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FORECASTS OF PETROLEUM DEMAND

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Abstract. Trends of consumption of petroleum products in Lithuania are analyzed. It is shown that these trends during the transition period to the market economy are not stable. Therefore, methods and models of the comparative analysis are proposed for the statistical modelling trends of consumption of petroleum products, comparing the relative indicators of consumption of petroleum products in transition economy and in the European Community of 15 EU developed market countries. Long–term forecasts of consumption of petroleum products in Lithuania for the perspective of 2010–2025 were calculated on the basis of perspective scenarios of statistical models. Forecasts of final consumption of petroleum products as well as automotive fuel demands are presented.

Keywords: petroleum products, modelling consumption of petroleum products, forecast consumption of petroleum products, forecasts of automotive fuel demands.

1. Introduction

Transport is an important economic branch of any country, including Lithuania, which represents the development level of a country. Approximately 13 % of Gross Domestic Product is developed in transport sector. In recent years the transport park has grown very rapidly and its structure has changed. Number of cars increased and in 2004 the number of road transport means reached approximately 1.3 millions. About 29 % of final energy [1] is consumed in transport sector.

When analyzing transport infrastructure, a firm relation is found with the development level of state economy, which plays a significant role in the development of transport plans in any country [2–5]. Interplay [4] of economy and transport in the analyzed region may be described in differential equations, depending on Gross Domestic Product (GDP), technology development level, labour force, private capital size, number of transport means, etc. To have analytical values of these indicators is possible only theoretically, however, practically, such overall statistics is not recorded (for example, in Lithuania) and to calculate directly the impact of transport on GDP or its reverse size is rather complicated. The aim of this article, employing the comparative analysis method, is to determine equations of statistical dependence of transport means and fuel consumption in transport means on basic region economic indicators: Gross Domestic Product and the number of habitants (H).

Consumption of petroleum products in Lithuania during the transition period to the market economy constantly diminished. Demands (in millions tons of oil equivalent–Mtoe) stabilized and positive trends have appeared only since 2000 (Fig 1).

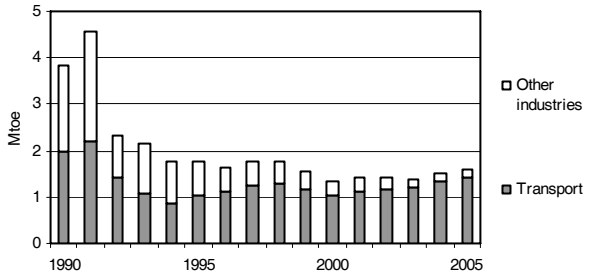

Fig 1. Trends of final consumption of petroleum products

Most of petroleum products are consumed in transport. However, if compared to gross final consumption of petroleum products, expenditure in transport in 1990–2005 remained almost stable, whereas consumption of petroleum products in other industry branches diminished considerably.

Mathematical statistics methods and models are applied for the forecast consumption of petroleum products. Their application is correct only at stable trends. However, the amount of data of stable trends of petroleum expenditure of several years is not enough for the statistical analysis and forecast of demands. Thus, in this case methods and models of the comparative analysis are rather promising.

In 2004 Lithuania joined the European Union (EU). Lithuania's main objective is to integrate into common EU power/fuel market and as soon as possible

to reach the up-to-date economic level of 15 EU countries. Therefore, trends and accomplishments in consumption of petroleum products in Lithuania and other 25 EU countries become the key objective of the comparative analysis.

2. Forecasts of final consumption of petroleum products according to the comparative analysis method

Relative indicators are used in the comparative analysis methodology – consumption of petroleum products (PP) and Gross Domestic Product per capita (PP/C, GDP/C) as well as intensity consumption of petroleum products, i.e. the amount of expenditure per GDP (PP/GDP). EUROSTAT data basis may be employed most efficiently for the statistical analysis of the above indicators.

Relative expenditure of petroleum products for a habitant depends on the achieved state of economy level.

Statistical analysis of average dependences of the indicator of 1997–2005 on GDP shows that the achieved levels of PP per capita and GDP (in thousands 1995 Euro – 1000 €95) per capita of individual countries correlate with each other – with the rise of economy relative consumption of petroleum products increases as well (Fig 2). However, the performed statistical analysis shows that this dependence is not linear (Fig 3) – PP per capita and GDP per capita direct dependence may be best approximated by exponential with correlation coefficient R^2 = 0,83. Approximation curves of the dependence show that in regard to this model most of all only 8 no typical countries (Estonia, Slovakia, Poland, Hungary, Slovenia, Greece, Ireland, and Holland) remain behind the limits of confidence level.

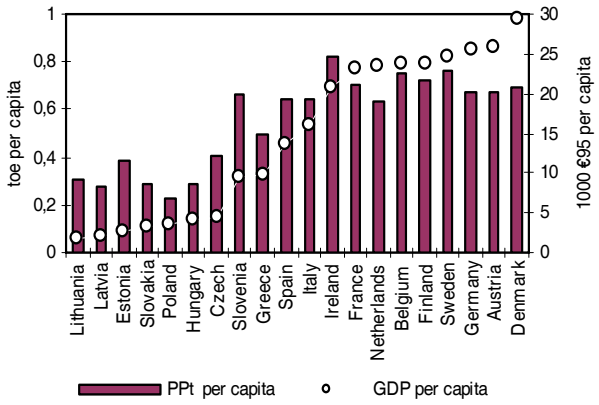

Fig 2. Changes of relative final consumption of petroleum products per capita in EU countries

Mathematical model of dependence of PP per capita on GDP per capita may be used for the forecast consumption of petroleum products in Lithuania (Table 1), considering perspective values in calculations of GDP per capita [6–9]. Choosing the obtained statistical dependences, minimal, maximal as well as average scenario (the most probable one) of forecasts, were calculated (Fig 4).

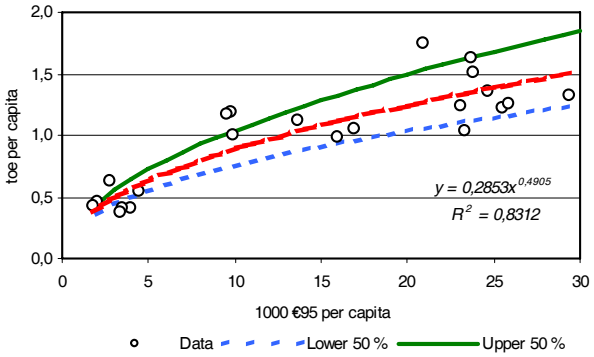

Fig 3. Dependence function of relative consumption of petroleum products on GDP per capita in different EU countries

Table 1. Forecasts of final consumption of petroleum products (PP per capita and GDP per capita dependence scenario)

Year	GDP, Billions €95	Population, Millions	GDP/C, 1000 €95/C	PP/GDP, toe/1000 €95	PP/C, toe/C	PP, Mtoe
	Base					
2005	7,97	3,45	2,31	0,190	0,44	1,51
2010	11,62	3,32	3,50	0,151	0,53	1,75
2015	15,49	3,28	4,72	0,129	0,61	2,00
2020	20,64	3,24	6,37	0,111	0,71	2,29
2025	27,51	3,18	8,65	0,095	0,82	2,61
	Upper confidence level 50 %					
2010	11,62	3,32	3,50	0,171	0,60	1,99
2015	15,49	3,28	4,72	0,149	0,70	2,30
2020	20,64	3,24	6,37	0,129	0,82	2,66
2025	27,51	3,18	8,65	0,111	0,96	3,06
	Lower confidence level 50 %					
2010	11,62	3,32	3,50	0,133	0,46	1,54
2015	15,49	3,28	4,72	0,113	0,53	1,75
2020	20,64	3,24	6,37	0,096	0,61	1,98
2025	27,51	3,18	8,65	0,081	0,70	2,23

