does a given change in the relative disutility of unemployment influence labor market outcomes). Second, we compare the effectiveness of the different policy measures – hiring subsidies, employment subsidies, wage taxes, and unemployment benefits – on labor market outcomes. Doing so, the paper provides a framework for the analysis of labor market policy in the Israeli economy.

The paper proceeds as follows: Section 2 models the policymaker in a model of the aggregate labor market with frictions. Section 3 presents the solution of the model. Section 4 discusses the data and the calibration. Section 5 studies the effects of policy and the relevant tradeoffs. Section 6 concludes.

2 The Model

This section presents the model of the aggregate labor market with frictions. Frictions refer to search costs and to the time-consuming matching process. It builds upon the Diamond-Mortensen-Pissarides model,[3] casting the analysis in stochastic, discrete-time terms. We add to the standard model of aggregate labor market frictions a policymaker who cares both about the rate of unemployment rate and about firms asset value. The policymaker chooses schedules for policy instruments that will maximize his/her objective function.

Matching Technology. Workers looking for jobs and firms looking for workers are faced with frictions such as different locations leading to regional mismatch or lags and asymmetries in the transmission of information. These frictions are embedded in the concept of a matching

[3]Key contributions were made by Diamond (1982a,b), Mortensen (1982) and Pissarides (1985). For recent surveys see Mortensen and Pissarides (1999a) and Pissarides (2000).

function which produces hires out of vacancies and unemployment, leaving certain jobs unfilled and certain workers unemployed. It satisfies the following properties:

$$\begin{aligned} M_t &= \widetilde{M}(U_t, V_t) \\ \frac{\partial \widetilde{M}}{\partial U} &> 0, \quad \frac{\partial \widetilde{M}}{\partial V} > 0, \ M_t \leq \min(U_t, V_t) \end{aligned} \tag{1}$$

where U is the stock of unemployed workers, V is the stock of vacancies and M is the flow of hires from unemployment to employment.

Firms' Objectives. Firms maximize the expected, discounted present value of profits (where all other factors of production have been "maximized out"):

$$\max_{\{V_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} (\prod_{j=0}^{t} \beta_j) \left[(F_t - W_t N_t + \tau_N F_t - \Gamma_t) \right] \tag{2}$$

where $\beta_j = \frac{1}{1+r_j}$ and r is the rate of interest, F is output, W is the real wage, N is the employment stock and Γ denotes hiring costs. An employment subsidy is postulated as $\left(\tau_N \frac{F_t}{N_t}\right) N_t = \tau_N F_t$ with $0 \leq \tau_N < 1$.[4] A hiring subsidy affecting Γ is introduced below.

This maximization is subject to the employment dynamics equation given by:

$$N_{t+1} = N_t(1 - \delta) + Q_t V_t \tag{3}$$

where $Q_t = \frac{M_t}{V_t}$ and workers are assumed to be separated from jobs at an exogenous rate δ.[5]

Wage Determination. The wage is determined by the Nash solution to the following bargaining problem:

[4] This formulation makes total subsidy payments increase at the rate of growth of the economy.

[5] The assumption of a constant match separation rate δ is a good approximation in the Israeli economy. The separation rate series has no trend and is stationary around its average value (4 percent a quarter).

$$W_t = \arg\max(J_t^N - J_t^U)^{\xi}(J_t^F - J_t^V)^{1-\xi} \tag{4}$$

where J^N and J^U are the present value for the worker of employment and unemployment respectively; J^F and J^V are the firm's present value of profits from a filled job and from a vacancy respectively; and $0 < \xi < 1$ reflects the degree of asymmetry in bargaining. Workers pay a wage tax at rate $0 \leq \tau_W \leq 1$. In this equilibrium set-up, the analysis would not change if these taxes were levied on firms.

Relying on the empirical results in Yashiv (2000b), the value of unemployment, to be denoted b, is formalized as follows:

$$b_t = z\frac{F_t}{N_t} + \rho(1 - \tau_W)W_t \tag{5}$$

The first term captures the value of home production or any non-pecuniary income and is assumed proportional to average (or marginal) output with a parameter z. The second term captures unemployment benefits with the gross replacement ratio denoted ρ; benefits are taxed at the rate τ_W.[6]

The Policymaker. The policymaker sets policy instruments in order to maximize his objective, which can be expressed as a function of both the unemployment rate $(\frac{u}{n})$ and the vacancy creation rate $\left(\frac{v}{n}\right)$.

which can be expressed as a function of unemployment rate $(\frac{u}{n})$, vacancy creation rate $\left(\frac{v}{n}\right)$ and asset value of the match.

$$\underset{\tau_N,\tau_W,\tau_\theta,\rho}{G} = Q\lambda\frac{v}{n} - Af(\frac{u}{n}) \tag{6}$$

The objective function is expressed in per-capita terms. The first expression on the RHS pertains to the total asset value of job-worker matches in the economy. It is given by the product of

[6] This benefit tax scheme is true for the Israeli economy. Quantitative analysis of a differential unemployment benefits tax rate yielded results that are similar to changing ρ and so are not reported.

the vacancy rate ($\frac{v}{n}$) and the asset value of the match in the steady state ($Q\lambda$),derived below. The second expression on the RHS is a function of the unemployment rate to be parameterized below. The parameter A measures how much the policymaker cares about the rate of unemployment relative to the asset value of the match.

The policymaker chooses the value of four policy instruments: an employment subsidy (τ_N), a hiring subsidy (τ_θ), the replacement ratio for unemployment benefit payments (ρ), and a wage tax (τ_W).

This maximization is subject to the following budget constraint:

$$\tau_W WN - \left(\tau_N \frac{F}{N}\right) N - \tau_\theta \, \Gamma N - \rho WU = T' \tag{7}$$

where $T' \lesseqgtr 0$ is the total constraint.

Dividing throughout by N to convert into per capita terms and by $\frac{F}{N}$ to convert it into fractions of average output we get:

$$\tau_W s - \tau_N - \tau_\theta \, \widetilde{\Gamma} - \rho s \left(\frac{U}{N}\right) = T \tag{8}$$

where $s = \frac{WN}{F}, \widetilde{\Gamma} = \frac{\Gamma}{\frac{F}{N}}, T = \frac{T'}{\frac{F}{N}}$. This says that government expenditures less revenues total some amount T in per capita, average output terms.

Steady State Flows. The steady-state flow relation, often labeled 'the Beveridge curve', is given by:

$$M = \left(\delta + G^L - 1\right) N \tag{9}$$

where $G^L - 1$ is the rate of growth of the labor force.

3 Equilibrium

Firms solve their constrained maximization problem (equations 2 and 3) to determine the amount of vacancies (V) to open; this is done taking as given the evolution of productivity and the rate of interest. The matching function (1) yields a flow of hires out of stocks of vacancies and unemployed workers; together with the separation rate δ and with labor force growth it generates changes in the stock of employment (and unemployment) according to (3). Once matched, bargaining between firms and workers yields a wage solution (4). In this partial equilibrium, the stocks U, N, and V, the flow of hiring M, and the wage w are determined. Consequently the vacancy matching rate Q is determined. This solution obtains given marginal productivity $\frac{\partial F_t}{\partial N_t}$, the interest rate r_t, the separation rate δ, the policy preference parameter A, the policy variables (unemployment benefits ρ, wage taxes τ_W and employment τ_N and hiring τ_θ subsidies), the budget constraint T, and the initial values of U, N and V. The policymaker chooses the values of the policy instruments in order to maximize his objective function (6), taking into account the firms' constrained maximization problem (2 and 3).

In order to fully characterize this equilibrium we solve the firms' problem and wage bargaining (3.1). A non-stochastic steady state (3.2) is then derived. Finally, the policymaker's problem is solved (3.3).

3.1 Firms' F.O.C and Wage Solution

The F.O.C of problem (2)-(3) are given by (where Λ is the discounted Lagrange multiplier):

$$\frac{\partial \Gamma_t}{\partial V_t} = Q_t E_t \Lambda_t \tag{10}$$

$$E_t\Lambda_t = E_t\beta_{t+1}\left[\frac{\partial F_{t+1}}{\partial N_{t+1}}(1+\tau_N) - W_{t+1} - \frac{\partial \Gamma_{t+1}}{\partial N_{t+1}}\right] + E_t(1-\delta)\beta_{t+1}\Lambda_{t+1} \tag{11}$$

as well as equation (3) and the relevant transversality condition.

The first, intratemporal condition (10) sets the marginal cost of hiring $\frac{\partial \Gamma_t}{\partial V_t}$ equal to the expected value of the multiplier times the probability of filling the vacancy. The second, intertemporal condition (11) sets the multiplier equal to the sum of the expected, discounted marginal profit in the next period $E_t \beta_{t+1} \left[\frac{\partial F_{t+1}}{\partial N_{t+1}}(1+\tau_N) - W_{t+1} - \frac{\partial \Gamma_{t+1}}{\partial N_{t+1}} \right]$ and the expected, discounted (using also δ) value of the multiplier in the next period $E_t(1-\delta)\beta_{t+1}\Lambda_{t+1}$.

