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Hanna Dudek[1], **Monika Krawiec**[2], **Grzegorz Koszela**[3]
Department of Econometrics and Statistics,
Warsaw University of Life Sciences – SGGW

Are Changes in Food Consumption in the European Union Environmentally Friendly?

Abstract. Food production and consumption have significant impacts on the environment. Changes in consumption patterns typically entail changes in related production systems. Consumers through their consumption behavior, market demand for food, and choices between animal and vegetal products indirectly influence the environment. The paper is aimed at assessing changes in food consumption in the European Union with regard to their environmental impact. The empirical analysis covering the period from 2004 to 2011 is based on the most recent FAO data on calorie supply per capita and its split between animal and vegetal products. The investigation uses econometric models for panel data. Results obtained reveal a significant increase in supply from animal products in "new" EU members and a significant decrease in "old" EU members. In both groups, there is no significant change in supply from vegetal products, although they are not homogenous with regard to the food supply.

Key words: food consumption, animal and vegetal products, environment, panel data models

Introduction

Since the release of the Brundtland Report [UNWCED 1987], the relationship between economic growth and the environment has been an issue of growing interest. Both production and consumption activities can generate negative effects on the environment. Duarte et al. [2015] cite several studies that point to the damages caused to the natural environment by the long-term process of economic growth. Recognition of the problem results in an increasing tendency to create an economic growth that goes along with natural resource preservation under the concept of sustainable development. Its integral parts are sustainable production and sustainable consumption. Putting sustainable consumption into practice is a challenge that requires, among others, the effort to change consumption patterns.

In general, changes in consumption patterns typically entail changes in related production systems through shifting consumption within a product group to less environmentally harmful products in the same product category; through shifting consumption from one product category to another; through reducing the consumption of certain product categories or commodities such as energy, water, meat, or petrol; through reducing overall consumption [Wolff and Schönherr 2011]. Consumers have a major role in determining the type of production. Through their consumption behavior and market demand for goods and services they indirectly influence the environment.

According to Westhoek et al. [2014], the consumption of meat, dairy, and eggs is increasing worldwide, and this will aggravate the environmental impact related to livestock production. Agriculture and livestock farming are great direct water consumers and direct

[1] doctor habilitated, associate professor, e-mail: hanna_dudek@sggw.pl
[2] PhD, e-mail: monika_krawiec@sggw.pl
[3] PhD, e-mail: grzegorz_koszela@sggw.pl

pollutants. They are the highest in Nitrogen and Phosphorus, and also with water activity in biochemical oxygen demand, and solid suspension. In atmosphere emissions, livestock farming is the activity that represents the biggest amount of methane, and agriculture – of nitrous oxide [Flores-Garcia and Mainar 2009]. Agriculture also accounts for 70% of all water use. Both primary food production and food processing are critically dependent upon reliable water supply and water quality. The production of food also requires vast amounts of land. Of the global soil surface, 31% is suitable for growing crops, while an additional 33% is suitable for grassland. However, agricultural land is becoming a scarce resource as a result of ongoing industrialization, urbanization, infrastructural development, land degradation, and desertification [Gerbens-Leenes and Nonhebel 2002].

Concerns about animal welfare, reactive nitrogen, greenhouse gas emissions, and also global warming have stimulated public debate in Europe about eating less meat and dairy products. However, consumer choices of foods and diet are determined by a complex set of personal values, social norms, habits, and aspirations. Foods with positive sustainability characteristics are often more costly than conventional foods due to higher costs of compliance with environmental standards and/or lower productivity of resource use. While it may not be a problem for consumers in the middle and higher categories of income, limited affordability is often a drawback for adoption of sustainable consumption among poorer households [de Haen and Requillart 2014].

The general aim of the paper is to assess changes in consumption with regard to their environmental impact. More precisely, the intention is to determine trends in food supply regarding the division into animal and vegetal products and to answer the question of whether observed changes are environmentally friendly. Moreover, the study verifies the significance of the influence of population income on the level of food supply. Empirical analysis is based on the most recent FAO data for European Union countries, covering the period from 2004 to 2011 (up to now, FAO hasn't published any new data on this subject). The data is available at www.fao.org. The examination is carried out for two groups of countries: the so-called "old" EU members and the so-called "new" EU members. In order to study the issues, econometric methods for panel data analysis are applied.

