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Does the Wage Tax System Cause Budget Deficits?
A Macro-Economic Experiment*

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Abstract

In this paper we investigate experimentally the effects of a wage tax financed unemployment benefit system on the development of the budget deficit, unemployment, and some other indicators of economic performance in an international economy. We find support for the hypothesis that out-of-equilibrium price uncertainty affects the behavior of economic agents. Due to uncertainty about prices risk-averse producers are hypothesized to be reluctant to employ inputs with the additional effect of too low wages and too high output prices. Our results support this hypothesis of a 'risk-compensated price-mechanism'. We also find that the downward pressure on wages is exacerbated by an over-supply of labor by consumers. These observations can explain the budget deficits we observe in the laboratory economies. Furthermore, we find that tax adjustments in order to facilitate a balancing of the budget has strong adverse effects on unemployment and real GDP.

JEL Classification Number: C90, D21, D51, D60, E62, H2, H62
Keywords: Budget deficit, experiment, price uncertainty, unemployment benefit, wage tax

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1 Introduction

The problem of persistent budget deficits is of great concern among economists since at least the eighties (see e.g. Yellen (1989) and the literature cited therein). Although there is an ongoing debate on the actual economic costs of budget deficits, many scholars in economics seem to support the view that running budget deficits means to live at the cost of the future.[1] Politicians, however, are often reluctant to raise taxes or decrease expenditures to close a government budget gap. A well-known example in this respect is George Bush's "Read my lips: no new taxes" statement during his election campaign for the US presidency.

Many European countries are still struggling with significant budget deficits. The problem becomes more severe if the economic climate gets worse. In fact, public debt and government budget deficits in Europe increased significantly as the economic fair-weather conditions deteriorated in the seventies. The reluctance of politicians to cut back expenditures and/or raise taxes made the situation even worse and brought the whole concept of the welfare state into question.

Politicians may fear that policies targeted at cutting deficits will be negatively judged by the voters. In this context, the literature in political economics has identified a whole array of politico-institutional determinants of government budget deficits. Among the studied models are those based on the assumption of opportunistic policymakers and naive voters, models of inter-generational redistribution, and models emphasizing the effects of budgetary institutions. (For overviews in this domain the interested reader is referred to e.g. Van Velthoven, Verbon, and van Winden (1993) and Alesina and Perotti (1995).)

This paper focuses on the tax system used to finance unemployment benefits as a potential determinant of budget deficits. In most countries unemployment benefits are financed via a tax on labor. This holds true despite of the fact that quite some theoretical and empirical work exists arguing that such a system has negative feedback effects on the performance of an economy.[2] However, the standard empirical models used in these studies are plagued by problems associated with macro-economic field data, namely lack of control and the associated noise in the data. This results in uncertainty about the actual impact of taxation on economic performance and the government budget (see e.g. Sørenson (1997)). On the other hand, the theoretical models that are used have the disadvantage that they rely on strong assumptions about consumer and firm behavior, leaving aside the often made simplifying assumption of a representative household. Furthermore, they typically also focus on equilibria making it impossible to make statements about out-of-equilibrium situations, which in reality are rather the rule than the exception.

In this paper we take a different and new tack to investigate the development of budget deficits. We do so, firstly by employing a new methodology (laboratory experimentation) and, secondly, by exploring a hitherto underexposed determinant of

[1] For some influential studies regarding the effects and costs of budget deficits, see Barro (1989) and Bernheim (1989).

[2] See, among others, European Commission (1994).

the government budget deficit (discussed below), which sheds a negative light on wage taxation as a means to finance unemployment benefits. The present study uses for the first time the methodology of laboratory experiments in this context. Laboratory experiments have several advantages in comparison with the empirical analysis of field data and theoretical models. In particular, experiments allow to control the economic environment and to focus on (relatively) simple cases without having to make assumptions about behavior. It also allows the study of out-of-equilibrium states. It opens up the possibility to investigate the dynamics of the behavioral adjustment process and facilitates the identification of causes and consequences of individual behavior. These advantages, of course, are not for free. For example, restrictions have to be made with respect to the complexity of the laboratory economy, since otherwise the experiments may become too costly or unwieldy. Hence, in our view, experiments focusing on macro-economic issues are not a substitute for traditional research methods but may be a useful complementary tool with its own strengths and limitations.

To be more specific, in this paper we present the results of an experimental investigation of the effects of a wage tax financed unemployment benefit system on the development of the budget deficit, unemployment, and some other indicators of economic performance in an international economy.[3] The international economy consists of two 'countries', a large and a small one, allowing the investigation of a large and a (relatively) small open economy simultaneously. Each experimental session consists of two parts. In the first part wage taxes are held constant at the theoretical (general) equilibrium level. In the second part taxes are adjusted such that the previous period government budget would have been balanced.

The experimental method allows us (among other things) to expose a factor hitherto neglected in (most) theoretical models and empirical studies. We find support for the hypothesis that out-of-equilibrium price uncertainty affects the behavior of economic agents. Due to uncertainty about prices, and hence revenues, risk-averse producers are hypothesized to be reluctant to employ inputs with the additional effect of too low input prices (wages) and too high output prices. Our results support this hypothesis of a 'risk-compensated price-mechanism'. We also find that the downward pressure on wages is exacerbated by an over-supply of labor by consumers. These observations can explain the budget deficits we observe in the laboratory economies in the part where wage taxes are held constant. In the second part, where taxes adjust to previous periods deficits, we observe that the policy of tax adjustment is successful, in the sense that convergence to a balanced budget is observed. This success however comes at the cost of significantly increased unemployment rates and sharp decreases in real GDP's, in both countries. The observed adverse effects on economic performance may also explain politicians' reluctance to raise taxes to close budget gaps. It is important to note that theoretically the investigated economies generate a balanced budget in equilibrium. However, the general equilibrium model neglects out-of-equilibrium aspects and, therefore, the aforementioned 'risk-compensated price-mechanism'. Relying solely

[3]The research presented is part of a larger research project on the economic effects of tax systems commissioned by the Dutch Ministry of Social Affairs and Employment and initiated via a motion carried by the Dutch Second Chamber of parliament. To the best of our knowledge, it is for the first time that policymakers explicitly asked for advice with the help of laboratory experiments in a decisionmaking process concerning macro-economic issues.

on GE-models may, therefore, lead to unexpected budget deficits and disappointing economic performance. Furthermore, given the 'risk-compensated price-mechanism' it seems plausible that using wage taxes to cover government budget deficits will make the economic situation worse.

