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PANEL MODELS AS A TOOL FOR INVESTIGATING THE EFFECTS OF CONSUMPTION VAT IN POLAND IN THE YEARS 1995-2011

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Abstract: Econometric models are employed to establish the redistributive properties of tax systems, but this area of their application is weakly covered in the literature. Used to investigate the burden of consumption taxes, the panel data models allow identifying differences in the burden of indirect taxes falling on households and establishing household types where it is the greatest. This article is an attempt at applying panel regression to explore the redistributive effects of VAT in Poland in the years 1995-2011.

Keywords: VAT, consumption, households, tax regression, panel models

THE REDISTRIBUTIVE CONSEQUENCES OF VAT IN POLAND

The redistributive effects of VAT in Poland have been studied since its introduction in 1993. The first study in this field was carried out in the years 1992-1993 by the *Integrated Tax and Transfer Research Group*[1]. Its purpose was to analyse the amount of VAT paid by households in relation to their disposable incomes, size and socio-economic status. This methodological approach was modified and improved by all subsequent investigations dealing with the redistributive effects of consumption taxes.

As shown by the studies conducted in Poland, the structure of the VAT burden carried by households is strongly related to their wealth. Because Polish VAT is regressive, its impact on the consumption of the lowest-income households is relatively stronger [Dobrowolska 2008]. It has also been found that between

[1] The research team consisted of scientists representing the University of Łódź, the Justus Liebig University in Gießen, the University of Naples Federico II, the Institute of Finance and the Institute of Labour and Social Studies.

1995 and 2011 the average tax burden on households due to the standard VAT rate rose more than twofold, whereas the burden of reduced VAT rates decreased by 18% on average. The situation was caused by the increasing, from 1994, range of goods and services taxed with the standard VAT rate and the decreasing range of goods and services to which preferential VAT rates applied, but also by changes affecting the structure of household consumption [Dobrowolska et al. 2011].

From the social perspective, the main disadvantage of consumption taxes is that they are not fair. They are not directly related to taxpayer's incomes and property status and their shiftability causes that they are comparatively more burdensome for the low-income taxpayers whose consumption accounts for a large share of their expenditure than for taxpayers whose consumption constitutes a small proportion of high incomes. This regularity is perceived as breaching the ability-to-pay principle and is strongly determined by the regressive character of the taxes. Because indirect taxes are regressive, it is not trivial from the social policy standpoint what proportions of budget revenues are derived from direct and indirect taxes. „Because an indirect tax is shiftable, it is difficult to determine what tax burden is actually carried by different agents and to pursue a redistribution policy preferred by the state and accepted by the citizens" [Krajewska 2004].

An attempt at marrying social justice and the economic efficiency of indirect taxes is the application of practically uniform tax rates (this approach is recommended by the European Union and also imposed by the mechanism of the almost ubiquitous VAT tax) that do not affect the structure of consumption, however making some exemptions, out of respect for social justice, for essential goods and luxury goods, in the latter case mainly through the excise mechanism [Ostaszewski et al. 2004].

The above observations have led to a widespread opinion that the distribution of the VAT burden among particular types of households needs to be constantly monitored, not only for the purpose of controlling its social impacts, but also to gain very useful knowledge on how its rates can be respectively diversified or homogenised.

METHODS OF INVESTIGATING THE REDISTRIBUTIVE EFFECTS OF INDIRECT TAXES

There are two main methods in the literature that allow the burden of indirect taxes to be assessed. One method involves observations of the relative tax burden in successive income groups. The percentage share of the tax in the incomes, or expenditures, of individual income groups provides an indication of its character. If the share is decreasing while incomes (expenditures) are going up, than the tax is regressive; a constant share means that the tax is proportional (linear); and a share increasing with rising incomes shows that the tax is progressive. This classification refers to the mean tax rate. In some cases, the marginal tax rate is used to establish

whether the tax is progressive or regressive. With this criterion, a tax is considered progressive when the marginal tax rate is increasing with growing incomes. As a matter of fact, the two approaches produce different results [Neneman 1997].

Another approach makes use of simple regression, for instance one of the form [Adams 1980]:

$$\ln(VAT)_i = \alpha + \beta \ln(Y)_i + \varepsilon_i \tag{1}$$

where:

- $(VAT)_i$ the amount of VAT paid by a household in the i-th income group,
- α a fixed effect,
- β a coefficient of tax burden elasticity with respect to household expenditures or disposable income,
- $(Y)_i$ expenditures or disposable income of a household in the i-th income group,
- ε_i normally distributed random term.

The estimate of β directly indicates the redistributive character of the tax system. If the estimate is greater than 1, then the system is progressive; if it is smaller than 1, then the system is regressive.

The redistributive effects of the tax system can also be determined with econometric models, but this area of their applications is still insufficiently covered in the literature [more on this subject in Dobrowolska 2008]. The relevant approaches use classical estimation methods and estimation methods with panel data models.