Methods

Panel data involve regularly repeated observations on the same individuals. Because they have both cross-sectional and time series dimensions, the application of regression models to fit econometric models are more complex than those for simple cross-sectional data sets. The standard linear panel model can be written as:

$$y_{it} = \alpha + \mathbf{x}_{it}\boldsymbol{\beta} + u_i + \varepsilon_{it} \tag{1}$$

where y_{it} is an outcome (dependent variable) for the i-th country at time t,
$\mathbf{x}_{it}$ – a row vector of observations on k explanatory factors for the i-th country at time t.
α – intercept,
β – a column vector of slope parameters,
u_i – an individual country-specific effect, $u_i \sim IID(0, \sigma_u)$, i=1, 2,…,N,

ε_{it} – error term, $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon)$, i=1, 2,…,N, t=1, 2,…,T.

The error term ε_{it} is assumed to be uncorrelated with the explanatory variables and with the individual country-specific effect. The assumptions on u_i help to determine the type of model that should be estimated. In the absence of the individual effect, pooled OLS estimator can be applied[4], otherwise random or fixed effects models (shortly named RE and FE respectively) are usually estimated. The key consideration in choosing between these approaches is whether u_i and $\mathbf{x}_{it}$ are uncorrelated, which is an assumption of the RE model [Wooldridge 2002]. The choice between fixed or random effects relies on the comparison of these two estimators by Hausman test[5]. Here, the null hypothesis is that the preferred model is the random effects model vs. the alternative of the fixed effects model.

Data

The study uses daily calorie supply per capita in European Union countries. This data is based on the food balance sheets available at FAOSTAT data sources. They show the per capita supply of total calories and the split between calories from animal and vegetal products. However, it is important to note that the data does not reflect exact consumption itself, as it includes losses through distribution and food preparation. The food balance sheets show the availability of food for human consumption. The total quantity of all foodstuffs produced in a country added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period, gives the supply available during that period.

In order to explain daily calorie supply per capita, the median of equivalized[6] net income in PPS (Purchasing Power Standard) was used (from Eurostat database). Such data gives information on the average wealth of people living in a given country.

Results and discussion

In the period under consideration, there was observed significant differentiation in consumption of vegetal and animal products within the European Union (Figures 1 and 2). On the base of Figure 1, one may state that in 2004 the least caloric meals were consumed by Cyprians, Bulgarians, Slovaks and Croats (on average less than 3000 kcal per day). On the other side, the most caloric meals were consumed by Belgians and Greeks (on average more than 3700 kcal per day). However, in most countries there was observed average consumption of 3000 – 3500 kcal.

When analyzing the consumption structure, one can notice that in 2004 in the European Union, the average share of animal products in general consumption reached

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[4] Pooled OLS is compared with FE by the F test and RE – by the Breusch and Pagan test. If the null hypothesis is not rejected in either test, the pooled OLS regression is favoured.

[5] It should be noted that the differences in the estimates of fixed effects and random effects models in finite samples can originate from different sources, therefore results of Hausman test should be interpreted with caution. For example, FE estimator may also be inconsistent due to dependence of time-varying explanatory variables and idiosyncratic error term (see for example [Ahn and Low 1996]).

[6] 50/30 equivalence scale was applied, which states that the first adult receives a weight of one, subsequent adults receive a weight of 0.5, and children of 0.3.

29%, whereas the smallest shares (less than 25%) were observed in Bulgaria, Greece, Croatia, Romania, and Slovakia. The largest shares (more than 35%) were observed in Luxembourg, France, and Finland. When comparing caloric intake from animal products, there is a clearly visible division into “old” and “new” European Union members. Intake of less than 1000 calories from animal products was observed in all “new” members and in Greece, Spain, and Italy. Intake of more than 1000 calories from animal products was observed in all other countries under consideration. The smallest intake of calories from animal products (600 kcal) was observed in Bulgaria, whereas in France and Luxembourg it was twice as much.

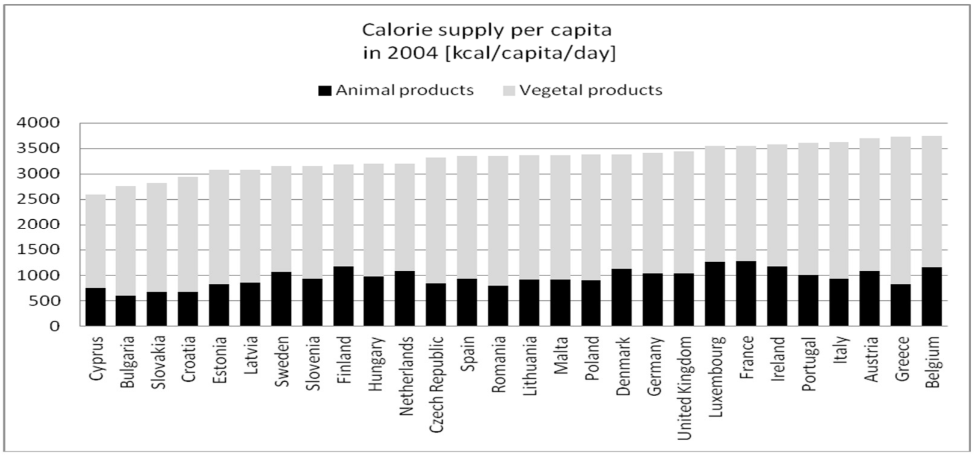


Fig. 1. Calorie supply per capita in 2004

Source: own elaboration on the base of FAO data.

Figure 2, presenting calorie supply per capita in 2011, allows an assessment of possible changes in consumption in the period under consideration. It shows that in 2011 in most countries there was still an observed food supply of 3000-3500 kcal daily per capita. In the European Union, the average share of animal products still equaled 29% of general consumption. However, in the majority of “new” European Union members there was observed an increase in animal product consumption, whereas half of the “old” members demonstrated a significant decrease in animal product consumption.

Table 1. Estimates of trend models

Results	Food origin			
	Animal		Vegetal	
	“old” members	“new” members	“old” members	“new” members
const	1091.21***	829.40***	2285.11***	2293.09***
t	-4.09***	3.30**	1.72	3.12
H	0.0001	0.0001	0.0006	0.0004
B-P	296.23***	296.25***	371.03***	316.44***
F	78.10***	80.06***	133.81***	119.26***

Source: own calculations. Note: * indicates statistical significance at 0.1, ** at 0.05, and *** at 0.01.

Table 1 presents results of trend estimations explaining calorie intakes from animal and vegetal products for “old” and “new” EU members. Test results[7] indicate random effects models, thus we present only their estimates.