The rest of the paper is organized as follows. Section 2 presents the experimental set-up (including the implementation of the economies and the the tax system in the lab), section 3 presents and discusses the experimental results, and section 4 concludes.

2 Experimental Set-Up

In this section we describe the economic environment, the implemented tax-benefit system and the experimental procedures and parameters in more detail. The main aim of this paper concerns the performance of a wage tax system to finance unemployment benefits in an international economy, especially regarding the development of budget deficits. The choice of the economy and the tax-benefit system reflects not only the wish to parallel 'outside-lab' economies in some fundamental ways but, more particularly, that main parts of this study were carried out for the Dutch Ministry of Social Affairs and Employment.

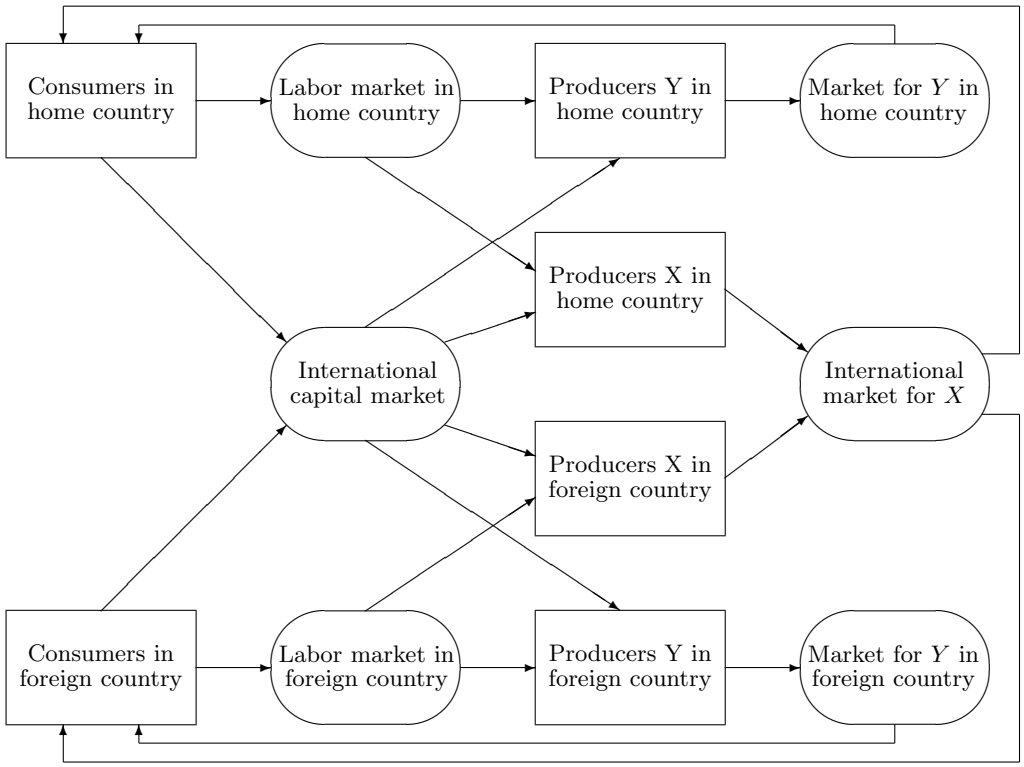
2.1 The Economic Environment

The implemented economy is best described with the help of the flow diagram contained as panel (a) in Figure 1. The economy consists of two countries, a small 'home' country and a large 'foreign' country. In the economy four goods can be traded, capital K and labor L as production inputs and two consumption goods, called X and Y, as production outputs. In each country there are two types of economic agents, consumers and producers. Consumer preferences reflect a desire to consume X and Y but also to consume leisure $\mathcal{L}$. Each trading period consumers are endowed with some units of labor ($\bar{L}$) and capital ($\bar{K}$), but not with X and Y. Consumers can sell their endowments on the input markets to producers for fiat money ('francs'). With these sales proceeds they can buy X and Y from producers on the output markets. An additional source of fiat money income for consumers are unemployment benefits. For each unsold unit of their labor endowment they receive an unemployment benefit w_0. In addition, the unsold labor units are counted as leisure ($\mathcal{L} = \bar{L} - L$) from which consumers derive some utility. Consumers' real-money payoffs are solely determined by the consumption of leisure, X, and Y.

On the input markets producers have to buy inputs L and K from consumers to be able to produce X or Y. After having bought the inputs production takes place and producers can sell their production goods on the output markets to consumers in order to make profits. Each producer is either an X- or an Y-producer and endowed with the respective production technology. Producers' real-money payoffs are solely determined by the profits they make.

In each country the labor market is local. That is, consumers can sell labor only to producers (X or Y) located in their own country and producers can buy labor only

Figure 1: Flow diagram of the economic environment (a) and sequence of events (b)



(a)

Input markets open	Production	Output markets open	Subjects receive gains
Phase 1	Recording time	Phase 2	Recording time

(b)

from consumers in their own country. The capital market, in contrast, is international. Each consumer from each country can sell capital to each producer of each country, and each producer can buy capital from each consumer from either country.

On the production side, in each country there is a 'sheltered' sector (Y). That is, Y-producers can sell their products only to consumers from their own country, and consumers who want to buy units of Y have to buy them from their local producers. In contrast, X-producers are operating in an 'exposed' sector. That is, good X is tradeable and can be bought by each consumer in either country from each X-producer in either country.

Both types of producers are endowed with a (decreasing returns to scale) CES-production function. They differ, however, in two respects. The Y-technology is relatively labor intensive with a rather small elasticity of substitution between labor and capital whereas the technology for producers operating on the exposed X-sector is relatively capital intensive with a higher substitution elasticity. One may interpret the

labor intensive and sheltered Y-sector as the 'service'-sector and the capital intensive and exposed X-sector as the export orientated 'industry'-sector of the economies.[4]

The economy operates in a sequence of trading periods. Each trading period is split in two phases (see panel (b) in Figure 1). In each period, at the beginning of phase 1 consumers receive their endowments of labor and capital. In addition, consumers and producers receive some cash to initialize trade. During the first phase the input markets (two local labor markets and the international capital market) are open. Closing of the input markets ends phase 1. Then there is a short break in which production takes (automatically) place, and subjects have time to record their sales and purchases. Thereafter, phase 2 starts with the opening of the output markets (two local markets for Y and one international market for X). Phase 2 ends after a pre-specified time span (or if all goods in question are sold out). A trading period ends with a break where subjects have time to record their sales and purchases, look at the trading history, and calculate their payoffs.

