THE EFFECTS OF GLOBAL REAL ECONOMIC CRISIS ON THE MARKETS FOR FOSSIL AND RENEWABLE FUELS

Péter Jobbágy &Attila Bai

University of Debrecen Centre for Agricultural and Applied Economic Sciences Faculty of Applied Economics and Rural Development Institute of Business Economics Hungary,
H-4032 Debrecen, Böszörményi Str. 138. jobbagyp@agr.unideb.hu, abai@agr.unideb.hu

Abstract: The 2008/2009 world economic crisis had significant impact on the oil and fuel markets. The crisis developed from the meltdown of American and European mortgage and financial markets and rapidly involved the global real economy. As each country reacted differently to the crisis, the changes in the fuel market also showed significant geographic variation. In our present research, the actions of the US, German and Hungarian fuel markets were analysed for the answer to the reasons for the differences in crisis reactions. We examined the tendency of fuel consumption, the changes of price elasticity for gasoline and diesel and the possible effects of the crisis on the regulatory system.

Keywords:global economic crisis, fuel market, biofuels

1. Introduction

Crude oil is one important core point of the modern economy, thus actions on the crude oil market interact closely with events in the global economy. This interaction was no different during the 2008/2009 world economic crisis, during which the threat of global market recession drove prices higher to a great extent, accelerated the process of collapse. After that the prices fell to their lowest level and they only began to recover by the economic boost. *Figure 1* illustrates the tendency of crude oil prices.

Figure 1: Crude oil prices between 2007 and 2010
Source: Energy Centre Ltd, 2011

This tendency is slightly modulated by the higher rate of the presence of biofuels, both on the national and global markets (*Figure 2*). Biofuels, as substituting products, have considerable subsidisation and compete with fossil fuels. The

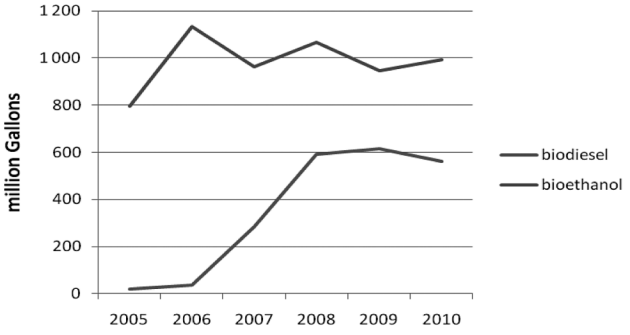

Figure 2: Development of biofuel trade
Source: FAPRI, 2011

figure demonstrates that the recession especially affected the bioethanol trade; turnover from biodiesel was diminished to a much lesser degree. In one respect, the reason for this difference is that ethanol is present on the global market with significantly higher volume. From another aspect, the biggest exporter, Brazil, is flexibly handling the incorporation of bioethanol, hereby regulating – considering world economic tendencies – the bioethanol quantity getting into the world market.

1.1. Regulation system

Markets for biofuels are strongly regulated by developed countries. Regulation is primarily for environmental protection. Therefore, it mostly finds expression in minimal incorporation quotas, tax allowances and penalties that are to

be paid in cases of non-observance of quotas. We essentially verify that the regulation increasingly inclines towards the latter system as support for increased biofuels turnover imposes a significant burden on the budget. We introduce the regulation systems of major world market operators, as follows:

The market for traditional biofuels is basically determined in Brazil by the incorporation rate, which must be directly changed by 20-25% annually, in the USA by the RFS (Renewable Fuel Standard, 2007) modified by the EISA (Energy Independence and Security Act, 2010), in the EU by the renewable fuels rate expected for 2020 by the regulation no. 2009/28/EC.

The EU law limits the emission quantity of various biofuels during their life cycle (through that the applicable agricultural/industrial technologies also), in the case of import biodiesel, the sustainable requirements for production, as well. Thus, biofuels are only included in quotas' fulfilment and can only be supported from 2011 (in cases of factories launched before 2008, from 2013) if their production and utilization decrease the emission of GHGs by at least 35%, compared to fossil energy sources. With the currently applied general technologies, emission decreases exceeding 35% can be reached only with the utilization of rapeseed (- 38%) and corn (-47-49%). In the case of biofuel imports into the EU, social (work safety) criteria have already been specified that makes it difficult for exporter countries (e.g. Brazil) to export biofuels to the EU (Popp et al, 2010).

Table 1 shows the most important expectations on biofuels concerning the near future.

Table 1: Expectation on biofuels

Expected quantity	2010		2012		2020 (EU)	2022 (US)
	total biofuel	2nd gen. biofuel	total biofuel	2nd gen. biofuel	total biofuel	2nd gen. biofuel
EU (energy%)	5.75	-	-	-	10	-
USA (million l)	-	25	-	1893	107.47*	3785
Expected green-house gas emission	*1BE*[2]	*1BD*[3]	*1BM*[4]	*2CE*[5]	*2FTD*[6]	*2DME*[7]
EU (g CO_2eq/MJ)[1]	24-70	37-68	15-23	13-25	4-6	5-7

Source: IEA, 2010; 2009/28/EC Directive; Coyle, 2010
Symbols: * million tons
[1]: depends on raw material and technology, [2-4]: 1st generation biofuels ([2]: bioethanol, [3]: biodiesel, [4]: bio-methane) [5-7]: 2nd generation biofuels ([7]: cellulose based ethanol, [8]: Fischer-Trops diesel, [9]: dimethyl-ether)

In Brazil, the obligatory incorporation rate of biodiesel was increased from 2% in 2008 to 3% in 2009. Tax allowance on biodiesel production fluctuates between 0–100%, depending on what kind of raw material, what kind of territory and what type of holdings (family or joint) are producing biodiesel. In the USA, there is a 0.12 USD/l tax allowance on corn-based fuel production, while on new generation biofuels, there is a 0.27 USD/l tax allowance (Coyle, 2010); meanwhile, the EU Member States have different support systems, but as per fuel type the allowance is not differentiated.

Regulation on biofuels has an impact on automobile industry, too. Fulfilment of the specifications of RFS would be possible by raising the current 10% incorporate norm; however, this increases the risk in the motor industry too, which gives warranties on their cars only up to 10%. In the EU, in the case of diesel oil, this figure is 7%, for petrol 10%, biofuel (and 15% ETBE) can be incorporated into the standard fuel. However, this has not been published in national legislation yet; by June 2010, merely four Member States (Austria, France, Germany and The Netherlands) had launched it. Naturally, E-85 and B-100 standards also exist, which can safely be used only with FFV, functioning at an extremely low rate.

2. Materials and methods

2.1. Objectives

Following objectives were set for the examinations:

1. a search for possible correlations between the increase of real GDP and oil utilization
2. an analysis of the relation between fuel prices and consumption on the national level
3. an examination of price elasticity on fuel demand
4. an analysis of the effects of the possible changes brought about by regulation systems on some biofuel markets

2.2. Target areas

We chose three countries, the USA, Germany and Hungary, as target points of the analyses. The reasons for our choices are as follows:

1. The global financial and real economy crisis started in the USA and the most bioethanol is produced here (Popp et al 2010); thus, it has an important role in the global biofuel sector
2. Germany is the EU and European leader in biodiesel production and consumption; its market actions determine the biofuel market of whole Europe, particularly as regards Central and Eastern European biofuel producing countries having commercial relationships with Germany
3. