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DETERMINANTS OF FARM INCOME IN THE EUROPEAN UNION IN NEW AND OLD MEMBER STATES. A REGIONAL STUDY[1]

Key words: agricultural income, European Union, Cobb-Douglas function, quantile panel regression

ABSTRACT. The aim of the article was to identify the determinants of income of representative farms at the level of European Union regions. For this purpose, FADN data was used for the years 2004-2017. Due to varied conditions of agricultural development, EU regions were divided into groups according to seniority of members. Income was examined using basic panel regression and quantile panel regression models using the extended Cobb-Douglas formula. Apart from the basic input of production factors (labour, capital and land), the impact of subsidies as well as production and financial management strategies in the farms were also investigated. It was found that farm income in so-called new member states were more sensitive to growing specialization, direct payments and capital expenditure, while, in the so-called old EU, there was a relatively high elasticity of income in relation to the labour factor. On the other hand, income was negatively affected by an increase in the level of financial leverage. The results of the quantile regression model show that, with increasing farm income, the role of labour and land factors decreases, while the significance of the capital factor remains relatively constant.

INTRODUCTION

One of the criteria for assessing the level of socio-economic development of the economy of a given country or region is the income of its inhabitants. The essence of its role largely boils down to determining quality of life, as it determines the degree to which various needs of the population are satisfied [Zegar 2001]. It should be noted that while the absolute level of income is important, income relations among social groups and their variation within these groups are also important [Poczta-Wajda 2017, Chmielewska 2018]. A relatively frequently discussed problem is agricultural income, including its spatial and social differentiation. Therefore, the question arises about the determinants of these incomes.

Many scientific studies indicate that integration with the EU was a key process for structural changes and income growth in the agricultural sector in new Member States

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[Zawalińska et al. 2015, Runowski 2017, Floriańczyk 2006]. It has been noted that, after 2004, income levels have gradually converged, especially between the regions of "old" and "new' Member States, i.e. the predominance of agricultural income in Old Member States has decreased in relation to newly acceded countries [Chmielewska 2018][2], although regional differences still remain relatively large. The faster growth of agricultural income in "new" Member States was mainly due to the fact that this sector was covered by the common agricultural policy (CAP), which comprised the direct payments system. It should be noted, however, that there are very significant differences between individual countries in terms of the absolute value of payments and their proportion in income[3], which is due to various causes, such as historical reasons for determining direct payment systems; types of agricultural production in particular regions of the EU (e.g. the dominance of large-area cereal crops and pastures in the regions of eastern Germany and central France, while in Mediterranean regions permanent crops prevail – olive groves, citrus fruits etc.); as well as agrarian structures (fragmented farms in Central and Eastern Europe versus large-area French or British agriculture). Another important effect of subsidies is reducing poverty in farming families at a regional level [WB 2017].

The next important factor influencing agricultural income is labour productivity, which is significantly lower in the regions of newly acceded countries. Growing productivity of labour and other factors of production is, on the one hand, a result of, and, on the other hand, a necessary condition for the development of the region, as well as the entire national economy. Many authors note that it determines the flow of surplus labour force resources from agriculture to other branches of the economy, which, at the same time, favours the development of other sectors of the economy [Cyrek 2013, Szczebiot-Knoblauch, Kisiel 2014, Parzonko 2016]. Growth in labour productivity enables agriculture and other sectors of agribusiness to increase the supply of food for domestic and foreign markets, but it also causes changes in the demand for agricultural products.

The income situation of agricultural holdings in a dynamic perspective is also influenced by price scissors, i.e. prices of means of production purchased by farmers and prices of goods sold. In long-term analyses, it is found that these scissors are diluted, which means that prices of purchased goods and means of production increase faster than the purchase prices of agricultural products. Thus, the income of agricultural holdings decreases in a dynamic perspective. It is also noticed in many regions of the „old" Member States that a progressively higher input of production factors is involved in agricultural activity, but this results in lower effectiveness of the last unit of such input. The imperative of increasing the efficiency of production factors involved in agricultural production implies subsequent capital expenditure, with decreasing sale prices of agricultural products, a growing scale of production and unfavourable relations of market prices [Czyżewski 2017, p. 16-57].