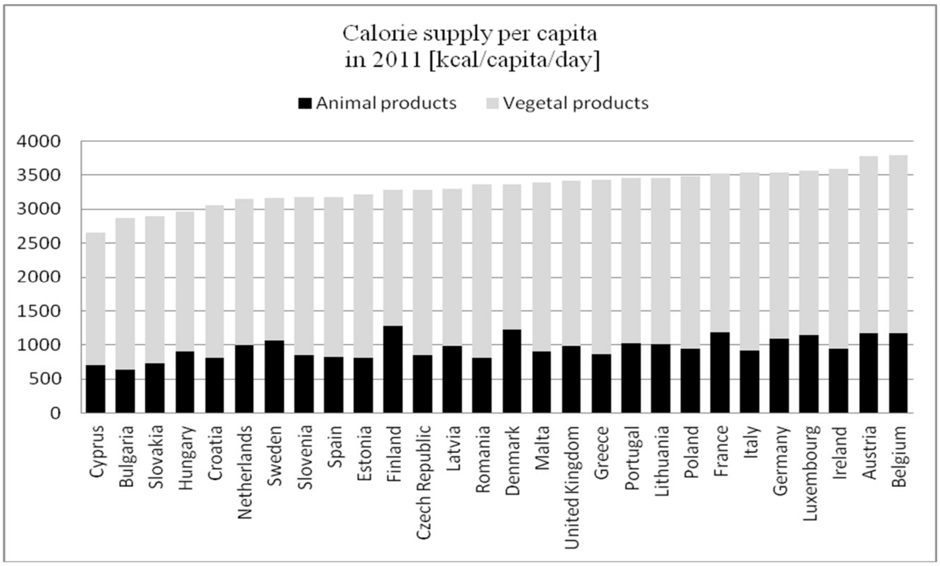


Fig. 2. Calorie supply per capita in 2011

Source: own elaboration on the base of FAO data.

On the basis of results given in Table 1, one can observe a significant increase in supply from animal products in “new” EU members and a significant decrease in “old” EU members. In both groups of countries there was no significant change in supply from vegetal products.

Table 2. Estimates of models explaining food supply by income

Results	Food origin			
	Animal		Vegetal	
	“old” members	“new” members	“old” members	“new” members
const	6.78***	6.11***	7.75***	7.58***
lnIncome	0.02	0.07***	0.003	0.02*
H	1.72	0.42	0.99	2.45
B-P	286.27***	304.31***	358.57***	185.71***
F	57.00***	129.95***	135.62***	79.35***

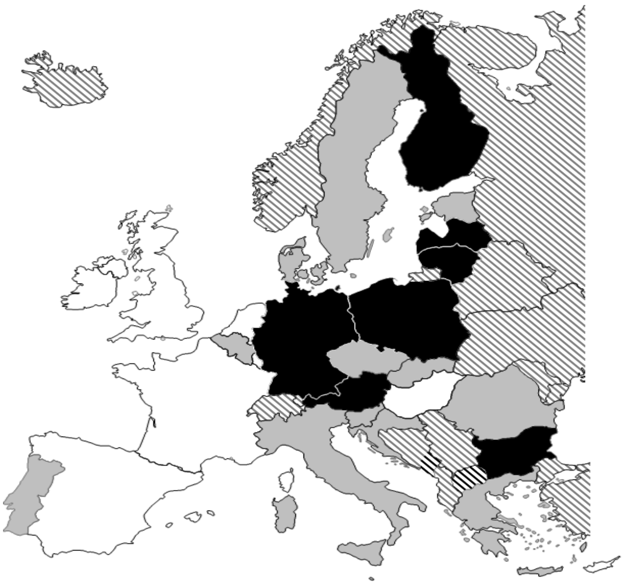
Source: own calculations, Note: * indicates statistical significance at 0.1, ** at 0.05, and *** at 0.01.

In Table 2, there are displayed estimates of models where the dependent variable is a logarithm of calorie intake from animal and vegetal products and the independent variable

[7] In all models the Breusch-Pagan test and F test reject pooled OLS models, the Hausman test statistic indicates RE models.

is a logarithm of equivalized net income. Like in trend models, here again tests indicate random effects models, thus we present solely their estimates.

Results, given in Table 2, may be interpreted as income elasticities due to the fact the models are estimated on the basis of logarithmic values of dependent and independent variables. For example, a 1% income increase in “new” EU members causes an increase in supply from animal products by 0.07% and increase in supply from vegetal products by 0.02%. Our findings are consistent with observations of other researchers that in general, when standards of living are low, increasing incomes will favor more foods of animal origin, while the consumption of grains and carrots will drop [Grigg 1994]. As far back as 1960, Perisse et al. [1969] showed that a rise in income was accompanied by a significant increase in the share of lipids from animal products, by a reduction in the share of carbohydrates as the increase in the consumption of sugar products did not compensate for the reduction in cereal consumption, and by stability of a share of protein calories, with a substitution of plant proteins by animal proteins. Since the 1960s, this trend has been confirmed in developed countries and has gradually spread to emerging countries. For example, Regmi et al. [2008] analyzed the convergence of food diets from 1990 to 2004 among 47 countries grouped by level of income. They revealed that expenditures on major food groups (meats, vegetables, sweets and soft drinks) converged toward the level of high-income countries, although this convergence also included upper middle-income and lower middle-income groups in poor countries. On the other hand, income increase in “old” EU members does not cause any increase in food supply and the probable cause of this phenomenon is the saturation effect.