When the data are generated by economic processes that are very similar and the same econometric model can be applied to describe them, then the data characterising the investigated objects can be aggregated and estimated jointly. This type of estimation is more efficient than one using single models. A typical example of the panel data is household budget statistics. The panel models[2]can also generate information on fixed effect decomposition.

The method that this analysis proposes as a means of investigating the redistributive effects of VAT estimates the panel models that, *inter alia*, make it possible to specify how being a given type of a household contributes to differences in its burden. With the fixed effect estimates being known, the differences in the amounts of VAT paid by households in Poland can be identified and thereby household types where its burden is the greatest. A one-way model allows differences related exclusively to the household type (other factors being omitted) to be found. A two-way model enables a concurrent investigation into the household type and the time factor effect on the burden of VAT.

[2] For the purpose of this article, the term panel models will be used as equivalent to econometric panel data models.

The redistributive effect of VAT on households can be analysed with respect to their incomes, but also their size or socio-economic status. The distribution of tax burden determined by these characteristics provides grounds for indicating which household types are the most burdened by VAT.

APPLYING THE PANEL MODELS TO INVESTIGATE THE REDISTRIBUTIVE EFFECTS OF VAT IN POLAND IN THE YEARS 1995-2011

The redistributive effects of VAT in Poland in the years 1995-2011will be analysed with the panel regression models.

The research uses a sample of Polish households divided into decile income groups, which the GUS (Poland's Central Statistical Office) analysed during a household budget survey carried out in the years 1995-2011. Therefore, 170 observations (10 decile groups observed over 17 years) are used to verify the panel models empirically.

VAT amounts paid by particular types of household are estimated with detailed, unpublished GUS data on household expenditures. A full description of the assumptions for estimating VAT amounts paid by households can be found in the article by B. Dobrowolska [Dobrowolska 2008].

In the panel regression used in this analysis the explained variable is the PLN amount of VAT paid by a household and the explanatory variable is household net incomes, also in PLN. The net income was accepted as the most appropriate because it includes all monetary components that are really available to households, unlike the gross income that contains also amounts that households cannot use, such as income tax or social insurance premiums, and thereby not increasing their potential for consumption.

Some relationships between the selected variables were omitted from the analysis, as its main purpose is to determine how being a particular type of a household influence sits burden of VAT.

Testing for the most appropriate function showed a linear function and a power function to have the best statistical characteristics indicating the model's usefulness. A somewhat better fit between the empirical and theoretical values was obtained for the linear models. The stratification procedure was performed by income groups. Because the models with fixed effect decomposition turned out to yield better results for most estimated equations than those with the decomposition of the random term **(**as indicated, for instance, by $R^2_{adj.}$values[3], but mainly by the results of the Hausman test), only the estimates of:

- - the one-way model with fixed effect decomposition (variant A),
- - the two-way model with the decomposition of the random term (variant B)

[3] R^2_{adj} -adjusted determnination coefficient

were used in further analysis.

All variables' values are given in current prices, because the same approach is used in the financial models [Łapińska–Sobczak 1997] and because adjustment of the estimated models' variables to their real values deteriorated the properties of the specified equations. For these reasons, the nominal data were used.

The statistical quality of the estimated equations is very good, as shown by the high value of the determination coefficient R^2; it must be noted, however, that the two-way model time offered a better fit to the empirical data (see Table 1).

Table 1. Parameter estimates of the linear model of *VAT* paid, where the explanatory variable is net incomes (*incom*) of successive decile groups– models with fixed effect decomposition

Explanatory variable	Model 1 A One way model			Model 1 B Two way model		
	coefficient	t	p	coefficient	t	p
Incom	0.0995	80.944	0.0000	0.084	87.326	0.0000
Constant				-4.860	-4.851	0.0000
R^2	0.988			0.998		
LRT	227.271		0.00000	296.770		0.00000
F	49.594		0.00000	42.274		0.00000

Fixed-effect estimates in model 1 A

Group	Coefficient	Standard Error	t-ratio
1	-0.09301	1.73947	-0.05347
2	-7.08765	1.75922	-4.02885
3	-7.75230	1.80379	-4.29778
4	-10.83693	1.85304	-5.84819
5	-12.46440	1.91223	-6.51827
6	-15.17600	1.98579	-7.64228
7	-18.86736	2.08166	-9.06361
8	-24.50245	2.22951	-10.99008
9	-30.59516	2.47176	-12.37791
10	-72.81382	3.64098	-19.99844

Fixed-effect estimates in model 1 B

Group	Coefficient	Standard Error	t-ratio
1	10.90776	2.05665	5.30366
2	4.70450	1.98468	2.37041
3	5.58290	1.85704	3.00635
4	3.96231	1.75419	2.25877
5	3.89126	1.66809	2.33276
6	2.91581	1.60489	1.81683
7	1.27186	1.58014	0.80490
8	-1.50764	1.63868	-0.92004
9	-3.38881	1.89671	-1.78668
10	-28.33995	3.90414	-7.25894

Fixed-effect estimates in model 1 B (cont'd).

