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AN EXPERIMENTAL INVESTIGATION OF WAGE TAXATION AND UNEMPLOYMENT IN CLOSED AND OPEN ECONOMIES*

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Abstract

We investigate experimentally the economic effects of wage taxation to finance unemployment benefits for a closed economy and an international economy. The main findings are. (i) There is clear evidence for a vicious circle in the dynamic interaction between the wage tax and unemployment. (ii) In the short run employment is boosted by budget deficits. However, subsequent tax rate adjustments in order to balance the budget lead to employment levels substantially lower than theoretically predicted. (iii) There exists a downward pressure on factor employment caused by a sales risk for producers. For labor the wage tax exacerbates this effect.

JEL Classification Number: C90, D50, E24, F41
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1 Introduction

For more than two decades now unemployment has figured prominently on the political agenda of many European countries. Although by now a great number of theoretical and empirical studies exists and many proposals have been made, there is no consensus yet on how to structurally solve the issue.[1] Anticipated fiscal strains from pay-as-you-go financed pension systems, due to population aging, has only added fuel to the debate.

Welfare state arrangements, and the accompanying tax burden, are generally considered an important factor fostering unemployment. As pointed out by Snower (2000), these arrangements were established in Europe under economic fair-weather conditions, during the first 25 years of the postwar period. Once the weather started to deteriorate in the seventies they more and more resembled quicksand. Rising unemployment led to higher social transfers, producing higher taxes on a shrinking tax base, which in turn negatively affected employment: "And so the cycle continues" (ibid., p. 44)). Substantial theoretical and empirical evidence indeed exists for a negative feedback effect from a higher tax burden on labor (the tax-wedge), suggesting the possibility of a vicious circle.[2] Thus, it seems that Snower's cycle is an important explanatory factor for persistently high unemployment rates. However, granting the possibility of a vicious circle, the existing literature is only of limited help in establishing its actual relevance. Theoretical models not only rely on assumptions regarding the behavior of economic agents, they also typically focus on equilibria. Empirical studies, on the other hand, are confronted with the usual problems associated with field data. Lack of control over the data generating process leads to a lot of noise hampering the estimation of relevant parameters. From this perspective, it comes as no big surprise to find, for example, that empirical estimates of tax rate elasticities of pre-tax real wages differ dramatically across studies and countries, resulting in great uncertainty regarding the quantitative impact of taxation (Sørensen (1997, p. 230)).

The goal of this paper is to help improve our understanding of the determinants of unemployment, including the role played by the aforementioned vicious circle, by taking a novel approach: laboratory experimentation. We will focus on the functioning of an unemployment benefit system financed by wage taxation, as common in Europe. This study is based on a larger research project regarding the economic performance of tax systems commissioned by the Dutch Ministry of Social Affairs and Employment, following a motion carried by the Second Chamber of parliament.[3] To the best of our knowledge, it is for the first time that policymakers explicitly asked for laboratory experiments to support macroeconomic policymaking. Our study fits into a gradually growing stream of macroeconomic experiments showing the usefulness of experiments in this area as a complementary research tool next to the more traditional methods of theoretical and empirical analysis.[4] The important advantage of experiments is

[1] See, e.g., Economic Policy (1997, p. 217).

[2] See, e.g., Elmeskov et al. (n.d.), European Commission (1994), Nickell and Layard (1997), Pissarides (1998), Sørensen (1997). For a relatively early theoretical study showing the possibility of a "*crowding-out-effect* with massive unemployment", see van Praag and Halberstadt (1980).

[3] see van Winden et al. (1999)

[4] On taxation issues, see Davis and Swenson (1993), Quirmbach et al. (1996). For other macroeconomic experiments, see Bosch-Domènech and Silvestre (1997), Hey and di Cagno (1998), Lian and

that we can control the environment (in contrast to empirical analyses of field data), without having to make assumptions about behavior and restricting the analysis to equilibrium states (in contrast to theoretical models). By focusing on relatively simple economies - which are real in the basic sense that real people make real choices with real consequences - we may learn more about the dynamics and consequences of the behavioral adjustment processes that the vicious circle argument refers to.

More specifically, we will experimentally investigate the functioning of a wage-tax financed unemployment benefit system, under different tax rules, in two economic environments: a closed economy, and an international economy with a relatively small 'home country' and a large 'foreign country'. The latter allows us to study a large and a (relatively) small open economy simultaneously. In both cases there are input markets for capital and labor, and output markets for the goods produced by two production sectors. In the open economies environment, there are international markets for capital and one of the goods. In each environment two tax regimes are imposed in sequence. During the first part of each experimental session the wage tax rate is held constant. This allows us to investigate if the economies stabilize and at what level of the different economic variables. To analyze the dynamic interaction between the wage tax and unemployment (as well as other important indicators of economic performance) the tax rate is adjusted to the previous period's budget surplus (deficit) in the second part of each session. Since we are interested in investigating whether wage-tax financed unemployment benefits may produce a vicious circle boosting unemployment, we want to abstract in this first approach from other factors conducive to unemployment (like efficiency wages or institutions fostering insider-outsider effects). Therefore, competitive double auction markets will be used. These markets have shown to facilitate equilibration and to produce efficient outcomes in experimental markets (see e.g. Davis and Holt (1993)). To find a vicious circle in such a competitive environment would only seem to strengthen the significance of the result.[5] Moreover, in this way, we give the theory of competitive markets, that we will use as benchmark, its best chance to perform well.

The main findings of our study are the following. First, for all economies we find clear evidence of a vicious circle in the dynamic interaction between the wage tax and unemployment. Second, in the short run employment is boosted in a Keynesian way by budget deficits. However, subsequent tax rate adjustments in order to balance the budget lead to employment levels that substantially fall short of the predictions obtained from the general equilibrium benchmark model. Third, and related to the previous point, there appears to be a downward pressure on the employment of production factors caused by an (out-of-equilibrium) sales risk for producers. Due to uncertainty about output prices, and hence revenues, producers are reluctant to employ inputs. For labor this downward pressure on employment is exacerbated by the wage tax. Our results provide support for the hypothesis of a 'risk-compensated price mechanism' where the reluctance of producers to employ inputs is accompanied by (in comparison

Plott (1998), Noussair et al. (1995, 1997).

[5] According to Snower (1994, p. 65), unemployment benefit systems typically augment common labor-market failures, particularly those highlighted by the efficiency wage, insider-outsider, and union theories.

with the equilibrium predictions) too low input prices and too high output prices. This mechanism is not accounted for in general equilibrium models. Reliance on such models in policymaking would therefore lead to unexpected unemployment and disappointing economic performance. This may also help explain why one seems to have been taken by surprise by the vicious circle of wage taxation and unemployment.

The organization of the paper is further as follows. Section 2 presents the experimental design and theoretical predictions. Results are given and discussed in section 3. Section 4 concludes.

2 Experimental design and theoretical predictions

2.1 Experimental environment

We consider two types of economies, a closed economy and an international economy. The latter involves two 'countries', a relatively small 'home country' (h) and a relatively large 'foreign country' (f). In both economies there are consumers and producers participating in computerized multiple unit double auction markets.[6] Consumers are endowed with $\bar{K}$ units of capital and $\bar{L}$ units of labor that they can sell to the producers as inputs (K, L) on a capital and a labor market, respectively. Consumers derive utility (Dutch guilders) from 'leisure' (the unsold units of labor $\bar{L} - L$) and the consumption of two market goods: X and Y. In addition to their proceeds from sales, they obtain an unemployment benefit for each unsold unit of labor that can be used for the purchase of consumption goods on the output markets. Goods X and Y are produced in two separate sectors. The producers in these sectors need capital and labor as inputs, which are transformed to outputs via given production technologies. The technologies for the two goods differ in the sense that the production of good X is relatively capital-intensive whereas the production of good Y is relatively labor-intensive. Producers derive earnings (Dutch guilders) from profits, determined by the difference between their proceeds from sales in their respective output market and the costs of inputs. The cost of labor includes a proportional wage tax.

In total, there are four markets in the closed economy: two factor markets (for K and L) and two output markets (for X and Y). In the international economy, both the capital market and the market for X are 'international' ('exposed'), whereas the markets for labor and good Y are 'local' ('sheltered'). Consequently, the total number of markets in this economy equals six. To implement a large foreign economy in the lab - making the home country similar to a 'small' open economy - we choose the following design.

While keeping the number of consumers and producers the same for both countries in the international economy, we endow the consumers in the foreign country with seven times as many units of labor and capital as the consumers in the home country. Moreover, a scaling factor in the production functions of foreign producers is adjusted such that theoretically supply and demand in the foreign economy are seven

[6] For a description of the multiple unit double auction, see Plott and Gray (1990).

Table 1: Experimental parameters

Preferences

Consumers: $U_i = 25\left[\ln X_i + \ln Y_i + .25\ln(\bar{L}_i - L_i)\right]$
$U_i = 0$ if either X_i, Y_i, or $\bar{L}_i - L_i$ equals zero

Producers: $\Pi_j = p_z Z_j - (1+\tau)wL_j - rK_j,\ Z = X, Y$
In international economy: p_y, Y, τ, w, and L are determined 'locally' (within a country)
p_x, X, r, K are determined 'internationally' (one market)

Parameters:

Endowments and francs/dutch cents conversion rates

	Closed economy	International economy	
		Home country	Foreign country
Consumers	$\bar{L} = 60,\ \bar{K} = 40,$ $Cash = 725$ $Conversion\ rate = 1.2$	$\bar{L} = 15,\ \bar{K} = 10$ $Cash = 181$ $Conversion\ rate = 3.6$	$\bar{L} = 105,\ \bar{K} = 70$ $Cash = 1268$ $Conversion\ rate = 1.8$
Producers X	$\bar{L} = 0,\ \bar{K} = 0,$ $Cash = 4890$ $Conversion\ rate = 0.4$	$\bar{L} = 0,\ \bar{K} = 0$ $Cash = 1223$ $Conversion\ rate = 2.8$	$\bar{L} = 0,\ \bar{K} = 0$ $Cash = 8557$ $Conversion\ rate = 0.4$
Producers Y	$\bar{L} = 0,\ \bar{K} = 0,$ $Cash = 3260$ $Conversion\ rate = 0.6$	$\bar{L} = 0,\ \bar{K} = 0$ $Cash = 815$ $Conversion\ rate = 4.2$	$\bar{L} = 0,\ \bar{K} = 0$ $Cash = 5705$ $Conversion\ rate = 0.6$
Number of agents:			
Consumers	6	3	3
Producers X	4	2	2
Producers Y	6	3	3

Production:

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: 1.15 in closed economy
1 for home country in international economy
1.21 for foreign country in international economy

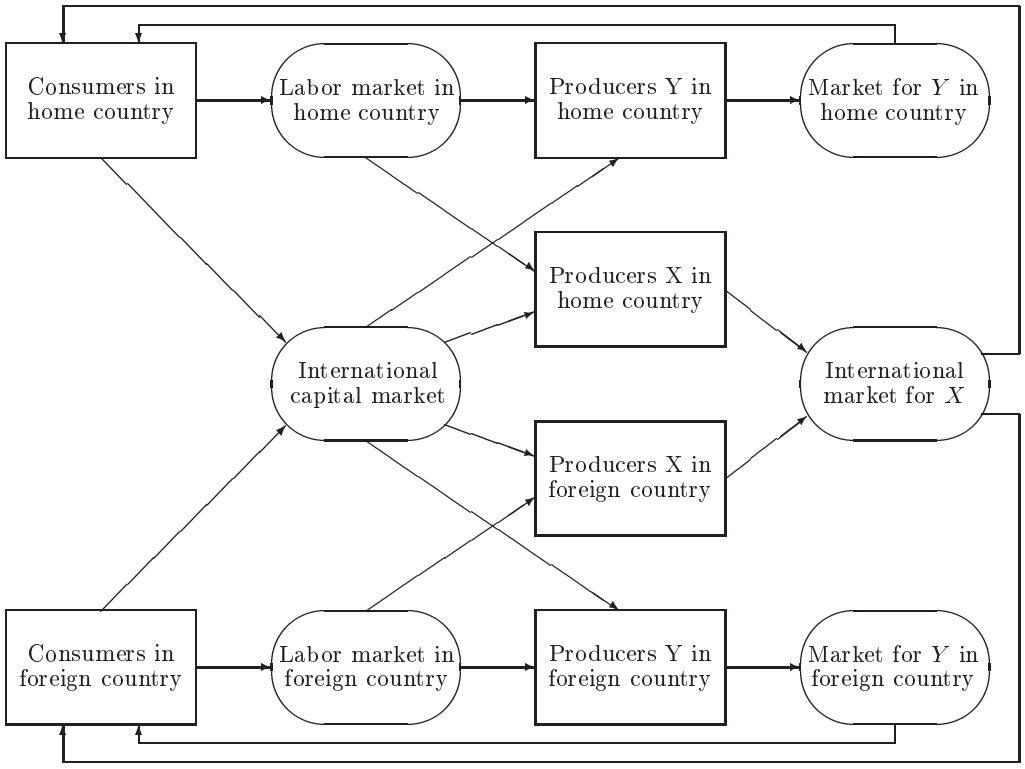
'Government':

Unemployment benefit: $w_0 = 70$

Wage tax rate: $\tau = .3777$ in 'constant tax periods'
$\tau_{t+1} = \frac{w_0}{w_t}\frac{\bar{L} - L_t}{L_t}$ in 'variable tax periods'
with an upper bound of 0.9*

Note: * This upper limit was set given the experience with a sales tax system investigated in van Winden et al. (1999). Pilot studies showed that tax rates too close or even above 100 percent might have a strong discouraging effect on trading.

Figure 1: Flow diagram of the international economy (a) and sequence of events (b)



(a)

Input markets open	Production	Output markets open	Calculation of gains
Phase 1	Recording time	Phase 2	Recording time

(b)

times as high as in the home economy. Table 1 shows the parameters of the experimental economies, including continuous approximations of the earnings functions (utility and profit functions) of consumers and producers, and the production technology of producers.[7]

Panel (a) of Figure 1 presents a flow diagram of goods and services for the more complex international economy. In case of the closed economy, the total number of consumers and producers is the same as in the international economy. However, in that case there is only one market for labor and one market for good Y, instead of two.

[7]In addition to the endowment of capital and labor for consumers both consumers and producers are endowed with some cash. Note, furthermore, that with the requirement of at least three agents on each side of a market (as e.g. in Quirmbach et al. (1996)), which seems to be the smallest number of agents ensuring that the markets approximate competitiveness (see also Davis and Holt (1993, p.150)), the minimal number of subjects would have been 64, in case of the alternative approach of increasing numbers of agents instead of endowments. Apart from potential control problems with that many subjects, lab size restrictions urged us to choose the design of this study.

Furthermore, consumers are endowed with four times as many units of capital and labor as the consumers in the home country of the international economy. The scaling factor in the production function of the producers is adjusted such that theoretically supply and demand will be four times as large as in the home country of the international economy.

In both economies 'francs' are used as experimental currency unit, implying that only one currency exits in the open economies. Since we are not focusing on issues of international finance, we do not want to complicate the experiments by introducing multiple currencies. The rate at which earnings in francs were converted into Dutch guilders (*conversion rate*) is presented in Table 1. This table also shows the two ways in which the wage tax is implemented. During the first seven (closed economy) or eight (international economy) trading periods in which the experimental sessions are divided (see below) the tax rate is kept constant, while it adjusts to the budget deficit in the previous period (outlays on unemployment benefits minus tax revenues) in the later periods. The reason for choosing this procedure is that, on the one hand, we want to have a sufficient number of repetitions with a constant environment - keeping conditions exactly the same in each period - to see whether economic behavior stabilizes, and, if so, at what level. On the other hand, we want to analyze the dynamic interaction between the wage tax and unemployment (and other indicators of economic performance) if the wage tax adjusts to deficits or surpluses, as occurs in reality, while keeping the other conditions constant.

2.2 Procedures

In total seven experiments were conducted: four concerning the closed economy, and three involving the international economy. Table 2 provides some data characterizing these sessions. All experiments were run at the CREED-laboratory of the University of Amsterdam. Subjects, undergraduates at the University and mostly coming from its Faculty of Economics and Econometrics, participated in three meetings. At the first meeting they got thoroughly acquainted with the trading rules, forms and tables to be used, and the software of the double auction markets. Producers and consumers were separately trained.[8] Then, at the second meeting, subjects participated, in their respective role, in the closed economy experiment. Again after a few days, this was followed by the third meeting concerning the international economy experiment. Each meeting lasted about 3.5 hours. Thorough training is common for more complex market experiments. In this case, because of the complexity of the international economy (with one of the novel aspects being the many units to be traded by subjects in the foreign economy), it was also decided to use only experienced subjects for this experimental environment. The closed economy experiment, with its intermediately sized endowments, enabled subjects to gain experience with a similar (but not identical) environment.[9]

[8] To avoid experimenter-induced effects, the bids and asks of the experimenters who acted as counterparts in the markets for training were randomly varied within a considerable range, which was the same for all training sessions.

[9] Furthermore, subjects were selected for the open economy experiment on the basis of their performance (earnings) in the closed economy experiment. All subjects got informed about this during the

Table 2: Summary of experiments

Date	Economy	Number of subjects	Experience	Number of periods*	Number of constant tax periods
05/10/98	Closed	16	Training	14 (3)	7
05/10/98	Closed	16	Training	13 (3)	7
06/10/98	Closed	16	Training	12 (3)	7
06/10/98	Closed	16	Training	14 (3)	7
08/10/98	International	16	Closed economy	16 (2)	8
08/10/98	International	16	Closed economy	16 (2)	8
09/10/98	International	16	Closed economy	16 (2)	8

Note: * Number of practice periods in parentheses.

At the beginning of the experiments subjects received the instructions, consisting of a general part which was read aloud and a specific part to be read by themselves. The specific part only presented instructions that were relevant to the subject in its specific role of consumer or producer.[10] Apart from similar information provided on the computer screen, subjects received personal history forms containing all the information that was relevant to the subject (endowments, markets they were allowed to trade in, any taxes or subsidies, and the conversion rate of francs into guilders).[11] By having them fill in their purchases or sales of goods as well as their earnings these forms were also intended to make subjects more fully aware of the consequences of their actions. Quizzes were used to check the understanding of the procedures, the reading of the redemption values and production schedules, and the calculation of earnings.[12]

Each experiment consisted of a number of trading periods, with a couple of practice rounds at the beginning in which no money was earned (see table 2). Except for the adjustment of the wage tax in later periods, all periods were identical in terms of endowments and parameter values. Nothing carried over from one period to the next (apart from subjects' earnings in the experiment). Each period was divided into two phases. In the first phase the factor markets for capital and labor were open, while in the second phase the product markets were open. Including some recording time and time to look up information, each phase took about five minutes.[13] Panel (b) of figure 1 shows - from the left to the right - the sequence of events. Standing bids and asks in the labor market were presented as 'market prices' (exclusive of the wage tax) and as 'inclusive prices' (including the tax), where for consumers the former and for producers the latter was highlighted on the computer screen. After the closing of the factor markets

first meeting. Subjects received a show-up fee of 70 guilders for the training. They got a show-up fee of 40 guilders and earned on average 27 guilders in the closed economy session. For the open economy session these figures were, respectively, 10 and 67 guilders. All money was paid out privately at the end of the third meeting.

[10] In the experiment consumers were labeled 'type-I traders' and producers 'type-II traders'. Moreover, labor and capital were denoted as good V and good W, respectively.

[11] Markets were labeled as V1(2), W1, X1, and Y1(2); the unemployment benefit was denoted as a subsidy for unsold units of V.

[12] Appendix A contains a sample copy of instructions, trading rules, and personal forms used in the experiment.

[13] Two pilot experiments had shown that this timing was sufficient to allow subjects to trade all the units they wanted to trade, and to fill in the personal history forms.

Table 3: Theoretical predictions

	Closed economy	International economy	
Variable		Home country	Foreign country
Production:			
X	177	177	
Y	151	19	132
Inputs:			
K	240	240	
L	226	28	197
Relative prices:*			
p_x	.3088	.1882	
p_y	.3628	.2211	.2211
r	.0504	.0307	
w	.2780	.1694	.1694

Note: * Relative prices are defined by dividing nominal prices with the sum of all nominal prices. The relative prices in the international economy differ from those in the closed economy, since there are two local markets for labor and the labor intensive product Y, respectively. Treating each of them as just one market would give the same relative prices in the closed economy and the international economy.

consumers were informed about the unemployment benefits received due to unsold labor units, while producers were informed about the number of goods produced with the inputs they bought. In addition, some market statistics were provided concerning the amounts of capital and labor traded, average prices, and the average price subjects received (paid) for the inputs they sold (bought). After the closing of the product markets similar market statistics were provided on the computer screen.

2.3 Theoretical predictions

As analytical benchmark we use the predictions obtained from the numerical solution of a general competitive equilibrium model including the requirement of a balanced budget. In this model we neglect the double auction character as well as the sequential structure of the experimental markets, assuming price taking behavior. We are forced to do so since theoretical models able to capture the complexity of the experimental economies are lacking. Similar benchmark modeling is used in other studies of experimental markets (e.g. Noussair et al. (1995, 1997) and Quirmbach et al. (1996)). The main results concerning production levels, quantities of traded inputs, and relative prices are shown in Table 3.

3 Empirical analysis

In this section we present our main experimental results and observations. We first look from a more general perspective at the functioning of the (closed and open) economies and their performance relative to the theoretical benchmark model under the constant

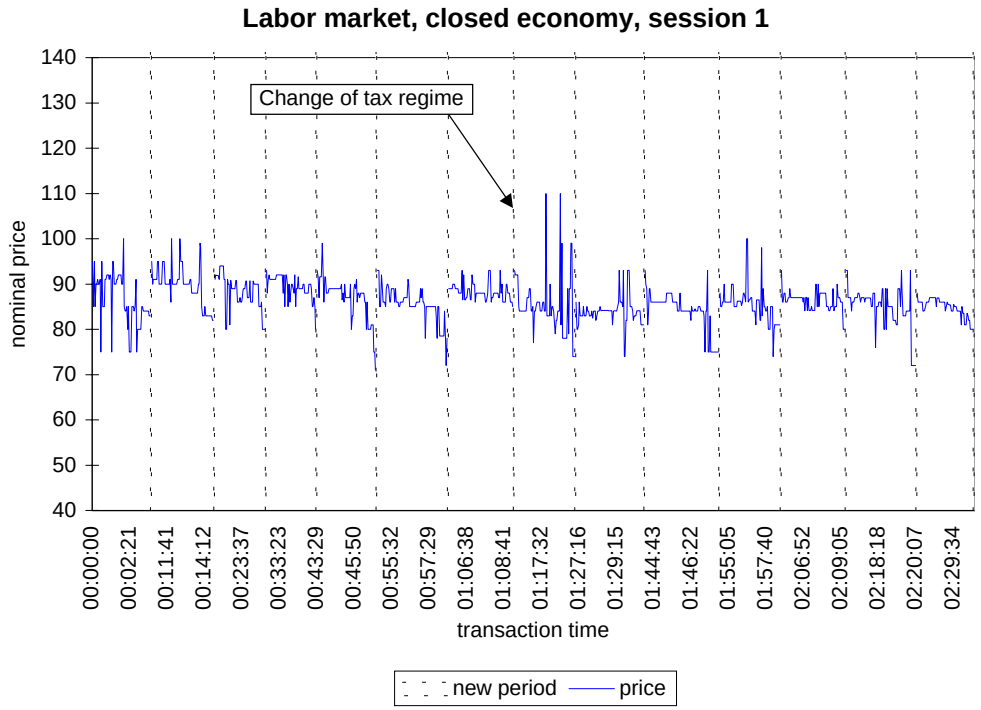


Figure 2: Transaction prices on the labor market of a closed economy session

tax regime. Then, we will zoom in on the issue whether indeed a vicious circle in the dynamic interaction between wage taxation and unemployment can be observed. In this context we will also look at the (short run, 'Keynesian') impact of budget deficits on employment. Finally, we present and provide evidence for a behavioral explanation of the observed divergence between the empirical results and the theoretical predictions.

3.1 Some general results

The first result concerns the functioning of the experimental economies.