The wage solution is given by (see Pissarides (2000) for the derivation):[7]

$$W_t = \eta \left(\frac{\partial F_t}{\partial N_t}(1+\tau_N) - \frac{\partial \Gamma_t}{\partial N_t} + E_t P_t \Lambda_t \right) + \omega z \frac{F_t}{N_t} \tag{12}$$

3.2 The Non-Stochastic Steady State

The non-stochastic steady state is characterized by two key relations. First, the rate of vacancy creation – based on the steady state form of (10) and (11) – is given by:

$$\frac{\frac{\partial \Gamma}{\partial V}}{\frac{F}{N}} = Q\lambda = Q \frac{G^X \beta}{1 - G^X \beta (1-\delta)} \pi \tag{13}$$

This equation is set in terms of average output. The LHS are marginal costs; the RHS is the probability of filling a vacancy (Q) times the asset value of the match in the steady state ($\lambda = \frac{\Lambda}{F/N}$). This value is the product of per-period marginal profits, denoted π[8], and a discount factor $\Phi =$

[7] where:

$$\eta \equiv \frac{\xi}{1-(1-\xi)\rho}$$

$$\omega \equiv \frac{(1-\xi)}{[(1-\tau_W)-(1-\xi)\rho(1-\tau_W)]}$$

[8] where $\pi = \frac{\left[\frac{\frac{\partial F_t}{\partial N_t}}{F/N}(1+\tau_N) - \frac{\frac{\partial \Gamma}{\partial N}}{F/N} \right](1-\eta) - \omega z}{1+\eta P \Phi}$

$\frac{G^X\beta}{1-G^X\beta(1-\delta)}$ that takes into account the real rate of interest, the rate of separation and productivity growth.

The second key steady-state relation is the steady state flows relation discussed above. This is now expressed relative to N and using the definition of the labor force ($L = N + U$):

$$\delta + G^L - 1 = \frac{M}{L - U} \tag{14}$$

>From this equation the rate of unemployment in equilibrium, the natural rate, is given by:

$$\frac{U}{L} = \frac{\delta + (G^L - 1)}{\delta + (G^L - 1) + P} \tag{15}$$

where:

$$P = \frac{M}{U} \tag{16}$$

3.3 The Policymaker's Solution

The policymaker sets the policy instruments in order to maximize the above objective function:

$$\underset{\tau_N,\tau_W,\tau_{\theta,\rho}}{G} = Q\lambda\frac{v}{n} - Af(\frac{u}{n})$$

where:

$$\lambda = \Phi\pi$$

π denotes the value of per-period marginal profits and Φ denotes a discount factor that takes into account the real rate of interest, the rate of separation and productivity growth, i.e.:

$$\Phi = \frac{G^X\beta}{1 - G^X\beta(1-\delta)}.$$

The structure is then as follows: the unemployment rate $\frac{u}{n}$ and the vacancy rate $\frac{v}{n}$ are determined by (13) and (14). The policymaker influences (13) through the choice of the policy instruments. Thus the policymaker can choose $\frac{u}{n}$, $\frac{v}{n}$ and the policy instruments so as to maximize his objective subject to the budget constraint.

Alternatively, one can view the solution as solving the system of equations: equations 13, 14, 8, and the relevant F.O.C for the policymaker i.e. $\frac{\partial G}{\partial(\cdot)} = \frac{\partial G}{\partial(\cdot\cdot)}$ – for $\frac{u}{n}, \frac{v}{n}$, and for the policy instruments. This solution holds true given the exogenous values of the rate of discount (β), marginal productivity ($\frac{\partial F}{\partial N}$), the labor force (L) and its growth (G^L), the rate of separation (δ), the policymaker preference parameter (A), budget constraint (T) , and the parameters z and those of the production function, matching function, policymaker loss from unemployment function, and firms adjustment costs function.

4 The Baseline Model

In this section we parameterize the various function in the model (4.1) and set the baseline calibration values (4.2).

4.1 Parameterization

For production a standard Cobb-Douglas function is assumed:

$$F_t = A_t {N_t}^{\alpha} K_t^{1-\alpha} \tag{17}$$

where A is technology and K is capital.

Hiring costs refer to the costs incurred in all stages of recruiting: the cost of advertising, screening, training, and the cost of disrupting production. Relying on the empirical results in

Yashiv (2000b), who tested alternative functional forms and variables to be included, the following formulation is used:

$$\Gamma_t = \frac{\Theta(1-\tau_\theta)}{1+\gamma}(\psi\frac{V_t}{N_t} + (1-\psi)\frac{M_t}{N_t})^{1+\gamma}F_t, \qquad 0 \leq \tau_\theta < 1 \tag{18}$$

where a hiring subsidy τ_θ is postulated; Θ is a scale parameter while $1+\gamma$ expresses the degree of convexity. Hiring costs are internal to production and hence are proportional to output (F). They are increasing in a weighted average of the vacancy ($\frac{V_t}{N_t}$) and hiring ($\frac{M_t}{N_t}$) rates as part of the costs relates to vacancies, even if unfilled, and part to actual hires. The function is linearly homogenous in V, M, N and F. It encompasses the cases of a fixed cost per vacancy and of increasing costs. When $\gamma = 1$ (and there are no subsidies) the function reduces to a quadratic formulation ($\frac{\Theta}{2}(\psi\frac{V_t}{N_t} + (1-\psi)\frac{M_t}{N_t})^2 F_t$) which is analogous to the standard formulation in "Tobin's q" models of investment where costs are quadratic in $\frac{I}{K}$.

Empirical work [previous work on Israeli data (Yashiv (2000a)), as well as work on other economies surveyed by Petrongolo and Pissarides (2001)] has shown that a Cobb-Douglas function with constant returns to scale is useful for parameterizing the matching function, i.e.:

$$M_t = \mu U_t^{\sigma} V_t^{1-\sigma} \tag{19}$$

where μ stands for matching technology.

For the policymaker's loss function we assume a quadratic function for losses from unemployment:

$$f(\frac{U}{N}) = \frac{1}{2}\left(\frac{U}{N}\right)^2 \tag{20}$$

4.2 Calibration

For the *parameters* the structural estimates reported in Yashiv (2000 a,b) are used to give numerical values to the parameters γ and ψ of the hiring cost function, the labor parameter in the production function (α), the worker's bargaining parameter (ξ) and the unemployment elasticity σ of the matching function. The scale parameters of the hiring cost function (Θ) and of the matching function (μ) are set so that the solution of the system will yield the steady state values of $\frac{U}{N}$ and $\frac{V}{N}$ discussed in the table's notes.

For the *variables* in steady state, data averages[9] are taken or solved out of the steady state relations.[10] Based on the data, the baseline has no hiring or employment subsidies ($\tau_\theta = \tau_N = 0$), wage taxes (τ_W) are set at 28%, and the replacement ratio (ρ) at 0.4.[11]

The baseline values are shown in Table 1.

Table 1

5 Policy

In this section we focus on two policy issues. First, we examine the role of the relative disutility of unemployment in the policymaker's objective function (A). Second, we set the value of this policy preference parameter so that the steady state values of the key variables (unemployment, vacancy creation, wage share) would equal the long run averages in the Israeli economy. We then

[9] Appendix A gives full definitions and sources of the data.

[10] See the notes to Table 1 for further details.

[11] The value of the wage tax is based on Table 6.10 in the CBS Annual Bulletin of Statistics, reporting household direct taxes and social security payments as a fraction of national income. For the replacement ratio National Insurance Agency and CBS data are used to divide the monthly average of nominal unemployment benefits per person by the average nominal wage for employee post in the business sector.

compare the effectiveness of the different policy instruments in steady state, by varying a number of instruments at a time. Throughout we assume that the policymaker's budget constraint i.e.:

$$\tau_W s - \tau_N - \tau_\theta \widetilde{\Gamma} - \rho s \left(\frac{U}{N}\right) = T$$

is set so that T equals the budget surplus at its benchmark value with (which is $T = -0.163$ given $\tau_W = 0.28; \rho = 0.4; \tau_\theta = 0; \tau_N = 0$).

5.1 The Role of the Policymaker's Preferences

As noted, it is assumed that the policymaker cares both about the unemployment rate and about the asset values of job-worker matches, which are part of the firms' value. Note that a higher rate of unemployment increases both the firms' matching rate (Q) and the asset value of the match (λ), but it also has a negative direct impact through $f(\frac{u}{n})$. Thus, there exists a trade-off between the two effects of unemployment on the policymaker's objective: the direct disutility of unemployment and the indirect positive influence through the match asset value. The value of A (the relative disutility of unemployment) determines the relative value of each effect.

Table 2 quantifies the effects of this parameter by varying its value and examining the impact on the key variables in steady state and on the value of the policy parameters. The value of unemployment benefits is set at its benchmark value (i.e. at the long run data average), while the policymaker chooses hiring and employment subsidies (or taxes) and the wage tax in order to maximize the objective function.

Table 2

As the results presented in the table indicate, for a low values of $A,$ the direct effect of unemployment on the policymaker's objective is very small relative to the indirect, positive impact through the asset value of the match. Therefore, raising the unemployment rate has a positive effect on the objective function and this gives the policymaker the incentive to set a hiring tax in order to generate higher unemployment. As to the vacancy creation rate, for a given rate of unemployment, it has a positive effect on the asset value of the match. However, higher vacancy creation generates lower unemployment (due to the steady state flows condition) which lowers the asset value. For sufficiently low values of A, the second effect dominates the first, and the resulting vacancy rate is relatively low. The policymaker achieves these results by setting a high hiring tax and a high employment subsidy. The essential effect of the employment subsidy is to increase match profits while the hiring tax deters firms from posting more vacancies despite the high match profits. A high wage tax covers unemployment benefit payments as these increase with the rise in the unemployment rate, and mitigates the rise in firms' match profits.

As we move across the columns of Table 2, the value of the relative disutility of unemployment increases. When A goes up, the direct, negative effect of unemployment becomes stronger relative to the indirect, positive impact on the policymaker's objective through the asset value of the match. As a result, the unemployment rate goes down and the vacancy creation rate rises. The hiring tax declines and becomes a subsidy for values of A above a certain threshold; this subsidy is financed partly by a moderate increase in the wage tax and partly by the reduction in unemployment benefit payments, which occurs as the unemployment rate declines. The asset value of the match declines.

The main implication is that a policymaker who cares a lot about firm value will set a policy that generates a relatively high rate of unemployment. Note that this runs counter to the traditional effect, whereby the policymaker who cares about unemployment tries to lower it. Here, however, it is shown that the fall in the rate of unemployment generates a negative effect on match asset values, which may dominate its direct positive effect. It is also worth noting that, while both the employment subsidy and the wage tax do not vary a lot across specifications, the hiring tax/subsidy is very variable. This is so because the hiring subsidy is a very effective policy instrument when the policymaker wants to attain a higher level of vacancy creation and lower unemployment.

5.2 The Relative Effectiveness of Policy Instruments

In order to analyze the effectiveness of the different policy instruments, we establish a benchmark whereby A is set so that the key variables are at their long run data averages (we chose $A = 14$). First, we assume that all four policy instruments are set free and examine the resulting policy and its impact on the vacancy creation rate, the unemployment rate, the match asset value and the wage share. Second, we analyze the impact of imposing restrictions on the instruments the policymaker can choose. Therefore, we assume that each time one or two of the four policy instruments are set at their benchmark values, and we experiment with the remaining, free instruments.

Table 3 reports the variations in policy schedules. The key numbers in the table – indicated in bold in the top two rows – are the values of fixed and free policy instruments under consideration. Throughout we postulate that unemployment benefits cannot be negative and all taxes are bounded between -100% and +100%

Table 3

5.2.1 Unconstrained Policy

In Column 1 the policymaker sets all four policy parameters freely. The results indicate that both the unemployment and vacancy creation rates are almost identical to their benchmark values (i.e. to Israeli data averages). However, there is more that a 100% increase in the asset value of the match. The policymaker achieves these results by setting the values of ρ and τ_θ equal to their minimal possible values (thus there are no unemployment benefits and there is a hiring tax of 100%), by setting a high wage tax and by providing a high employment subsidy. We turn now to analyze the effect of each policy instrument on this solution.

The hiring tax reduces vacancy creation and leads to a higher unemployment rate, thereby generating the well-known search externalities $-$ the matching rate for firms (Q) increases and that for workers (P) declines. The asset value of the match goes up because there is an increase both in the probability of filling a vacancy (Q) and in per-period match profits (π).

The annulment of unemployment benefits (ρ) generates a reduction in wages as benefits determine the workers' threat point in the wage bargain; hence there is an increase in match profits and in the asset value of the match; vacancy creation is enhanced and unemployment falls.

Changes in the wage tax (τ_W) induce a direct effect on the worker share in the wage bargain. The relative value of the part of the reservation wage which is independent of the actual wage $\left(z\frac{F}{N}\right)$ changes when wages are taxed at a different rate. Setting a high tax rate increase the workers' share and the gross wage, and decreases firms' match profits. This operates to restrain vacancy creation, leading to higher unemployment.

The employment subsidy has a substantial positive effect on match profits; it also increases wages as both the subsidy τ_N and the matching rate P rise and it has a moderate positive impact on the vacancy creation rate.

Taken together, unemployment and vacancy creation barely change relative to the benchmark, since the positive and negative effects described above offset each other. The positive impact of the hiring tax, the employment subsidy and the lower unemployment benefits on match asset values is much stronger than the negative impact of increasing the wage tax. Note that the wage tax is raised in order to finance the employment subsidy. As long as the positive impact of increasing the employment subsidy exceeds the negative impact caused by raising the wage tax, the policymaker will go on raising the wage tax. These negative and positive impacts on the policymaker's objective fully offset each other when $\boldsymbol{\tau}_W$ reaches 0.66. It is worth noting that the value of the wage tax that makes the above two effects offset each other depends on the value of both the hiring subsidy and unemployment benefits, so it changes when we impose constraints on policy instruments.

5.2.2 Constrained Policy

In columns 2, 3 and 4 one policy instrument is set at its benchmark value, so the policymaker chooses the values of three free instruments.

In column 2 the employment subsidy is set to be zero. As in the unrestricted case (column 1), the policymaker sets the values of ρ and τ_θ equal to their minimal possible values. However, he sets a low wage tax ($\tau_W = 0.23$). An employment subsidy is not allowed, so the tradeoff between a high wage tax and a high employment subsidy does not exist and the policymaker wants to lower the wage tax. As the results indicate, there is a moderate increase in unemployment and a decrease in vacancy creation; the match asset value is slightly lower than in the unrestricted case, but is still twice as high as the benchmark.