2.2 The Tax-Benefit System

This study investigates an international economy where unemployment benefits are financed via a tax on labor. Such wage tax systems are very common, in particular in Europe. We implement a stylized version that contains all important aspects of such a system in the laboratory economy. As already mentioned above consumers receive for each unemployed unit of labor an unemployment benefit w_0. The government finances these benefits with the help of a tax on employed labor to be paid by producers. To be more specific, let τ_{wk} be the wage tax rate on labor in country k. Then a Z-producer ($Z = X, Y$) in country k, denoted j_{zk}, employing $L_{j_{zk}}$ labor units at a wage w_k has to bear labor costs $(1+\tau_{wk})w_k L_{j_{zk}}$. The total tax burden of producers in sector X and Y in country k is then $\tau_{wk}w_k L_{xk}$ ($L_{xk} := \sum_{j_{xk}} L_{j_{xk}}$) and $\tau_{wk}w_k L_{yk}$ ($L_{yk} := \sum_{j_{yk}} L_{j_{yk}}$), respectively.

Total tax revenues for the government in country k is then simply $\tau_{wk}w_k L_k$, where $L_k := L_{xk} + L_{yk}$ is total employment in country k. On the other hand, country k's government expenditure is given by $w_0(\bar{L}_k - L_k)$, where $\bar{L}_k$ denotes the labor force in country k. The condition for a balanced budget is, therefore, $\tau_{wk}w_k L_k = w_0(\bar{L}_k - L_k)$. In reality a balanced budget may be rather the exception then the rule. Facing of a budget deficit or surplus the government therefore has to adjust its policy if a balanced budget is aimed at. In the economies studied here this is done by adjusting the wage tax rate. In particular, if the government faces an unbalanced budget in period t it will adjust the wage tax in period $t+1$ such that with the new tax rate the budget in period t would have been balanced. More formally, the tax adjustment rule is given by

$$\tau_{wk}^{t+1} w_k^t L_k^t = w_0(\bar{L}_k - L_k^t), \tag{2.1}$$

with an upper limit of 0.9.[5]

[4]The implemented elasticities of substitution are actually based on elasticities of substitution also used in the applied general equilibrium model MIMIC designed for the Dutch economy by the Central Planning Bureau in The Hague (see e.g. Graafland and de Mooij (1994).

[5]This upper limit was set in view of an alternative (sales) tax system investigated in van Winden et al. (1999). Pilot studies showed that tax rates too close to 100% might have a strong discouraging

2.3 Parameter Choice

The chosen parameter values reflect several considerations. They ensure that in equilibrium traded quantities and relative prices are, on the one hand, sufficiently separated and, on the other hand, still in a range such that not too much time is needed to trade the units subjects wanted to trade. The parameter choices also reflect the implementation of an international economy with a small and a large country.[6] Table 1 gives an overview of the chosen experimental parameters.

Preferences and production. As already mentioned consumers receive 'utility' (Dutch guilders in the experiment) by consuming leisure, X, and Y. In the table the continuous approximation of the induced consumer preferences (per period) is shown. (The experimental subjects received a payoff table.) It is the log-linearized version of a Cobb-Douglas utility function putting more weight on the consumption goods than on leisure.
Producers are endowed with a CES-production technology (Table 1 shows the continuous version of the production tables with which subjects in the role of producers were endowed). Subjects in the role of producers earn their money by making profits. The profit functions reflect the fact that producers have to pay a proportional tax on labor costs.

Endowments and number of agents. At the beginning of each trading period consumers are endowed with L, K, and some initial cash. Producers do not receive L and K but some initial cash to initialize trade. The difference in size between the two countries is reflected by the fact that in the large country these endowments are seven times as large as in the small country. This difference in size is also reflected in the scaling parameter A of the production function. Together these parameter values ensure that (theoretical) supply and demand for all goods in question is in the large country seven times as large as in the small country. In all experiments the number of consumers, X-, and Y-producers is the same in both countries.[7]

Tax-benefit system. The unemployment benefit w_0 an unemployed unit of labor receives is held constant throughout an experimental session. During the 'constant tax regime' (that is, during the first half of an experimental session) wage taxes are also held constant, at the rate of the general equilibrium solution with a balanced budget. During the second half of an experimental session ('dynamic tax regime') the taxes are adjusted according to the formula given at the bottom of table 1 (see also equation 2.1). The reason to hold taxes constant in the first half of an experimental session is twofold. Firstly, it gives the economies a sufficient chance to stabilize, and, secondly, allows

effect.

[6] Given the already complicated nature of the international economy the same currency is used in both countries.

[7] Using the same number of subjects in both countries has two reasons. Firstly, it makes - with the only exception of size - the two countries completely symmetric. Secondly, the alternative would have been to increase the number of participants in the large country instead of the endowments. This would have required a minimum of 64 subjects per session, which was technically not feasible. Note, that we have at least three agents on each side of the market, which in other experiments turned out to be sufficient to ensure that the markets approximate competitiveness (see, e.g., Davis and Holt (1993, p. 150)).

to investigate at what level (with respect to, e.g., budget deficits or surpluses) this happens. Secondly, we are particularly interested in how the economies behave if the wage tax is adjusted to deficits or surpluses while keeping all other economic parameters constant. This allows to isolate the pure tax adjustment effect on the performance of the economies. It may also give new insights into the dynamics of the economies if political interference is necessary or wanted. Therefore, the dynamic tax regime is introduced.

Table 1: Experimental parameters

Preferences and production

Consumers:

$U_{ik} = 25\left[\ln X_{ik} + \ln Y_{ik} + .25\ln(\bar{L}_{ik} - L_{ik})\right]$,
$U_{ik} = 0$ if either $X_{ik},\ Y_{ik},$ or $\bar{L}_{ik} - L_{ik}$ equals zero

Quantities L_{ik}, Y_{ik} are determined 'locally' (within a country)
Quantities X_{ik} are determined 'internationally' (one market)

Producers:

$\Pi_{j_{xk}} = p_x X_{j_{xk}} - (1+\tau_{wk}) w_k L_{j_{xk}} - rK_{j_{xk}}$,
$\Pi_{j_{yk}} = p_{yk} Y_{j_{yk}} - (1+\tau_{wk}) w_k L_{j_{yk}} - rK_{j_{yk}},\ k = s, l$

Prices p_{yk}, w_k, taxes τ_{wk}, and quantities $L_{j_{zk}}$, $Y_{j_{yk}}$ are determined 'locally' (within a country)
Prices p_x, r, and quantities $K_{j_{zk}}$, $X_{j_{xk}}$ are determined 'internationally' (one market)

Production function:

$Z = A\left[\eta_z^{1-\gamma_z} L^{\gamma_z} + (1-\eta_z)^{1-\gamma_z} K^{\gamma_z}\right]^{\frac{0.9}{\gamma_z}}$

Labor intensity: $\eta_x = .5625,\ \eta_y = .675$
Substitution elasticity: $\gamma_x = -2,\ \gamma_y = -6$
Scaling factor A: 1 for small country
1.21 for large country

Endowments and number of agents:

	Small country	Large country
Consumer	$\bar{L} = 15,\ \bar{K} = 10,\ Cash = 181$	$\bar{L} = 105,\ \bar{K} = 70,\ Cash = 1268$
Producer X	$\bar{L} = 0,\ \bar{K} = 0,\ Cash = 1223$	$\bar{L} = 0,\ \bar{K} = 0,\ Cash = 8557$
Producers Y	$\bar{L} = 0,\ \bar{K} = 0,\ Cash = 815$	$\bar{L} = 0,\ \bar{K} = 0,\ Cash = 5705$

Number of agents:		
Consumers	3	3
Producers X	2	2
Producers Y	3	3

Tax-benefit system:

	Both countries
Unemployment benefit (w_0)	70
Initial wage tax rate (τ_w^0)	.3777
Wage tax adjustment rule (τ_w^{t+1})	$\tau_{wk}^{t+1} w_k^t L_k^t = w_0(\bar{L}_k - L_k^t)$ with an upper bound of .9

2.4 Experimental Procedures

The experiment took place in the CREED laboratory of the University of Amsterdam. All subjects were undergraduate students, the majority of them coming from the Faculty of Economics and Econometrics of the University. They were recruited by announcing an invitation to participate in a decision-making experiment. Since the experiment was rather complicated they had to subscribe to a package of three sessions. This package contained a training session (where participants learned how to handle the computer and read the tables, and were acquainted with the trading rules), a 'closed economy' session, and the international economy session.[8] Subjects' received their earnings only if they showed up on all three occasions. The parameter values of the 'closed economy' session were similar but not identical to the parameter values of the experiment reported here. At the beginning of the training session each subject was randomly assigned the role of a consumer, X-, or Y-producer.[9] This role was the same in all sessions a subject participated in.

At the beginning of an experimental session subjects received the instructions containing a general part - read aloud by the experimenter - and a type specific part - read quietly by the subjects. The instructions also contained a questionnaire to ensure that all rules were understood by the subjects. Trading was not started until everybody had answered all questions correctly. Questions by the participants were answered privately. They also received personal history forms containing all information (like endowments, market restrictions, taxes, subsidies, etc.) relevant to the particular type of economic agent.[10] By requiring subjects to fill in the transactions and earnings we indented to make subjects aware of the consequences of their decisions. All together we conducted three experimental sessions with the international economy.[11] All sessions were run in October 1998.

Each experimental session consisted of a series of 16 trading periods with two practice periods at the beginning. Subjects could not earn anything in this practice periods. Nothing - except subjects' earnings - carried over from period to period. This ensured that each period can be viewed as the one shot repetition of the same economy.
In the first eight periods taxes were held constant at their initial values (constant tax regime). From period nine on taxes adjusted in accordance to the above described

[8] To avoid experimenter-induced effects, the bids and asks of the experimenters - who acted as counterparts in the markets during the training sessions - were randomly varied within a considerable range, which was the same in all training sessions. For international economy session subjects were selected on the basis of their performance in the closed economy session.

[9] In the experiment the words consumer and producer were not used. They were called 'type-I traders' and 'type-II' traders, respectively.

[10] The labor market in the small (large) country, the capital market, the X-market, and the Y-market in the small (large) country were labeled $V1$ ($V2$), $W1$, $X1$, and $Y1$ ($Y2$), respectively. The unemployment benefit was called a subsidy for unsold units of V.

[11] We are aware of the fact that from a statistical point of view we are at the lower side with respect to independent observations. However, because of the systematic observed in both countries in all sessions we are quite confident that the results we found are robust. One has also to take into account that running such complicated experiments is not only time intensive (each subject participating in the international economy also had to participate in the training and closed economy sessions and was, therefore, altogether more than 10 hours in the laboratory) but also very costly (all together the payments for subjects accumulated to $14428,-$ Dutch guilders.

adjustment rule in order to facilitate a balancing of the budget (dynamic tax regime). In each period phase 1 (input markets) lasted 4 minutes and 30 seconds followed by a short break of 20 seconds. Thereafter, phase 2 started (output markets) what lasted 3 minutes and 30 seconds. This was followed by a 2 minutes break before the next trading period began. Each session lasted approximately 3 hours and 30 minutes. The average earning (net of show-up fee) per subject in an international economy session was approximately $67,-$ Dutch guilders.[12]

In all markets an adapted version of the Plott and Gray (1990) multiple unit double auction process was used. Each subject was seated in a separate booth at a computer. The computer screen displayed the highest bid and lowest ask on each market (where an agent was allowed to trade). At any time agents had the possibility to look at there own as well as the whole history of transactions. Furthermore, at the end of each phase they received a summary statistics of their own transaction (total quantities and average prices) as well as of all transactions. In the break between phase one and two producers' production was automatically calculated by the computer. After phase two the computer also calculated automatically the agents earnings. At any time subjects' had the possibility to control the computer's calculations with the help of their tables.

3 Experimental results

In this section we start out with a brief summary of the general performance of the economy, followed by an introduction of the statistical technique used to analyze the main results. The, rest of this section is divided into two subsections. In the first subsection the results for the constant tax regime and in the second subsection those for the dynamic tax regime will be presented and discussed. We concentrate on the analysis of the budget deficit (surplus) and two important indicators for the performance of the economies, unemployment and real GDP, in the small and the large country.

From a more general perspective it is, of course, interesting to analyze the functioning of the economy as a whole and its performance relative to the theoretical benchmark model. Because of space constraints we will only give a very brief summary here. (For a more detailed analysis - including a detailed discussion of the theoretical benchmark model and also an investigation of the closed economy - we refer the interested reader to Riedl and van Winden (2000).) An important general result is that we do not find any 'lack-of-order', in the sense that from an economic perspective the input and output markets respond in the 'right' direction.[13] Furthermore, we find that (in the constant tax regime) a great majority of the real economic variables (input and output quantities) exhibits a movement towards the theoretical predictions. We also find, however, that the input (output) prices show a tendency towards too low (high) values, and that this is accompanied with budget deficits. In the following we will elaborate on these findings, where, with respect to prices we will restrict our analysis to (nominal) wages, which are of direct relevance for the government's budget.