Result 1 *The development of prices in both the closed and the open economy shows a clear structure, with generally most variation during the initial periods. Input and output markets generally respond in the theoretically expected direction when relative prices change.*

SUPPORT. Figure 2 presents a typical time series. For one of the sessions, the figure shows on the vertical axes the nominal prices of the transactions on the labor market, with the time of the transaction (in real time, starting from zero) indicated on the horizontal axes. The vertical lines separate subsequent trading periods. Focusing first on the initial seven periods where the tax rate is fixed the variation in transaction prices appears to get smaller over time. A similar pattern is observed after period eight, when the tax rate adjusts to the previous period budget deficit. Moreover, within periods prices show some tendency to decline towards the end, where also the number

of transactions is generally smaller. This pattern also holds for other markets in the experimental sessions.[14] Regarding the input markets generally a (mostly significant) positive relationship between the capital-labor employment ratio and the inverse input price ratio is observed. A similar picture concerning the relationship between the X-Y consumption ratio and the inverse of the output price ratio is obtained for the output markets.[15]

Figures 3 and 4 illustrate the development of the quantity and price variables over the periods. The straight horizontal lines indicate the theoretical predictions. Figure 3 shows the evolution of sales of inputs and outputs (averaged across sessions). Perhaps the most striking result is the decrease in economic activity once the tax rates start to adjust to the previous period budget deficit or surplus (this happens in period 8 in the closed economy and in period 9 in the open economy). We will come back to this below. Here we will mainly focus on the constant tax periods. Notice, that with only one exception (L_h in the open economy) all quantities start too low in comparison with the theoretical levels. However, in many cases there also seems to be some convergence to the theoretical predictions. Figure 4 shows the evolution of relative prices. What can be seen from that figure is that, with the exception of p_{yf}, all output prices start at a higher level than predicted. With respect to the input prices it can be seen that wages in the closed economy and in the foreign country of the international economy are too low, whereas the wage rate in the home country is too high. Interestingly, in the international economy, the capital price is far too low without showing any tendency to increase, whereas the capital price in the closed economy starts too high but steadily decreases over time. Note, that the relatively high capital price in the closed economy is accompanied by to little capital employment. As the capital price decreases employment of capital slowly converges to the full employment level (see panels (a) in figures 3 and 4). In the international economy, with its low capital price over all periods, capital employment already starts nearby full employment and also converges quickly to it (see panels (b) in figures 3 and 4).[16]

[14] Time series of transaction prices of all markets and experimental sessions can be found in Appendix B.

[15] We tested these relationships by using cross-sectional time-series FGLS regressions (allowing for heteroscedasticity between panels and AR(1) within panels; we also allowed for different intercepts per session by using session dummies.). The units of observation for the input market regressions are the ratio of employed capital and employed labor (as dependent variable) and the ratio of the average nominal inclusive wage and the average nominal capital price (as independent variable), per session and period. For the output market regressions, the dependent variable is the ratio of X-consumption and Y-consumption, and the independent variable the ratio of the average nominal price of Y and the average nominal price of X. With respect to the input markets the coefficient of the price ratio shows the 'right' positive sign for all sectors, except the Y-sector in the home country where it is insignificantly negative. For the X-sectors in the closed economy and the foreign country in the international economy, as well as sector Y in the foreign country the coefficient is significantly positive at least at the 5 percent level. For the X-sector in the home country and the Y-sector in the closed economy the coefficient of the price ratio is positive but not significant. With respect to the output markets we find, for both countries in the international economy, the expected positive coefficient for the price ratio, which is significant at the 10 percent level in both cases. For the closed economy the coefficient is negative but not significant.

[16] Since subjects in the open economies already had experience with the closed economy these differences between the closed and open economy may be due to experience effects.

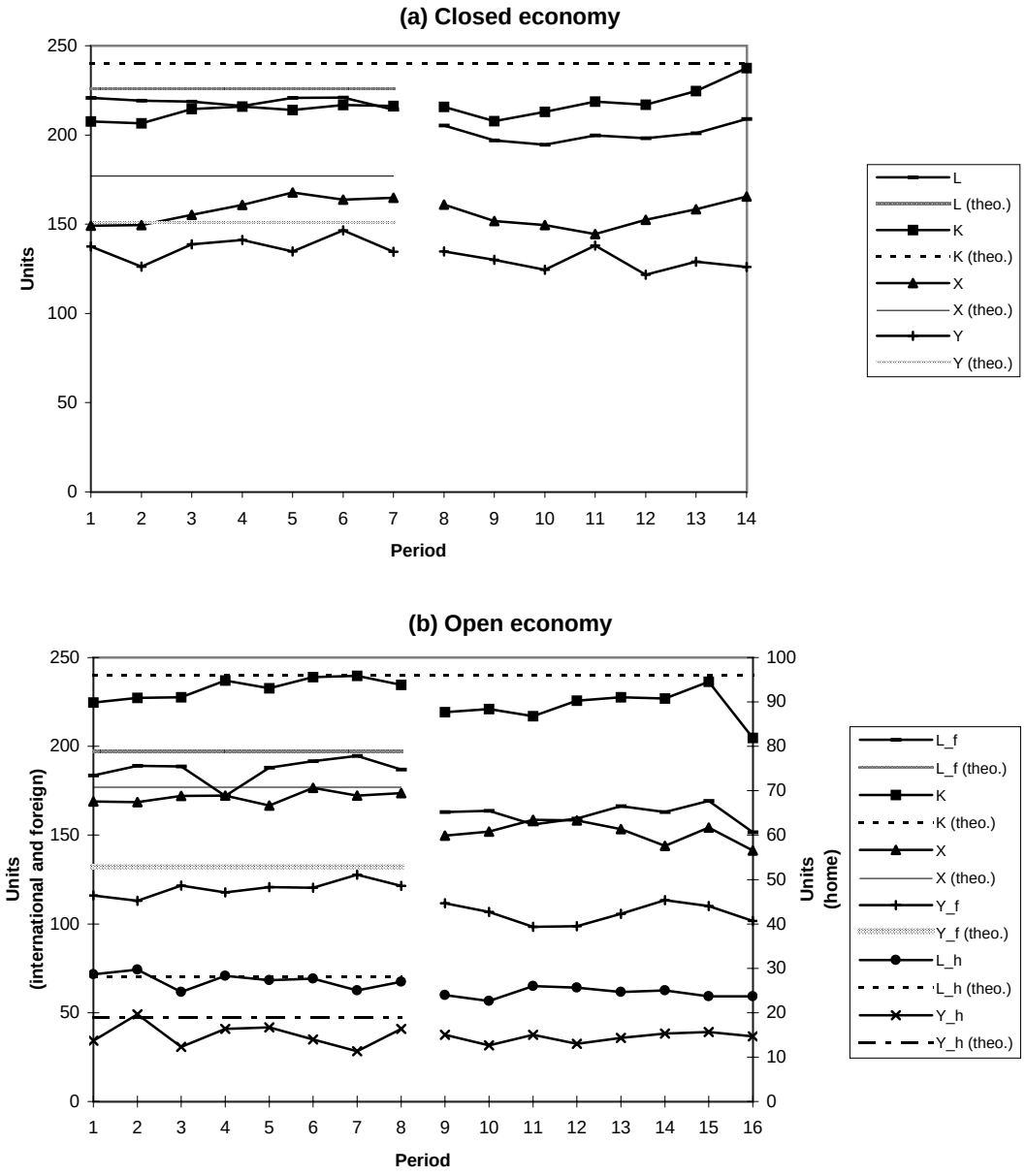


Figure 3: Development of transacted quantities over periods (averages across sessions)

Constant tax regime. We will now investigate more thoroughly whether the economic process shows a tendency to converge towards the equilibrium predictions during the constant tax periods. Since the theoretical equilibrium model does not capture the full complexity of the experimental economy (for it has nothing to say about its dynamics), it would be surprising to find convergence for each of the economic variables. Figures 2, 3, and 4 already illustrate that deviations are to be expected. Nevertheless, because of the good performance of the competitive model in simpler market experiments, it is interesting to investigate its predictive power in this more complicated environment. Table 4 presents the results of a convergence analysis for the periods

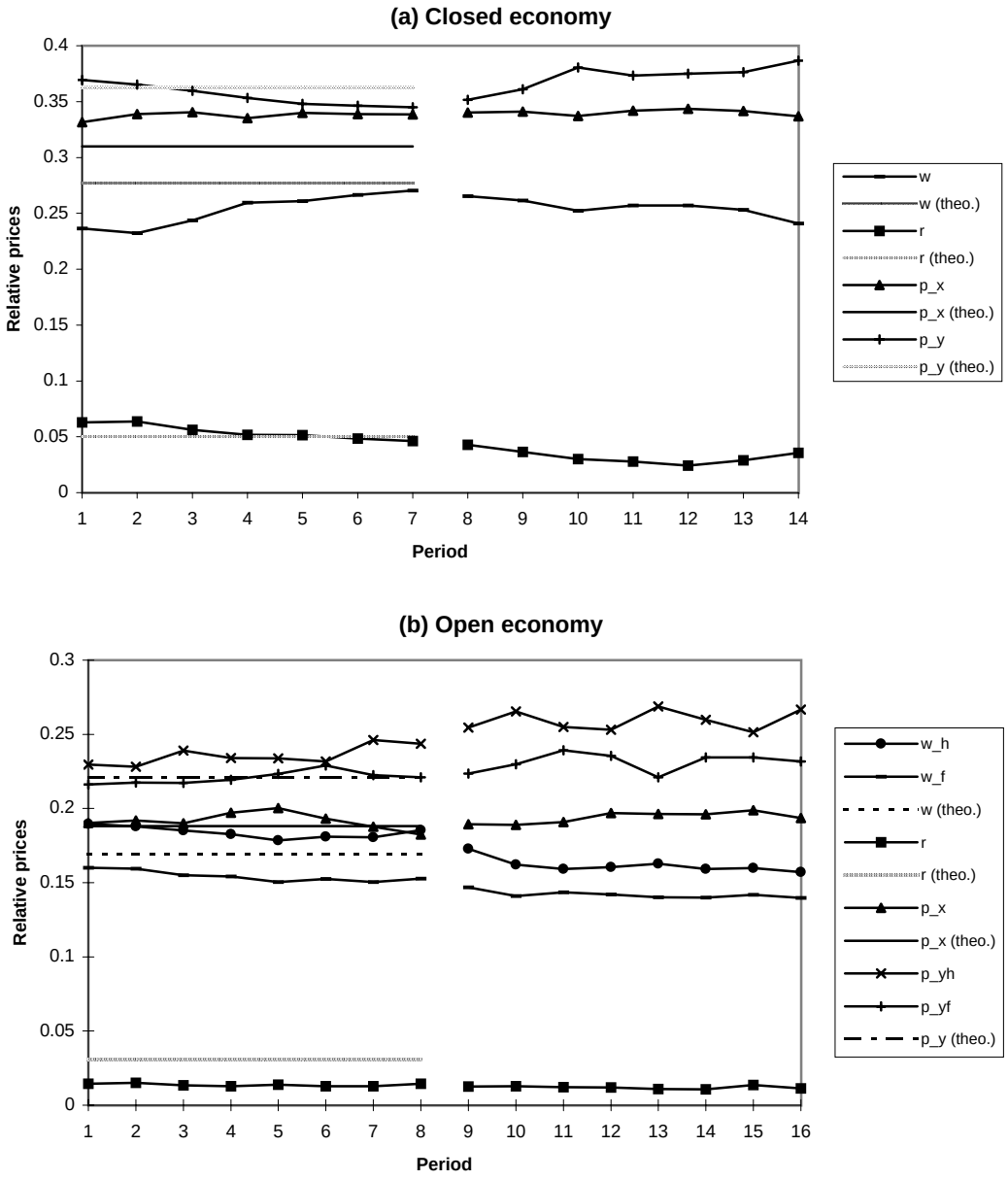


Figure 4: Development of relative prices over periods (averages across sessions)

with constant (at the theoretical equilibrium level) tax rates, based on the following estimation model (see Noussair et al., 1995):

$$y_{it} = B_{11}D_1(1/t) + B_{12}D_2(1/t) + \cdots + B_{1i}D_i(1/t) + \cdots + B_{1n}D_n(1/t) + B_2(t-1)/t + u$$

where y stands for the particular outcome (price or quantity) focused upon, i denotes the experimental session, t the trading period in the session, D_i a dummy variable which is equal to 1 for i and 0 otherwise, B_{1i} the session specific starting value of a possible convergence process, and u the error term. Note that B_2 is the asymptote of y. The model assumes that for each experimental session the dependent variable in

question may start at a different initial value (B_{1i}) but will over time converge to the common asymptote (B_2). As in Noussair et al. (1995) we say that a variable 'strongly congverges' to the predicted value if B_2 is not significantly different from that value. Table 3 summarizes the results of this analysis for the real variables, the relative prices, and the relative surpluses. (For a description of all variables see the note at the bottom of the table. The reported p-value results from a two-sided F-test comparing B_2 with the predicted value 'Prediction'.) Inspection of the table leads to the following general finding.

Result 2 Constant tax regime
Only a minority of variables strongly converges to the predicted values. Thus, from a statistical point of view the theoretical benchmark model has to be rejected.

SUPPORT. Only two of the nine asymptotic values of the price and quantity variables concerning the closed economy are not significantly different from the values predicted by the model (at the 5 or 10 percent significance level). Although a better outcome is obtained for the international economy, still seven of the 14 values are significantly different from the equilibrium predictions.

The better performance of the theoretical model in case of the international economy is somewhat surprising, because of the greater complexity of this environment (six instead of four markets, and on aggregate many more units of inputs and outputs to be sold). However, the reason may very well be that subjects in this environment were experienced in the sense that they all had participated in one of the closed economy sessions. Apart from this observation, it is interesting to look at a somewhat less demanding form of convergence than the insignificant deviation of an asymptotic value from the corresponding predicted value. As in Noussair et al. (1995), let 'weak convergence' be defined by the outcome that the majority of the starting values B_{1i} are further apart from the predicted value of a variable than the estimated asymptotic value B_2. The following result is obtained.

Result 3 Constant tax regime
In a great majority of the cases, including all input and output quantity variables, weak convergence towards the theoretical predictions occurs. For the closed economy this is the case for five of the nine variables, and for the international economy for 12 out of 14 variables.

SUPPORT. Follows from simple inspection of table 3, using the above definition of weak convergence.

The following observation, that we will elaborate on in section 3.3, concerns the direction of the deviation of the asymptotic values from the theoretically predicted values.

Observation 1 Constant tax regime
For all input as well as output variables it holds that the asymptotic value is smaller than the predicted value. With one exception (w_h), the same holds for the input prices. For the output prices, on the other hand, the reverse holds, with again one exception (p_y).

Table 4: Convergence results for constant tax periods

Variable	B_{11}	B_{12}	B_{13}	B_{14}	B_2	Prediction	p-value	R^2	ρ
				Closed economy					
X	184.4	115.6	139.8	143.8	166.2	177	.031	.50	.18
	(8.33)	(21.39)	(3.58)	(8.31)	(4.69)				
Y	154.3	118.7	104.5	158.7	138.8	151	.005	.49	.02
	(3.51)	(9.87)	(8.09)	(10.43)	(3.92)				
K	218.1	215.3	197.6	192.0	217.4	240	.000	.32	.20
	(5.09)	(9.49)	(4.26)	(6.64)	(3.51)				
L	245.9	190.5	186.3	260.6	217.5	226	.224	.48	.45
	(11.58)	(21.82)	(8.13)	(18.02)	(6.83)				
r	.0934	.0061	.0649	.1039	.0494	.0504	.898	.57	.57
	(.0114)	(.0229)	(.0060)	(.0186)	(.0071)				
w	.2387	.2501	.2198	.2046	.2665	.2978	.030	.53	.51
	(.0061)	(.1013)	(.0092)	(.0109)	(.0050)				
p_x	.2991	.3618	.3350	.3317	.3401	.3088	.000	.70	−.20
	(.0060)	(.0031)	(.0024)	(.0033)	(.0022)				
p_y	.3687	.3819	.3803	.3598	.3439	.3628	.000	.34	.06
	(.0103)	(.0237)	(.0050)	(.0074)	(.0041)				
s	−.001	−.097	−.101	−.011	−.062	0	.000	.30	.15
	(.0263)	(.0427)	(.0119)	(.0120)	(.0041)				
				International economy					
X	165.3	109.2	229.8		173.1	177	.638	.63	.73
	(10.86)	(15.75)	(21.40)		(8.13)				
Y_h	13.5	14.0	18.1		15.0	19	.003	.06	−.24
	(3.82)	(2.55)	(1.20)		(1.19)				
Y_f	74.7	154.5	112.1		122.9	132	.108	.60	.61
	(14.70)	(13.11)	(4.76)		(5.41)				
K	229.9	208.8	229.0		238.1	240	.439	.39	.08
	(9.47)	(4.35)	(3.17)		(2.38)				
L_h	27.7	23.6	36.0		26.4	28	.343	.29	.35
	(1.31)	(3.54)	(3.51)		(1.69)				
L_f	148.5	173.7	228.4		188.5	197	.220	.48	.42
	(15.42)	(13.25)	(4.87)		(5.60)				
r	.0172	.0201	.0067		.0132	.0307	.000	.28	.84
	(.0028)	(.0032)	(.0048)		(.0021)				
w_h	.1820	.2096	.1797		.1804	.1694	.009	.38	.75
	(.0100)	(.0074)	(.0046)		(.0039)				
w_f	.1809	.1295	.1742		.1507	.1694	.000	.61	.73
	(.0044)	(.0082)	(.0106)		(.0039)				
p_x	.1824	.2381	.1541		.1916	.1882	.572	.58	.78
	(.0096)	(.0084)	(.0119)		(.0063)				
p_{yh}	.2075	.2300	.2440		.2402	.2211	.020	.20	.68
	(.0152)	(.0105)	(.0074)		(.0076)				
p_{yf}	.2299	.1727	.2414		.2239	.2211	.738	.38	.83
	(.0162)	(.0185)	(.0070)		(.0086)				
s_h	−.118	−.129	.140		−.093	0	.040	.26	.28
	(.033)	(.087)	(.085)		(.042)				
s_f	−.320	−.176	.045		−.099	0	.000	.64	.45
	(.069)	(.020)	(.063)		(.022)				

Note: X, Y, Y_h, Y_f denote sales in sectors X and Y; K denotes employed capital; L, L_h, L_f are employed units of labor; r is the relative price of capital, w, w_h, w_l are the relative wages; p_x is the relative price of X; p_y, p_{yh}, p_{yf} are the relative prices of Y; s, s_h, s_f are budget surpluses relative to gross national income; the subscripts h and f in the international economy denote the home and the foreign country, respectively. Standard errors in parentheses; estimates corrected for heteroscedasticity and AR(1).

Relatively good news for the theoretical benchmark model is obtained by looking at the total welfare (earnings) of consumers in the experiments in comparison with the predicted level, denoted as 'system efficiency'. We focus again on the periods with constant tax rates.

Result 4 Constant tax regime
In both the closed economy and the open economy system efficiency is on average around 95%*, and for (almost) all periods above* 90%*.*

SUPPORT. See table 5. The table reports 'system efficency' for all sessions and all periods as well as the averages across the constant tax periods, the dynamic tax periods, and all periods.

3.2 Unemployment, taxation, and budget deficits: the vicious circle

The above results concerning (weak) convergence and system efficiency throw a favorable light on the theoretical benchmark model, at least in a qualitative sense. The next result, which focuses more specifically on the development of the unemployment rate under the constant tax regime, corroborates this picture.

Result 5 Constant tax regime
In the closed and the open economies the unemployment rate strongly converges towards the theoretical prediction from above, in the sense that the asymptotic value, albeit larger, is not significantly different from the predicted value.

SUPPORT. This follows from the data on employment (L; L_h, L_f) in table 4. Figure 5 illustrates the development of the unemployment rate, averaged over the experimental sessions, where we focus here on the periods with a constant tax rate (i.e., the first seven for the closed economy, and the first eight for the open economy). The unemployment rate is defined as the ratio of non-employed units of labor and the total number of labor units available in the economy (expressed as a percentage).

The bad news, however, is that these relatively favorable results for the theoretical benchmark model appear to be accompanied by persistent budget deficits, as indicated by the following result.

Result 6 Constant tax regime
The closed and the open economies show convergence towards a budget deficit. Moreover, in all sessions, except for one concerning the international economy, the experiments also begin with a budget deficit.

SUPPORT. Table 4 shows that in the closed and the open economies the asymptotic value of the relative budget surplus (nominal budget surplus as a fraction of national income) is negative and significantly different from zero (see the variables s, s_h, and s_f). In addition, in the closed economy all starting values are negative, whereas in the international economy this holds for two of the three sessions (both in the home and in the foreign country) with weak convergence from below towards the theoretical

Table 5: System efficiency: Sum of consumers welfare relative to theoretical prediction (in percent)

	Closed economy				International economy								
	CE01	CE02	CE03	CE04	OE01			OE02			OE03		
Period					Home	Foreign	Total	Home	Foreign	Total	Home	Foreign	Total
1	97.0	92.2	90.0	94.7	61.3	93.6	83.0	94.5	95.2	95.0	97.7	98.7	98.4
2	98.4	88.0	91.8	92.6	106.3	91.2	96.1	96.4	96.9	96.7	101.0	96.6	98.0
3	99.0	92.0	92.4	97.1	89.8	95.7	93.8	61.9	95.1	84.3	97.6	98.0	97.9
4	99.4	92.4	95.1	99.2	88.7	95.1	93.0	96.9	96.9	96.9	93.8	98.9	97.2
5	97.6	92.5	94.9	97.7	98.8	93.9	95.5	93.8	97.5	96.3	101.3	99.0	99.8
6	96.7	91.2	95.3	99.6	95.5	96.0	95.8	95.2	97.5	96.8	92.9	98.9	96.9
7	96.7	91.9	93.6	95.2	98.9	93.5	95.3	61.6	98.3	86.3	94.9	98.7	97.4
8	96.8	92.8	95.4	92.8	94.2	96.8	96.0	95.8	96.9	96.5	100.2	98.6	99.1
9	94.5	91.3	95.7	93.5	82.2	91.3	88.3	83.9	95.1	91.4	65.5	98.6	87.8
10	80.2	92.4	94.9	88.3	78.2	90.6	86.6	86.2	94.5	91.8	92.9	98.2	96.5
11	96.6	88.9	95.3	93.3	83.0	94.0	90.4	89.2	90.0	89.7	98.2	98.9	98.7
12	95.6	89.5	94.4	92.0	82.4	93.7	90.0	77.4	87.9	84.4	101.4	98.7	99.6
13	96.6		94.1	93.3	77.6	93.8	88.5	87.6	94.0	91.9	101.3	98.3	99.3
14	97.3			92.1	84.3	94.8	91.3	87.9	93.0	91.4	97.4	98.6	98.2
15					88.9	94.9	93.0	93.0	93.8	93.6	97.7	98.4	98.1
16					83.8	95.0	91.4	70.6	89.5	83.3	96.7	97.3	97.1
Averages across:													
Constant tax periods	97.8	91.4	93.4	96.6	91.7	94.5	93.6	87.0	96.8	93.6	97.4	98.4	98.1
Variable tax periods	93.9	91.0	95.0	92.2	82.5	93.5	89.9	84.5	92.2	89.7	93.9	98.4	96.9
All periods	95.9	91.3	94.1	94.4	87.1	94.0	91.8	85.7	94.5	91.6	95.7	98.4	97.5

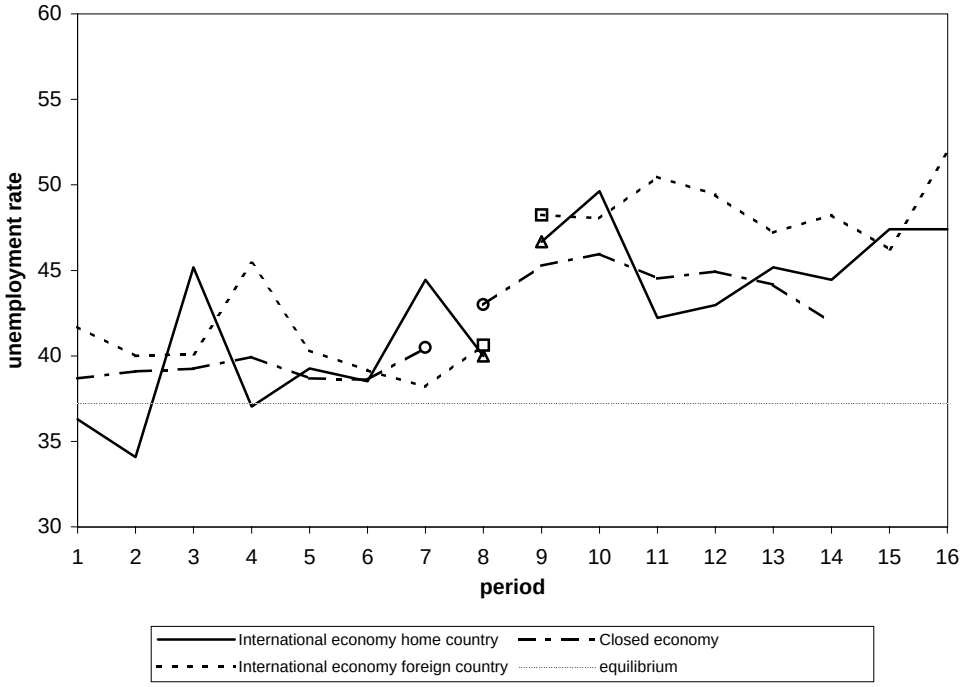


Figure 5: Unemployment rates

prediction. Figure 6 illustrates the time series for the relative budget surplus for the closed economy and the home as well as foreign country of the international economy, averaged over the experimental sessions. The series clearly show a persistent budget deficit for the periods with a constant tax rate.