In column 3, the hiring subsidy (tax) is set to be zero. As in column 1, the policymaker sets unemployment benefits to be equal to zero and the wage tax ($\boldsymbol{\tau}_W$) equal to 0.66. The employment subsidy is still very high but is lower than in the unrestricted case. That is because the annulment of τ_θ means no revenues from the hiring tax, and so the policymaker has less resources to finance an employment subsidy. The effect of the policy that restricts the hiring tax to be zero is a rise in the vacancy creation rate and a decline in the unemployment rate relative to the unrestricted case, and relative to the benchmark. Both the asset value of the match and the value of the policymaker's objective function are still high, but lower than in columns 1 and 2.

In column 4 unemployment benefits are set at their benchmark value ($\rho = 0.4$). As can be seen, there is a significant change relative to the previous columns, in terms of both policy instrument values and in terms of the values of the key variables. The policymaker sets a low hiring subsidy and a relatively high employment subsidy. The wage tax is high relative to its benchmark value, but is lower than in the unrestricted case. The reasons for this change in policy are as follows: the policymaker sets a relatively high wage tax in order to finance the employment subsidy; as we describe above, this combined policy generates an increase in the match asset value as long as the positive effect of the employment subsidy dominates the negative effect of the wage tax rise. However, the above two effects offset each other when the value of the wage tax reaches 0.488 (it is lower than in the unrestricted case because $\rho = 0.4$) . Similarly, if the policymaker were to set a hiring tax, as he does in the unrestricted case, and use the tax revenues to finance the employment subsidy, the negative impact on the objective function through the decrease in the vacancy creation rate and the increase in the unemployment rate will dominate the positive impact of the rise in match value.

In columns 5-8 we assume that each time, two out of the four policy instruments are set at their benchmark values, and we experiment with the two free instruments. When only two policy instruments are free, setting the value of one policy instrument determines the second policy instrument through the budget constraint.

In column 5 unemployment benefits and wage taxes are set to equal their benchmark values, while the policymaker chooses hiring and employment subsidies. The hiring subsidy ($\tau_\theta = 0.11$) has several effects: it lowers vacancy creation costs for the firms, thereby leading to more vacancy creation. Higher vacancy rates lead to lower unemployment, the matching rate for firms (Q) declines and that for workers (P) increases. The rise in P erodes firms' match profits. The asset value of the match declines because there is a decline both in the probability of filling a vacancy (Q) and in per-period match profits (π). The employment tax ($\tau_N = -0.001$) decreases match profits and leads to less vacancy creation. Lower vacancy rates lead to higher unemployment. Wages decline, as both the subsidy τ_N and the matching rate P decline. The decrease in per-period profits and in asset values is mitigated by the decrease in wages. The hiring subsidy and the employment tax effects on unemployment, vacancy creation and the matching rate fully offset each other, while there is a minor increase in the match asset value and in the value of the policymaker objective and a decline in the wage share (relative to the benchmark).

In column 6 the benchmark value of the unemployment benefits (ρ) and no employment subsidy are imposed. The policymaker sets $\tau_\theta = 0.11$ and finances it by a minor rise in the wage tax ($\tau_W = 0.282$) The results are identical to column 5: the hiring subsidy reduces both the asset value of the match and wages while the increase in the wage tax decreases match profits and leads to less vacancy creation. In both column 5 and 6 the policymaker sets the same hiring subsidy, while the impact of the wage tax increase is identical to the impact of the employment tax.

In column 7, the benchmark value of unemployment benefits (ρ) and no hiring subsidy are imposed. The results are very similar to column 4, because the hiring subsidy that was set by the policymaker in column 4 is close to zero.

In column 8, both hiring and employment subsidies are set to be zero, as they are in Israeli data and the policymaker maximizes his objective by setting unemployment benefits and the wage tax. The results indicate that the policymaker sets unemployment benefits equal to zero, like he does in unrestricted case, because it increases both the vacancy creation rate and the asset of the match and generates a decrease in expenditures that enables him to decrease the wage tax.

5.2.3 Discussion

There are a number of lessons from these different cases: first, when we set unemployment benefits and the employment subsidy or the wage tax at their benchmark values, the free instruments results are close to their values in Israeli data. This finding implies that a formulation of the labor market as an interaction between workers, firms and a policymaker, who cares both about the unemployment rate and about match asset values, is not inconsistent with the data. Second, as the results presented in columns 2 and 3 suggest, the objective function value is higher when the employment subsidy is set to be zero rather than when the hiring subsidy is set to be zero. This result provides additional support to the conclusion that the hiring subsidy is a very effective policy instrument. Finally, the results show that unemployment benefits have a substantial impact on policy instruments choice and on the key variables values implied by it. However, in the real world it cannot be set too low, because it means that unemployed agents will have no income. Thus, in order to perform a more sophisticated policy analysis, we should assume that policymaker cares about unemployed workers (i.e. another term should be added to objective function of the policymaker).

6 Conclusions

The paper presented an empirically-grounded model of a policymaker's optimal decisions within a search and matching model. The effectiveness of the different policy measures and the impact of imposing restrictions on them were analyzed both qualitatively and quantitatively.