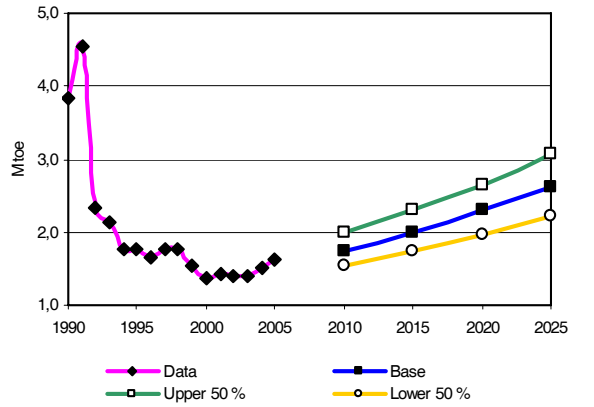

Fig 4. Trends and forecasts of final consumption of petroleum products

PP/GDP and GDP per capita dependence model may be used for the forecast consumption of petroleum products. However, these sizes are related to each other in reverse correlation – at the rise of economy level of countries the intensity consumption of petroleum prod-

ucts diminishes (Fig 5). As performed research reveals this dependence may be approximated quite precisely (R^2 = 0,84) by exponential (Fig 6).

Forecasts of final consumption of petroleum products calculated on the basis of statistical model are identical to the forecasts presented in Table 1 and fully match the trends given in Fig 4.

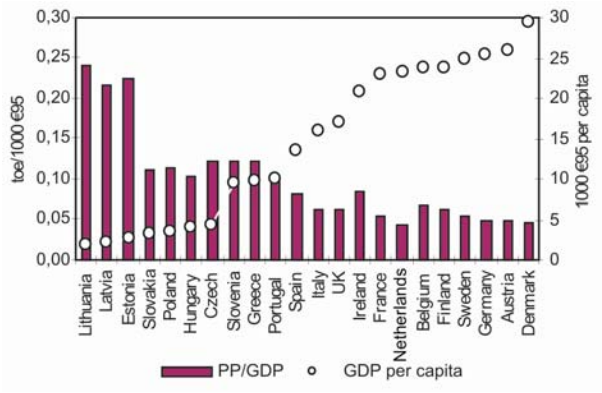

Fig 5. Changes of expenditure intensity of petroleum products (PP/GDP) and GDP per capita in EU countries

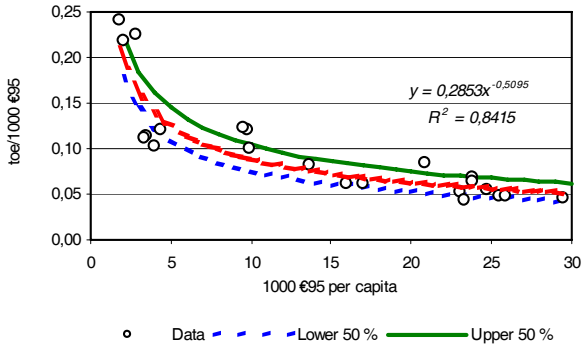

Fig 6. Dependence function of intensity consumption of petroleum products in EU countries on GDP per capita

Structure of expenditure is very important while forecasting consumption of petroleum products. The performed analysis shows that most of petroleum products are consumed in transport in 2004 – 88 %.

3. Forecasts consumption of petroleum products in transport

While forecasting consumption of petroleum products in transport it is expedient to analyze specific relative indicators – the number of transport means per capita (TM/C), consumption of petroleum products per transport mean (PPt/TM), intensity consumption of petroleum products in transport (PPt/GDP) as well as dependence of those indicators on GDP per capita indicator. The performed analysis shows that change of relative indicators of petroleum expenditure depends on state of economy level (Figs 7–8).

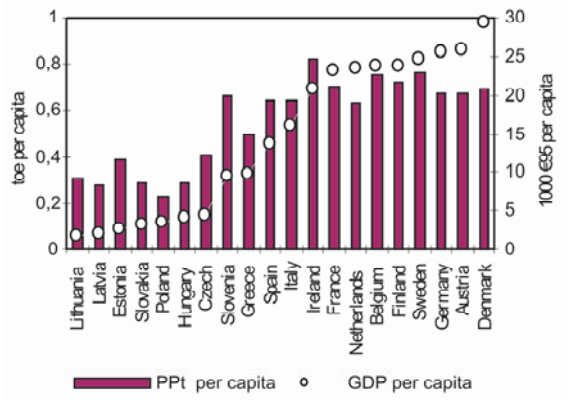

Fig 7. Relative consumption of petroleum products in road transport and GDP per capita for different countries

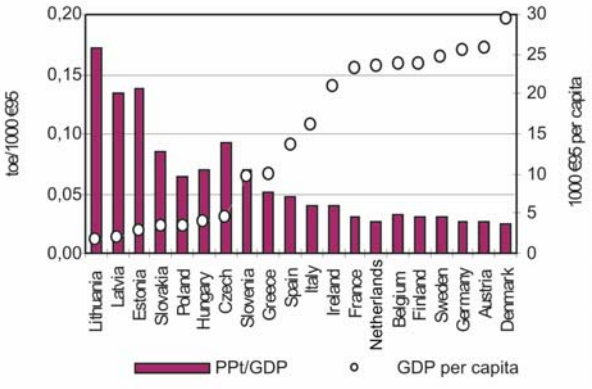

Fig 8. Intensity consumption of petroleum products in road transport and GDP per capita for different countries

Dependences of consumption of petroleum products in transport and expenditure intensity on the state of economy level may be approximated by nonlinear functions (Figs 9, 10). Intensity function of petroleum expenditure in transport may be corrected with more detailed Lithuanian statistical data. Forecast consumption of petroleum products in transport may be calculated on the basis of obtained approximation function. Performed research revealed that forecasts obtained on the basis of any statistical dependence function are identical (Table 2).

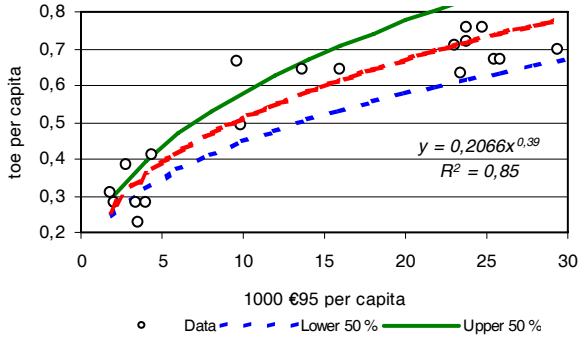

Fig 9. Dependence function of relative consumption of petroleum products in road transport (PPt) on GDP per capita

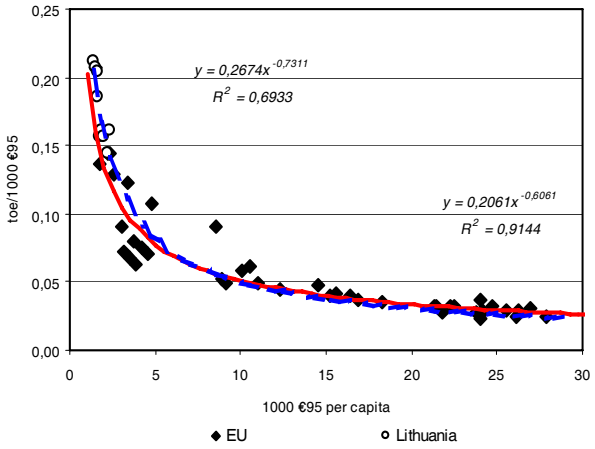

Fig 10. Dependences of intensity consumption of petroleum in road transport on GDP per capita in EU ($y = 0{,}2061x^{-0{,}6061}$) and Lithuania ($y = 0{,}2674x^{-0{,}7311}$)

Table 2. Forecasts of fuel consumption in road transport (basic scenario) by intensity approximation function

Year	GDP/C, 1000 €95/C	PPt/GDP, toe/1000 €95	PPt, Mtoe
2005	2,33	0,137	1,09
2010	3,50	0,113	1,32
2015	4,73	0,091	1,41
2020	6,38	0,073	1,51
2025	8,64	0,058	1,61

Consumption of petroleum products in transport mainly depends on specific expenditure indicators: the number of transport means per capita and fuel expenditure per transport means. Therefore, while forecasting consumption of petroleum products it is expedient to take into account the dynamics of number of Lithuanian transport means in 1997–2004 in Lithuania. Performed statistical analysis reveals that dynamics of number of transport means in Lithuania may be approximated rather precisely (R^2 = 0.96) by logarithmic function (Fig 11). Then TM per capita indicator forecasts may be calculated together with extrapolated values of logarithmic curves.