Results 5 and 6 suggest that the observed low unemployment rate, close to the theoretical level, is at least partly due to a Keynesian type of demand mechanism. We proceed with focusing first on what happens once the tax rate is allowed to adjust to the budget deficit in the previous period (as of period eight in the closed economy and period nine in the open economy).

Variable tax regime. It turns out that introducing tax adjustment to cover the previous period's deficit (surplus) changes the picture rather dramatically, as the next result shows.

Result 7 Variable tax regime
Once the tax rate starts to adjust to the budget deficit, in all economies the deficit becomes (on average) smaller, while the tax rate as well as the unemployment rate increases to a level substantially higher than predicted by the theoretical benchmark model.

SUPPORT. See figures 5 and 6. Recall that the theoretically predicted tax rate is at the constant level of the initial periods shown in figure 6. Furthermore, the predicted unemployment rate is at 37.2 percent (see the straight horizontal line in figure 5), while the deficit should be zero.

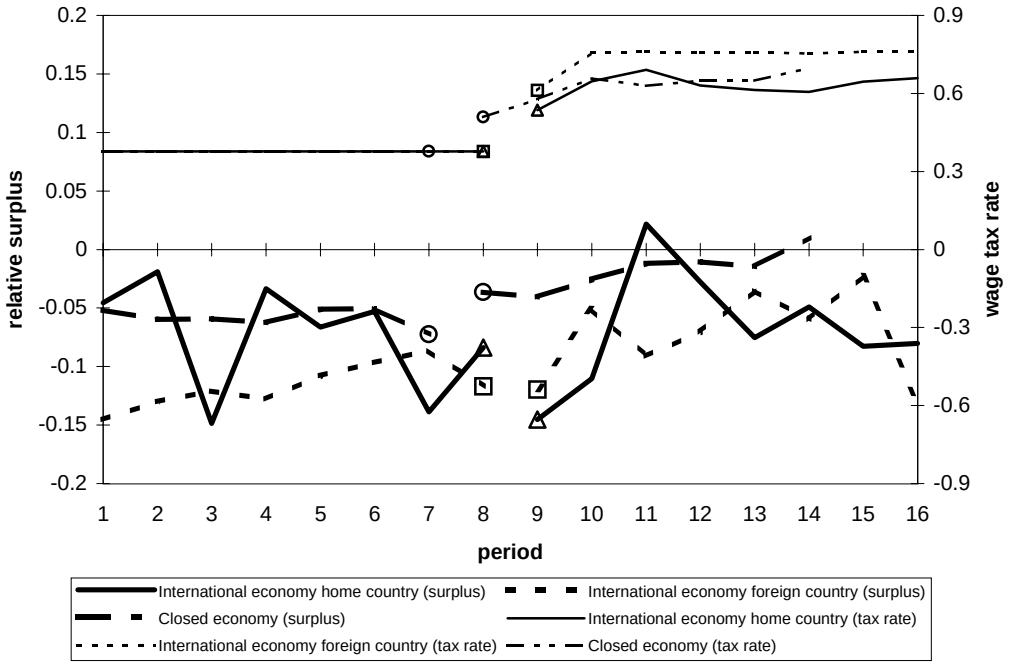


Figure 6: Budget surplus (as a fraction of national income) and wage tax rates

Note from figure 3 that not only the employment of labor but all levels of inputs and outputs are adversely affected by the tax adjustment, in both the closed and international economy. The same holds for our measure of system efficiency, as shown in table 5. To give an impression of the effects in quantitative terms we focus on two economic measures: the unemployment rate and real GNP.[17] We compare for these measures the asymptotic outcomes of a convergence analysis (as used for Result 2) applied to the constant and variable tax regime.[18] This analysis shows that the unemployment rate - measured as deviation from the equilibrium rate - increases from 2.4 to 7.9 percent in the closed economy, from 5.9 to 11.8 percent in the home country and from 4.3 to 18.3 percent in the foreign country of the international economy.[19] Real GNP decreases by 7.6 percent in the closed economy, by 7.9 percent in the home country and by 12.9 percent in the foreign country of the international economy. Observe, furthermore, from figure 3 that in contrast with the employment of labor the use of capital recovers in the later periods, in both the closed and international economy. Figure 4 shows that the latter is facilitated by a decrease in the price of capital. Although the before-tax wage rate also decreases, the increase of the tax rate negatively

[17] For the calculation of real GNP we use the first trading period as base 'year'; that is, the respective trading period 1 prices (p_x^1 and p_y^1) are used as weights for the produced quantities of X^t and Y^t in period t. Hence, real GNP in period t is given by $p_x^1 X^t + p_y^1 Y^t$. Similar results are obtained with other periods as base year.

[18] The regression model for the variable tax regime is the same as for the constant tax regime except that the trading periods for the former case are redefined such that trading period 9 becomes period 1 in the regression.

[19] For the variable tax regime these asymptotic values of the unemployment rate are also significantly larger than the predicted value. The F-test produces (two-sided) p-values of 0.007, 0.057, and 0.001 for the closed economy, the home country, and the foreign country, respectively.

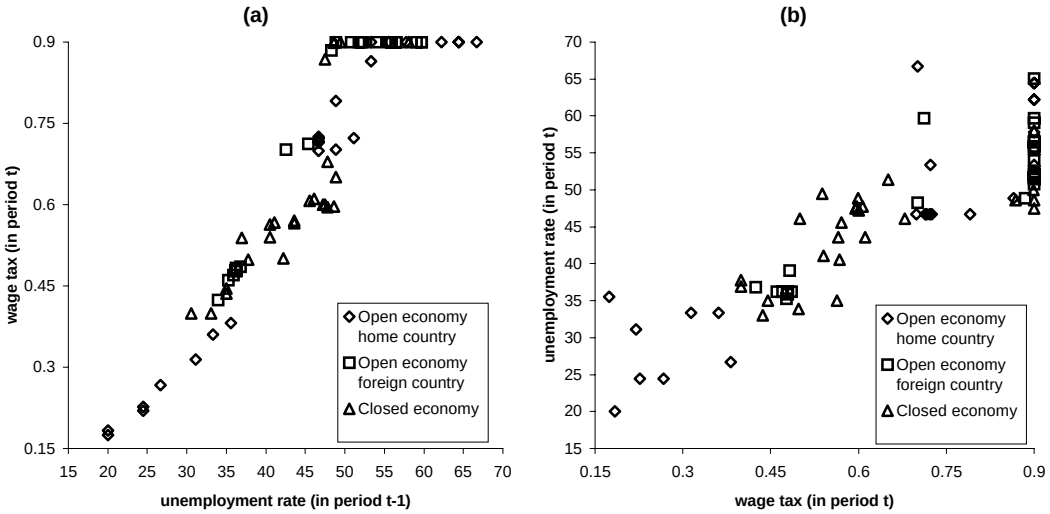


Figure 7: The vicious circle between unemployment and wage tax rates

affects the wage costs. Note that, due to the balancing of the budget in the variable tax regime, any decrease in the before-tax wage rate is counteracted by an increase in the tax rate, even if the employment of labor stays constant.

In order to investigate the role played by the wage tax more deeply, we will first look at the impact of the unemployment rate in a period on the tax rate in the subsequent period. Note in this context that the tax adjustment rule does *not* necessarely imply a positive correlation between the next period's tax rate and the previous period's unemployment rate, since the previous period's wage rate also plays a role. Note furthermore, that in each period the economic environment is exactly the same except that the tax rate adjusts to the budget surplus in the *previous* period such that the budget would be balanced if everything else stayed the same.

Result 8 VARIABLE TAX REGIME
The tax rate is significantly positively related to the unemployment rate of the previous period.

SUPPORT. Figure 7(a) clearly shows a positive dependence of the tax rate on the previous period unemployment rate (up to the imposed maximum rate of 0.9, which is sometimes obtained as the upper part of the figure shows). The Spearman rank order correlation coefficients are high for both the closed economy (0.93) and the home (0.96) as well as foreign country (0.92) of the international economy, and highly significant ($p < 0.0001$ in all cases). The same picture is obtained by running tobit regressions (with robust standard errors) with the tax rate in period t ($\tau_w(t)$) being the independent variable and the unemployment rate in period $t-1$ ($u(t-1)$) as the explanatory variable. For all economies (closed economy, and the home and foreign country of the open economy) the coefficient of $u(t-1)$ is positive and highly significant ($p < 0.001$ in all cases).

The next result concerns the relationship between the unemployment rate in a period and the tax rate that holds for that period.

Result 9 VARIABLE TAX REGIME
The unemployment rate in its turn is significantly positively related to the tax rate.

SUPPORT. Figure 7(b) illustrates. The Spearman rank order correlation coefficient clearly shows a positive relationship for both the closed economy (0.67) and the home (0.80) as well as foreign country (0.80) of the open economy, and is highly significant ($p < 0.0001$). Qualitatively the same results are found by running tobit regressions (with robust standard errors) with unemployment in period t ($u(t)$) as independent and the tax rate in period t ($\tau_w(t)$) as explanatory variable. In all cases (closed economy, and the home and foreign country of the international economy) the coefficient of $\tau_w(t)$ is positive and highly significant ($p < 0.001$). Note, that this is a controlled observation, since the tax rate (which is the only parameter that changes over periods) is given at the beginning of a period.

Together, Results 7 to 9 clearly point at the existence of a vicious circle (Snower's cycle), as discussed in the Introduction. In the experimental economies, the budget deficit developed under a constant tax rate triggers a dynamic adjustment process with increasing tax rates and unemployment rates that only gradually appears to stabilize at substantially higher rates for these variables (cf. Result 7). These results are found for both the closed and the international economy, and in the latter case for both the home and the foreign country. The next result makes this outcome explicit.

Corollary 1 *The experimental results provide evidence for a vicious circle in the dynamic interaction between wage taxation and unemployment.*

Finally, it is noticed that the positive relationship between the unemployment rate and the wage tax rate supports the conclusion that - in line with Keynesian theory - budget deficits have a beneficial (short-run) impact on unemployment, as witnessed by the periods with a constant tax rate.

3.3 An explanation of the unemployment rate

What explanation can be offered for the bad performance of the economies in terms of employment (and other performance measures, like real GNP) in comparison with the theoretical predictions? And what role is played by the taxation of wages in this respect? Given the complexity of the market systems examined, and the few existing studies that have investigated systems of markets in the lab, we can clearly only aim at a tentative answer to these questions at this stage. We believe, though, that the following discussion reveals an underexposed determinant of unemployment and provides an interesting angle for further research.

Our starting point is Observation 1 indicating that during the constant tax periods inputs and (consequently) outputs tend to be below the theoretically predicted levels and seem to be accompanied by lower than predicted input prices and higher output prices. It seems that in the economies there is a downward pressure on the employment of production factors, labor as well as capital. To obtain a further piece of evidence in this respect, we have looked at the average per period percentage of producers for which

Table 6: Fraction of producers where marginal revenue product of a production factor exceeds the (after tax) input price

	Closed economy	International economy		
		Home country	Foreign country	Both countries
Labor	0.52	0.54	0.62	0.58
	(0.20)	(0.14)	(0.00)	(0.00)
Capital	0.69	0.72	0.70	0.72
	(0.00)	(0.00)	(0.00)	(0.00)

Note: Based on average current period input and output prices and all periods; within parentheses the probability of obtaining values as least as extreme as observed when $p = 0.5$; binomial test, one-sided.

the marginal revenue product of labor and capital exceeded the respective input price, using the average current period input and output prices.[20] Accounting for errors, a percentage of 50% would seem to be in line with (risk-neutral) profit maximizing behavior. The following is observed, however.

Observation 2 *For the closed economy and the home as well as foreign country of the international economy it holds that, on average, for about* 70 *percent of the producers the marginal revenue product of capital exceeds the input price. For labor this fraction is smaller, though with approximately* 55 *percent still above the fifty percent level. This is related to the fact that for labor this fraction shows a temporary drop when the wage tax rate (which is part of the input price) starts to adjust to the budget deficit, pointing at some inertia in the behavioral adjustment process.*

SUPPORT. See table 6. Interestingly, the results are even somewhat stronger for the open economies where subjects (having participated in the closed economy before) were more experienced. As regards the effect of the tax rate, in the closed economy for example the fraction concerning labor temporarily drops from an average of 54 (61) percent over the last three (all) periods of the constant tax regime to 38 percent in the first two periods of the variable tax regime (when the tax rate substantially increases, see figure 8; where t ($t-1$) indicates that the current (previous) period product price is taken for the expected output price). It gradually increases again thereafter.

This additional observation supports the view that producers' reluctance to buy inputs plays a role in explaining the unemployment rate. Importantly, it is not a lack of labor supply that can account for the higher than predicted unemployment level. Using the theoretical labor supply function - for each consumer and trading period - it turns out that a great majority of the consumers actually supplied too much labor at current period prices.[21]

[20] Similar results are obtained if the average previous period product price is taken for the expected output price.

[21] For the closed as well as the small and large country of the international economy this happens, averaged over consumers and periods, in at least 80 percent of the cases, for both the constant and the variable tax regime. These results are significantly different from 50 percent, using a binomial test

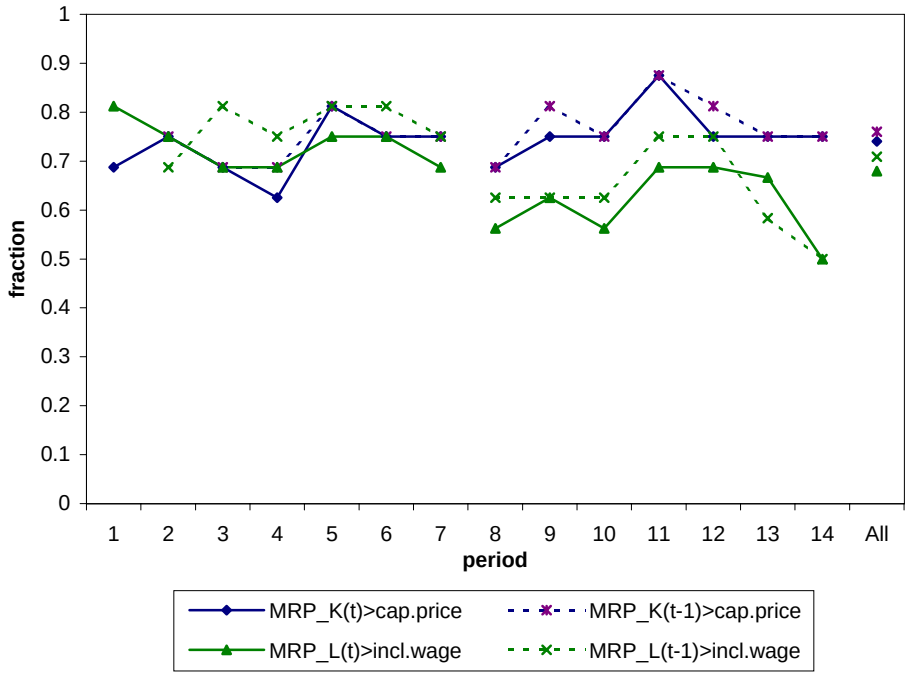


Figure 8: Fraction of producers where marginal revenue product of a production factor is larger than the (after tax) input price (X-producers in closed economy)

In our view a key factor in the explanation of the downward pressure on input demand seems to be that in a real economy (like in the lab) producers are facing a risk when buying inputs, which is not accounted for in a general equilibrium model. This risk is due to uncertainty about the prices that the goods produced with the inputs will make in the output markets. The fact that producers are facing this risk, in combination with risk aversion, can explain the reluctance of producers to employ 'enough' labor and capital, as well as the observed downward pressure on input prices and upward pressure on output prices (see Observation 1). Interestingly, a similar *risk-compensated price mechanism* has been observed by Noussair et al. (1995) in their experimental investigation of patterns of international trade.[22] It is important to note that in their study simultaneous (double auction) input and output markets are used. This suggests that our findings are not due to the sequential markets setup.[23] Furthermore, some theoretical (albeit partial equilibrium) studies exist showing that price uncertainty will indeed reduce factor demand by a risk-averse competitive firm (see Batra and Ullah (1974), Hartman (1975, 1976), Holthausen (1976)). In this context it is noted that risk-

($p < 0.0001$, one-sided). We can think of two factors that may have biased consumer behavior in this direction. First, the relatively small weight (1/9) attached to leisure in the utility function may have played a role here (see table 1). Second, the fact that the labor supply function is steep at the low wage rates (close to the minimum level of the unemployment benefit) that subjects were confronted with may have led to 'overshooting' due to errors.

[22] Noussair et al. speak of a 'risk-compensated input/output price-adjustment process'.

[23] Hey and di Cagno (1998), investigating experimentally two sequential double auction markets, also report as general finding that not enough trade took place compared with the competitive equilibrium predictions.

averse behavior seems to be a realistic assumption.[24] However, so far field empirical studies addressing the consequences for input demand appear to be lacking.[25]

Although further empirical as well as theoretical research is needed to establish the precise power of the explanation offered above, it points at a potentially important (and up till now underexposed) determinant of unemployment. Moreover, it has an important bearing on the debate concerning the pernicious character of wage taxation (and, more generally, the taxation of inputs). If producers are indeed reluctant to buy inputs due to uncertainty about output prices, having to pay taxes up-front would seem to exacerbate the negative effects on employment.[26] From this perspective, shifting taxation from labor to production (sales) - which effectively makes the government sharing the risk faced by the producer - would be an alternative worthwhile investigating.

4 Concluding discussion

For the closed as well as the small and the large country of the international economy, we have found substantial evidence for negative economic effects of wage taxation as a means of financing unemployment benefits. Our results provide empirical support for a vicious circle in the dynamic interaction between the wage tax and the unemployment rate. Furthermore, in line with Keynesian theory, it turned out that employment is boosted (in the short run) by allowing budget deficits. Keeping the tax rate constant at the level predicted by the competitive equilibrium model, remarkable (weak) convergence towards the competitive equilibrium is observed for many variables. However, this development is accompanied by economically significant budget deficits. Once the wage tax is forced to adjust in the direction of a budget balance the employment level, as well as real GDP and other indicators of economic performance, gradually tend to stabilize at a level that substantially falls short of the equilibrium prediction. An important observation in this context is that there appears to be downward pressure on the employment of production factors (capital as well as labor) which is not accounted for in existing general equilibrium models. This is explained by the risk (risk averse) producers are facing when buying inputs before precisely knowing what they will make for their outputs. Accordingly, they restrict the purchase of inputs, which restricts outputs. Consequently, there is a tendency for input prices to be lower, and for output prices to be higher than the equilibrium predictions. It is consistent with the so-called risk-compensated price mechanism that a wage tax exacerbates these effects. Our findings suggest that policymakers relying on the outcomes of (theoretical) models neglecting this mechanism would underestimate the negative effects of wage

[24] For an empirical study showing risk-aversion by firms, see Gunjal and Legault (1995). According to Stiglitz (1999, p. 254): "There is by now a large body of literature arguing that normally firms act in a risk averse manner (...)". Zhang (1998, p. 1753) notes: "Investors of all types generally exhibit aversion to risk". Furthermore, a study by Brockhaus (1982) suggests that there is no difference in this respect between producers ('entrepreneurs' and managers) and the population at large.

[25] See Ghosal (1995). A somewhat related area of research focuses on the effect of macroeconomic uncertainty on private investment. Also here few empirical studies exist, typically showing a negative effect (of inflation, for instance; see Aizenman and Marion (1993), Brunetti and Weder (1998)).

[26] Loss aversion, as in prospect theory (Kahneman and Tversky (1979)), would make this negative effect only stronger.

taxation. According to the European Commission (1994), plans for an alternative, employment friendlier fiscal structure deserve greater attention and serious study. Our study suggests that shifting taxation from inputs (labor) to outputs might be worthwhile investigating. Another interesting issue for future research would be to investigate the effects of adjusting the unemployment benefit instead of the wage tax to balance the budget (cf. Rochetau (1999)).

From a broader methodological point of view, the technology developed for running macroeconomic experiments opens up the possibility to study many other important issues in the lab, like public debt or the impact of labor market institutions, for example. In light of the findings obtained so far, macroeconomic experiments seem to offer an interesting and challenging research tool which complements the more traditional theoretical and field empirical analysis.

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A Instructions, redemption values, production schedules, trading rules

This section contains a sample copy of the English translation of the instructions for home-country consumers and producers in the international economy experiment. The instructions for foreign-country consumers and producers and the instructions for the closed economy experiment are basically the same. It also includes redemption values, production schedules, and the trading rules used in the experiments. Note: Words and sentences between "< >" have been added for the reader.

A.1 Instructions

<General Instructions (part 1)>

General Instructions

These instructions are part of an experimental study of decision-making in markets. If you follow the instructions carefully you can earn a considerable amount of money. Your earnings will be paid out to you in cash, personally and confidentially, at the end of the experiment.

In today's session, you will participate in a number of markets during a number of time periods in which trading can take place. During these trading periods, you will act as either a Type-I trader or a Type-II trader. In all the trading periods, you will be the same type of trader. You will find a REGISTRATION TABLE in the envelope on your table. Look up the type you represent at the top of the form. If you are a Type-I trader you will also find a REDEMPTION VALUES TABLE. If you are a Type-II trader you will find a PRODUCTION TABLE. These tables will help you to weigh up the decisions you can make. **It is not allowed to exchange the information on these tables with others.** It concerns your own personal information. In the training session, you have already familiarized yourself with the trading rules. You will find a summary of these rules in your envelope.

In the markets, the "franc" will be used as the unit of currency. All trading will take place in francs. At the end of the experiment, you will be paid in guilders. The exchange rate - which indicates how much a franc is in guilders (or cents) - is shown on your registration table. The more francs you earn, the more guilders you will earn.

Four different goods can be traded: V, W, X and Y. Goods W and X will be traded in two separate markets, one for W (denoted W1) and one for X (denoted X1). Goods V and Y will be traded in four separate markets, two for V (denoted V1 and V2) and two for Y (denoted Y1 and Y2). Your trading will be restricted to some of these markets. The markets in which you can trade are shown on your registration table.

Each trading period consists of two phases. In phase 1, only the markets for V and W are open. In these markets, the Type-I traders are sellers and the Type-II traders are buyers. Once phase 1 is finished phase 2 begins. In phase 2, only the markets for X and Y are open. In these markets, Type II-traders are now sellers and Type-I traders are buyers. Type-I traders can earn money by consuming goods, while Type-II traders can earn money by making a profit.

The Specific Instructions for Type-I and Type-II traders that you will find below, show you precisely how your earnings will be determined. We ask you now to read these carefully. If you have a question regarding these instructions, which are your personal information, put up your

hand. We will then come to your table to answer your question. If everybody has finished with the Specific Instructions we will carry on with some final instructions for both types of traders.

<In the experiment the Specific Instructions were given here. (For their content, see below.)>

<General Instructions (part 2)>

Instructions for both types of traders

HOW THE SYSTEM WORKS

Type-I traders receive an initial endowment of cash (an initial cash) and an initial endowment of V and W. They want to consume V but also X and Y. In phase 1 they can sell V and W to Type-II traders in order to increase their amount of cash to be able to buy X and Y in phase 2.

Type-II traders receive an initial endowment of cash (an initial cash). In phase 1 they can use this to buy units of V and W. They need these units to produce units of X and Y, which they can sell to Type I-traders in phase 2 to make a profit.

EARNINGS

In the Specific Instructions it is explained how your earnings in a period are determined. Your earnings will be expressed in francs. At the end of today's meeting, your total earnings during all the trading periods will be exchanged into guilders using the exchange rate stated on your registration table.

INITIAL ENDOWMENTS

At the beginning of each trading period, you will receive an initial cash with which you can buy goods. In addition, Type-I traders also receive some units of V and W which they can sell. These initial endowments, which will be the same in each period, are mentioned on your registration table.