Note: black - upward trend, white - downward trend, grey – no clear trend, lined – not EU members

Fig. 3. Tendencies in the food supply from animal products in EU countries.

Source: own elaboration.

Our results, displayed in Tables 1 and 2, reflect average trends and relationships in the two groups of countries under consideration, e.g. “new” and “old” members of the

European Union. However, these groups are not completely homogenous with regard to the food supply. Figure 3 presents the map where different colors correspond to different tendencies[8] in the food supply from animal products. Black color denotes an increasing tendency, White denotes a decreasing tendency and Grey denotes no clear tendency (lined countries are not EU members). Six of the “old” EU members represent decreasing food supply from animal products. It is worth mentioning that the group includes countries with high numbers of inhabitants, such as France, the UK, and Spain. Only three of the “old” EU members show increasing tendencies in supply from animal products (Austria, Finland, Germany).

The situation is different in the case of “new” EU members. Only two of them (Hungary and Cyprus) are characterized by downward trends in food supply from animal products, while four of them (Bulgaria, Latvia, Lithuania, and Poland) are characterized by upward trends in food supply from animal products. This is not good from an environmental aspect, as – according to Westhoek et al. [2014], who explored possible consequences of replacing 25-50% of current meat, eggs and dairy consumption in the EU with plant-based foods – reducing livestock production by 50% will lead to large structural changes within the EU agricultural sector, resulting in a reduction in the emission of greenhouse gases (25-40%), and reactive nitrogen (around 40%). Moreover, due to reduced feed demand, the use of imported soybean meal would drop by 75% and the EU would become a large net exporter of basic food commodities. Actually, it is quite optimistic that the population of White-colored countries, representing downward trends in food supply from animal products, constitutes 41% of the total EU-28 population, whereas the population of Black-colored countries, representing upward trends in food supply from animal products, corresponds to 29% only.

Concluding remarks

Agriculture and food consumption are identified as drivers of environmental pressures as there are a number of factors in agricultural food production and consumption that have significant impacts on the environment. These factors are, for example: water use and water pollution, energy use, climate change, chemical usage or desertification. However, in the long-run food production and consumption evolve under the effect of dietary changes that are caused, among others, by increases in income. In the period under consideration (2004-2011), most of the EU countries reported a rise in the income of their populations. However, in the case of “old” EU members, this didn’t have a significant effect on changes in consumption of both animal and vegetal products, whilst in the case of “new” EU members it caused an increase in food consumption. Nevertheless, income elasticities of consumption, presented in the paper, have low values, implying weak effects.

Initially, in 2004 “new” EU members were characterized by lower consumption of animal products than the majority of “old” EU members. Then it changed and most of the “new” members started to exhibit an increase in consumption of animal products. This phenomenon is unfavorable, taking into account the negative environmental consequences of livestock farming that are listed in the introduction. Moreover, according to Eurostat, the

[8] At least 50% value of R squared and a trend parameter significant at 0.05 were taken as the evidence for a tendency

food and drink value chain in the EU causes 17% of direct greenhouse gas emissions and 28% of material resource use. Furthermore, animal calorie production is particularly inefficient compared to that of vegetable calories, as large quantities of the calories are fed to livestock in order to maintain living functions and for the production of non-edible body parts, e.g. bones.

In the majority of “old” EU member countries, consumption of animal products has declined. What is more, the number of people living in countries which represent decreasing consumption of animal products is higher than the number of people living in countries which represent increasing consumption of animal products. Both groups of countries do not exhibit any significant changes in consumption of vegetal products.

Hopefully, a growing segment of consumers in the medium- and high-income categories who benefit from income increases will use their potential to contribute to environmentally friendly agriculture by purchasing foods from certified sources and by reducing the share of resource-intensive products, such as meat, in their diets. Possibly, when “new” EU members catch up with the living standards of “old” members, their consumption patterns will converge toward those environmentally friendly diets.

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