[2] There is almost a 30-fold difference between the highest income per AWU in EU regions: Lombardy: EUR 6,6201 and the lowest Jadranska Hrvatska: EUR 2,249 (2015) [DG Agri 2018].

[3] Direct payments in the EU are at a very diversified level, and so are the highest in Malta (448 euro/ha), Cyprus (429 euro/ha), the Netherlands (417 euro/ha), and the lowest in Latvia (109 euro/ha) and Croatia (99 euro/ha). The share of subsidies in gross value added in e.g. the Netherlands and Italy does not exceed 10%, while in Finland it is almost 196%, and in Latvia and Slovakia over 90%.

The aim of this article is, therefore, to identify and compare the income determinants of representative farms in FADN regions. The additional criterion used is seniority in EU membership of a country to which the region belongs. The time scope of analysis covers the period 2004-2017. As FADN data are rather microeconomic in nature and farms covered by databases are oriented towards market production, determinants were examined by means of an extended production function.

DATA AND METHODS

According to the hierarchy of farm objectives proposed by Jacek Kulawik [1995], it can be assumed that its ultimate goal is to maximize income, which further determines the standard of living of the farmer and his family. From a microeconomic perspective, the economic result of an entity is determined by the combination of applied input (labour, land, capital) and its productivity. In the conditions of the common agricultural policy, payments under the first and second pillar became additional determinants of farm income. Moreover, as Brent Gloy et al., [2002] indicate the results of the agricultural holding are also influenced by determinants concerning the organisation of production (production and financial management).

In this article, the determinants of farm income according to the popular Cobb-Douglas formula were studied. Therefore, the elasticity of farm income changes in relation to input, such as land, labour or capital, was examined. Land input was expressed in hectares of agricultural land used by the farm; labour was expressed in hours (sum of own and hired labour), while capital was expressed as intermediate consumption and depreciation [Petrick, Kloss 2012]. In the next step, subsidies under the CAP were introduced, however, they were divided into direct payments (including, first of all, decoupled payments) and payments under the second pillar covering agri-environmental payments, subsidies for maintaining activity in less-favoured areas (LFA) and payments related to rural development. Then, we extended the production function by measures defining production, investment and financial decisions, which were not directly based on input in the function.

The following indicators were used:

– Herfindahl's specialisation index (ranged from 0 to 1) – the higher the value of index, the more specialised the farm;
– reproduction ratio understood as the ratio of gross investment (SE516 variable in FADN database) to depreciation (SE360) [Grzelak 2015];
– share of current assets (SE465) in total assets of the farm (SE436) [Kulawik, Płonka 2014];
– total assets (SE436) to equity (SE501) ratio.

The dependent variable (farm income) was the total remuneration of the labour factor, i.e. the sum of net income (SE420) increased by the wages paid (SE370) [DG Agri 2017]. Thus, e adopted category represents the total sum of income created in an agricultural holding, which is divided between the farmer and his family and hired workers.

The Cobb-Douglas function is linearized by a double-sided logarithm, which allows the interpretation of the elasticity of income in relation to percentage changes in input.

As a result, the income model took the following form:

$$\ln(Inc_{it}) = \beta_0 + \beta_1 \ln(L_{it}) + \beta_2 \ln(UAA_{it}) + \beta_3 \ln(IC_{it}) + \beta_4 \ln(D_{it}) + \ln(DP_{it}) + \beta_7 \ln(PG_{it}) + \beta_8 \ln(AE_{it}) + \beta_9 \ln(CA/TA_{it}) + \beta_{10} \ln(INV/D_{it}) + \beta_{11} \ln(HI_{it}) + u_i + \varepsilon_{it}$$

where: Inc – farm income, *L* – labour input, *UAA* – land input, *IC* – total intermediate consumption, *D* – depreciation, *DP* –direct payments, *PG* – 2nd pillar payments, *AE* – total assets to equity ratio, *CA/TA* – Share of current assets in total assets of the farm, *INV/D* – reproduction ratio, *HI* – Herfindahl's specialisation index.

