

Input versus Output Taxation in an Experimental International Economy.

Arno Riedl & Frans van Winden

Maastricht University & University of Amsterdam

forthcoming *European Economic Review*

Introduction & Motivation

Time usually elapses (...) between the incurring of costs by the producer (with the consumer in view) and the purchase of the output by the ultimate consumer. Meanwhile the entrepreneur (...) has to form the best expectations he can as to what the consumers will be prepared to pay when he is ready to supply them (...). J. M. Keynes (1970 [1936], p. 46)

Introduction & Motivation

- **Effects of taxation on behavior of consumers and producers.**
 - Taxing inputs versus taxing outputs \leftrightarrow time, uncertainty
 - Policy relevance (EU white papers)
 - Shifting taxation from inputs to outputs a good thing to do?
 - unclear from optimal taxation & pure theory perspective
 - Diverging opinions of experts on effects of different tax systems
- **Research method:**
 - Experimental study on macroeconomic policy issue
(Dutch Ministry of Social Affairs and Unemployment)

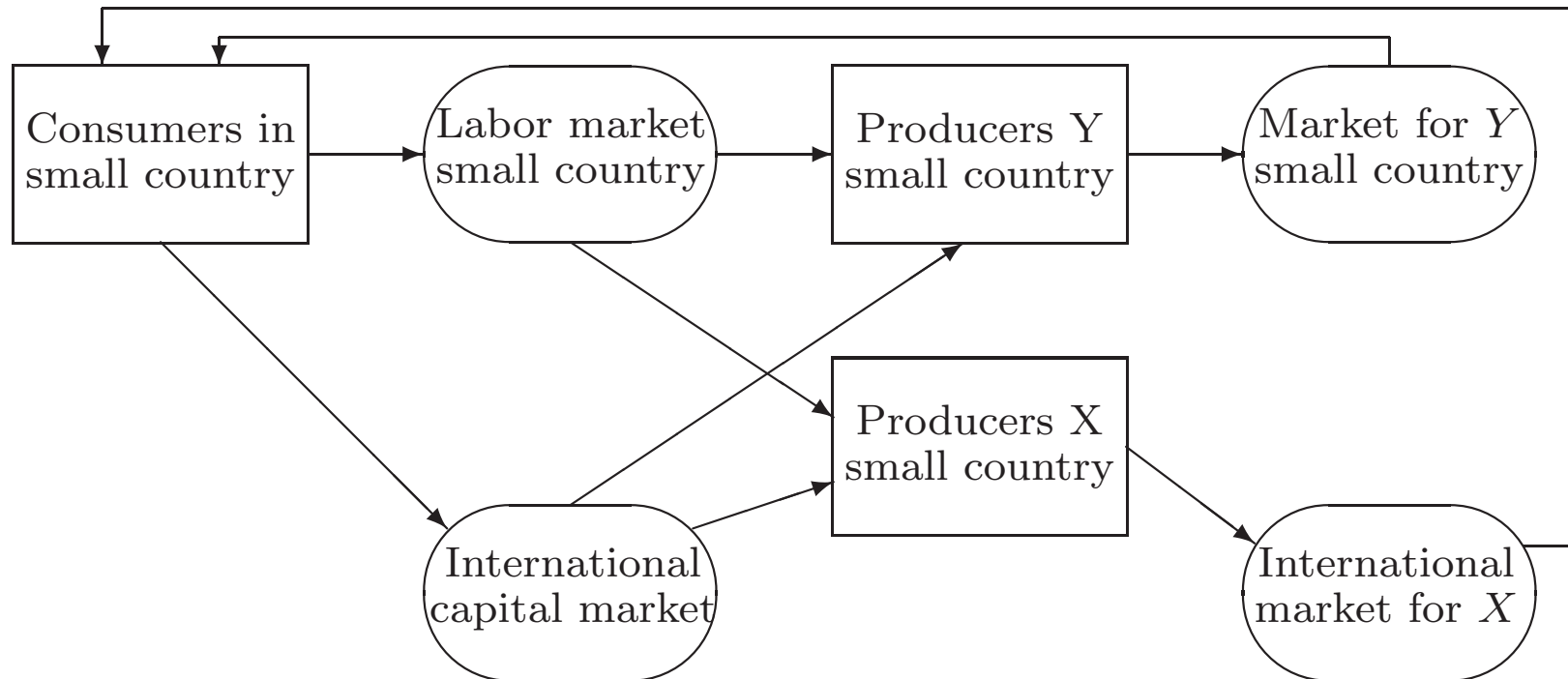
An International Lab-Economy - An Informal Description