The main conclusions that emerge from the analysis are:

(i) A policymaker who cares a lot about firm values will set a policy that generates a relatively high rate of unemployment. This runs counter to the traditional effect, whereby the policymaker who cares about unemployment tries to lower it. Here, however, it is shown that the fall in the rate of unemployment generates a negative effect on match asset values, which may dominate its direct positive effect.

(ii) The results of simulations imply that a formulation of the labor market as an interaction between workers, firms and a policymaker, who cares both about the unemployment rate and about match asset values, is consistent with the data.

(iii) The results suggest that a hiring subsidy is a very effective policy instrument when the policymaker wants to influence labor market outcomes such as vacancy and unemployment rates.

References

[1] Diamond, Peter A., 1982a. "Aggregate Demand Management in Search Equilibrium," **Journal of Political Economy** 90(5), 881-894.

[2] Diamond, Peter A., 1982b. "Wage Determination and Efficiency in Search Equilibrium," **Review of Economic Studies** 49, 761-782.

[3] Mortensen, Dale T., 1982. " The Matching Process as a Noncooperative Bargaining Game," in J.J. McCall (ed.) **The Economics of Information and Uncertainty,** University of Chicago Press, Chicago.

[4] Mortensen, Dale T. and Christopher A. Pissarides, 1999a. "Job Reallocation, Employment Fluctuations, and Unemployment," Chapter 18 in John B. Taylor and Michael Woodford (eds.), **Handbook of Macroeconomics** Vol. 1B, North-Holland, Amsterdam.

[5] Mortensen, Dale T. and Christopher A. Pissarides, 1999b. "Unemployment Responses to 'Skill Biased' Technological Shocks: the Role of Labour Market Policy," **The Economic Journal** 109, 242-265.

[6] Petrongolo Barbara and Christopher A. Pissarides, 2001. "Looking into the Black Box: A Survey of the Matching Function," **Journal of Economic Literature** 39,2**.**

[7] Pissarides, Christopher A., 1985. "Short-Run Dynamics of Unemployment, Vacancies and Real Wages," **American Economic Review** 75, 676-690.

[8] Pissarides, Christopher A., 1998. "The Impact of Employment Tax Cuts on Unemployment and Wages; The Role of Unemployment Benefits and Tax Structure." **European Economic Review** 42, 155-183.

[9] Pissarides, Christopher A., 2000. **Equilibrium Unemployment Theory**, 2nd edition, MIT Press, Cambridge.

[10] Yashiv, Eran, 2000a. “The Determinants of Equilibrium Unemployment,” **American Economic Review** 90 (5), 1297-1322.

[11] Yashiv, Eran, 2000b. “Hiring As Investment Behavior,” **Review of Economic Dynamics** 3, 486-522.

[12] Yashiv, Eran, 2004. “Macroeconomic Policy Lessons of Labor Market Frictions,” **European Economic Review,** 48, 259-284.

Appendix A

Data: Sources and Definitions

All data are quarterly for the periods noted. The following table lists definitions and original sources.

Series	Definition and Sources
F	Real business sector GDP
	CBS, 1964-1995
L, N, U	Labor force, business sector employment, and unemployment
	CBS, 1960-1995
r	Real interest rate on bank credit
	= nominal rate, deflated by business sector GDP deflator inflation
	BOI, 1972-1995
V	Vacancies
	ES, 1975-1989
M	Filled Vacancies
	ES, 1975-1989

Notes:

CBS=Central Bureau of Statistics

BOI=Bank of Israel

ES=Employment Service

Table 1

Baseline Model

a. Parameters

function	symbol	value
hiring	Θ	1,015,940
	γ	4.4
	ψ	0.3
separation	δ	0.0406
matching	μ	0.73
	σ	0.3
wage	ξ	0.17
production	α	0.68
non-pecuniary income	z	0.09

b. Exogenous Variables

variable	symbol	value
interest rate	r	0.01
productivity growth (gross rate)	G^X	1.005
labor force growth (gross rate)	G^L	1.006

c. Policy Variables

policy measure	**symbol**	**value**
hiring subsidies	τ_θ	0
employment subsidy	τ_N	0
wage tax	τ_W	0.28
replacement ratio	ρ	0.4

d. Steady State Values

	symbol	**value**
unemployment rates	$\frac{U}{N}$	0.0776
	$\frac{U}{L}$	0.0720
vacancy rate	$\frac{V}{N}$	0.0582
matching rate	$\frac{M}{N}$	0.0466
workers' matching rate	$P = \frac{M}{U}$	0.60
firms' matching rate	$Q = \frac{M}{V}$	0.80
wage share	$s = \frac{WN}{F}$	0.67
per-period profits	π	0.094
expected asset value of the match	$Q\Phi\pi$	1.65