All financial data in the FADN database are expressed in current prices in euro. To make them comparable over time and eliminate the impact of prices (which individual farmers have no influence over), they were deflated by price indices collected from Eurostat (2005 = 100, intermediate consumption deflated by the total intermediate consumption index, depreciation by fixed capital consumption, subsidies and income by the Harmonised Index of Consumer Prices – HICP) and converted at the 2005 constant exchange rate (for countries that joined the euro area after 2004, the rate of the year of accession to the euro zone was chosen). The analysis included regions in the countries that joined the EU in 2004, excluding Cyprus and Malta, and regions in the countries of the so-called "old" EU-15. Finally, the panel for regions in the EU-8 covered 182 cases in the years 2004-2017, and for the EU-15 it was 1,414 observations made in the same research period.

Because of the occurrence of autocorrelation (cross-sectional and serial) and heteroskedasticity, panel models were estimated using Driscoll and Kraay's robust standard errors [Driscoll, Kraay 1998]. On the basis of Hasuman's test, a choice was made between a model with fixed and random effects. For the EU-15 models, the fixed effects model was more appropriate, while the EU-8 models were estimated using random effects. This means that, in the latter case, individual effects were not estimated as separate parameters [Arellano 2003] for each region. As Jeffrey Wooldridge points out [2002, p. 251-252], the difference between the two types of models primarily lies in the fact that, in the first case, the correlation between the individual effect and the vector of explanatory variables is allowed, while, in the second case, it is assumed that there is no correlation.

The relative impact of individual determinants on income levels may change as income levels increase and this is a phenomenon that affects farms in both EU-15 and EU-8 regions. In the second stage of the study, an innovative approach of panel quantile regression with fixed effects was applied [Machado, Silva 2019]. The estimated Method of Moments – the Quantile Regression (MM-QR) model was based on the basic version of the Cobb-Douglas function for the whole panel of 1596 cases, as well as for individual deciles of income distribution.

RESULTS

In the analysed period, there was a strong income disparity between average farms in regions belonging to the so-called old and new Member States. Farms in the first group generated, on average, an income of EUR 42.9 thousand, while in the second group it was EUR 25.6 thousand, despite the fact that farms in the EU-8 regions had, on average, a larger area (97 vs. 77 ha). The larger average farm area resulted from historical factors and the existence of large farms in countries such as the Czech Republic, Hungary or Slovakia, while numerous small farms are not included in the FADN field of observation. Income per hour was EUR 10.8 in the EU-15 and only EUR 3.9 in the EU-8. It is also worth noting that total capital expenditure (intermediate consumption plus depreciation) in farms of the EU-15 regions were higher than in the EU-8 by about 28%, while the difference in income was 67%. This may be related to relatively high capital productivity values in some EU-15 regions, mainly in Mediterranean regions [Kryszak 2018].

Despite a smaller average area, farms in EU-15 regions received higher direct payments. This was due to higher rates of decoupled payments per hectare, which are the main component of direct subsidies. Importantly, as regards second pillar CAP payments (LFA, agri-environment and rural development), farms in the EU-8 regions benefited to a greater extent. Farms in the EU-15 were on average more specialised and more likely to use external sources of finance, as evidenced by the leverage ratio values. The average share of current assets in total assets in both groups of households was at a similar level (ca. 25%). Farms in the EU-8 regions were characterised by a higher average reproduction rate. This results from the modernisation effort which these farms undertook after 2004 in order to modernise and increase the competitiveness of production.

Table 1. Descriptive statistics of the variables used in farm income models

Variable	EU-8				EU-15			
	Mean	SD	max	min	Mean	SD	max	min
Farm income [thous. EUR]	25.6	32.3	194.5	3.5	42.9	42.3	344.2	8.7
Land [ha]	97	142	615	9	77	95	530	2.0
Labour [thous. hours]	6.6	7.3	42.9	2.1	4.0	2.9	24.1	1.9
Intermediate consumption [thous. EUR]	64.4	104.5	474.7	6,9	80.5	97.0	637.4	4.6
Depreciation [thous. EUR]	14.4	25.7	176.8	1.5	20.0	22.1	150.7	0.1
2nd Pillar payments [thous. EUR]	5.7	10.5	58.8	0.01	4.4	6.3	39.2	0.0
Direct payments [thous. EUR]	14.7	22.9	105.0	1.0	20.5	26.1	16.5	0.07
Reproduction rate	1.280	0.628	4.208	0.272	0.958	0.684	11.206	-5.317
Specialisation ratio	0.176	0.027	0.261	0.105	0.251	0.099	0.661	0.096
Current assets in total	0.246	0.116	0.517	0.038	0.247	0.138	0.684	0.014
Assets to equity ratio	1.219	0.163	1.668	1.014	1.269	0.313	2.465	1.000

Source: own calculations based on FADN data

Table 2. Determinants of income of a FADN representative farm for EU-15 and EU-8 panels in the years 2004-2017

Variable	EU-15			EU-8		
	CD (DK-FE)	CD (DK-FE)	CD (DK-FE)	CD (DK-RE)	CD (DK-RE)	CD (DK-RE)
Number of observations	1,412	1,394	1,394	181	-	-
Land input [ha]	0.112	0.025	0.068	0.242***	0.036	0.012
	(0.080)	(0.062)	(0.046)	(0.087)	(0.061)	(0.092)
Labour input in hrs	0.721***	0.637***	0.547***	0.167	0.305***	0.256**
	(0.172)	(0.136)	(0.137)	(0.110)	(0.079)	(0.087)
Intermediate consumption	0.402***	0.377***	0.432***	0.681***	0.361***	0.550***
	(0.064)	(0.074)	(0.075)	(0.166)	(0.074)	(0.081)
Depreciation	-0.283***	-0.242***	-0.193***	-0.289	-0.456***	-0.494***
	(0.047)	(0.042)	(0.042)	(0.166)	(0.103)	(0.066)
2nd pillar payments	-	-0.018	-0.017	-	-0.008	-0.004
	-	(0.019)	(0.021)	-	(0.016)	(0.742)
Direct payments	-	0.229**	0.152*	-	0.617***	0.564***
	-	(0.094)	(0.074)	-	(0.151)	(0.160)
Reproduction rate	-	-	0.031**	-	-	0.084**
	-	-	(0.011)	-	-	(0.023)
Herfindahl specialisation ratio	-	-	1.331***	-	-	3.958***
	-	-	(0.353)	-	-	(1.006)
Current assets in total	-	-	0.193	-	-	-0.216
	-	-	(0.188)	-	-	(0.285)
Assets to equity ratio	-	-	-0.921***	-	-	-0.190
	-	-	(0.191)	-	-	(0.155)
Constant	2.407*	1.307	2.300	2.894***	1.874***	0.689
	(1.244)	(1.587)	(1.605)	(0.850)	(0.709)	(0.739)
Within R^2	0.204	0.221	0.296	-	-	-
Overall R^2	-	-	-	0.908	0.934	0.945
Sigma_u	-	-	-	0.138	0.040	0.028
Sigma_e	-	-	-	0.240	0.224	0.203

Standard errors in brackets;

***, **, * denotes the significance level: 99, 95 and 90%, respectively

Source: own calculations using STATA software

Table 2 presents the results of estimations of econometric models of income for representative farms at the level of EU-8 and EU-15 regions, while Table 3 presents the results of quantile regression estimations.

Fixed effect models for the EU-15 explained, on average, between 20 and 30% of within income volatility. In the STATA module for Driscoll-Kraay error models and fixed effects, statistics on overall R^2 are not available. On the basis of additional HAC estimates – heteroskedasticity and autocorrelated, which differ only in standard errors and not in the values of the regression coefficients themselves, it can be concluded that relatively high values of total R^2 were obtained at a level of 0.57 to 0.69. A better model fit was achieved for the models for representative farms in the EU-8 regions – total R^2 exceeded 90%.

The increase of land input, only to a small extent, contributed to the increase of farm income. In most of the specifications, the marginal effect on the land factor was statistically insignificant and close to 0. Only in the basic specification for the EU-8, a noticeable effect of this factor was noted, but after the inclusion of payment into the model, a significant decrease in the elasticity of income in relation to land is observed. It proves that growing income results not only from an increase in the scale of production, but also from receiving area payments.

As far as labour input is concerned, it was a strong determinant of income growth in almost all specifications for the EU-15 and EU-8. In the case of farms in the so-called Old Member States, an increase in labour input by 1% contributed to an increase in income by 0.55-0.72%, while in the case of EU-8 regions, elasticities ranged from 0.17 to 0.31. A weaker impact of the labour factor may result from the over-employment in agriculture observed in the EU-8, especially at the beginning of the research period. Moreover, in some regions of the EU-15, labour-intensive production methods (e.g. vineyard and olive production in the Mediterranean) are predominant, hence the importance of the role of the labour factor.