Period	Coefficient	Standard Error	t-ratio
1995	-7.08015	2.49027	-2.84313
1996	-7.13962	2.36240	-3.02219
1997	-9.11738	2.26208	-4.03054
1998	-7.02281	2.19616	-3.19776
1999	-4.41018	2.16918	-2.03311
2000	-4.16867	2.13920	-1.94870
2001	-3.58284	2.12791	-1.68374
2002	-3.91593	2.12002	-1.84712
2003	-5.92313	2.11248	-2.80387
2004	0.99618	2.10724	0.47274
2005	-1.53606	2.10691	-0.72906
2006	-2.51144	2.12524	-1.18172
2007	-0.07633	2.18526	-0.03493
2008	5.20451	2.29346	2.26928
2009	11.53478	2.35859	4.89055
2010	13.43074	2.44982	5.48234
2011	25.31830	2.50885	10.09160

where: Y_i- net per capita incomes of households (PLN) in the decile group

Source: calculated by the author with the Limdep 7.0 software package based on unpublished GUS data derived from the Household budget surveys 1995-2011

The amount of household net incomes used as the explanatory variable was statistically significant in both equations, and the signs of the slope coefficients

were as expected. Increasing household incomes usually cause the amounts of VAT paid to grow too.

The research has demonstrated that the amount of VAT a household will pay depends on its wealth. Both models point to the statistical significance of the group effects, which is also confirmed by the values of the *LRT* and *F* statistics. Therefore, the household's belonging to a particular decile group has a major effect on how much it will pay in VAT.

Let us remind that the two-way models, unlike the one-way ones, generate not only individual effects, but also an estimate of the fixed effect pertaining to all investigated groups of households. The fixed effects specific to particular decile groups of households should therefore be viewed as deviations from the fixed effect common to the entire sample.

An analysis of the group effects obtained from the two-factor model of VAT paid by particular decile groups of households (Table 1 B) has showed the deviations from the „general fixed effect" to have opposite signs for households in the first seven decile groups than for the households in decile groups VIII – X. While the tax burden carried by the less wealthy households (deciles I – VII) is heavier than average, in the wealthier households (above decile VII) it is below average. This exposes the regressive character of Polish VAT. This regressiveness is probably caused by households having different structures of consumption spending. A proven fact is that the poorer a household is, the larger share of consumption expenditures in its total spending.

Further, the fixed-effect values for the time effects (see Table 1 B) show that in the period under consideration the amount of VAT paid by Polish households increased the most in 2011.The main cause of the increase was rises in VAT rates that were introduced that year[4]. The most important changes consisted in the standard VAT rate and the reduced VAT rate being raised by 1 percentage point, respectively from 22% to 23% and from 7% to 8%.

An additional reduced VAT rate of 5% has been introduced permanently for some goods that previously benefitted from super reduced VAT rates of 3% and 0%. The 5% rate applies to basic foodstuffs, such as grain products (bread, flour, oats, pasta), dairy products, meat products, juices, as well as specialist books and magazines[5]. The reasons for VAT rates being changed from 2011 was the expiry of derogations negotiated with the European Commission that allowed the application of reduced VAT rates to some products, as well as the condition of public finances in Poland[6].

[4] Regulation of the Minister of Finance of 22 Dec. 2010 concerning the implementation of the provisions of the valued added tax act (Dz.U. Nr 246, poz. 1649)

[5] The full catalogue of goods taxed with 5% VAT rate can be found in Annex 10 to the valued added tax act of11 March 2004.

[6] The 8% and 23% VAT rates were introduced for a period to expire at the end of December 2013. Then the previous rates of 7% and 22%were to be restored, unless the ratio between public debt and

A notable fact is that accounting for the time effect in the decomposition of the fixed effect increased the value of R^2.

CONCLUSION

The panel regression models can serve as a tool for investigating the redistributive effects of indirect taxes. One advantage of using panel regression to study the redistributive consequences of consumption taxes is that it allows the differences in the tax load carried by particular types of households to be identified, and thereby the types of households where the load is the greatest. Unlike the one-way models that can expose differences related exclusively to the household type (other factors being unaccounted for), the two-way models are useful in investigating the impact of both the household type and the time factor on the burden of indirect taxes.

The conducted analysis used the panel regression models to study the economic consequences of VAT imposed on Polish households in the years 1995-2011. The analysis has demonstrated that Polish VAT is regressive. The regressiveness of indirect taxes is probably caused by the structure of households' consumption spending. It is generally known that the poorer a household is the larger share of consumption expenditures in its total spending.

Further, the application of two-way panel models showed, owing to the isolation of the time effect, that the amounts of VAT paid by particular decile groups of households in the investigated period were related to the social and tax policy of the state.

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