MARKET RESTRICTIONS

As already indicated in the first part of the General Instructions, there are different markets for the goods V, W, X and Y. The markets for V and W (V1, V2 and W1) will be open for 4 minutes and 30 seconds. After a short pause of 20 seconds, the markets for X and Y (X1, Y1 and Y2) will be open for 3 minutes and 30 seconds. There is only one exception to this rule which occurs if a good is sold out. In this case, the market for this good will close. The cash which is involved with an outstanding bid on this market will then be available again for other purchases.

Your trading will be restricted to some of the markets. The markets in which you can trade are mentioned on your registration table.

Some of you will have to pay taxes and/or receive subsidies. All the tax rates and subsidies relevant to the markets in which you can trade are mentioned on your registration table. N.B. In each separate market, all traders of a certain type (Type-I or Type-II) will be faced with the same tax rates and/or subsidies concerning the good that is being traded in this market.

You will encounter market prices as well as inclusive prices. Market prices are of direct importance for Type-I traders. Inclusive prices are of direct importance for Type-II traders because these prices include the taxes or subsidies which apply to them.

Apart from two practice periods (in which you cannot earn any money), there will be 16 trading periods in total. After each period there will be a 2 minutes pause before the next period begins. For those of you who have to pay taxes it is important to note that the tax rates during the first 8 periods (periods 1 - 8) will remain the same. Thereafter, beginning with period 9, the tax rates can be different in different periods. We will warn you when this occurs.

If you have a question put up your hand. We will then come to you to answer your question.

<Specific instructions for consumers (Type-I) and producers (Type-II)>

<Consumers in small country>

Specific instructions for Type-I traders

Each trading period consists of 2 phases: phase 1 and phase 2.

Phase 1:

In each period, you will receive an initial endowment of cash (an initial cash) and an initial endowment of V and W at the beginning of phase 1. Your initial endowment of V and W and your initial cash, which will be the same in each period, are mentioned on your registration table.

In phase 1, the markets for V and W are open and you are free to sell however much of your endowment of goods V and W to whoever wishes to buy these goods. The amount of francs that you receive per transaction depends on the market price at which you are selling and the amount of units that you are selling at this price.

However, note that you will receive francs for every unit of V that you do **not** sell in phase 1 on top of your sales proceeds and initial cash. For every unit of V that you do not sell you will receive a subsidy of 70 francs.

Your total cash inventory in francs at the end of phase 1 is therefore equal to:

Cash inventory end of phase 1 = initial cash + sales proceeds at market prices + subsidies.

In phase 2, you will need this cash inventory to buy units of X and Y. These units of X and Y, together with the units of V that you did not sell in phase 1 will determine your earnings for the trading period, as will be explained below.

Phase 2:

In phase 2, the markets for X and Y are open. In this phase, you are free to buy units of X and Y from whoever wishes to sell these units. However, to be able to buy these units you need to have enough cash to be able to pay the market price.

Each unit that you buy will be added to your endowment of the good in question. All the units you have in inventory at the end of the period, including the units of V which you did not sell in phase 1 are considered as having been consumed by you. Your earnings in francs in a trading period are determined by the redemption value of the goods consumed by you. The Redemption value table shows the amount that you will receive. Take the table out of the envelope in front of you.

Note first that the redemption value is always 0 as long as you do not have at least one unit of **all** the goods (V, X and Y). There is a warning at the top of the table about this. For the first unit of V that you consume in a trading period you will receive the amount mentioned in the first row of the column "V unit value". If you consume a second unit of V, you will receive the amount mentioned in the second row of the column "V unit value". The total amount that you will receive through your consumption of both units of V is in the second row of the column "V total value". You can calculate the amount that you will receive through consuming X and Y in exactly the same way. Your earnings in a period are then determined by the sum of your earnings through consuming X, Y and V. Thus:

Earnings in period = V total value + X total value + Y total value

You are already familiar with reading the redemption value table. We now ask you to answer the following questions using the table that you have received.

Question 1

Suppose that in a certain period you have not sold 14 units of V during phase 1. Furthermore, suppose that you have bought 1 unit of Y and 10 units of X during phase 2. Therefore, at the end of this period you have 14 units of V, 1 unit of Y and 10 units of X. What are your total earnings for this period?

Your answer: .....

Question 2

What are your total earnings in this period if you have 0 units of Y instead of 1 unit at the end of the period?

Your answer: .....

Question 3

Suppose that in a certain period you have not sold 2 units of V during phase 1. Furthermore, suppose that you have bought 7 units of Y and 3 units of X during phase 2. Therefore, at the end of the period you have 2 units of V, 7 units of Y and 3 units of X. What are your total earnings for this period?

Your answer: .....

Warnings: In the first place, note that you will earn nothing if you do not consume any units of a certain good (V, X or Y), regardless of the number of other goods you consume. Also note from the first row of the redemption value table that you will only start earning money once you have more than 1 unit of a product.
Further note that unsold units of W and leftover cash at the end of phase 2 will not provide you with any earnings.
Finally note that you will come across market prices as well as inclusive prices. Market prices are of direct importance for Type-I traders. Inclusive prices are of direct importance for Type-II traders because these prices include the taxes or subsidies that apply to them.

REGISTRATION TABLE

Take the registration table out of the envelope in front of you. The top of this table gives you personal information concerning: your type, the markets in which you can trade, your exchange rate, your initial endowments, the subsidies you will receive and/or the taxes you have to pay, as well as other relevant subsidies and/or taxes. In the table you should register your sales, your purchases and your earnings for each period. You are already familiar with filling in this table. We would just like to remind you that you should fill in the number of unsold units of V - in the first row under "your sales" - in the pause between phases 1 and 2. You should fill in the rest in the pause at the end of the period. You can use the example in the grey column to help you with this.

<Producers in small country>

Specific instructions for Type II traders

Each trading period consists of two phases: phase 1 and phase 2. In all trading periods you will either be a producer of X or a producer of Y. Your registration table and production table indicate whether you are an X producer or a Y producer.

Phase 1:

In each period, you will receive an initial endowment of cash (an initial cash) at the beginning of phase 1. Your initial cash, which is indicated on the registration table, is the same in each period. In phase 1, the markets are open for V and W and you are free to buy units of these goods from whoever wishes to sell them. If you buy goods your inventory of cash decreases. In the first place, you will lose francs because of the costs, which is determined by the market price, at which you buy and the number of units that you buy; these costs determine your purchasing costs at market prices. In the second place, you have to pay taxes on top of the market price of good V. The tax rate, expressed as a percentage of the market price of V, is mentioned on your registration table. There are no taxes on top of the market price of good W. Your purchasing costs at market prices plus the taxes you have to pay determine your total purchasing costs. These are equal to the purchasing costs at inclusive prices. If you wish to buy units of V or W you need to have sufficient cash in your inventory to pay the purchase costs at inclusive prices.

Your total cash inventory in francs at the end of phase 1 is equal to:

Cash inventory end of phase 1 = initial cash - purchase costs at market prices - taxes = initial cash - purchase costs at inclusive prices

Warning: You need both V and W to be able to produce units of X or Y, which you can sell in phase 2 of the trading period in order to make a profit. Your earnings in a period are only determined by the profit you make in phase 2.

The total number of units of V and W that you have in your inventory at the end of phase 1 determines how many units of X or Y you will produce. Your production table shows how many units of X or Y you will produce with a given quantity of V and W.

You are already familiar with reading the production table. We ask you to answer the following questions using the table you have received.

Question 1

Suppose that in a certain period you have bought 19 units of V and 12 units of W during phase 1. Therefore, at the end of this phase you have 19 units of V and 12 units of W in your inventory. What is your level of production?

Your answer: .....

Question 2

What is your production level if you have 0 instead of 19 units of V in your inventory at the end of phase 1?

Your answer: .....

Question 3

Suppose that in a certain period you have bought 5 units of V and 3 units of W during phase 1. Therefore, at the end of this phase you have 5 units of V and 3 units of W in your inventory. What is your level of production?

Your answer: .....

Your level of production is determined automatically by the computer at the end of phase 1.

Warnings: Note that if you do not buy any units of V **and** W (that is, you buy nothing) in phase 1, you do not produce anything and you do not make any profit or loss. If you do not buy any unit of V **or** W (that is, you only buy units of V or units of W) in phase 1, then you still do not produce anything but you do make a loss because of the total purchasing costs for the units bought.

Phase 2:

In phase 2 the markets for X and Y are open. As a seller of X or Y, your trading is restricted to one of these markets. In this phase, you are free to sell units of your production inventory of X or Y to whoever wishes to buy them. If you sell goods you receive francs. Your sales revenues depend on the market price at which you sell and the number of units you sell. This determines your sales revenues at market prices which are the same as your sales revenues at inclusive prices.

Your profits, which determine your earnings in a period, consist of your sales revenues at market prices in phase 2 **minus** your purchase costs of V and W at market prices in phase 1 **minus** the taxes you pay for V in phase 1. Your earnings in a period are therefore equal to:

Earnings in period = sales revenues at market prices - purchase costs at market prices - taxes = sales revenues at inclusive prices - purchase costs at inclusive prices

Warnings: Note that the units of X and Y that you do not sell in phase 2 will not provide you with any earnings. Furthermore, note that if you do not wish to make a loss in a period, you must try not to sell your inventory for less than the purchasing costs (including taxes). In other words, you should not spend more on the purchase of V and W in phase 1 than you expect to earn back on the sales revenues in phase 2.

REGISTRATION TABLE

Take the registration table out of the envelope in front of you. The top of this table gives you personal information concerning: your type, the markets on which you can trade, your exchange rate, your initial endowments, the subsidies you will receive and/or the taxes you will pay, as well as other relevant subsidies and/or taxes. In the table you should register your purchases, sales and earnings for each period. You are already familiar with filling this table. We would just like to point out again that you should fill in the required information in the break at the end of the session. You can use the example in the grey column to help you with this.

A.2 Registration tables

<Consumers in small country (selection)>

Your type: Type-I
Markets in which you can trade: V1, W1, X1, Y1
Your exchange rate: 10 francs = 36 cents

Your initial endowment:	
Inititial cash	181
Initial endowment V	15
Initial endowment W	10

Subsidies you receive:
for every not sold unit V: 70
Taxes you have to pay:
none

Other relevant subsidies: Type-II traders receive	
none	
Other relevant taxes: Type-II traders pay	
tax on market price V: 37.8%	N.B. Beginning with period 9 these taxes can change

	example		**practice period 1**		**practice period 2**		**period 1**	
Your sales	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
not sold units V	A							
total V subsidy	B							
sold units	C	E						
average sales price (in market prices)	D	F						
total sales proceedings	G=B+C*D+E*F							
end cash phase 1	H=initial cash+G							
Your purchases	good		good		good		good	
	X	**Y**	**X**	**Y**	**X**	**Y**	**X**	**Y**
bought units	I	J						
average purchase price (in market prices)	K	L						
total purchase costs	M=I*K+J*L							
end cash	N=H-M							

Your earnings	good			good			good			good		
	V	**X**	**Y**	**V**	**X**	**Y**	**V**	**X**	**Y**	**V**	**X**	**Y**
number of units	=A	=I	=J									
total value V, X, Y separately	O	P	Q									
earnings	R=O+P+Q			none			none					

<Consumers in large country (selection)>

Your type: Type-I
Markets in which you can trade: V2, W1, X1, Y2
Your exchange rate: 10 francs = 18 cents

Your initial endowment:	
Inititial cash	1268
Initial endowment V	105
Initial endowment W	70

Subsidies you receive:
for every not sold unit V: 70
Taxes you have to pay:
none

Other relevant subsidies: Type-II traders receive	
none	
Other relevant taxes: Type-II traders pay	
tax on market price V: 37.8%	N.B. Beginning with period 9 these taxes can change

	example		**practice period 1**		**practice period 2**		**period 1**	
Your sales	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
not sold units V	A							
total V subsidy	B							
sold units	C	E						
average sales price (in market prices)	D	F						
total sales proceedings	G=B+C*D+E*F							
end cash phase 1	H=initial cash+G							
Your purchases	good		good		good		good	
	X	**Y**	**X**	**Y**	**X**	**Y**	**X**	**Y**
bought units	I	J						
average purchase price (in market prices)	K	L						
total purchase costs	M=I*K+J*L							
end cash	N=H-M							

Your earnings	good			good			good			good		
	V	**X**	**Y**	**V**	**X**	**Y**	**V**	**X**	**Y**	**V**	**X**	**Y**
number of units	=A	=I	=J									
total value V, X, Y separately	O	P	Q									
earnings	R=O+P+Q			none			none					

<X-producers in small country (selection)>

Your type: Type-II
Markets in which you can trade: V1, W1, X1
Your exchange rate: 10 francs = 28 cents

Your initial endowment:	
Inititial cash	1223

Subsidies you receive:
none
Taxes you have to pay:
tax on market price V: 37.8%
N.B. Beginning with period 9 this tax can change

Other relevant subsidies: Type-I traders receive
for every not sold unit V: 70

	example		**practice period 1**		**practice period 2**		**period 1**	
Your purchases	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
bought units	A	B						
average purchase price (in inclusive prices)	C	D						
total purchasing costs	E=A*C+B*D							
total production	H							
average costs	I=E/H							
Your sales	good **X**		good **X**		good **X**		good **X**	
sold units	J							
average sales price (in inclusive prices)	K							
total sales proceedings	L=J*K							
Your earnings	M=l-E		none		none			

<Y-producers in small country (selection)>

Your type: Type-II
Markets in which you can trade: V1, W1, X1
Your exchange rate: 10 francs = 42 cents

Your initial endowment:	
Inititial cash	815

Subsidies you receive:
none
Taxes you have to pay:
tax on market price V: 37.8%
N.B. Beginning with period 9 this tax can change

Other relevant subsidies: Type-I traders receive
for every not sold unit V: 70

	example		**practice period 1**		**practice period 2**		**period 1**	
Your purchases	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
bought units	A	B						
average purchase price (in inclusive prices)	C	D						
total purchasing costs	E=A*C+B*D							
total production	H							
average costs	I=E/H							
Your sales	good **Y**		good **Y**		good **Y**		good **Y**	
sold units	J							
average sales price (in inclusive prices)	K							
total sales proceedings	L=J*K							
Your earnings	M=l-E		none		none			

<X-producers in large country (selection)>

Your type: Type-II
Markets in which you can trade: V2, W1, X1
Your exchange rate: 10 francs = 4 cents

Your initial endowment:	
Inititial cash	8557

Subsidies you receive:
none
Taxes you have to pay:
tax on market price V: 37.8%
N.B. Beginning with period 9 this tax can change

Other relevant subsidies: Type-I traders receive
for every not sold unit V: 70

	example		**practice period 1**		**practice period 2**		**period 1**	
Your purchases	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
bought units	A	B						
average purchase price (in inclusive prices)	C	D						
total purchasing costs	E=A*C+B*D							
total production	H							
average costs	I=E/H							
Your sales	good **X**		good **X**		good **X**		good **X**	
sold units	J							
average sales price (in inclusive prices)	K							
total sales proceedings	L=J*K							
Your earnings	M=l-E		none		none			

<Y-producers in large country (selection)>

Your type: Type-II
Markets in which you can trade: V2, W1, Y2
Your exchange rate: 10 francs = 6 cents

Your initial endowment:	
Inititial cash	5705

Subsidies you receive:
none
Taxes you have to pay:
tax on market price V: 37.8%
N.B. Beginning with period 9 this tax can change

Other relevant subsidies: Type-I traders receive
for every not sold unit V: 70

	example		**practice period 1**		**practice period 2**		**period 1**	
Your purchases	good		good		good		good	
	V	**W**	**V**	**W**	**V**	**W**	**V**	**W**
bought units	A	B						
average purchase price (in inclusive prices)	C	D						
total purchasing costs	E=A*C+B*D							
total production	H							
average costs	I=E/H							
Your sales	good **Y**		good **Y**		good **Y**		good **Y**	
sold units	J							
average sales price (in inclusive prices)	K							
total sales proceedings	L=J*K							
Your earnings	M=l-E		none		none			

A.3 Redemption value tables

<Consumers in small country>

Redemption values table Type-I

N.B. The redemption value is 0 if you have not got at least 1 unit of **all** the goods (V, X and Y).

unit	V unit value	V total value	X unit value	X total value	Y unit value	Y total value
1	0.00	0.00	0.00	0.00	0.00	0.00
2	4.33	4.33	17.33	17.33	17.33	17.33
3	2.53	6.87	10.14	27.47	10.14	27.47
4	1.80	8.66	7.19	34.66	7.19	34.66
5	1.39	10.06	5.58	40.24	5.58	40.24
6	1.14	11.20	4.56	44.79	4.56	44.79
7	0.96	12.16	3.85	48.65	3.85	48.65
8	0.83	13.00	3.34	51.99	3.34	51.99
9	0.74	13.73	2.94	54.93	2.94	54.93
10	0.66	14.39	2.63	57.56	2.63	57.56
11	0.60	14.99	2.38	59.95	2.38	59.95
12	0.54	15.53	2.18	62.12	2.18	62.12
13	0.50	16.03	2.00	64.12	2.00	64.12
14	0.46	16.49	0	64.12	0	64.12
15	0.43	16.93	.	.	.	.

<Consumers in large country (selection)>

Redemption values table Type-I

N.B. The redemption value is 0 if you have not got at least 1 unit of **all** the goods (V, X and Y).

unit	V unit value	V total value	X unit value	X total value	Y unit value	Y total value
1	0.00	0.00	0.00	0.00	0.00	0.00
2	4.33	4.33	17.33	17.33	17.33	17.33
3	2.53	6.87	10.14	27.47	10.14	27.47
4	1.80	8.66	7.19	34.66	7.19	34.66
5	1.39	10.06	5.58	40.24	5.58	40.24
6	1.14	11.20	4.56	44.79	4.56	44.79
7	0.96	12.16	3.85	48.65	3.85	48.65
8	0.83	13.00	3.34	51.99	3.34	51.99
9	0.74	13.73	2.94	54.93	2.94	54.93
10	0.66	14.39	2.63	57.56	2.63	57.56
11	0.60	14.99	2.38	59.95	2.38	59.95
12	0.54	15.53	2.18	62.12	2.18	62.12
13	0.50	16.03	2.00	64.12	2.00	64.12
14	0.46	16.49	1.85	65.98	1.85	65.98
15	0.43	16.93	1.72	67.70	1.72	67.70
16	0.40	17.33	1.61	69.31	1.61	69.31
17	0.38	17.71	1.52	70.83	1.52	70.83
18	0.36	18.06	1.43	72.26	1.43	72.26
19	0.34	18.40	1.35	73.61	1.35	73.61
20	0.32	18.72	1.28	74.89	1.28	74.89
21	0.30	19.03	1.22	76.11	1.22	76.11
22	0.29	19.32	1.16	77.28	1.16	77.28
23	0.28	19.60	1.11	78.39	1.11	78.39
24	0.27	19.86	1.06	79.45	1.06	79.45
25	0.26	20.12	1.02	80.47	1.02	80.47
26	0.25	20.36	0.98	81.45	0.98	81.45
27	0.24	20.60	0.94	82.40	0.94	82.40
28	0.23	20.83	0.91	83.31	0.91	83.31
29	0.22	21.05	0.88	84.18	0.88	84.18
30	0.21	21.26	0.85	85.03	0.85	85.03
31	0.20	21.46	0.82	85.85	0.82	85.85
32	0.20	21.66	0.79	86.64	0.79	86.64
33	0.19	21.85	0.77	87.41	0.77	87.41
34	0.19	22.04	0.75	88.16	0.75	88.16
35	0.18	22.22	0.72	88.88	0.72	88.88
36	0.18	22.40	0.70	89.59	0.70	89.59
37	0.17	22.57	0.68	90.27	0.68	90.27
38	0.17	22.73	0.67	90.94	0.67	90.94
39	0.16	22.90	0.65	91.59	0.65	91.59
40	0.16	23.06	0.63	92.22	0.63	92.22
41	0.15	23.21	0.62	92.84	0.62	92.84
42	0.15	23.36	0.60	93.44	0.60	93.44
43	0.15	23.51	0.59	94.03	0.59	94.03
44	0.14	23.65	0.57	94.60	0.57	94.60
45	0.14	23.79	0.56	95.17	0.56	95.17
46	0.14	23.93	0.55	95.72	0.55	95.72
47	0.13	24.06	0.54	96.25	0.54	96.25

A.4 Production tables

<Producers in small country>

Production table Type-II X

units W \ units V	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.
1	0	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	.
2	0	2	3	4	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	.
3	0	2	4	5	6	6	7	7	7	7	8	8	8	8	8	8	8	8	8	8	.
4	0	2	4	5	6	7	8	8	9	9	9	10	10	10	10	10	10	10	10	10	.
5	0	2	4	5	7	8	9	9	10	10	11	11	11	11	12	12	12	12	12	12	.
6	0	2	4	6	7	8	9	10	11	11	12	12	13	13	13	13	14	14	14	14	.
7	0	2	4	6	7	8	10	11	11	12	13	13	14	14	15	15	15	15	16	16	.
8	0	2	4	6	7	9	10	11	12	13	13	14	15	15	16	16	16	17	17	17	.
9	0	2	4	6	7	9	10	11	12	13	14	15	15	16	17	17	17	18	18	19	.
10	0	2	4	6	7	9	10	11	13	14	15	15	16	17	17	18	18	19	19	20	.
11	0	2	4	6	7	9	10	12	13	14	15	16	17	17	18	19	19	20	20	21	.
12	0	2	4	6	7	9	10	12	13	14	15	16	17	18	19	19	20	21	21	22	.
13	0	2	4	6	7	9	10	12	13	14	15	17	17	18	19	20	21	21	22	23	.
14	0	2	4	6	7	9	11	12	13	15	16	17	18	19	20	20	21	22	23	23	.
15	0	2	4	6	7	9	11	12	13	15	16	17	18	19	20	21	22	23	23	24	.
16	0	2	4	6	7	9	11	12	13	15	16	17	18	19	20	21	22	23	24	24	.
17	0	2	4	6	7	9	11	12	14	15	16	17	19	20	21	22	23	23	24	25	.
18	0	2	4	6	7	9	11	12	14	15	16	17	19	20	21	22	23	24	25	25	.
19	0	2	4	6	8	9	11	12	14	15	16	18	19	20	21	22	23	24	25	26	.
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Production table Type-II Y

units W \ units V	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.
1	0	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	.
2	0	2	3	4	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	.
3	0	2	3	4	5	6	7	8	8	8	9	9	9	9	9	9	9	9	9	9	.
4	0	2	3	4	5	6	8	9	9	10	10	11	11	11	11	11	11	11	11	11	.
5	0	2	3	4	5	6	8	9	10	11	11	12	13	13	13	13	14	14	14	14	.
6	0	2	3	4	5	6	8	9	10	11	12	13	13	14	15	15	15	16	16	16	.
7	0	2	3	4	5	6	8	9	10	11	12	13	14	15	15	16	17	17	18	18	.
8	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	17	18	19	19	.
9	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	19	20	.
10	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
11	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
12	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
13	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
14	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
15	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
16	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
17	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
18	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
19	0	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	20	21	.
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Production table Type-II X

units W \ units V	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2	0	3	4	5	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3	0	3	5	6	7	8	8	9	9	9	9	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
4	0	3	5	6	8	9	10	10	11	11	11	12	12	12	12	12	12	12	12	12	12	12	12	13	13	13	13	13	13	13	13
5	0	3	5	7	8	9	10	11	12	13	13	13	14	14	14	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15
6	0	3	5	7	8	10	11	12	13	14	14	15	15	16	16	16	16	17	17	17	17	17	17	17	18	18	18	18	18	18	18
7	0	3	5	7	9	10	12	13	14	15	15	16	17	17	18	18	18	19	19	19	19	19	19	20	20	20	20	20	20	20	20
8	0	3	5	7	9	10	12	13	14	15	16	17	18	18	19	19	20	20	20	21	21	21	21	22	22	22	22	22	22	22	23
9	0	3	5	7	9	11	12	14	15	16	17	18	19	19	20	21	21	22	22	22	23	23	23	24	24	24	24	24	24	25	25
10	0	3	5	7	9	11	12	14	15	16	18	19	20	20	21	22	22	23	23	24	24	25	25	25	25	26	26	26	26	27	27
11	0	3	5	7	9	11	12	14	15	17	18	19	20	21	22	23	23	24	25	25	26	26	26	27	27	27	28	28	28	28	29
12	0	3	5	7	9	11	13	14	16	17	18	20	21	22	23	23	24	25	26	26	27	27	28	28	29	29	29	30	30	30	30
13	0	3	5	7	9	11	13	14	16	17	19	20	21	22	23	24	25	26	27	27	28	28	29	29	30	30	31	31	31	32	32
14	0	3	5	7	9	11	13	14	16	18	19	20	22	23	24	25	26	27	27	28	29	29	30	31	31	32	32	32	33	33	33
15	0	3	5	7	9	11	13	15	16	18	19	21	22	23	24	25	26	27	28	29	30	30	31	32	32	33	33	34	34	35	35
16	0	3	5	7	9	11	13	15	16	18	19	21	22	23	25	26	27	28	29	30	30	31	32	33	33	34	34	35	35	36	36
17	0	3	5	7	9	11	13	15	16	18	20	21	22	24	25	26	27	28	29	30	31	32	33	33	34	35	35	36	36	37	37
18	0	3	5	7	9	11	13	15	16	18	20	21	23	24	25	27	28	29	30	31	32	33	33	34	35	36	36	37	37	38	39
19	0	3	5	7	9	11	13	15	16	18	20	21	23	24	26	27	28	29	30	31	32	33	34	35	36	36	37	38	38	39	40
20	0	3	5	7	9	11	13	15	17	18	20	21	23	24	26	27	28	30	31	32	33	34	35	36	36	37	38	39	39	40	41
21	0	3	5	7	9	11	13	15	17	18	20	22	23	25	26	27	29	30	31	32	33	34	35	36	37	38	39	39	40	41	41
22	0	3	5	7	9	11	13	15	17	18	20	22	23	25	26	28	29	30	31	33	34	35	36	37	38	39	39	40	41	42	42
23	0	3	5	7	9	11	13	15	17	18	20	22	23	25	26	28	29	30	32	33	34	35	36	37	38	39	40	41	42	42	43
24	0	3	5	7	9	11	13	15	17	18	20	22	23	25	26	28	29	31	32	33	34	35	37	38	39	40	41	41	42	43	44
25	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	28	29	31	32	33	35	36	37	38	39	40	41	42	43	44	45
26	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	28	30	31	32	34	35	36	37	38	39	41	42	42	43	44	45
27	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	28	30	31	33	34	35	36	38	39	40	41	42	43	44	45	46
28	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	28	30	31	33	34	35	37	38	39	40	41	42	43	44	45	46
29	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	29	30	31	33	34	36	37	38	39	41	42	43	44	45	46	47
30	0	3	5	7	9	11	13	15	17	19	20	22	24	25	27	29	30	32	33	34	36	37	38	40	41	42	43	44	45	46	47
31	0	3	5	7	9	11	13	15	17	19	20	22	24	26	27	29	30	32	33	35	36	37	39	40	41	42	43	45	46	47	48
32	0	3	5	7	9	11	13	15	17	19	20	22	24	26	27	29	30	32	33	35	36	38	39	40	41	43	44	45	46	47	48

Production table Type-II Y

units W \ units V	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2	0	2	3	5	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3	0	2	3	5	6	8	9	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
4	0	2	3	5	6	8	9	10	11	12	13	13	13	13	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
5	0	2	3	5	6	8	9	10	12	13	14	15	15	16	16	16	16	17	17	17	17	17	17	17	17	17	17	17	17	17	17
6	0	2	3	5	6	8	9	11	12	13	14	15	16	17	18	18	19	19	19	19	19	19	20	20	20	20	20	20	20	20	20
7	0	2	3	5	6	8	9	11	12	13	14	16	17	18	19	20	20	21	21	22	22	22	22	22	22	22	22	23	23	23	23
8	0	2	3	5	6	8	9	11	12	13	14	16	17	18	19	20	21	22	23	23	24	24	24	25	25	25	25	25	25	25	25
9	0	2	3	5	6	8	9	11	12	13	14	16	17	18	19	21	22	23	23	24	25	26	26	27	27	27	27	28	28	28	28
10	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	24	25	26	27	27	28	28	29	29	30	30	30	30
11	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	30	31	31	32	32	32
12	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	24	26	27	28	29	30	30	31	32	33	33	34	34
13	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	24	26	27	28	29	30	31	32	33	33	34	35	35
14	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	30	31	32	33	34	35	36	36
15	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	30	31	33	34	35	35	36	37
16	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	30	32	33	34	35	36	37	38
17	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	36	37	38
18	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	36	37	38
19	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	36	37	39
20	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	36	38	39
21	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	37	38	39
22	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29	31	32	33	34	35	37	38	39
23	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39
24	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39
25	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39
26	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39
27	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39
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33	0	2	3	5	6	8	9	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	30	31	32	33	34	35	37	38	39

A.5 Trading rules

RULES FOR TRADING

1. Traders bid or ask. **Bidding** involves carrying out a **bid order (purchase proposal)**, consisting of (a) a bid price and (b) the number of units that one wishes to buy at this price. **Asking** involves carrying out an **ask order (sales proposal)**, consisting of (a) an ask price and (b) the number of units that one wishes to sell at this price.

2. Traders can also buy or sell. **Buying** involves carrying out a **buy order**, consisting of the number of units that one wishes to buy at the outstanding (current) ask price. **Selling** involves carrying out a **sell order**, consisting of the number of units that one wishes to sell at the outstanding (current) bid price.

3. Only the **highest bid price** and the **lowest ask price** are valid on the market irrespective of the number of units that one wishes to buy (demand) or sell (supply), respectively, at this price.

4. Transactions can involve either the total amount supplied or demanded on the market or part of it.

5. If the **total amount supplied on the market is bought**, then the market is open for new ask orders as well as new bid orders, and any price is permitted. If the **total amount demanded on the market is sold**, then the market is open for new ask orders as well as new bid orders, and any price is permitted.

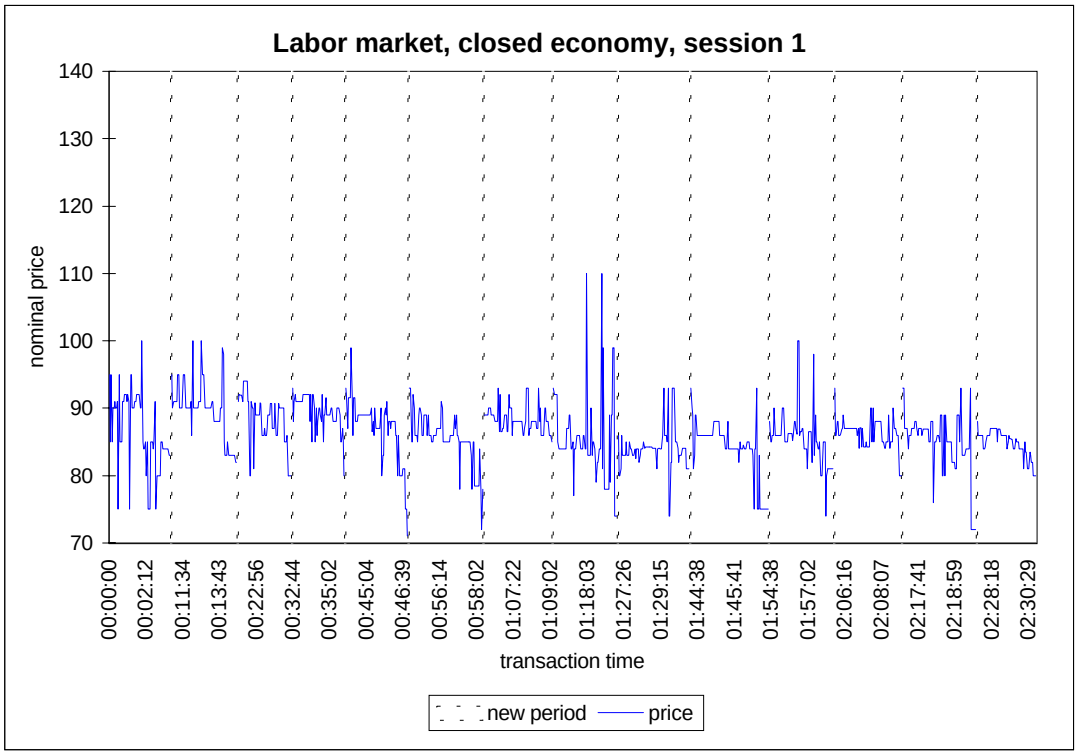
6. If only **part of the amount demanded is sold**, then the amount left remains on the market at the current price. If only **part of the amount supplied is bought**, then the amount left remains on the market at the current price.

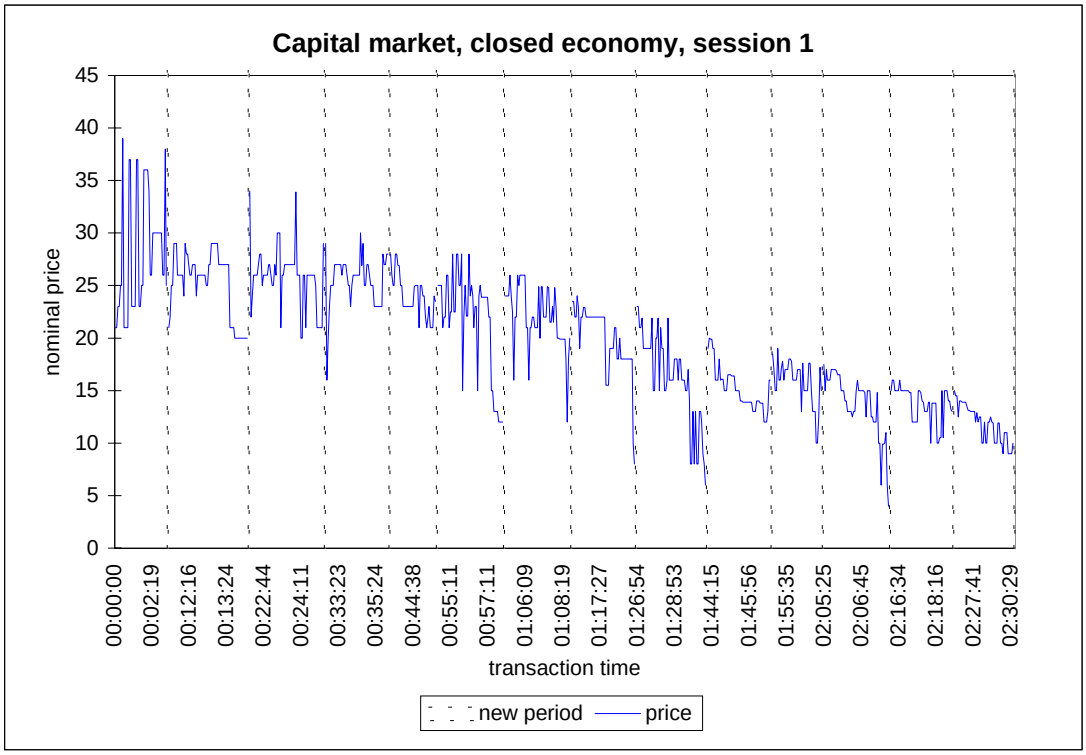
7. If a buy order is for **more than the amount supplied on the market**, then the buying trader receives the amount supplied on the market. The remaining units are regarded as a new purchase proposal at the current price. If a selling order is for **more than the amount demanded on the market**, then the trader selling sells the amount demanded on the market. The remaining units are regarded as a new sales proposal at the current price.

8. There is **another way to buy**. If a newly introduced bid price is higher than the current ask price, trading automatically takes place at the current ask price. If such a purchase proposal is for more than the current amount, then the amount remaining is dealt with as a new purchase proposal at the matching price.
   There is **another way to sell**. If a newly introduced ask price is lower than the current bid price, trading automatically takes place at the current bid price. If such a sales proposal is for more than the current amount, then the amount remaining is dealt with as a new sales proposal at the matching price.

B Time series of transaction prices (all sessions and markets)

This appendix contains the timeseries of nominal transaction prices for all markets and in all sessions. Due to some outliers not all transaction prices are shown. This concerns the following. In closed economy session 2: labor market in period 1, 2 units at price 165; period 4, 5 at 200; period 8, 11 at 200; X market in period 1, 10 at 220 and 5 at 220; period 12, 1 at 240, twice 1 at 230 and 4 at 230. In closed economy session 3: labor market in period 4, 5 at 150; capital market in period 5, 5 at 100. In closed economy session 4: Y market in period 10, once 4, once, 1 and once 3 units at 400. In international economy session 1: capital market in period 2, 1 at 70; in period 5, three times 2 at 67 and once 4 at 67; X market in period 3, 1 unit at 249; period 9, 1 at 250; period 16, 1 at 260. In international economy session 2: labor market small country in period 1, 1 unit at 150; capital market in period 15, once 10 units at 70.5 and once 6 units at 70.5.

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30
25
20
15
10
5
0
00:00:00
00:02:19
00:12:16
00:13:24
00:22:44
00:24:11
00:33:23
00:35:24
00:44:38
00:55:11
00:57:11
01:06:09
01:08:19
01:17:27
01:26:54
01:28:53
01:44:15
01:45:56
01:55:35
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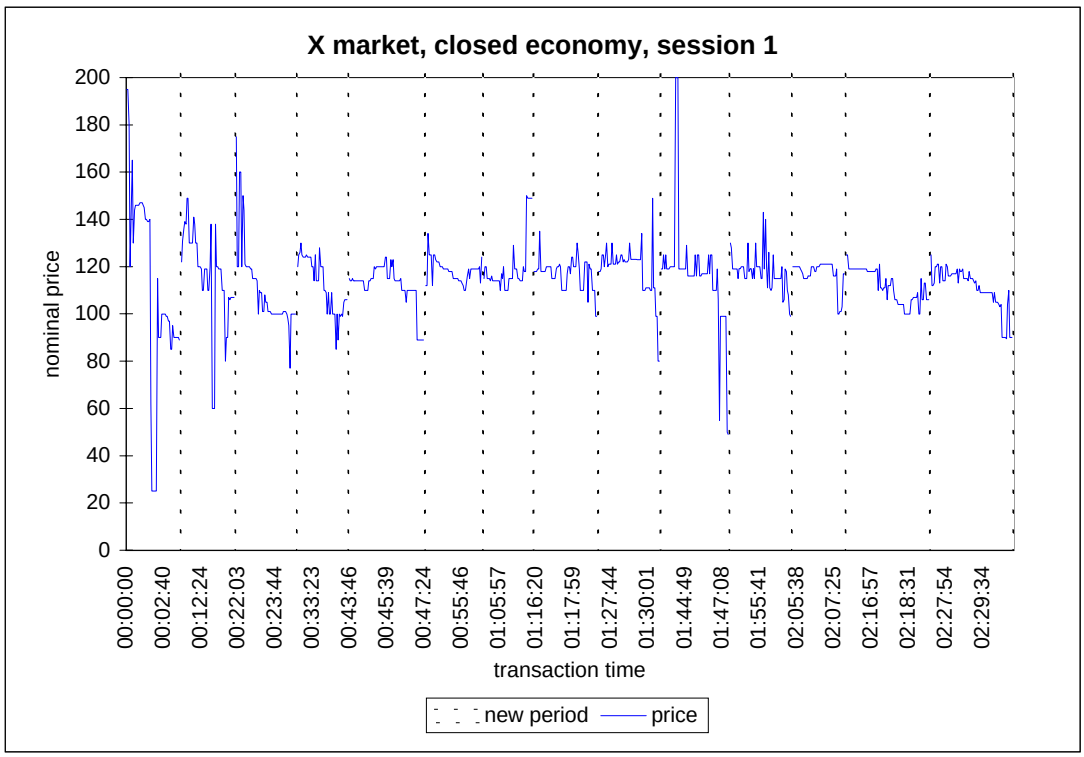
02:18:16
02:27:41
02:30:29
transaction time
new period
price


X market, closed economy, session 1
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140
120
100
80
60
40
20
0
00:00:00
00:02:40
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00:22:03
00:23:44
00:33:23
00:43:46
00:45:39
00:47:24
00:55:46
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01:16:20
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01:27:44
01:30:01
01:44:49
01:47:08
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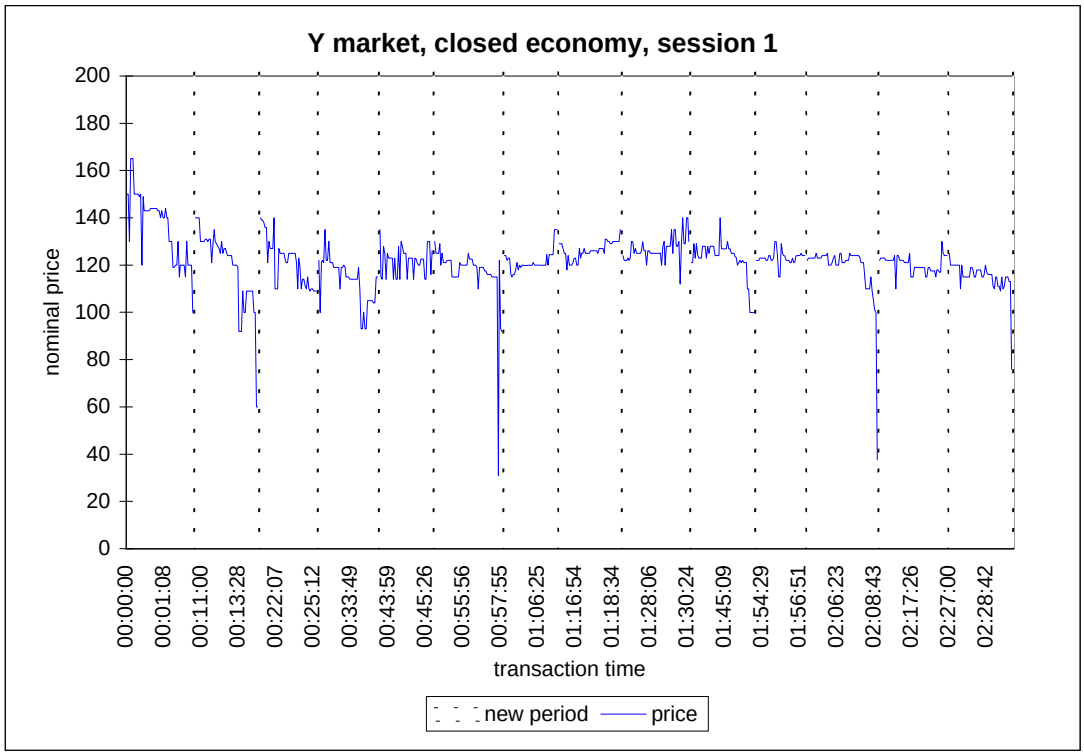
transaction time
new period
price


Y market, closed economy, session 1
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100
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60
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20
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00:01:08
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01:45:09
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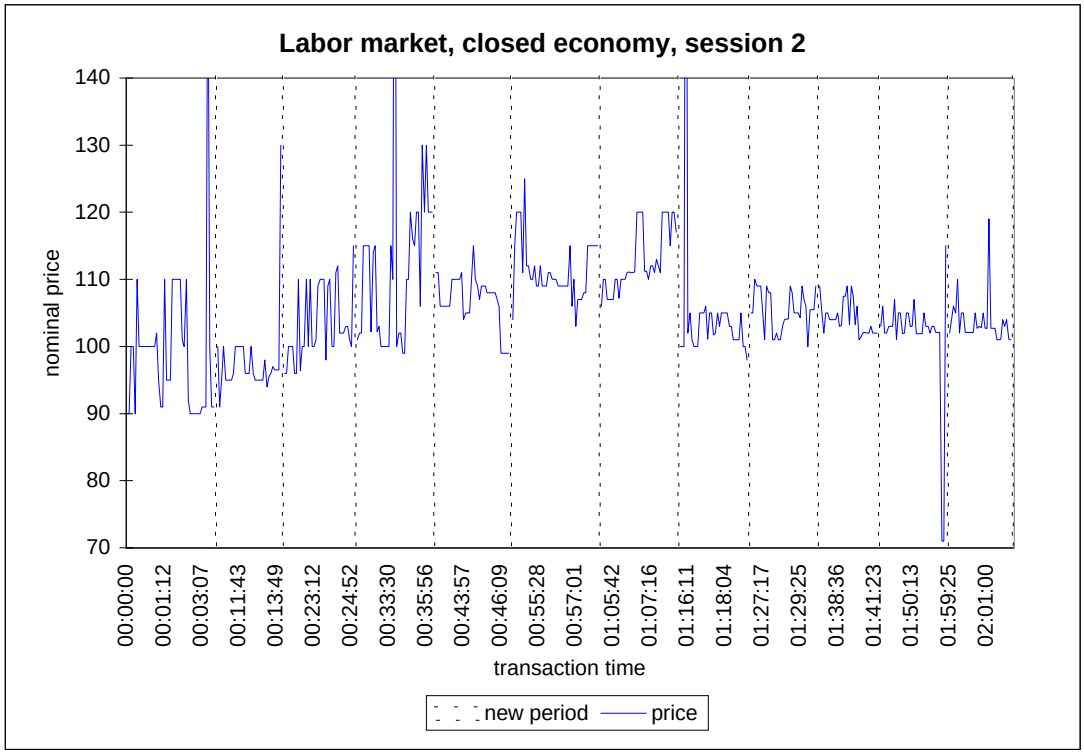
transaction time
new period
price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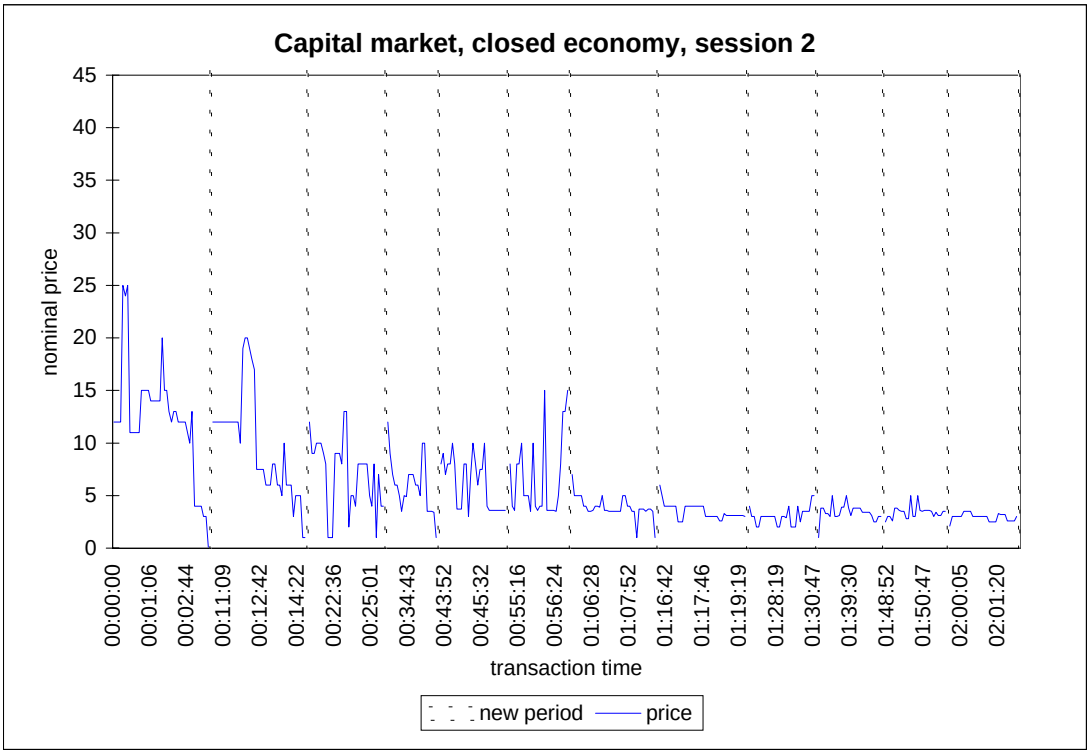
transaction time
new period
price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20
15
10
5
0
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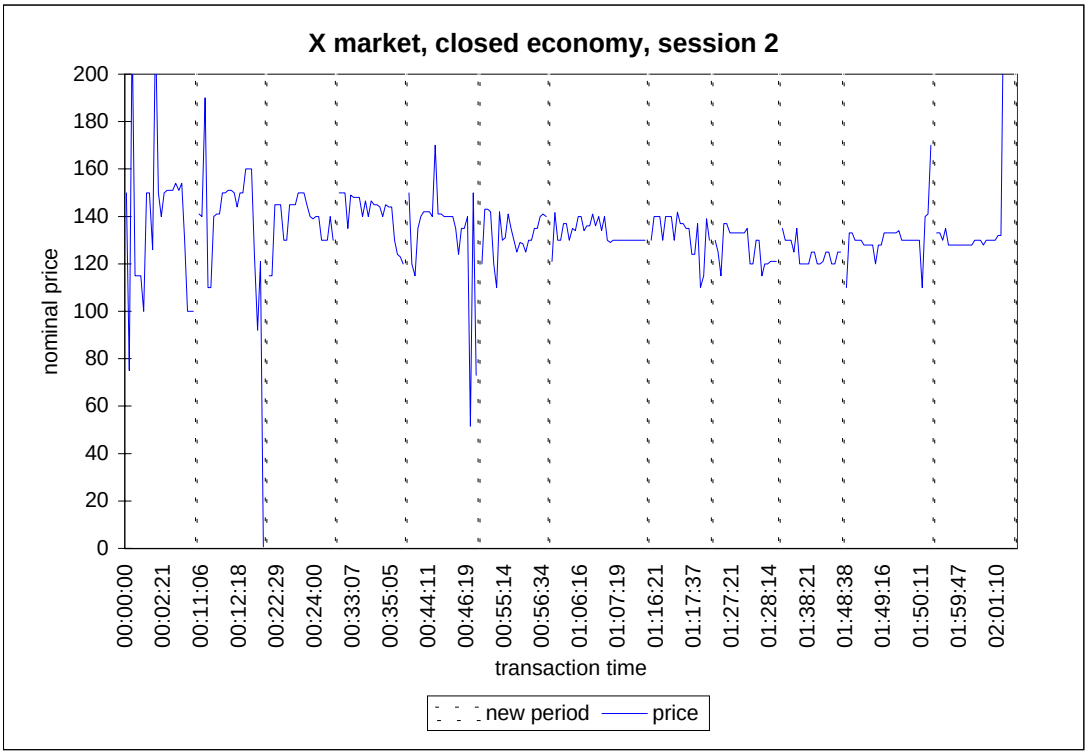
transaction time
new period
price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60
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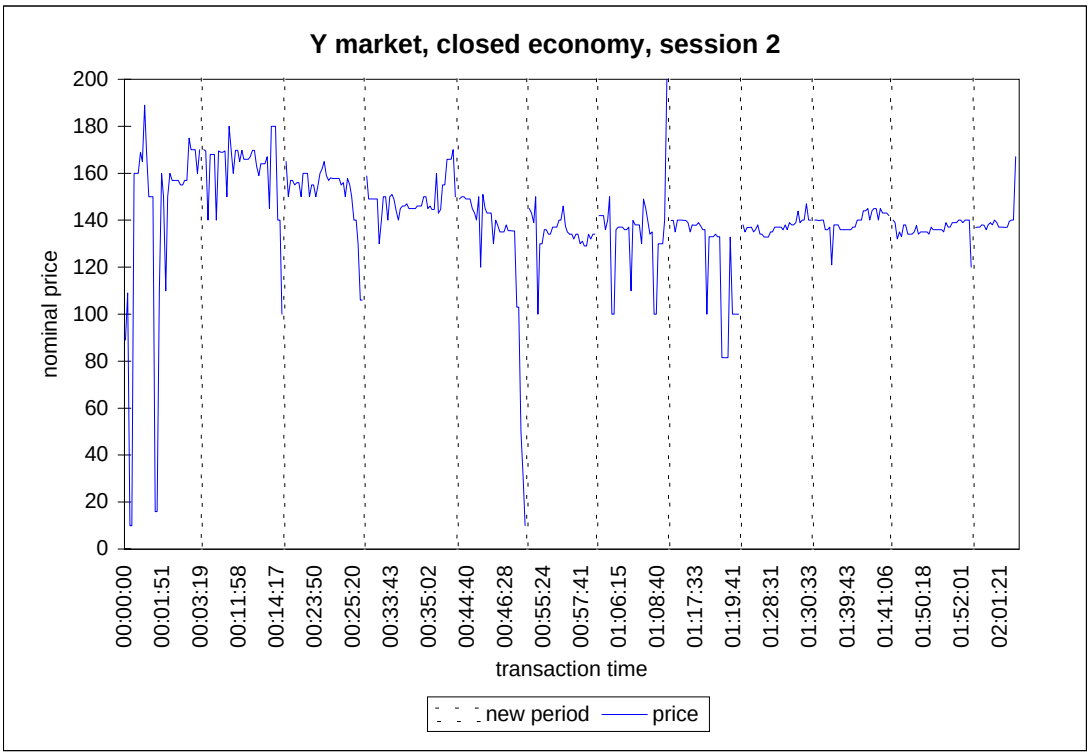
transaction time
new period
price


Y market, closed economy, session 2
nominal price
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60
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20
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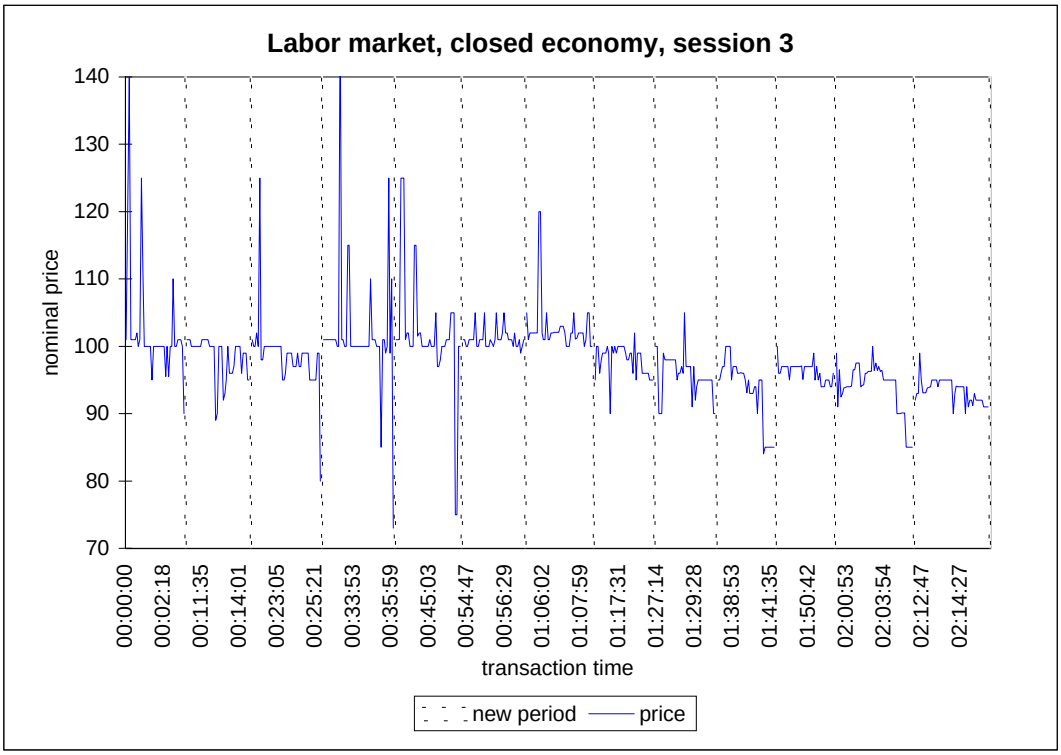
transaction time
new period
price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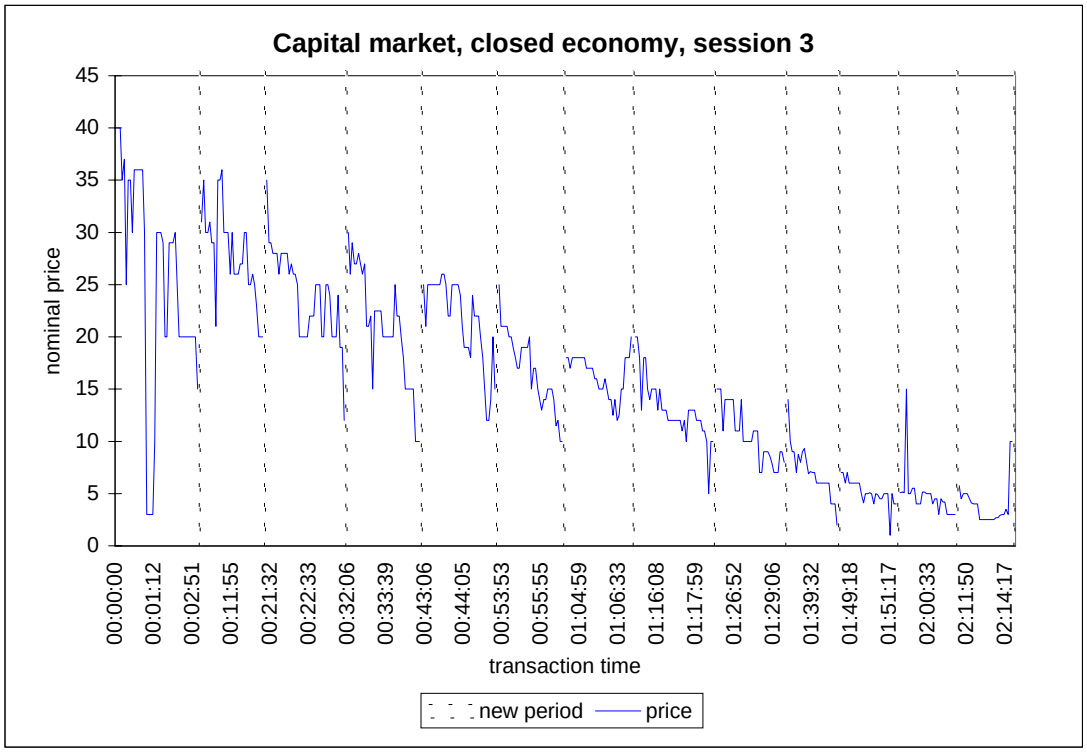
transaction time
new period
price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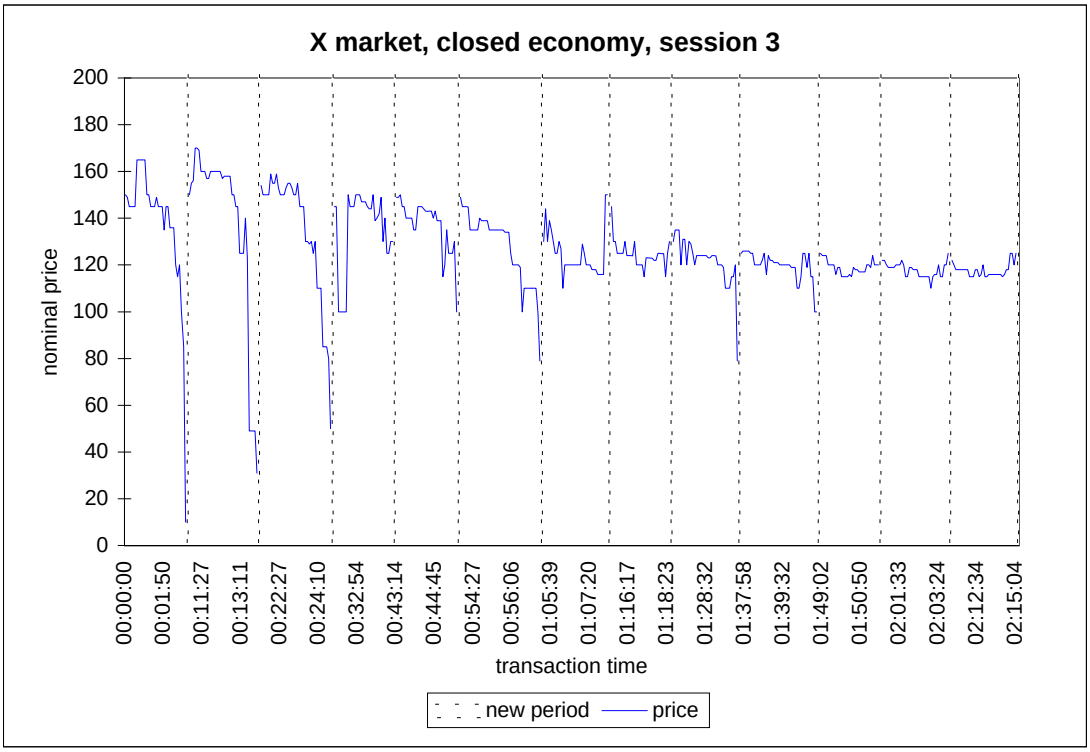
transaction time
new period
price


X market, closed economy, session 3
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60
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00:01:50
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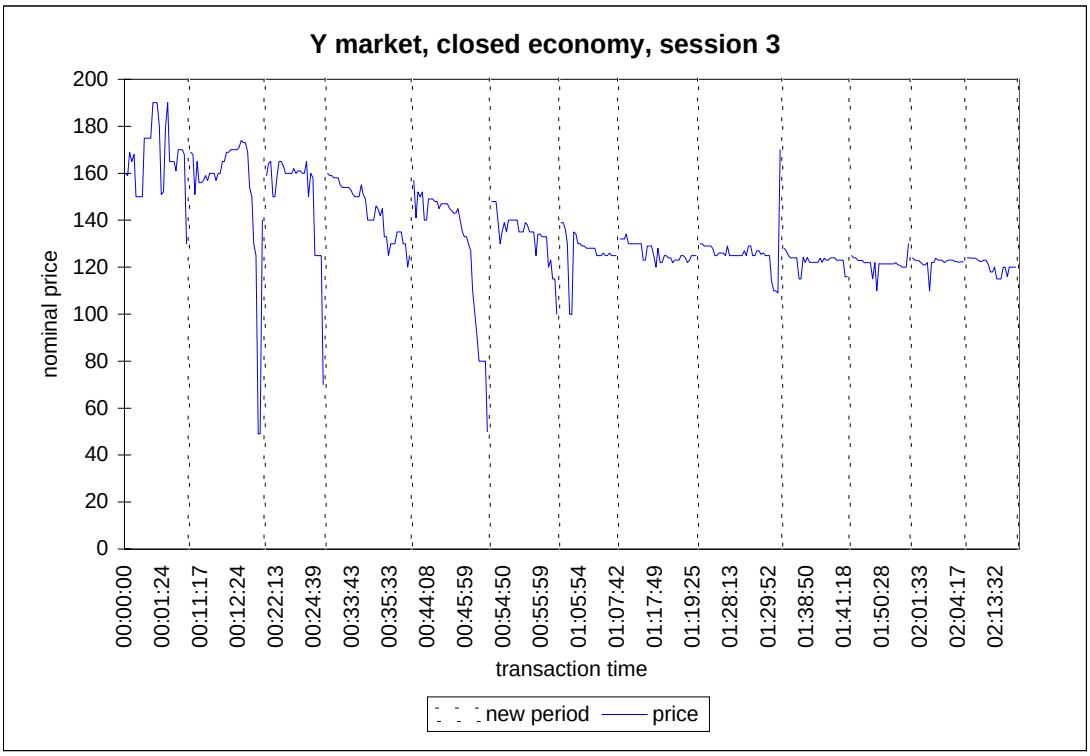
transaction time
new period
price


Y market, closed economy, session 3
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140
120
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60
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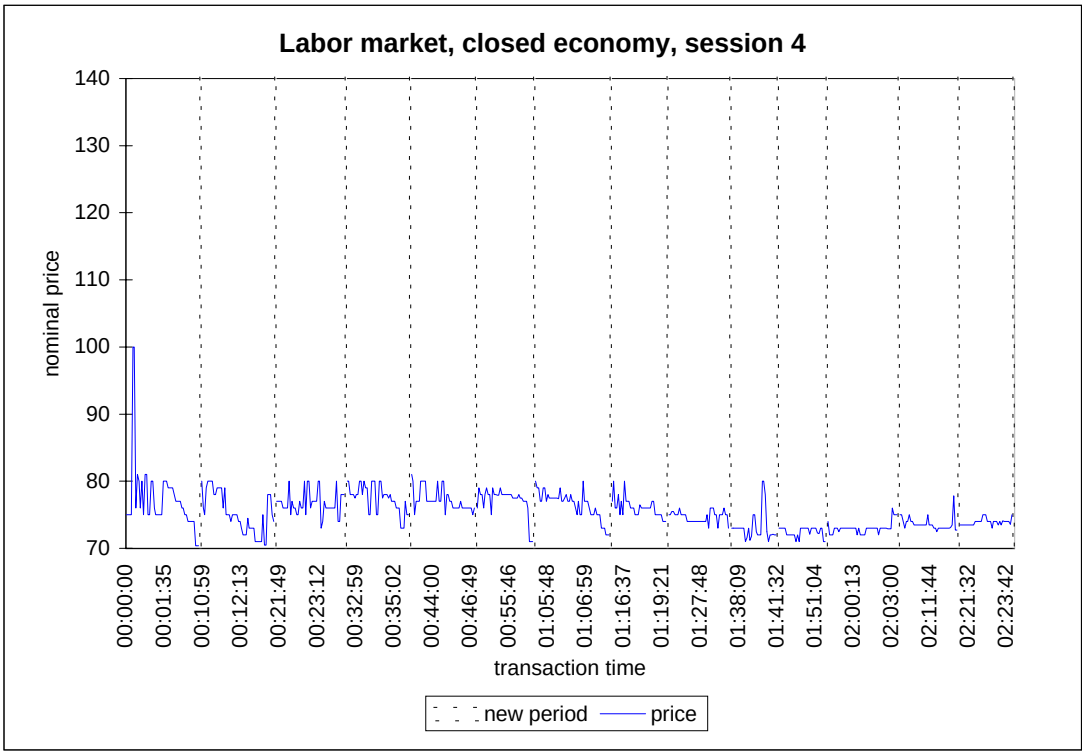
transaction time
new period
price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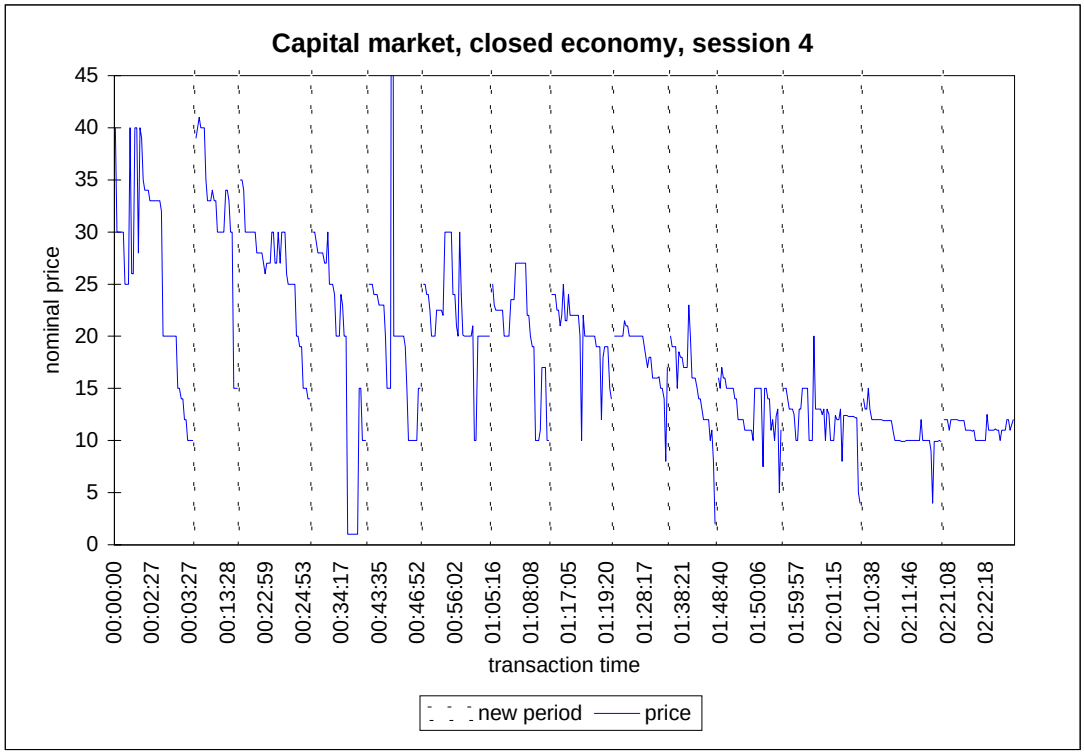
transaction time
new period
price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01:48:40
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02:10:38
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02:21:08
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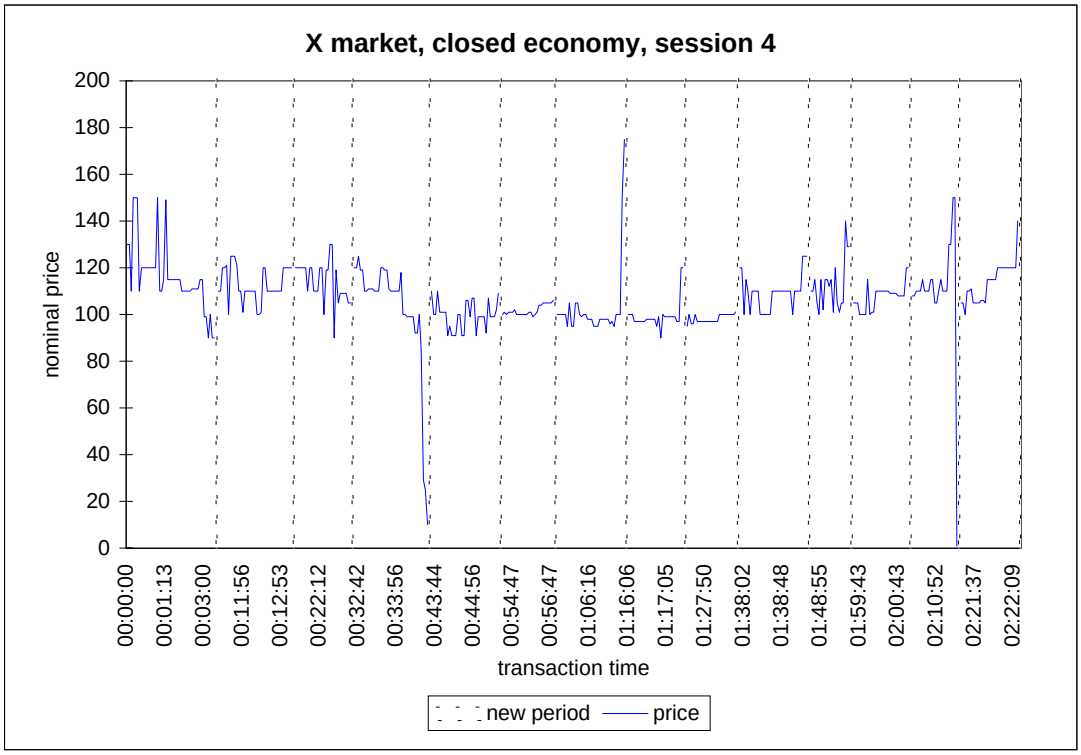
transaction time
new period
price