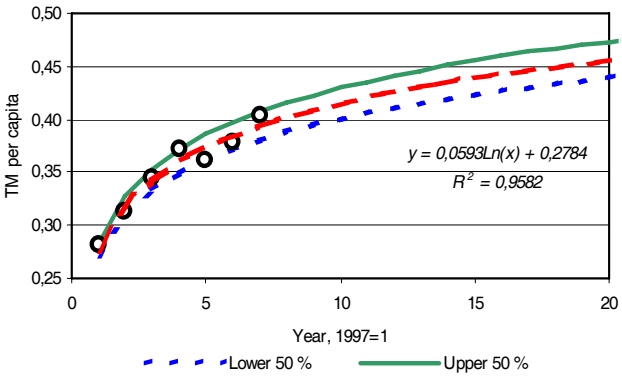

Fig 11. Dynamic function of the number of transport means per capita in Lithuania

Consumption of petroleum products in transport depends on the relative fuel expenditure for transport means. However, technical progress of automotive industry is equally incident for all 25 EU countries. The difference is that countries with lower economical development level more often use older cars, i.e. imported and already used cars from 15 EU countries. On the other hand, habitants of less economically developed countries due to economical reasons restrain from the development of transport means. But these peculiarities are not significant and statistical dependence of indicators of PPt/TM and GDP per capita is not essential (R^2 = 0.45) (Fig 12). Forecasts of consumption of petroleum products in transport extrapolating approximated dependences are given in Table 3.

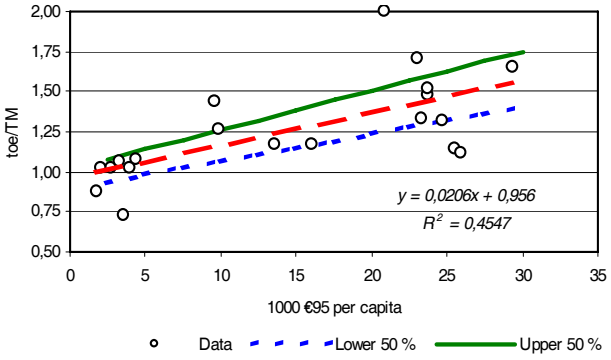

Fig 12. Average fuel consumption in transport means in 1997–2003, depending on GDP per capita

Table 3. Forecasts of fuel consumption in road transport (basic scenario) by transport means function

Year	GDP/C, 1000 €95/C	TM/C	TM, millions	PPt/TM toe/TM	PPt Mtoe
2010	3,50	0,434	1,44	1,03	1,48
2015	4,73	0,452	1,48	1,06	1,56
2020	6,38	0,466	1,51	1,09	1,64
2025	8,64	0,477	1,52	1,14	1,73

Summary of average forecasts of basic scenario consumption of petroleum products are given in Fig 13. Analysing the presented forecasts, we can see that consumption of petroleum products in road transport in 2010–2025 will increase somewhat more slowly than consumption of fuel in other industry branches.

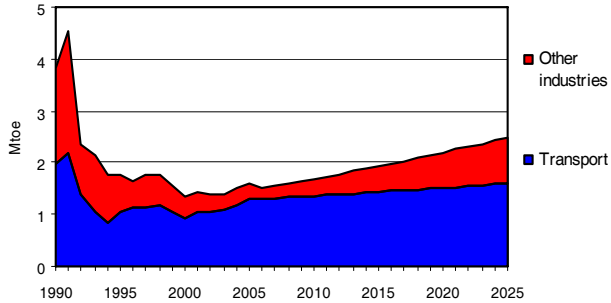

Fig 13. Forecasts of final consumption of petroleum products

4. Conclusions

1. Trends of consumption of petroleum products in Lithuania are analyzed and it is shown that these trends during the transition period to the market economy are not stable.
2. Methods and models of the comparative analysis are proposed for the statistical modelling trends of consumption of petroleum products, comparing the relative indicators of consumption of petroleum products in transition economy and the European Community of 15 EU developed market countries.
3. Long-term forecasts of consumption of petroleum products in Lithuania for the perspective of 2010–2025 were calculated on the basis of perspective scenarios of statistical models. Forecasts of final consumption of petroleum products as well as automotive fuel demands are presented.

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