- **International economy with two countries**
 - Small ('home') country, large ('foreign') country
- **Consumers and producers in each country**
 - Consumers: supply labor and capital, demand consumption goods, value consumption goods and leisure
 - Producers: demand labor and capital, supply consumption goods, earn profits
- **Two sectors in each country**
 - exposed sector X , sheltered sector Y
 - X capital intensive, Y labor intensive

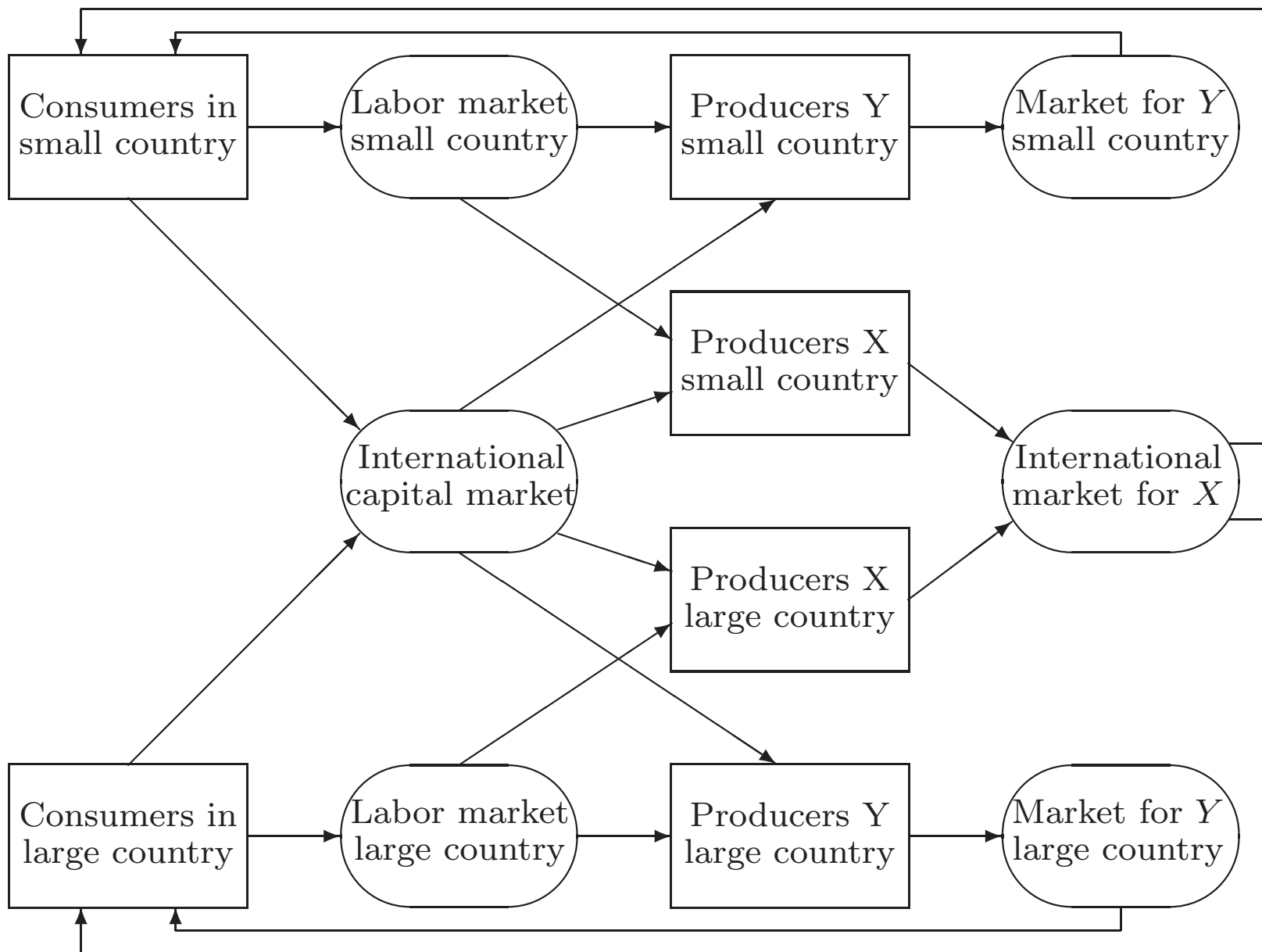
An International Lab-Economy - An Informal Description

- **Tax systems to finance (un)employment (benefits) subsidies**
 - WT-system: Wage Tax finances benefits for unemployed units of labor
 - STLS-system: Sales Tax finances benefits for unemployed units of labor and employment subsidies (Labor Subsidy)
 - Large country → always WT
 - Small country → WT or STLS
- Trading institution in all markets
 - Multiple-units double auction (highly competitive)

An International Lab-Economy - An Informal Description



An International Lab-Economy - An Informal Description



Preferences and production technologies

Consumers i (utility functions):

$$U_{ik} = 25 [\ln X_{ik} + \ln Y_{ik} + .25 \ln(\bar{L}_{ik} - L_{ik})],$$

$$U_{ik} = 0 \text{ if either } X_{ik}, Y_{ik}, \text{ or } \bar{L}_{ik} - L_{ik} \text{ equals zero, } k = s, l$$

} both tax systems

Preferences and production technologies

Consumers i (utility functions):

$$U_{ik} = 25 [\ln X_{ik} + \ln Y_{ik} + .25 \ln(\bar{L}_{ik} - L_{ik})],$$

$$U_{ik} = 0 \text{ if either } X_{ik}, Y_{ik}, \text{ or } \bar{L}_{ik} - L_{ik} \text{ equals zero, } k = s, l$$

} both tax systems

Producers j (production functions):

$$Z_{jzk} = A_k \left[\eta_z^{1-\gamma_z} L_{jzk}^{\gamma_z} + (1 - \eta_z)^{1-\gamma_z} K_{jzk}^{\gamma_z} \right]^{\frac{0.9}{\gamma_z}}, \quad Z = X, Y; \quad z = x, y; \quad k = s, l$$

Labor intensities : $\eta_x = .5625$, $\eta_y = .675$;

Substitution elasticities : $\gamma_x = -2$, $\gamma_y = -6$

Scaling factor: $A_s = 1$ (small country), $A_l = 1.21$ (large country)

Endowments

	Small country	Large country
Cons.	$\bar{L}_i = 15, \bar{K}_i = 10, Cash_i = 181$	$\bar{L}_i = 105, \bar{K}_i = 70, Cash_i = 1268$
X-prod.	$\bar{L}_j = 0, \bar{K}_j = 0, Cash_j = 1223$	$\bar{L}_j = 0, \bar{K}_j = 0, Cash_j = 8557$
Y-prod.	$\bar{L}_j = 0, \bar{K}_j = 0, Cash_j = 815$	$\bar{L}_j = 0, \bar{K}_j = 0, Cash_j = 5705$

Number of agents

Cons.	3	3
X-Prod.	2	2
Y-Prod.	3	3

Tax Systems

- **Three experimental sessions with WT-system**

Two regimes:

- Eight periods constant (wage) tax regime: $\tau_w^0 = .3777$
- Eight periods variable (wage) tax regime: $\tau_{wk}^{t+1} w_k^t L_k^t = w_0 (\bar{L}_k - L_k^t)$
- w_0 ... unemployment benefit

Tax Systems

- **Three experimental sessions with WT-system**

Two regimes:

- Eight periods constant (wage) tax regime: $\tau_w^0 = .3777$
- Eight periods variable (wage) tax regime: $\tau_{wk}^{t+1} w_k^t L_k^t = w_0 (\bar{L}_k - L_k^t)$
- w_0 ... unemployment benefit

- **Three experimental sessions with STLS-system (in small country)**

Two regimes:

- Eight periods constant (sales) tax regime: $\tau_x^0 = .6521, \tau_y^0 = .7518$
- Eight periods variable (sales) tax regime:

$$\tau_{xs}^{t+1} p_x^t X_s^t + \tau_{ys}^{t+1} p_{ys}^t Y_s^t = w_0 \bar{L}_s, \tau_{xs}^{t+1} / \tau_{ys}^{t+1} = \tau_{xs}^0 / \tau_{ys}^0$$
- w_0 ... unemployment benefit & employment subsidy

Theoretical General Equilibrium Predictions

	WT-system	STLS-system	
		equilibrium 1	equilibrium 2
	International		
K	240	240	240
X	177	181	182

Theoretical General Equilibrium Predictions

	WT-system	STLS-system	
		equilibrium 1	equilibrium 2
	International		
K	240	240	240
X	177	181	182
	Small country		
K_s	30	28	11
L_s	28	33	18
X_s^c	22	25	17
X_s^p	22	25	14
Y_s	19	21	11
τ_{ws}	0.3777		
τ_{xs}		0.4889	0.7835
τ_{ys}		0.5414	0.8677

From the small country's perspective: there is a good and a bad theoretical equilibrium.

Results - A Short Preview

- Clear behavioral equilibration process.
- WT-system shows persistent budget deficits leading to tax adjustments with a negative impact on economic performance.
- STLS-system generates budget surpluses and has positive effects on economic performance in the small country.
- No capital flight from the small to the large country under the STLS-system!
- No tendency towards more labor intensive production under the STLS-system.

Results - A Short Preview

- Clear behavioral equilibration process.
- WT-system shows persistent budget deficits leading to tax adjustments with a negative impact on economic performance.
- STLS-system generates budget surpluses and has positive effects on economic performance in the small country.
- No capital flight from the small to the large country under the STLS-system!
- No tendency towards more labor intensive production under the STLS-system.

The alternative sales-tax-*cum*-labor-subsidy system performs significantly better than the wage tax system.

Further Experimental Features

- Sequential markets, first factor markets then commodity markets
- Taxes are levied on producers
- Seeded profits for consumers, working capital for producers
- Computerized experiment at CREED-lab (University of Amsterdam)
- Each subject participated in (1) training session, (2) closed economy session, (3) international economy session (about 11 hours in total)
- Payment according to performance (utility, profits),
average earnings: € 15,- per hour in (3)

Experimental Results

- **Overall behavior of markets** in terms of prices and quantities
- **Comparison of tax systems:** focus on economic performance of small country
 - **Unemployment**
 - **Real GDP**
 - Budget surplus & taxes
 - Consumer earnings ('utility')
 - Net capital export
 - *Y*-production intensity

Experimental Results

- **Overall behavior of markets** in terms of prices and quantities
- **Comparison of tax systems:** focus on economic performance of small country
 - **Unemployment**
 - **Real GDP**
 - **Budget surplus & taxes**
 - **Consumer earnings** (‘utility’)
 - **Net capital export**
 - **Y-production intensity**

Convergence analysis:

$$y_{it} = a_{11}D_{A1}(1/t) + a_{12}D_{A2}(1/t) + a_{13}D_{A3}(1/t) + a_2D_A(t-1)/t + b_{11}D_{B1}(1/t) + b_{12}D_{B2}(1/t) + b_{13}D_{B3}(1/t) + b_2D_B(t-1)/t + u_{it}$$

Experimental Results

A first result.

With constant taxes and the WT-system obtaining in both countries, a majority of the variables (10 out of 18) exhibits at least weak convergence towards the theoretical general equilibrium levels. The *quantity* and *input price* variables are typically *converging from below*, while the *output prices* are typically *converging from above*.

Experimental Results

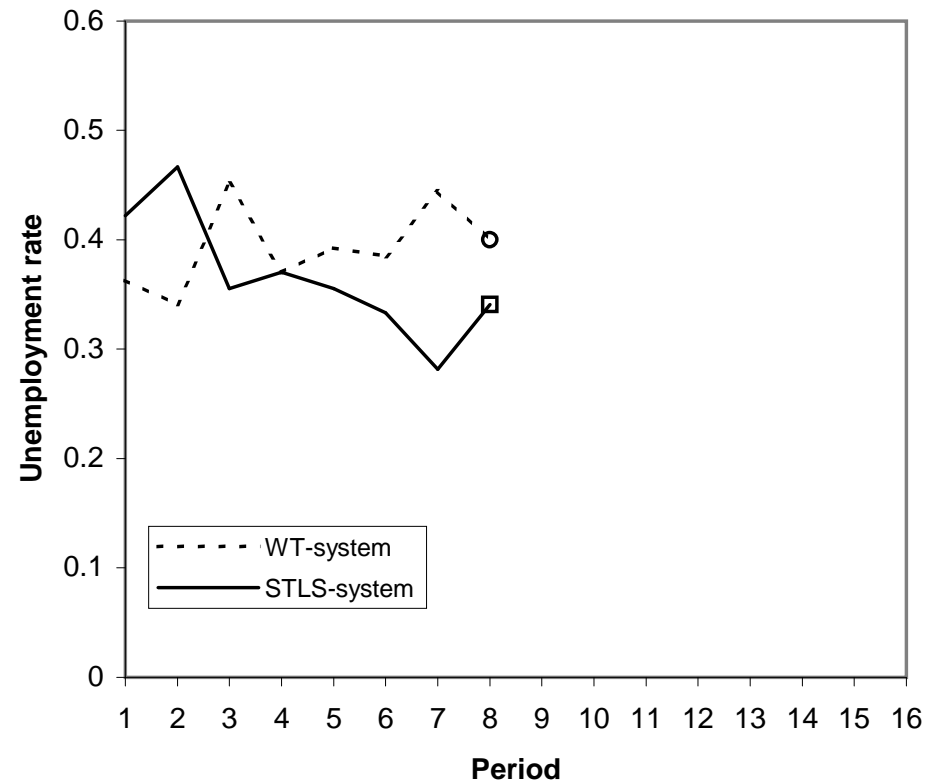
- Unemployment rates under the two tax systems - constant tax

Constant tax regime:

Initially, unemployment rates are similar under the different tax systems; in the longer run unemployment rates are lower under the STLS-system.

$$a_2 = 0.43, b_2 = 0.31,$$

$$p\text{-value} = 0.001$$



Experimental Results

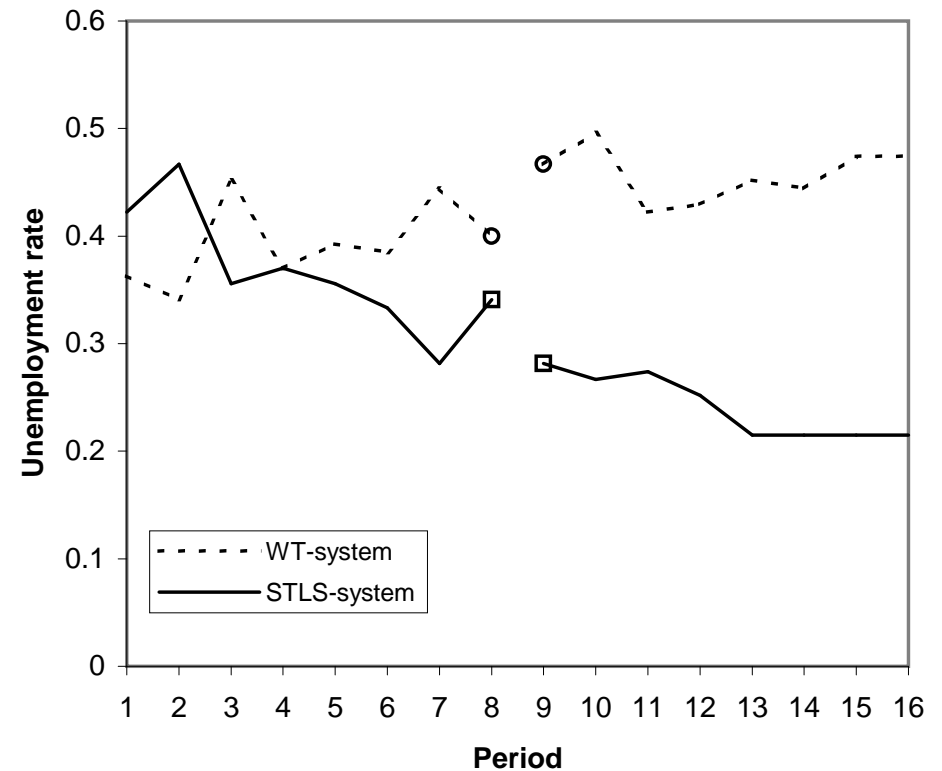
- Unemployment rates under the two tax systems - variable tax

Variable tax regime:

Initially as well as in the longer run unemployment rates are significantly smaller in the STLS-system than in the WT-system.

$$a_2 = 0.48, b_2 = 0.24,$$

$$p\text{-value} = 0.000$$



Experimental Results

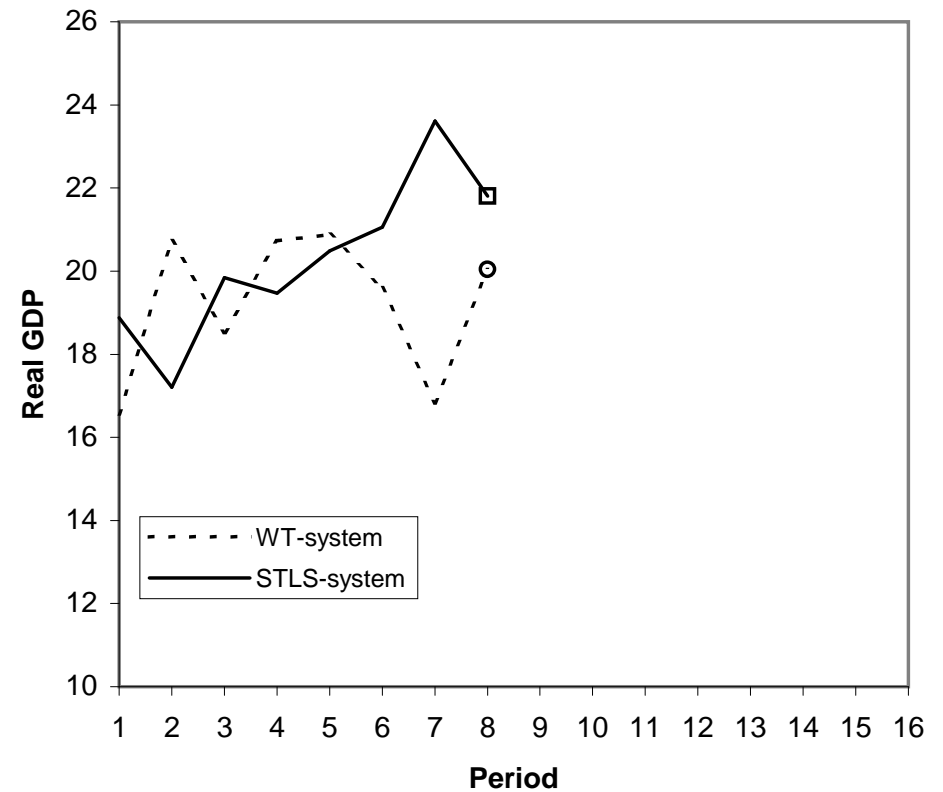
- **Real GDP under the two tax systems - constant tax**