X market, closed economy, session 4
nominal price
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140
120
100
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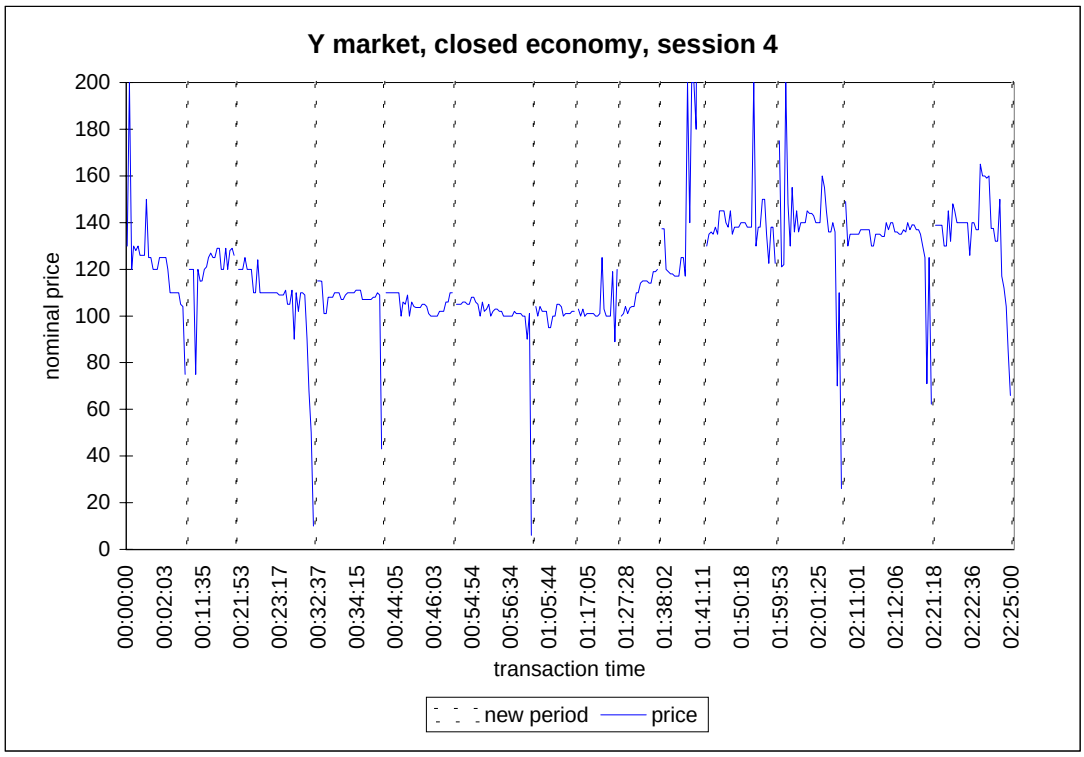
transaction time
new period
price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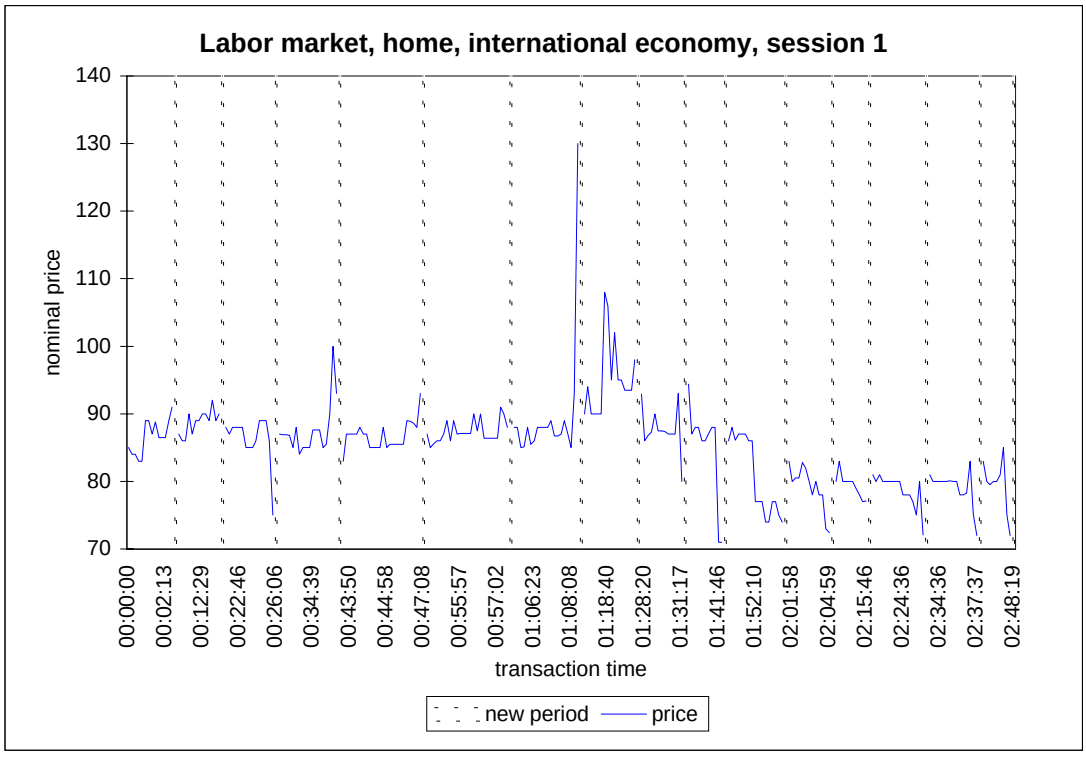
transaction time
new period
price


Labor market, home, international economy, session 1
nominal price
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110
100
90
80
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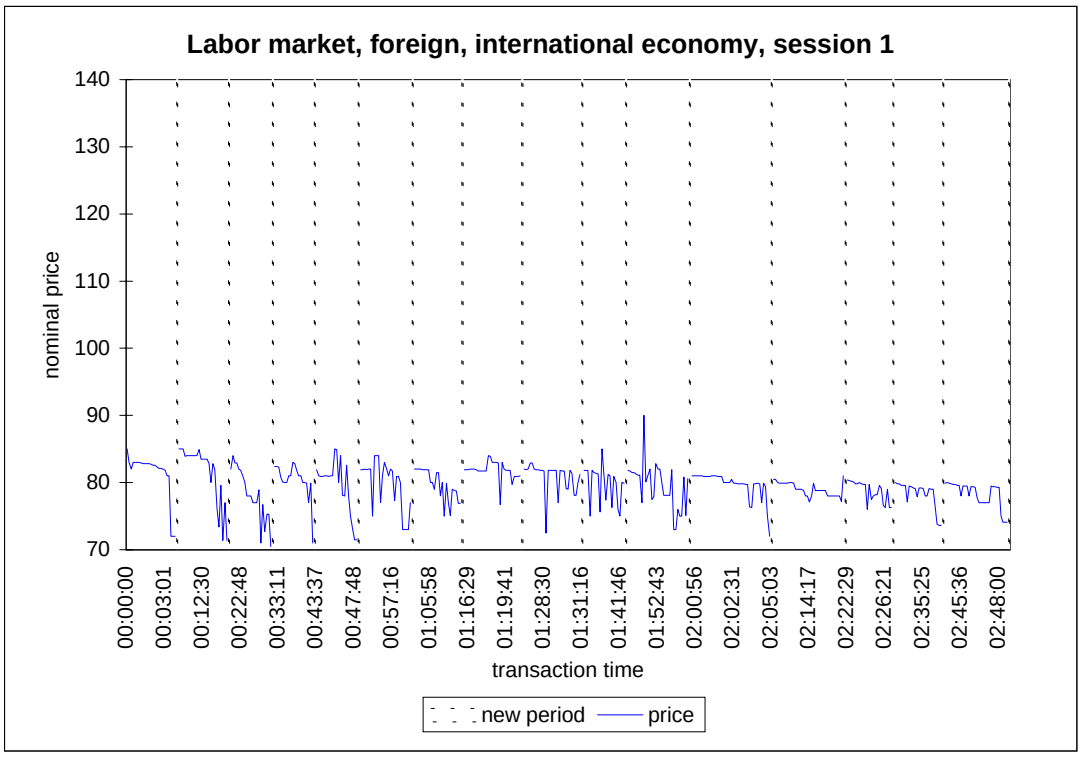
transaction time
new period
price


Labor market, foreign, international economy, session 1
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110
100
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80
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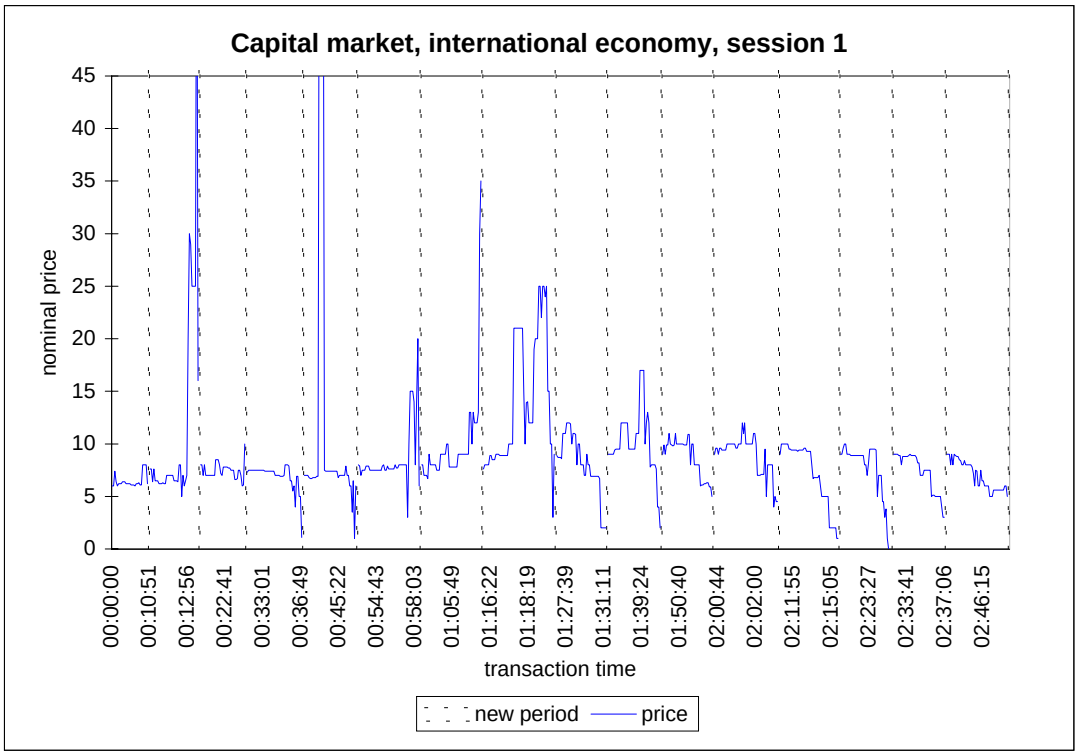
transaction time
new period
price


Capital market, international economy, session 1
nominal price
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20
15
10
5
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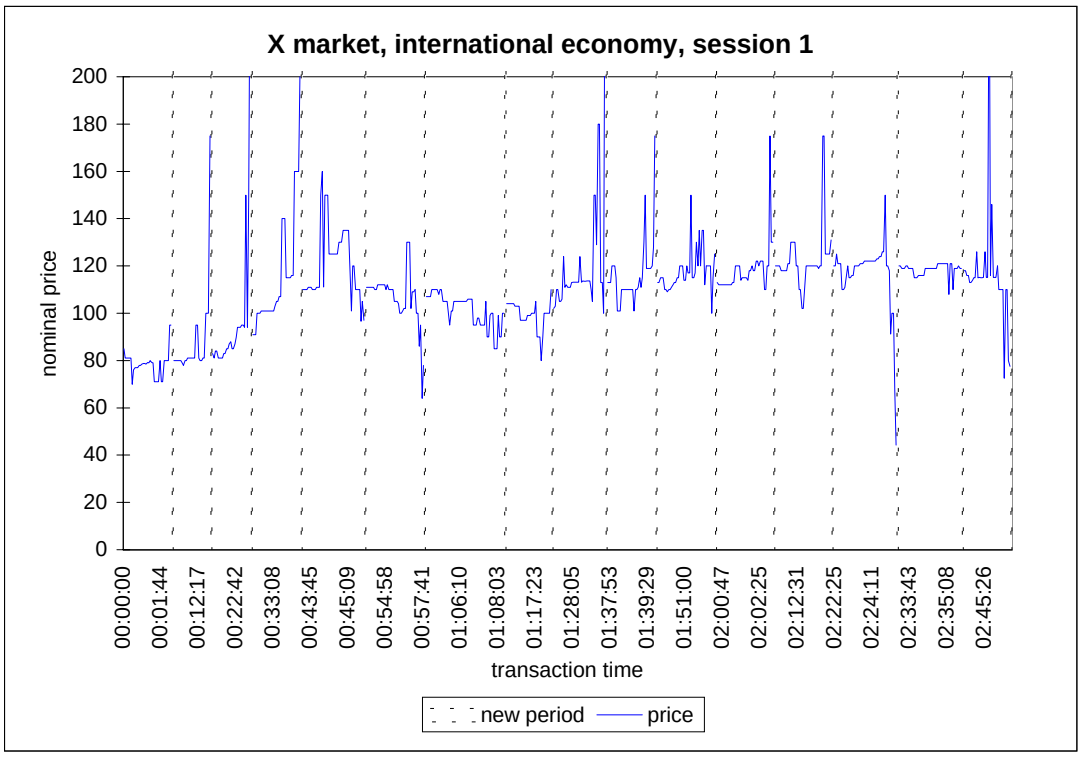
transaction time
new period
price


X market, international economy, session 1
nominal price
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140
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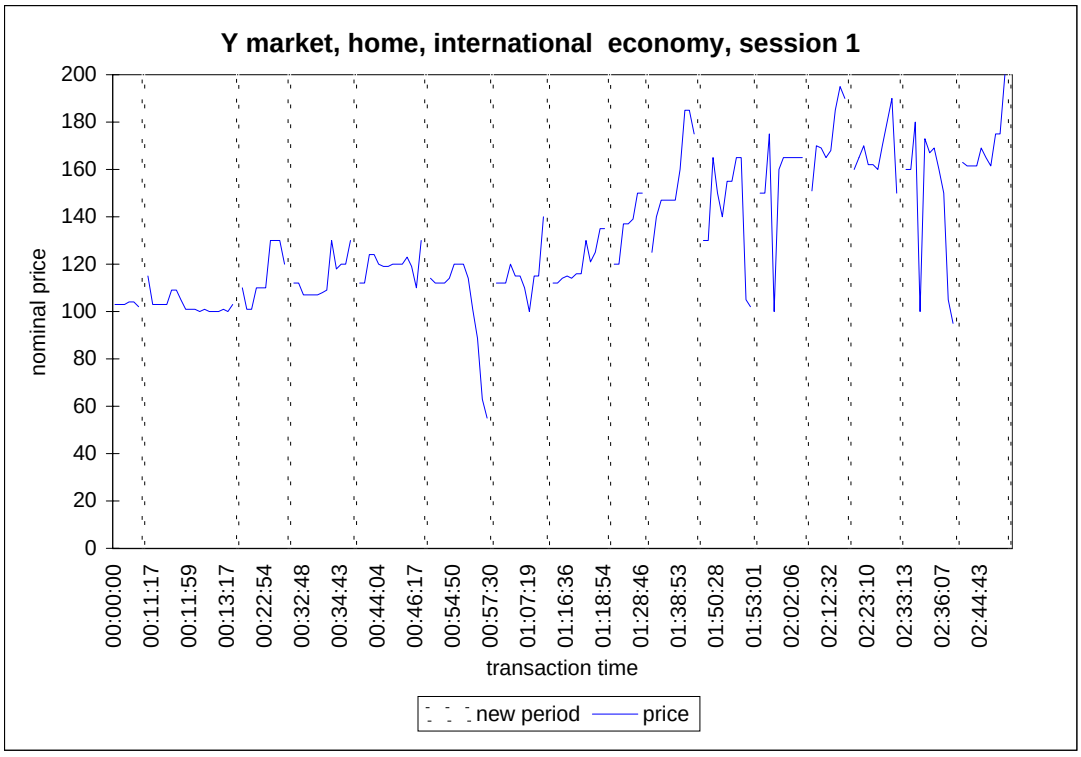
transaction time
new period
price


Y market, home, international economy, session 1
nominal price
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120
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01:50:28
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02:36:07
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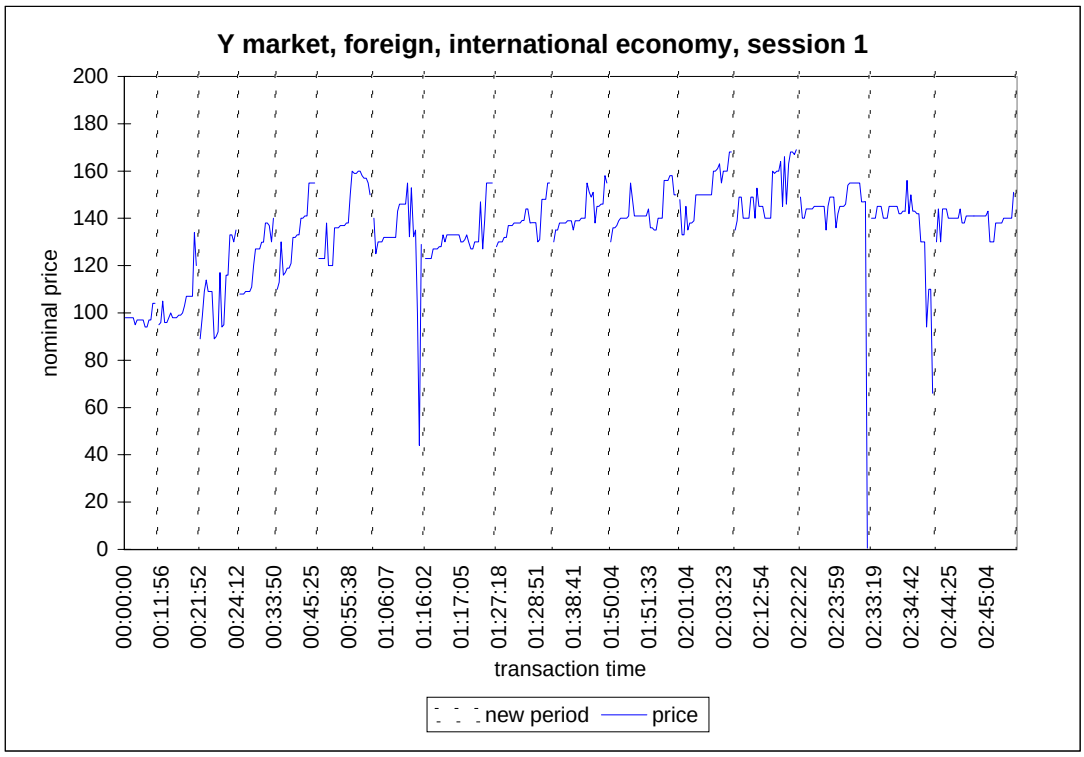
transaction time
new period
price


Y market, foreign, international economy, session 1
nominal price
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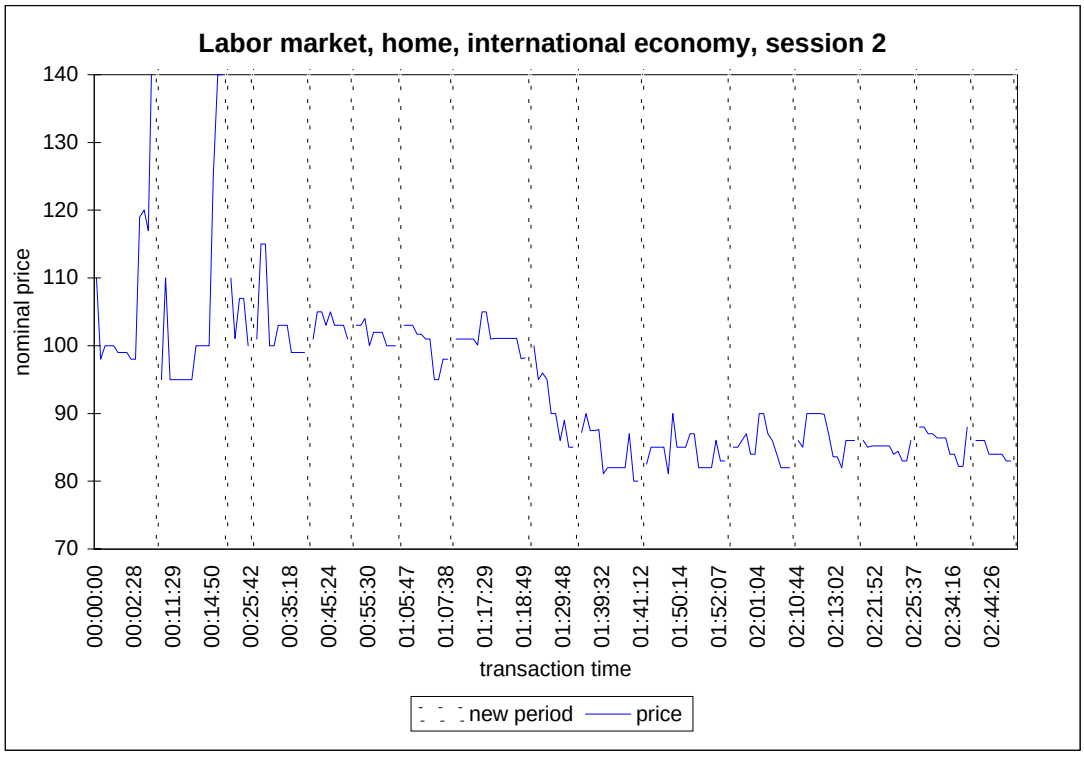
02:45:04
transaction time
new period
price


Labor market, home, international economy, session 2
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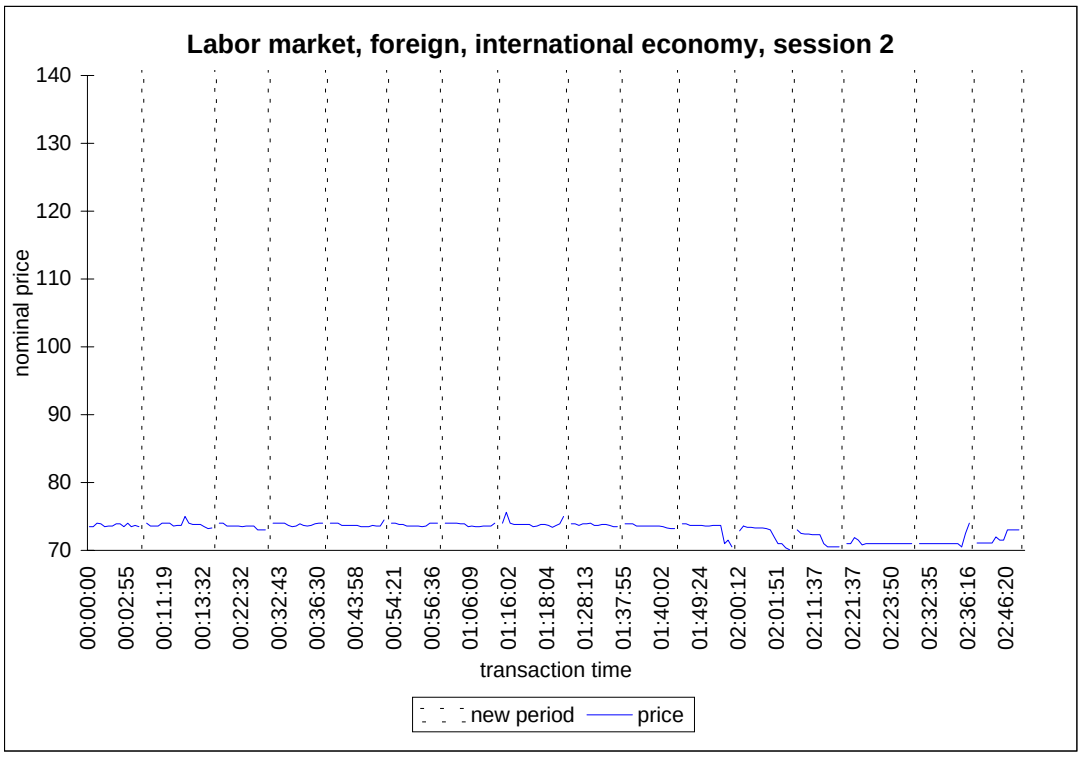
02:44:26
transaction time
new period
price


Labor market, foreign, international economy, session 2
nominal price
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02:00:12
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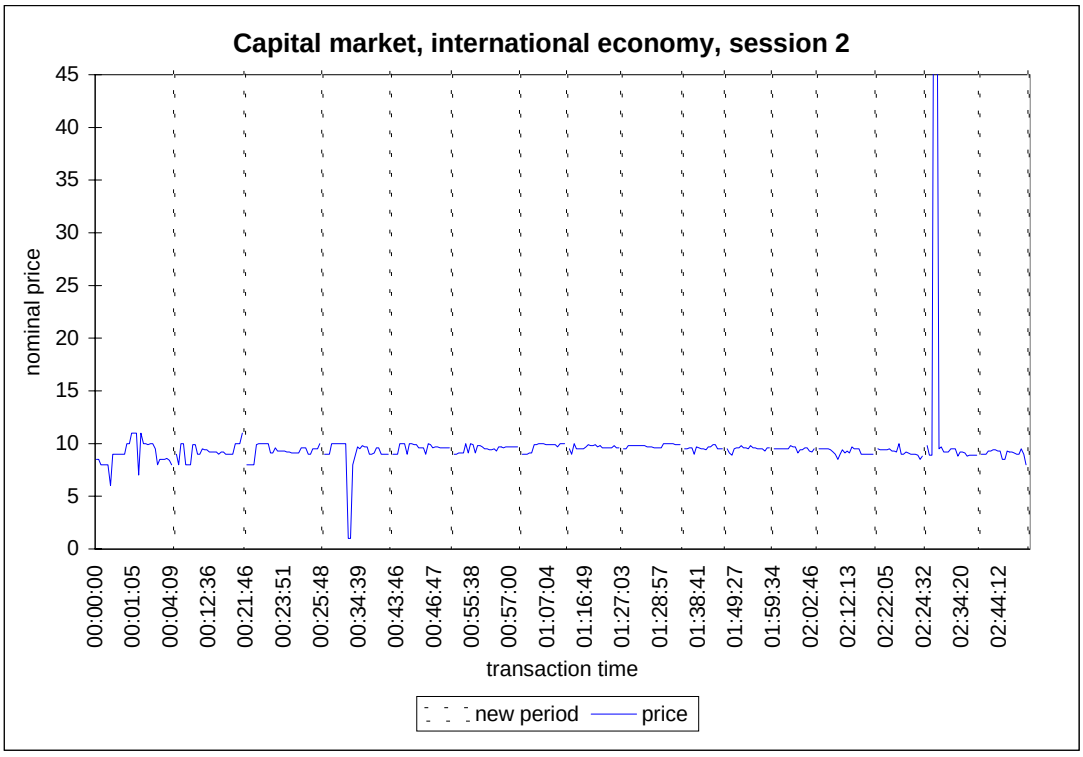
02:46:20
transaction time
new period
price