[12]Each subject in an international economy also received a show-up fee of $10,-$ Dutch guilders.

[13]Regarding the input markets we find a positive relationship between the capital-labor employment ratio and the inverse input price ratio. Regarding the output markets a similar picture of the relationship between the X-Y consumption ratio and the inverse of the output price ratio is obtained.

Before presenting our main results we will shortly introduce a statistical model that will be used repeatedly in this section. It was originally introduced and used by Noussair, Plott, and Riezman (1995) and turned out to be very useful for the investigation of the development of important economic variables over time. It assumes that for each experimental session any particular dependent variable may have a different initial value but that it will adjust over time and converge to a common asymptote. More formally, the model has the following form:

$$y_{it} = B_{11}D_1(1/t) + ... + B_{1i}D_i(1/t) + B_{1N}D_N(1/t) + B_2(t-1)/t + u_{it}, \qquad (3.1)$$

where y is the dependent variable in question, i denotes the experimental session, t the trading period, D_i is a session dummy that is equal to 1 for i and zero otherwise, and u_{it} is an error term. The model allows that the dependent variable has different starting points in different experimental sessions (the B_{1i}'s account for that) and assumes that the variable converges to a common value (B_2). This model tries to capture the direction of movement as well as the asymptotic behavior. Note that, for low t's the weight lies on the B_{1i}'s but that for large t's the weight is on the common term B_2. With this model at hand we are able to test if a variable converges to a hypothetical value simply by testing if the estimated coefficient is significantly different from the pre-specified value. The unit of observation is the value of the dependent variable per session (i) and period (t). In all regressions standard errors are corrected for possible heteroscedasticity and AR(1) by using the Newey-West procedure (Newey and West (1987)).

3.1 The Constant Tax Regime

Figure 2 shows the developments of the relative budget surpluses sur^k (with $k = s, l$ indicating the small and the large country, respectively) defined as the nominal surplus relative to nominal GDP[14] (averaged over sessions) for the constant tax regime (periods one to eight). It clearly shows that in both countries in all periods a substantial budget deficit exists. Furthermore, there is no indication that the deficits get smaller over time. A more thorough statistical investigation supports this picture. Applying the above introduced method to the relative surpluses gives,

$$\begin{aligned} sur^s_{it} = &-.118\ D_1(1/t) - .129\ D_2(1/t) + .140\ D_3(1/t) - .093\ (t-1)/t, \qquad (3.2)\\ &(-3.56) \qquad (-1.48) \qquad (1.65) \qquad (-2.20)\\ sur^l_{it} = &-.320\ D_1(1/t) - .176\ D_2(1/t) + .045\ D_3(1/t) - .099\ (t-1)/t, \qquad (3.3)\\ &(-4.66) \qquad (-8.90) \qquad (0.72) \qquad (-4.46) \end{aligned}$$

with t-values in parentheses. It shows that in two out of the three sessions both countries start out with a budget deficit (significant in three cases) and that in one session both countries exhibit a (not significant) budget surplus. More important, however, the asymptotes are significantly negative in both countries, indicating that in the long run budget deficits are to be expected. With 9.3 and 9.9 percent of nominal GDP

[14]Nominal GDP is defined by as $p_x X_k + p_{yk} Y_k$, where p_x and p_{yk} are the average prices for X and Y_k, respectively, and X_k and Y_k are the production levels of X and Y in country k, respectively.

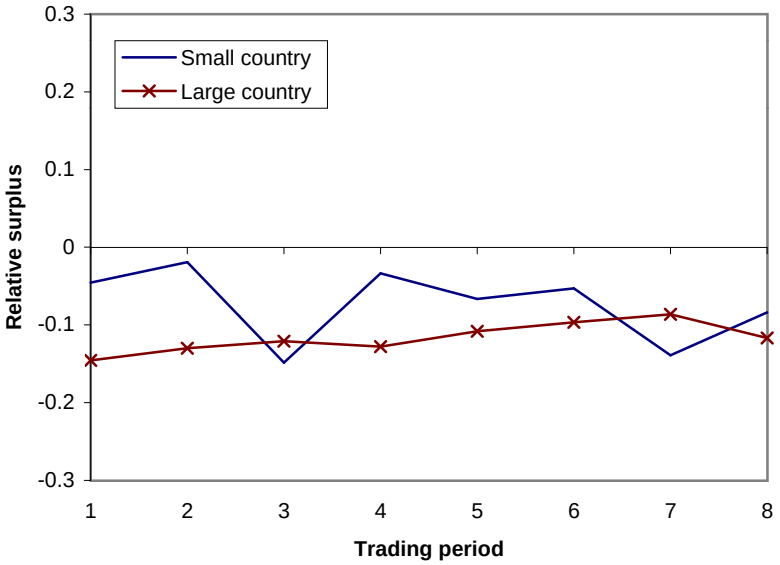


Figure 2: Development of the relative budget surplus

these deficits are also of economically significant magnitudes. Note, that the reported deficits are *not* accumulated. Since nothing carries over from one period to the next the emergence of budget deficits cannot be (directly) related to unfortunate developments in earlier periods. This leads to our

Result 1. *For the constant tax regime (periods 1 to 8) in both countries substantial and persistent budget deficits are observed, which do not vanish over time.*

Given this observation one would like to know what the reasons for the deficits are. In the analyzed tax-benefit system unemployed labor units receive nominally fixed unemployment benefits, which are financed with a proportional tax on the wage sum. Hence, technically, there are two sources for an observed deficit, given the tax rate: either the unemployment rate is too high, or nominal wages are too low (or both hold). We first look at the level and development of unemployment. Figure 3 shows the evolution of unemployment relative to equilibrium unemployment, in both countries.[15] The patterns are suggestive. In the small country unemployment starts close to the predicted equilibrium unemployment (in the first two periods it is even lower) but shows some tendency to increase over time. In the large country unemployment is too high in all periods and seems to be relative stable, with perhaps a slight tendency to decrease. In the last period of the constant tax regime the small and large country exhibit almost the same relative unemployment rate. The results of the following convergence analysis (t-values in parentheses) for the relative unemployment rates (u^k) are in line with this first impression:

[15]Equilibrium unemployment is the unemployment which should be observed if (i) all economic agents are rational utility (profit) maximizers, (ii) all markets are in equilibrium, and (iii) the budget is balanced.

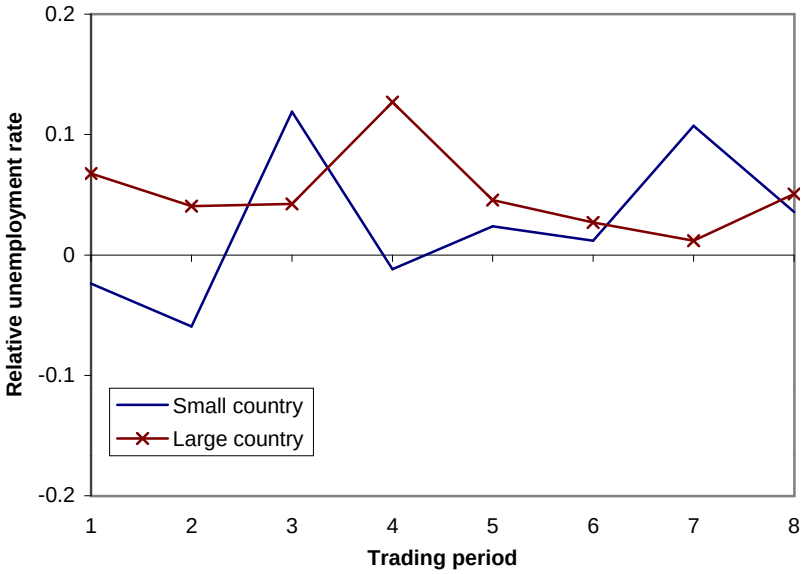


Figure 3: Development of the unemployment rate

$$u^s_{it} = \underset{(0.21)}{.010}\ D_1(1/t) + \underset{(1.26)}{.159}\ D_2(1/t) - \underset{(-2.28)}{.286}\ D_3(1/t) + \underset{(0.97)}{.059}\ (t-1)/t \tag{3.4}$$

$$u^l_{it} = \underset{(2.95)}{.246}\ D_1(1/t) + \underset{(2.95)}{.118}\ D_2(1/t) - \underset{(-1.76)}{.160}\ D_3(1/t) + \underset{(1.27)}{.043}\ (t-1)/t \tag{3.5}$$

In the small country, initial unemployment is in one session significantly lower than equilibrium unemployment, whereas in the other two sessions it is (insignificantly). In the large country, unemployment rates are at the beginning significantly higher than predicted in two sessions and (insignificantly) lower in the third session. In the long run, in both countries, there is a weak tendency towards too high unemployment rates. Statistically, however, the estimated long run unemployment rates are not different from the equilibrium unemployment rates. The next result summarizes.

Result 2. *For the constant tax regime (periods 1 to 8), in both countries, unemployment converges to equilibrium unemployment from above, in the sense that the asymptotic (long run) values, though larger, are statistically not significantly different from the predicted values.*

Results 1 and 2 lead to the following

Result 3. *In the constant tax regime, in both countries, nominal wages are too low for a balanced budget.*

What explanation can be offered for the two observations of too low nominal wages and the slight tendency towards too low employment generating the budget deficit? We look first at the employment decisions of producers. We calculate the percentage of cases for which the marginal revenue product of labor *exceeds* the gross (after tax) wage,

taking the average current period output price as a measure for the expected output price. Accounting for errors, a percentage of 50 percent would seem to be in line with risk-neutral profit maximizing behavior. To account for possible learning effects we take the decisions of producers in periods 3 to 8 as the units of observations. What we find is that for producers in both countries in a majority of cases the marginal revenue product of labor exceeds the gross wage. Hence, at given prices producers have a tendency to employ too few labor units. For producers in the small country this is the case in 59 percent and for producers in the large country in 64 percent of all cases. Using a binomial test, it turns out that for the large country the observed percentage is significantly different from 50 percent ($p = 0.004$). For the small country it is marginally significant ($p = 0.057$).

In our view this gives support to the following hypothesis that we will call the *risk-compensated price-mechanism.*[16] In real economies producers are facing a risk when buying inputs. This risk is due to the uncertainty about output prices and thus the revenues they can make when selling their products on the output market. The fact that producers are facing this risk, in combination with risk-aversion, can explain why they are reluctant to employ 'enough' labor (or factors, in general). Interestingly, there are also some theoretical (partial equilibrium) studies which support the 'risk-compensated price-mechanism' hypothesis. In particular, Batra and Ullah (1974), Hartman (1975, 1976), and Holthausen (1976) have shown that price uncertainty indeed reduces factor demand by risk-averse competitive firms.

However, reluctance of producers to employ labor alone cannot explain the observation of too low nominal wages. To find an answer to that we also have to analyze consumer behavior in more detail. In principle it could also be possible that consumers voluntarily supply too little labor. To investigate this issue we calculate for each consumer in each period the theoretical labor supply at actually observed prices. It turns out that in comparison to theoretical supply consumers supply *too much* labor at given prices. Again looking at periods 3 to 8 we find that in the small (large) country in 78 (100) percent of all cases actual labor supply exceeds theoretical labor supply at given prices. These percentages are significantly different from 50 percent, using a binomial test.

In summary, consumers supply too much labor whereas producers have a tendency to demand too little labor. This has two effects: (i) the unemployment rate gets an upward thrust, and (ii) labor is in excess supply which puts a downward pressure on the nominal wage, the relevant wage for tax revenues. Using this evidence we have the following

Result 4. *Producers' reluctance to employ labor and consumers' tendency to supply too much labor at given prices, driving nominal wages down, can explain the observed budget deficits.*

[16] A similar mechanism, called the 'risk-compensated input/output price-adjustment process', was first found by Noussair, Plott, and Riezman (1995) in a different market experiment with simultaneous input and output markets.

3.2 The Dynamic Tax Regime

We turn now to the analysis of the evolution of the economy when taxes adjust to the previous period budget deficit or surplus. This is of particular importance since the problem of budget deficits and the political means to reduce it is on the agenda of many governments. Furthermore, if it would turn out that fighting deficits makes the economic performance worse, e.g. in terms of unemployment and welfare, this would be an important explanation why it is so difficult to balance the budget without facing political resistance by various groups in the society.