As expected, capital expenditure played a greater role in the agriculture of the EU-8 regions, which resulted from a relatively lower capital saturation in these farms, but the marginal effect of intermediate consumption in the basic version of the Cobb-Douglas function seems to be overestimated – the inclusion of subsidies and farm management indicators leads to a decrease in the flexibility coefficient from 0.68 to 0.46-0.55. Depreciation, which is a measure of fixed asset engagement, negatively influenced income in both panels, which indicates that increasing fixed asset involvement does not lead to an increase in income, but may be a factor hindering the functioning of the farm.

The obtained estimates indicate the insignificant role of subsidies under the second pillar, which could be caused by the fact that receiving some public goods payments only compensates for the loss of income from e.g. farming in LFA. Furthermore, their reception is sometimes associated with a reduction in the intensity of production, and thus it affects the revenue side of the income account. On the contrary, direct payments play an important role in shaping income, especially in the case of farms in the EU-8 regions. The share of payments in total income in these regions remained at a lower level than in some EU-15 regions, but the impulse related to the stream of payments received by farms in the EU-8 regions after 2004 turned out to be an important determinant of the increase in income in the analysed period. As regards measures concerning the organisation of production and

Table 3. Panel quantile regression estimations for deciles of farm income distribution

Number of observations	Land	Labour	Intermediate consumption	Depreciation	Constant
Location function	0.099	0.563***	0.459***	-0.255***	2.782**
	(0.089)	(0.091)	(0.068)	(0.043)	(0.740)
Scale function	-0.044	-0.076*	0.006	0.032*	0.585
	(0.038)	(0.043)	(0.035)	(0.019)	(0.331)
$\tau = 0.1$	0.169*	0.682***	0.449***	-0.304***	-
	(0.094)	(0.134)	(0.081)	(0.053)	-
$\tau = 0.2$	0.146**	0.642***	0.452***	-0.288***	-
	(0.073)	(0.104)	(0.064)	(0.041)	-
$\tau = 0.3$	0.129**	0.613***	0.454***	-0.276***	-
	(0.061)	(0.086)	(0.053)	(0.034)	-
$\tau = 0.4$	0.113**	0.586***	0.457***	-0.264***	-
	(0.052)	(0.074)	(0.045)	(0.029)	-
$\tau = 0.5$	0.097**	0.559**	0.459***	-0.253***	-
	(0.049)	(0.069)	(0.042)	(0.027)	-
$\tau = 0.6$	0.083	0.535***	0.461***	-0.243***	-
	(0.051)	(0.072)	(0.044)	(0.028)	-
$\tau = 0.7$	0.067	0.507	0.463***	-0.231***	-
	(0.058)	(0.463)	(0.050)	(0.032)	-
$\tau = 0.8$	0.050	0.479***	0.466***	-0.219***	-
	(0.070)	(0.099)	(0.060)	(0.039)	-
$\tau = 0.9$	0.032	0.447***	0.468***	-0.205	-
	(0.086)	(0.122)	(0.074)	(0.048)	-

Standard errors in brackets;

***, **, * denotes the significance level: 99, 95 and 90%, respectively

Source: own calculations using STATA software

financial structure of the holding, farms in the EU-8 experienced a stronger impact from both the reproduction rate and specialisation. This shows that investment in fixed assets as well as the increasing specialisation of production observed in EU-8 regions were rational farm management strategies. Maintaining the majority of assets in liquid form did not have a significant impact on income growth, while the growing use of external capital negatively affected generated income. This effect was stronger (and statistically significant) in the EU-15 regions, where the use of external capital was at an average higher level (cf. Table 1). Taking into account lower elasticity of income in relation to intermediate consumption, it seems that farms in the EU should limit the use of external sources of financing in order to avoid the problem of overinvestment.

In the second stage of the study, the quantile regression model for the basic version of the Cobb-Douglas function was estimated. In the first line, the estimates for the whole panel were presented, while the second line consists of estimates for the scale function. If any of the parameters of this function is statistically significant, it can be treated as an indication that there are significant differences between particular quantiles (here: deciles) in the value of this parameter. The analysis for particular deciles indicates that with an increase in farm income, the impact of labour and land factors decreases. In the highest decile of income distribution, the marginal effect on labour is smaller than in the first decile by 34.5%, while in the case of land by as much as 81% and from the sixth decile it is no longer statistically significant. Importantly, the strength of the impact of intermediate consumption input is similar in each decile of income distribution and corresponds approximately to the estimates in the basic panel models in Table 2. Similar conclusions apply to depreciation. It turns out, therefore, that farms generating the highest income should rely on the use of the scale of production (especially in terms of area) to a relatively small extent, and rather maintain a relatively high level of current expenditure.

CONCLUSIONS

The aim of this study was to determine and compare the determinants of agricultural income at a level of FADN farms representative of regions, taking into account the criterion of seniority of EU Member States in the years 2004-2017. Determinants were studied using the Cobb-Douglas formula extended by indicators demonstrating the management of production and financial structure of the farm. In order to evaluate the relative impact of particular determinants on income, depending on its level, in the second stage the model of panel quantile regression was used.

The results of the analyses indicate an important pro-income role of area payments, especially in the EU-8. In EU-8 regions, capital expenditures were relatively more important for income growth, while in the EU-15 relatively large effects were achieved thanks to labour expenditure, which may be related to a smaller scale of the problem of over-employment, as well as labour-intensive types of production in Mediterranean regions. Farms in the EU-8 benefited to a greater extent from a growing level of specialisation and modernisation of production assets, while in EU-15 farms a strong negative effect of the increase of financial leverage was noted. It may indicate an excessive burden of foreign capital on farms. Moreover, analyses show that while the impact of the capital factor on income is relatively independent of the achieved income level, the impact of labour and land factors is clearly decreasing.

The results of the analysis lead to two more general conclusions. On the one hand, the results of the quantile regression provide support for "treadmill" EU agriculture. Maintaining a relatively high level of capital expenditure is important both for farms generating low and high incomes. On the other hand, differences in income determinants between farms in regions belonging to the EU-8 and EU-15 countries, as well as the decreasing role of labour and land factors in farms with the highest income, indicate that there is no single universal path of development for farms in such a diverse area as the European Union. It is also an argument in favour of making the mechanisms of the common agricultural policy even more flexible.

Some limitations of research include the criterion of seniority of EU member states in the division of regions according to Member State. This distinction is often used in literature and has an institutional character – it is assumed that the influence of the institutional environment and agricultural policy plays an important role. On the other hand, this division does not fully reflect the heterogeneity of European agriculture. The study of income determinants within groups of regions, determined on the basis of other criteria, can be the subject of future research.

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DETERMINANTY DOCHODÓW GOSPODARSTW ROLNYCH W UNII EUROPEJSKIEJ Z UWZGLĘDNIENIEM KRYTERIUM STAŻU CZŁONKOWSKIEGO. ANALIZA REGIONALNA

Słowa kluczowe: dochody rolnicze, Unia Europejska, funkcja Cobba-Douglasa, panelowa regresja kwantylowa

ABSTRAKT

Celem artykułu jest identyfikacja determinant dochodów reprezentatywnych gospodarstw rolnych na poziomie regionów Unii Europejskiej. W tym celu posłużono się danymi FADN za lata 2004-2017. Ze względu na odmienne uwarunkowania rozwoju rolnictwa dokonano podziału regionów Unii Europejskiej według kryterium stażu członkowskiego. Dochody badano za pomocą regresji panelowej i kwantylowej regresji panelowej z wykorzystaniem rozszerzonej formuły Cobba-Douglasa. Oprócz podstawowych nakładów czynników produkcji (pracy, kapitału i ziemi) badano również wpływ subsydiów oraz strategii zarządzania produkcją i finansami w gospodarstwie rolnym. Ustalono, że dochody gospodarstw w tzw. nowych krajach członkowskich w większym stopniu były wrażliwe na rosnącą specjalizację, płatności bezpośrednie oraz nakłady kapitałowe. W krajach tzw. starej Unii Europejskiej odnotowano względnie wysoką elastyczność dochodów względem czynnika pracy. Natomiast ujemny wpływ na dochód miał wzrost poziomu wykorzystania nakładów obcych. Wyniki modelu regresji kwantylowej pokazują, że wraz ze wzrostem dochodów gospodarstwa rola czynników pracy i ziemi zmniejsza się, podczas gdy znaczenie czynnika kapitałowego jest względnie stałe.

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