Capital market, international economy, session 2
nominal price
45
40
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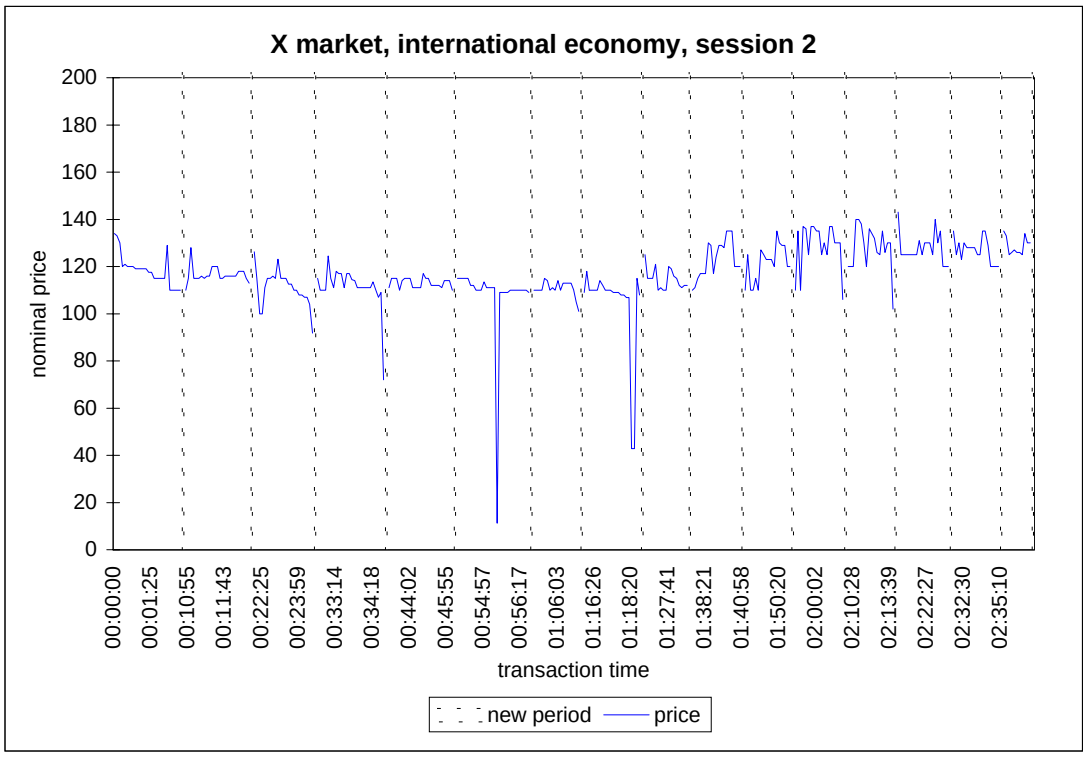
02:44:12
transaction time
new period
price


X market, international economy, session 2
nominal price
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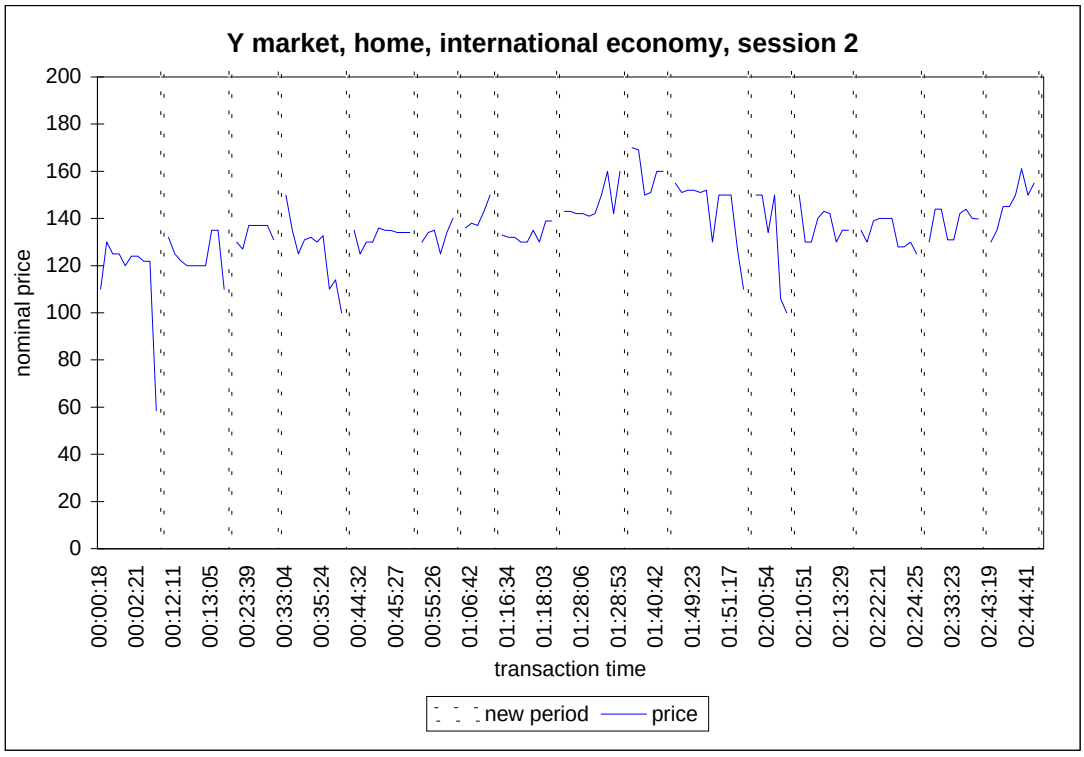
02:35:10
transaction time
new period
price


Y market, home, international economy, session 2
nominal price
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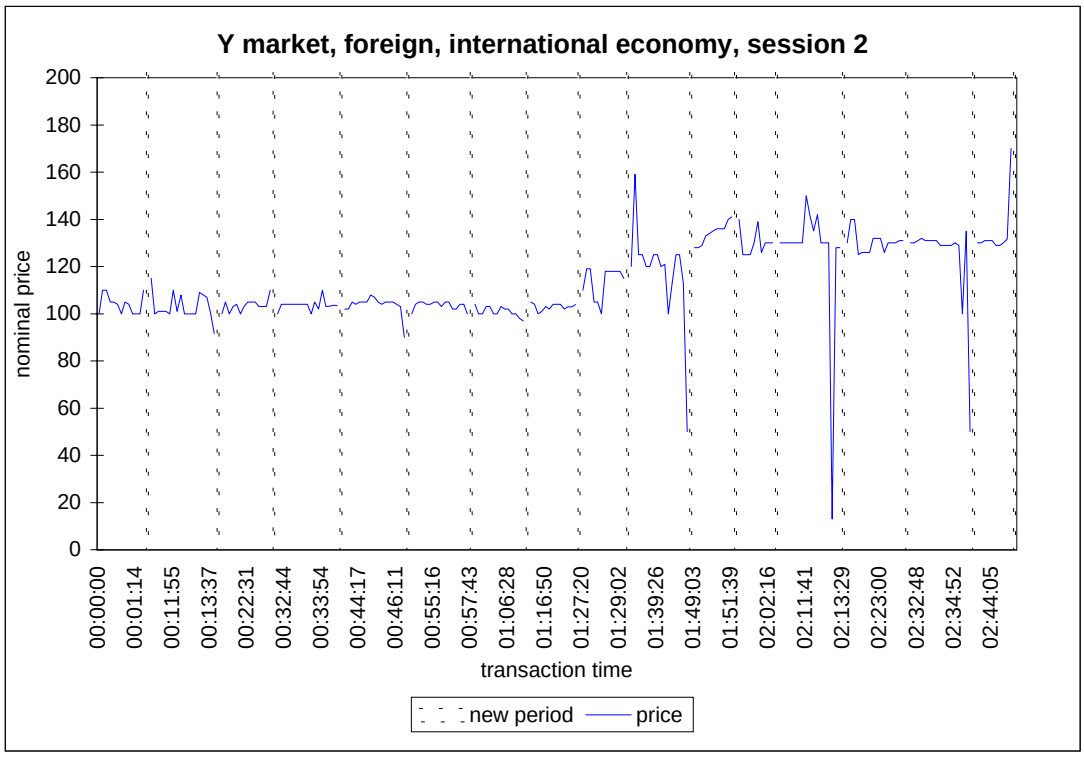
transaction time
new period
price


Y market, foreign, international economy, session 2
nominal price
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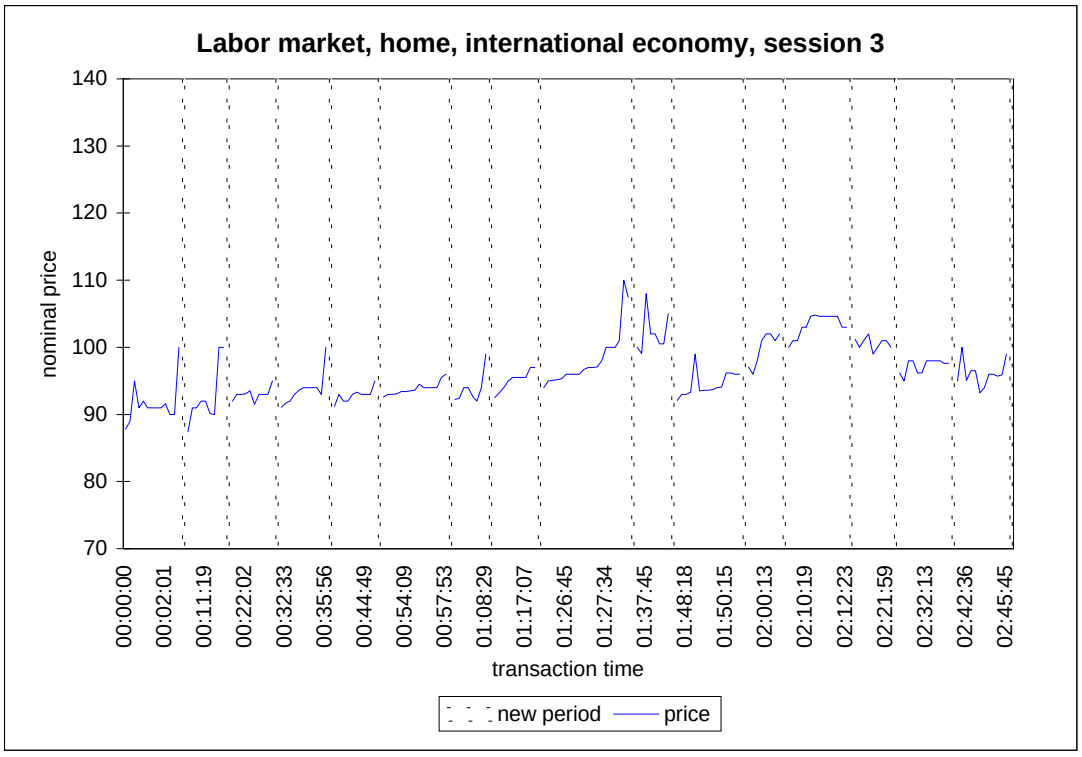
transaction time
new period
price


Labor market, home, international economy, session 3
nominal price
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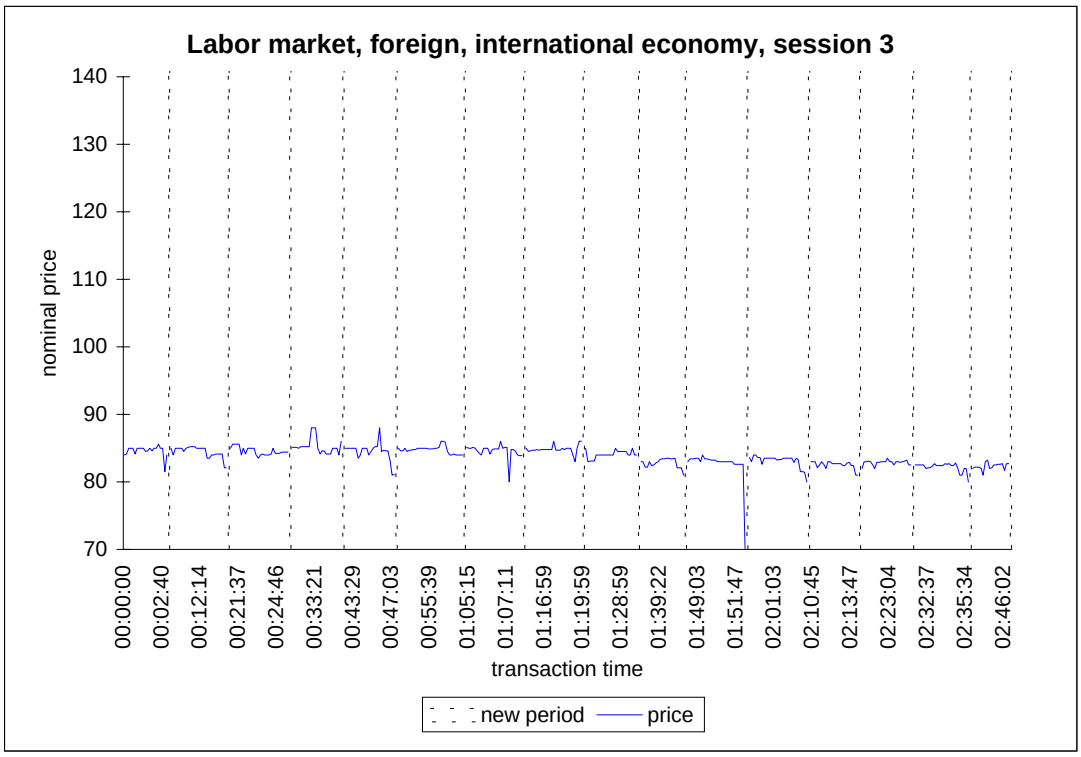
transaction time
new period
price


Labor market, foreign, international economy, session 3
nominal price
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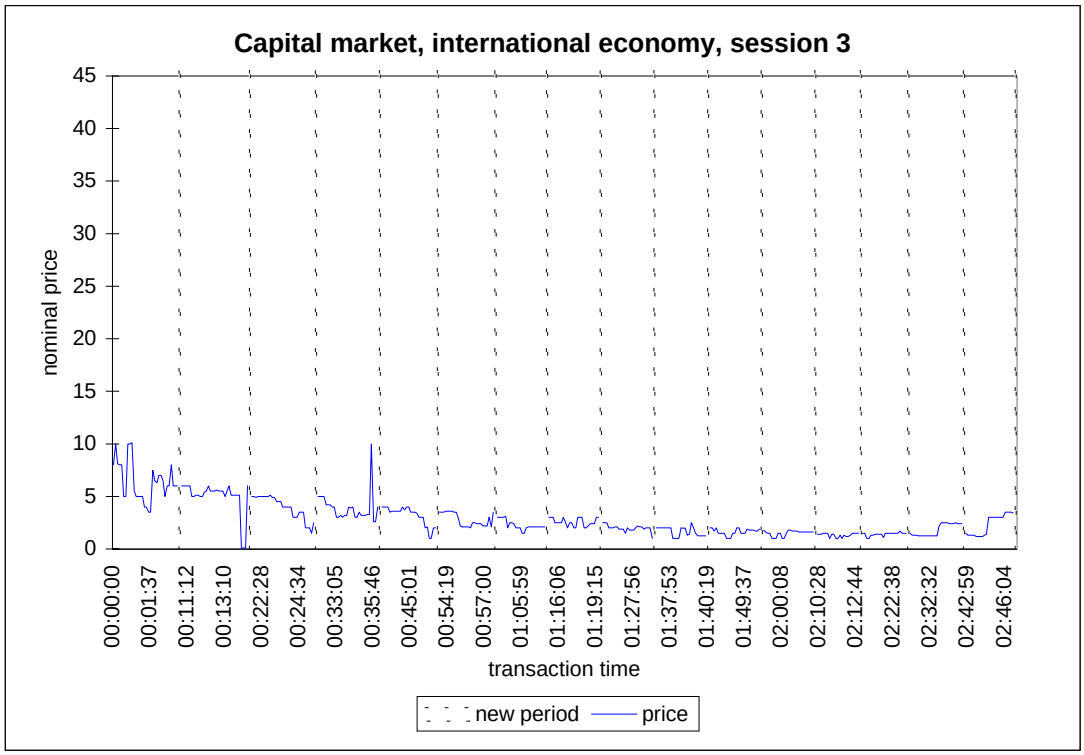
transaction time
new period
price


Capital market, international economy, session 3
nominal price
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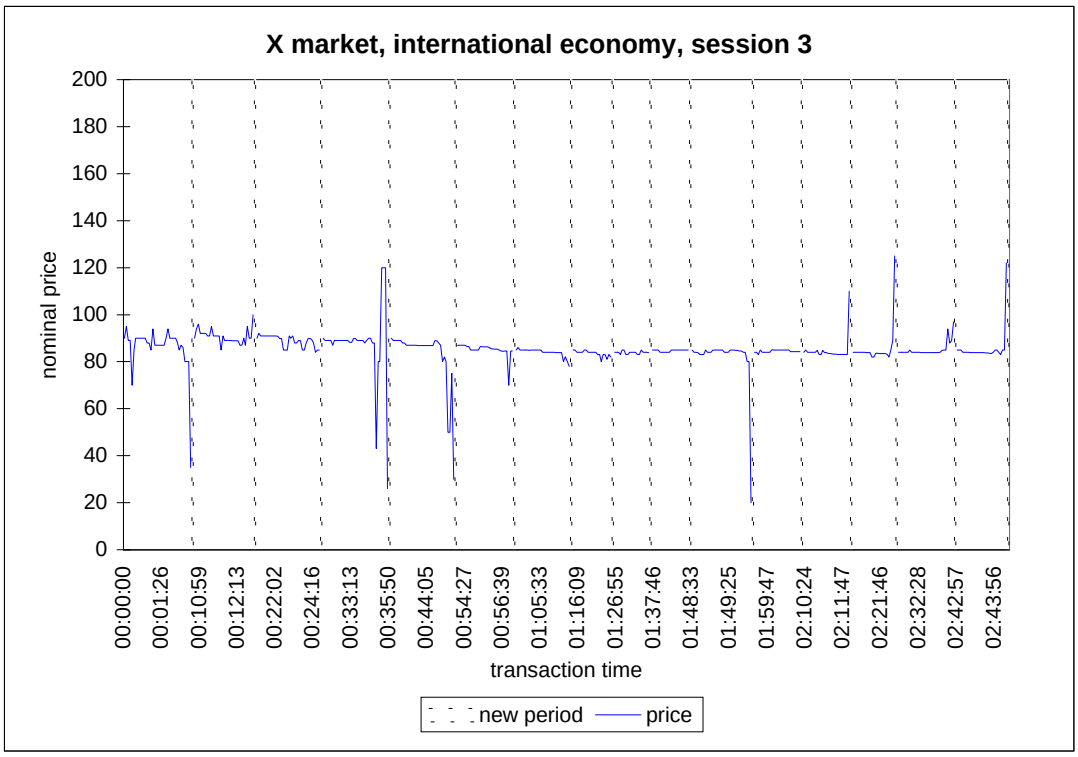
transaction time
new period
price


X market, international economy, session 3
nominal price
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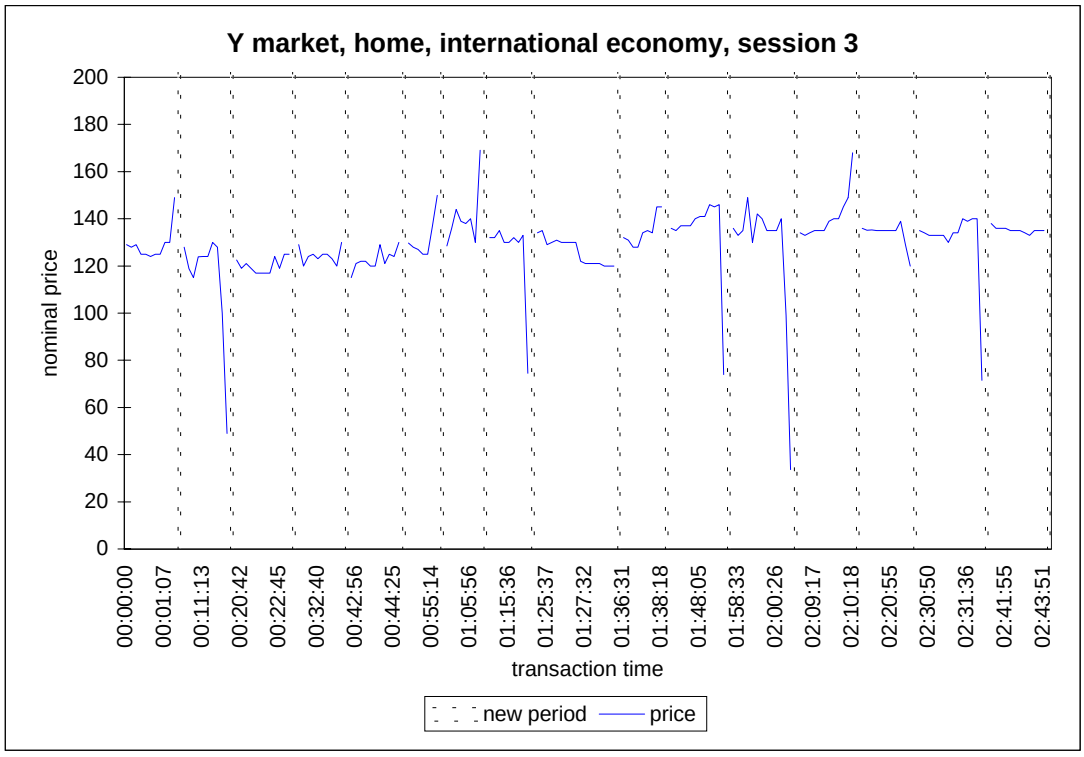
transaction time
new period
price


Y market, home, international economy, session 3
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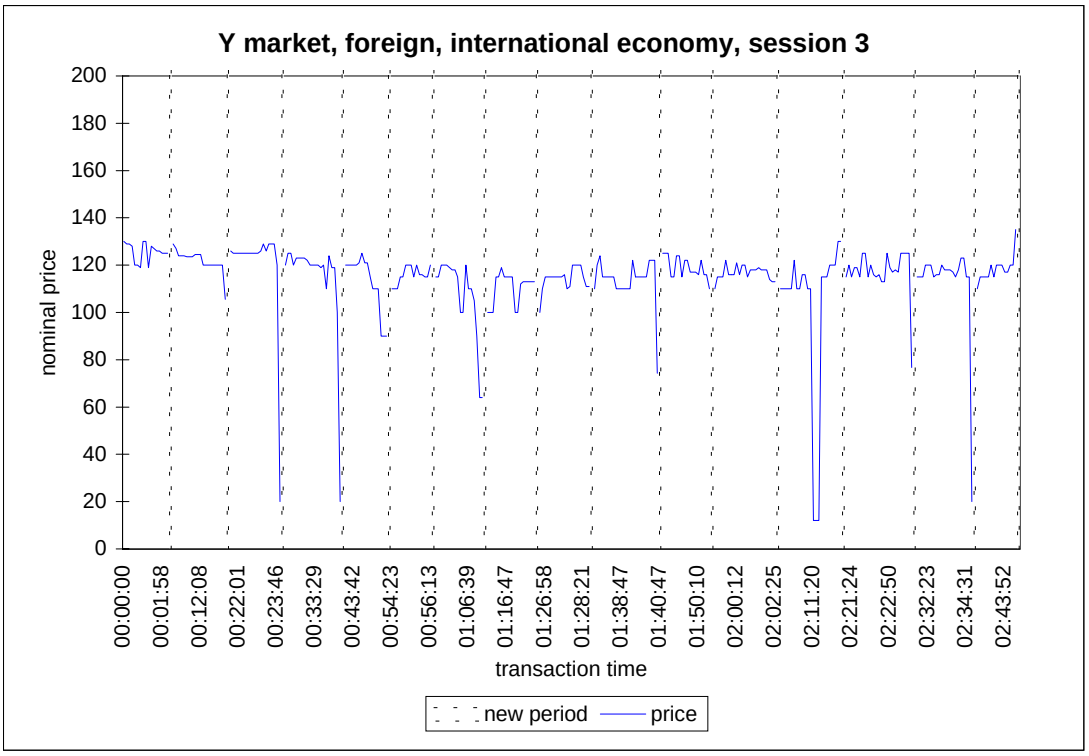
transaction time
new period
price


Y market, foreign, international economy, session 3
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transaction time
new period
price