As in case of the constant tax regime, we start our analysis with the investigation of the development of the governments' budget surplus. Figure 4 shows the evolution of the relative budget surpluses and the associated wage tax rates. (For a better comparison to the constant tax regime the development over all 16 periods is shown.) The broken lines indicate the regime change. Most remarkable is the initially sharp

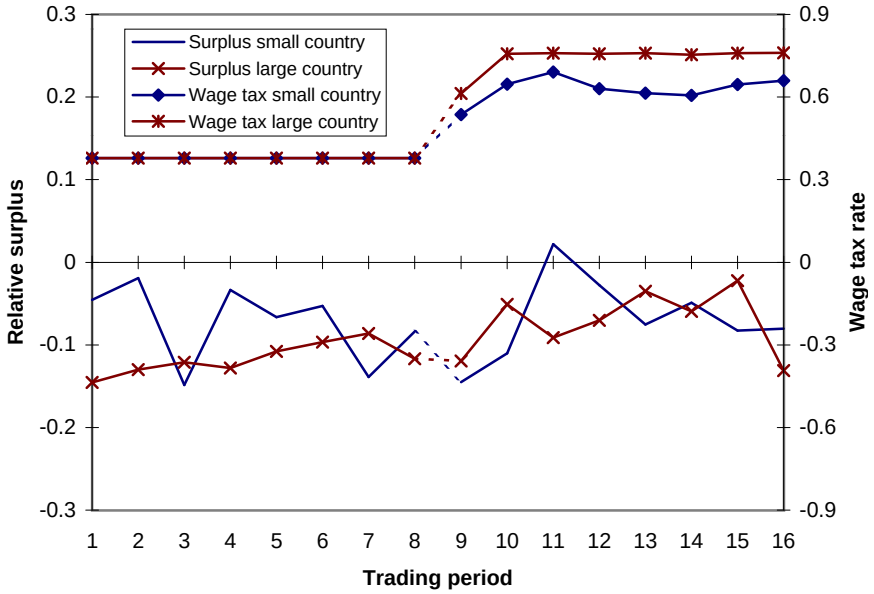


Figure 4: Relative budget surpluses and wage tax rates

increase of the wage tax rates, which is due to the budget deficits in the last period of the constant tax regime. After some further increase the tax rates flatten out and stabilize at a level approximately twice as high as the initial tax rates. The increased tax rates are accompanied by an (on average) decrease of the budget deficit. Notably, the systems do not succeed to balance the budgets completely. The following regression results show, however, that in the long run some convergence towards balanced budgets takes place.

$$sur^s_{it'} = \underset{(-12.02)}{-.397}\ D_1(1/t') + \underset{(0.01)}{.000}\ D_2(1/t') - \underset{(-0.04)}{.001}\ D_3(1/t') - \underset{(-1.37)}{.036}\ (t'-1)/t', \quad (3.6)$$

$$sur^l_{it'} = \underset{(-11.69)}{-.228}\ D_1(1/t') - \underset{(-2.24)}{.126}\ D_2(1/t') + \underset{(0.02)}{.001}\ D_3(1/t') - \underset{(-1.66)}{.033}\ (t'-1)/t', \quad (3.7)$$

where t' is defined to be $t-8$. (Thus, in the above regressions we treat the ninth trading period, i.e. the first in which the taxes are adjusted, as trading period 1.) In the small (large) country in two (one) out of the three sessions the tax adjustment leads initially to a balanced budget, while in one (two) session(s) the adjustment is not sufficient to balance the budget. The asymptotic values B_2 are still negative ($-.036$ in the small country and $-.033$ in the large country) but not significantly different from zero any more. Hence, the regression results indicate that in the long run convergence towards balanced budgets can be expected. We summarize in

Result 5. *For the dynamic tax regime (periods 9 to 16) the budget deficits converge to zero from below, in both countries.*

With respect to fighting the budget deficit the policy to adjust the wage tax can be judged as successful. The caveat, however, is that rather high taxes are needed to achieve that goal. To judge the success of that policy in more general terms of economic performance, we investigate the impact of the rather high taxes on some measures of economic welfare. Two measures are taken that are usually seen as important in the political debate but also in economics: unemployment and real GDP (RGDP).[17] We are mostly interested in the long run properties of these two measures. Therefore, we run the convergence regressions for both measures, for the constant as well as the dynamic tax regime. We then compare the asymptotic values of the constant tax regime with the asymptotic value of the dynamic tax regime. This comparison gives an indication how the economic performance is influenced by the tax adjustment policy. The following result is obtained.

Result 6. *In the long run the unemployment rates - measured as deviation from equilibrium unemployment rates - increase from 6 to 12 percent in the small country and from 4 to 18 percent in the large country. Long run RGDP decreases by 8 percent in the small country and by 13 percent in the large country.*

This result shows that the balanced budget is bought at a rather high cost in terms of economic performance and welfare. The unemployment rates increase substantially and the RGDP's experience sharp decreases. This result may - at least partly - explain why it is so difficult to achieve a balanced budget by adjusting taxes within a wage tax financed unemployment benefit system. The decrease in economic performance can be expected not only to affect some specific groups in society (like workers) but via the decrease in RGDP society at large. This may lead to a broad front of political resistance, which may be very hard to overcome.

However, there is still the question if it is the direct effect of increasing taxes that makes the situation worse. In principle, it could also be due to behavioral changes because of the mere fact that taxes are adjusted. A first piece of evidence that it is not the latter comes from the fact that producer as well as consumer behavior with respect to labor demand and supply, respectively, in the dynamic tax regime is qualitatively not

[17]For the calculation of RGDP we used the first trading period as base 'year'. That is, nominal GDP of each trading period is weighted by the trading period 1 prices of X and Y_k. We have run the analysis also by taking several other trading periods as base year. The results do not change.

different from behavior in the constant tax regime.[18] To investigate the tax effect we look at the correlation between tax rates (in a period) and the sequential unemployment and RGDP (in the same period). The scatter-plots in Figure 5 show the results.[19] They also include the Spearman rank statistics and the associated p-values. Note, that these are controlled observations, since the tax rates (which are the only parameters that change over periods) are fixed at the beginning of a period. The figures and correlation

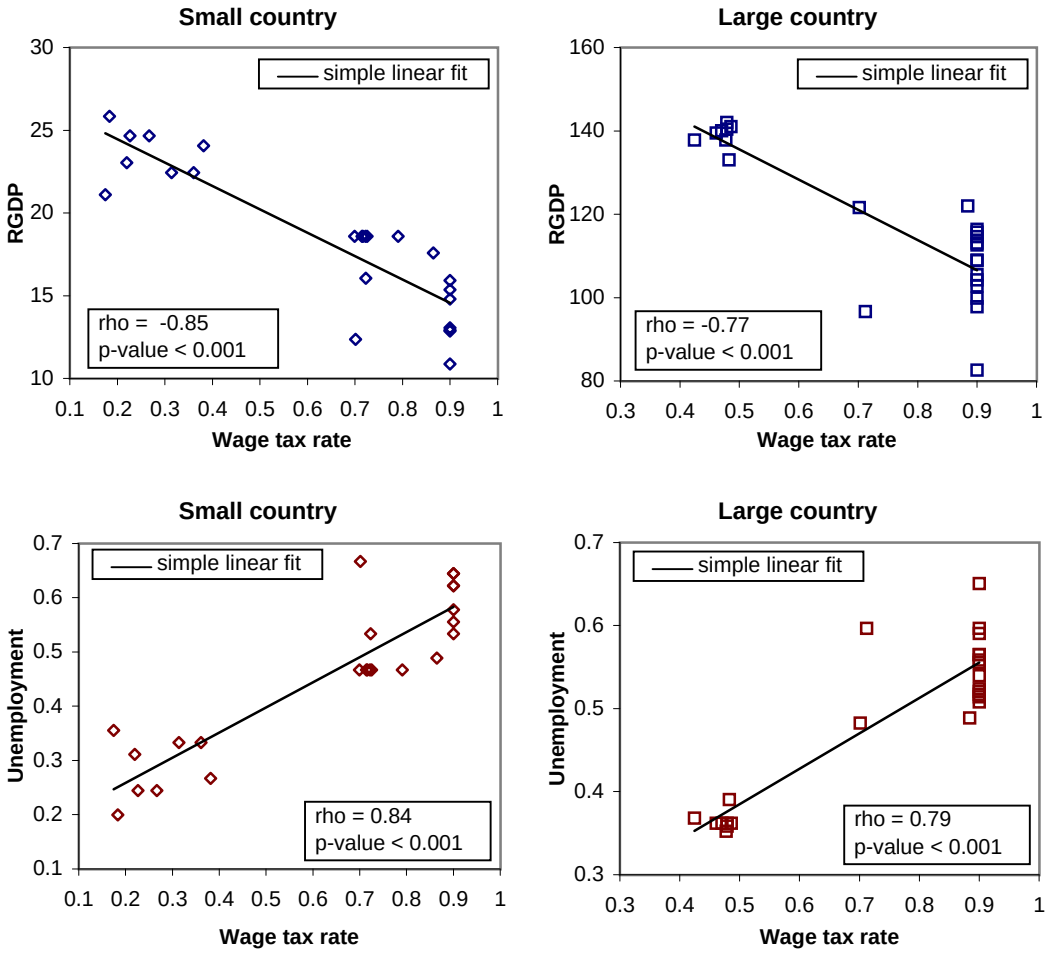


Figure 5: Correlations between wage tax rate and RGDP (above) and unemployment (below) in the small country (left) and the large country (right)

statistics clearly show that an increase in wage tax rates has strongly negative and highly significant effects on economic performance (unemployment and RGDP), in both

[18] On the producers' side the number of cases where they employ too few labor units (i.e. where the marginal revenue product exceeds the after-tax wage) even shows some tendency to decrease. Using decisions in periods 11 to 16 as units of observation marginal revenue product exceeds the gross wage in 53 percent of all cases in the small country and in 63 percent of all cases in the large country. For the same periods in the small (large) country in 94 (100) percent of all cases consumers supplied too much labor.

[19] As the right parts of the scatter-plots show, the maximum tax rate of 90 percent is sometimes obtained.

countries. The next result summarizes.

Result 7. *Increasing the wage tax rates has strong negative effects on the performance of the economy, in both countries. In both countries, an increase in the wage tax significantly decreases real GDP and significantly increases the unemployment rate.*

The negative effects of the analyzed tax-benefit system on the development of budget deficits and economic performance seems to be due to the combined effect that, at given prices, producers have a tendency to demand too little labor while at the same time consumers supply too much labor. This leads to an upward trend of unemployment rates and a downward pressure on nominal wages. Although further empirical as well as theoretical evidence is needed to arrive at definite conclusions, the results of our study point to an important and underexposed determinant of budget deficits and the difficulty to fight them with the help of tax adjustments in the widely employed system of wage tax financed unemployment benefits. If producers are risk-averse[20] and, therefore, reluctant to employ labor due to the uncertainty about output prices, having to pay taxes up-front seems to exacerbate the negative effects. From this perspective, it is worthwhile to investigate a taxation system where these negative effects can be avoided.[21]

4 Conclusions

In this paper we have presented the results of an experiment investigating experimentally whether and, if so, how a wage tax financed system of unemployment benefits affects the government's budget balance. In the experiment an international economy with a large and a small country was implemented, allowing the investigation of a large and a (relatively) small open economy.

The results show that the wage tax system has a strong tendency to produce budget deficits in both countries. These deficits are driven by the fact that, again in both countries, unemployment shows some upward trend whereas nominal wages are too low to cover the unemployment benefit outlays with the help of wage taxation. We find support for the so-called 'risk-compensated price-mechanism' hypothesis, which states that producers have a tendency to employ too few labor units because of risk-aversion and uncertainty about output prices and, hence, revenues at the time they have to make the employment decision. There is also strong evidence that consumers tend to supply too much labor, which leads to a downward pressure on wages.

It is shown experimentally that a policy that tries to balance the budget with wage tax adjustments can be successful in the sense that convergence to a balanced budget is observed. However, due to the observed behavioral regularities, this success comes

[20]For an empirical study showing that firms may indeed be risk-averse, see Gunjal and Legault (1995).

[21]In the study for the Dutch Ministry of Social Affairs and Employment, on which this paper is partly based, a new sales tax financed labor subsidy system is investigated. The results obtained there point into the direction that shifting taxation from inputs to outputs and simultaneously subsidizing labor employment has positive effects on the performance of an economy.

at the cost of reduced economic performance and welfare. It is shown that, in the long run, balancing the budget leads to a significant increase in unemployment and a significant decrease of real GDP, in the small as well as the large country. In our view, this offers another important piece of explanation why it is so difficult to fight budget deficits with the help of tax policies. Due to the worsening of the economic situation the policy maker will face a broad front of resistance.

In our study we not only detect negative macro-economic effects of a wage tax financed unemployment benefit system but also succeed in identifying behavioral regularities of producers and consumers, which can explain these effects from a micro-economic perspective. Therefore, it is worthwhile to investigate different taxation systems that may avoid these negative effects and to analyze if the observed regularities carry over to these other systems. In particular, shifting taxation from labor to outputs (via sales or value-added taxes) may have positive effects, because in such systems the government shares the revenue risk faced by producers. This may weaken the reluctance of producers to employ labor and may have over-all positive effects.

It is important to notice that the described effects are not captured by general equilibrium models. Therefore solely relying on these models for policy considerations may lead to wrong predictions and costly political mistakes. The results presented here also suggest that using experiments for policy issues is an important complementary research tool to theoretical work and the analysis of field data.

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