Table 2

The Role of Unemployment Aversion

	symbol	1	2	3	4	5	6	7
unemployment aversion	A	1	8	10	14	20	25	30
hiring subsidy	τ_θ	-1.19	-0.99	-0.54	0.03	0.403	0.48	0.64
employment subsidy	τ_N	0.15	0.152	0.156	0.161	0.163	0.161	0.159
wage tax	τ_W	0.48	0.481	0.484	0.488	0.491	0.492	0.492
vacancy rate	$\frac{v}{n}$	0.047	0.048	0.051	0.058	0.061	0.070	0.073
unemployment rate	$\frac{u}{n}$	0.133	0.125	0.106	0.08	0.065	0.051	0.047
vacancy matching rate	Q	1	0.97	0.91	0.81	0.72	0.66	0.64
unemployed matching rate	P	0.35	0.37	0.44	0.58	0.76	0.92	0.99
wage share	$s = \frac{WN}{F}$	0.670	0.702	0.706	0.713	0.717	0.719	0.720
per period profits	π	0.156	0.148	0.129	0.102	0.080	0.067	0.061
asset value	$Q\Phi\pi$	3.42	3.15	2.58	1.81	1.26	0.97	0.86

Notes:

1. π denotes per-period match profit and $Q\Phi\pi$ denotes the asset value of the match.
2. When $\boldsymbol{\tau}_\theta < 0$ it is a hiring tax; when $\boldsymbol{\tau}_N < 0$ it is an employment subsidy.
3. The following values are used throughout $\rho = 0.4$.

Table 3

Policy Effectiveness

	benchmark	1
Fixed policy	$\boldsymbol{\tau_W = 0.28; \rho = 0.4; \tau_\theta = 0; \tau_N = 0;}$	**-**
Free policy	**-**	$\boldsymbol{\tau_W = 0.66; \rho = 0.0; \tau_\theta = -1; \tau_N = 0.39}$
$\frac{v}{n}$	0.058	0.059
$\frac{u}{n}$	0.078	0.077
Q	0.80	0.79
P	0.60	0.60
$s = \frac{WN}{F}$	0.67	0.81
π	0.094	0.218
$Q\Phi\pi$	1.65	3.83
G	0.0531	0.181

2	3	4
$\boldsymbol{\tau}_N \mathbf{= 0}$	$\boldsymbol{\tau}_\theta \mathbf{= 0}$	$\boldsymbol{\rho} \mathbf{= 0.4}$
$\boldsymbol{\tau}_W \mathbf{= 0.23}; \boldsymbol{\rho} \mathbf{= 0.0}; \boldsymbol{\tau}_\theta \mathbf{= -1}$	$\boldsymbol{\tau}_W \mathbf{= 0.66}; \boldsymbol{\rho} \mathbf{= 0.0}; \boldsymbol{\tau}_N \mathbf{= 0.37}$	$\boldsymbol{\tau}_W \mathbf{= 0.488}; \boldsymbol{\tau}_\theta \mathbf{= 0.03}; \boldsymbol{\tau}_N \mathbf{= 0.161}$
0.056	0.069	0.058
0.086	0.053	0.081
0.83	0.67	0.81
0.54	0.88	0.58
0.64	0.816	0.71
0.199	0.153	0.102
3.62	2. 25	1.85
0.151	0.137	0.059

5	6	7	8
$\boldsymbol{\tau}_W \mathbf{= 0.28}; \boldsymbol{\rho} \mathbf{= 0.4}$	$\boldsymbol{\tau}_N \mathbf{= 0}; \boldsymbol{\rho} \mathbf{= 0.4}$	$\boldsymbol{\tau}_\theta \mathbf{= 0}; \boldsymbol{\rho} \mathbf{= 0.4}$	$\boldsymbol{\tau}_\theta \mathbf{= 0}; \boldsymbol{\tau}_N \mathbf{= 0}$
$\boldsymbol{\tau}_\theta \mathbf{= 0.11}; \boldsymbol{\tau}_N \mathbf{= -0.001}$	$\boldsymbol{\tau}_\theta \mathbf{= 0.112}; \boldsymbol{\tau}_W \mathbf{= 0.282};$	$\boldsymbol{\tau}_N \mathbf{= 0.161}; \boldsymbol{\tau}_W \mathbf{= 0.487};$	$\boldsymbol{\tau}_W \mathbf{= 0.251}; \boldsymbol{\rho} \mathbf{= 0}$
0.058	0.058	0.057	0.066
0.079	0.079	0.082	0.058
0.80	0.80	0.81	0.70
0.59	0.59	0.57	0.80
0.66	0.66	0.71	0.65
0.095	0.095	0.104	0.14
1.67	1.67	1.85	2.15
0.0533	0.0533	0.059	0.10

Notes:

1. In all cases $A = 14$ is used.

2. Constraints imposed on policy instruments: $-1 < \tau_\theta < 1; -1 < \tau_N < 1; -1 < \tau_W < 1; 0 < \rho < 1$