Constant tax regime:

Initially as well as in the longer run real GDP is similar under the different tax systems.

$a_2 = 20.0$, $b_2 = 21.8$,

p - value = 0.039



Experimental Results

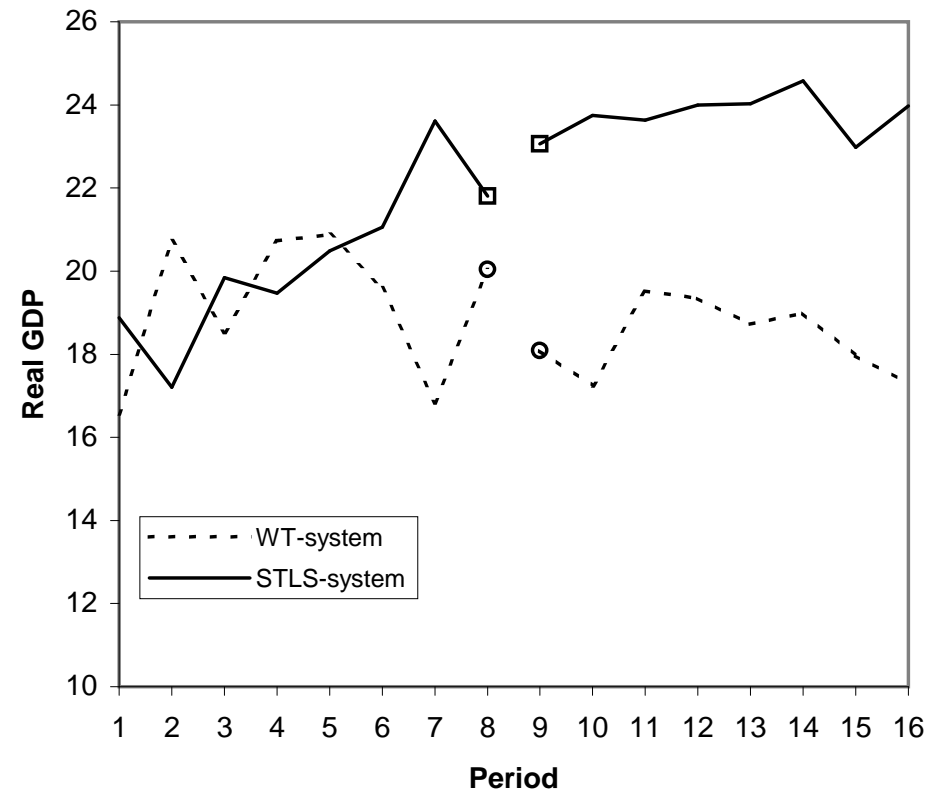
- **Real GDP under the two tax systems - variable tax**

Variable tax regime:

Initially as well as in the longer run real GDP is significantly larger in the STLS-system than in the WT-system.

$a_2 = 18.9$, $b_2 = 22.8$,

p - value = 0.000

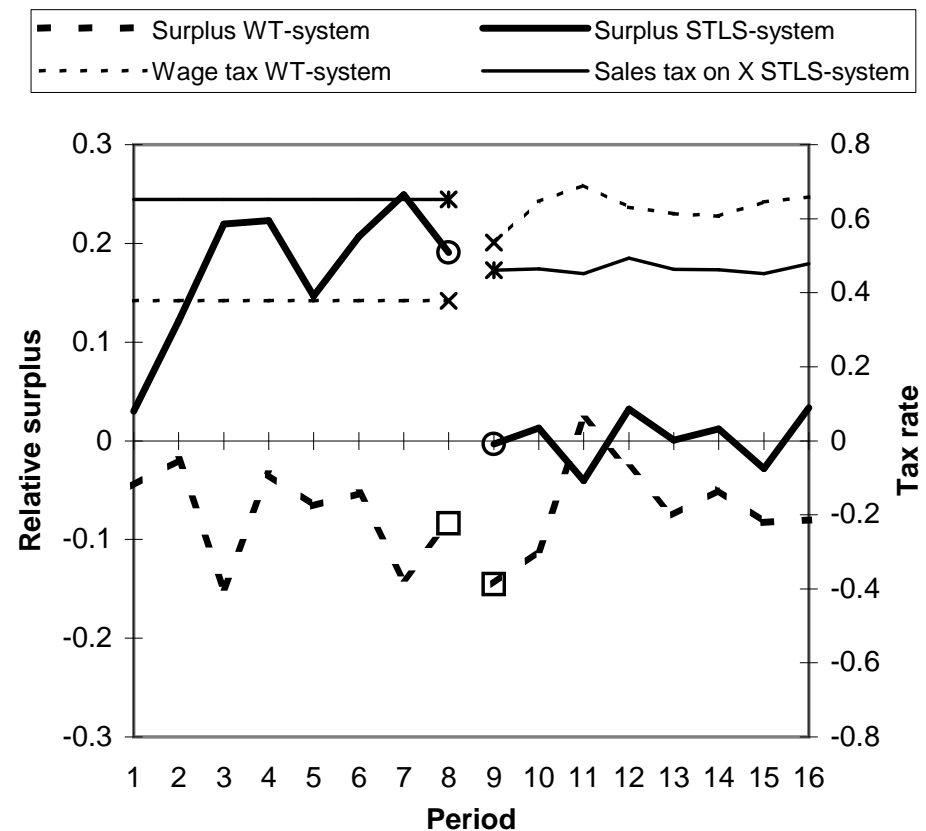


Experimental Results

• Budget Surplus and Taxes under the two tax systems

Constant tax regime:

The WT-system generates persistent budget deficits whereas under the STLS-system budget surpluses are observed. ($a_2 = -0.14$, $b_2 = 0.21$, p -value = 0.000)



Experimental Results

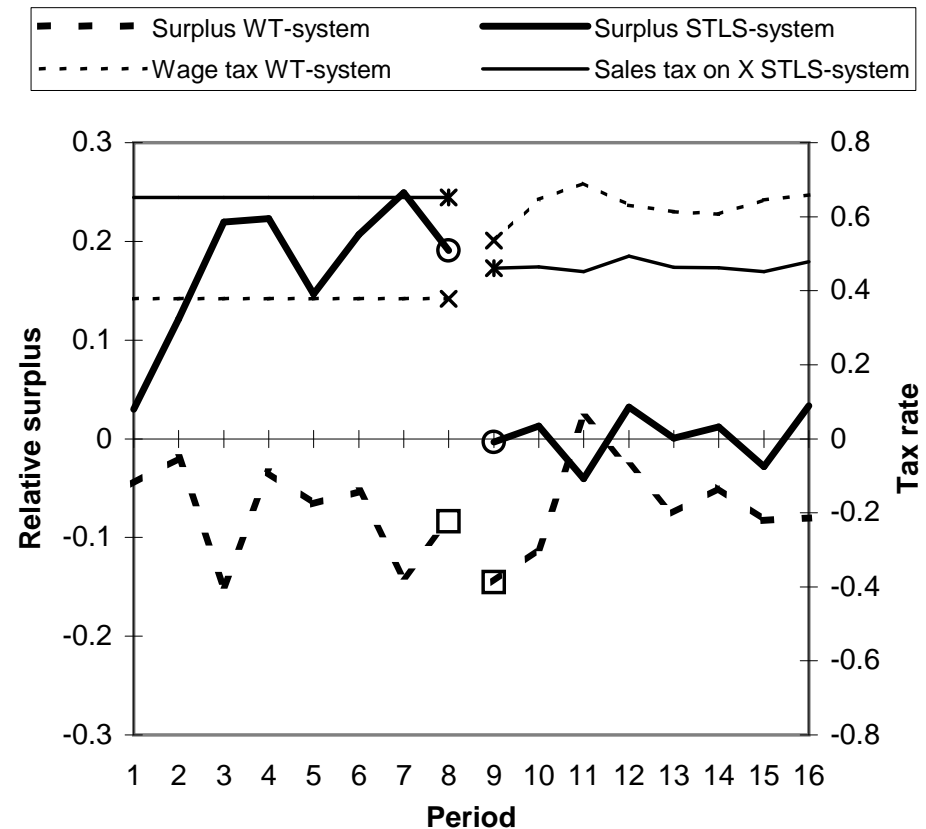
• Budget Surplus and Taxes under the two tax systems

Constant tax regime:

The WT-system generates persistent budget deficits whereas under the STLS-system budget surpluses are observed. ($a_2 = -0.14$, $b_2 = 0.21$, p -value = 0.000)

Variable tax regime:

Under both systems budgets are balanced and no significant difference between systems is observed. However, under the WT-system taxes are high, whereas under the STLS-system taxes initially decrease and remain at a moderate level.



Experimental Results

Further, similar results also hold for the other performance measures:

- consumer earnings
- net capital export
- Y -production intensity

Experimental Results

The effect of tax increases strongly differs across tax systems:

- Compared to wage tax changes, increases in the **sales tax** appear to have a much **smaller adverse economic impact**.
- An **increase** in the **wage tax** shows a clearly **detrimental effect** on labour unemployment and capital employment, no significant effect is observed for the sales tax.
- The **negative effect** of the **sales tax** on GDP is much **weaker** than that of the wage tax.

Variable	Unemploy-	Capital	Real GDP
	ment rate	employment	
	Small country		
τ_{ws}	.4420*** (.0554)	−27.95*** (6.02)	−11.95*** (1.92)
τ_{xs}	.1831* (.0728)	−8.87 (7.10)	−6.85*** (2.03)
τ_{wl}	−.0342 (.0425)	3.82 (5.70)	−.25 (1.32)
period	−.01 (.05)	1.11 (.54)*	−.03 (.14)
constant	.26*** (.06)	31.30*** (6.24)	26.72*** (1.78)

A behavioral explanation & empirical support

Claim: Uncertainty about product prices makes producers reluctant to incur production costs.

This can explain the good economic performance of the sales-tax-*cum*-labor-subsidy system in comparison with the wage tax system. Instead of being confronted with a tax burden up-front on the input of labor, producers under the former system receive a labor subsidy and only have to pay taxes in proportion to their sales revenues, which effectively means risk sharing by the government.

A behavioral explanation & empirical support

- **Four pieces of evidence:**

1. Under the WT-system quantity and input price variables typically converge from below, whereas output prices converge from above towards the theoretical equilibrium levels.
2. Producers' marginal revenue product typically *exceeds* the input price.

Fraction of cases where producers' mrp exceeds net input price.

		WT-system		STLS-system	
		Labor	Capital	Labor	Capital
Small country					
X-sector	all	0.4792	0.6458	0.7500	0.9583
		(0.6950)	(0.0028)	(0.0000)	(0.0000)
Y-sector	all	0.5764	0.7708	0.6944	0.6736
		(0.0399)	(0.0000)	(0.0000)	(0.0000)

A behavioral explanation & empirical support

- **Four pieces of evidence:**

3. The demand for factors is negatively correlated with output price uncertainty.

Correlation of factor employment and output price uncertainty

	St.dev. output price			St.dev. output price	
	WT-system	STLS-system		WT-system	STLS-system
L_{ys}	-0.0868 (0.5709)	-0.3490 (0.0188)	K_{ys}	-0.0056 (0.9711)	-0.3390 (0.0227)
L_{xs}	-0.3195 (0.0324)	-0.5016 (0.0004)	K_{xs}	-0.3004 (0.0450)	-0.6194 (0.0000)
L_x	-0.2828 (0.0598)	-0.6565 (0.0000)	K_x	-0.0523 (0.7331)	-0.6567 (0.0000)

4. Increases in the sales tax have much weaker adverse effects than increases in the wage tax.

Conclusions

- The sales-tax-*cum*-labor-subsidy system clearly outperforms the wage tax system
 - unemployment, real GDP, consumer earnings, ...
- The introduction of a sales tax instead of a wage tax does not lead to capital flight
- An increase in the sales tax appears to have a much weaker adverse effect than an increase in the wage tax
- Under the STLS-system economic activity is attracted by the good equilibrium

Conclusions

- The **sales-tax-cum-labor-subsidy** system clearly **outperforms** the **wage tax** system
 - unemployment, real GDP, consumer earnings, ...
- The introduction of a **sales tax** instead of a wage tax does **not lead to capital flight**
- An increase in the **sales tax** appears to have a much **weaker adverse effect** than an increase in the wage tax
- Under the **STLS-system** economic activity is attracted by the **good equilibrium**
- Explanation → producers are reluctant to incur production costs up-front when facing product price uncertainty
 - four pieces of empirical evidence

A Wider Bearing on Theoretical Modeling

Laboratory experiments can be informative for
macro-economic policy questions and ...

(...) as it turns out, the classical theories of price adjustment are incomplete” and “experiments teach us about theory and it is theory that we use when addressing complex and new problems. The progress builds in slow and in unexpected ways.”

Ch. Plott (2001, Nobel Symposium on Behavioral and Experimental Economics, p.3 & p.27)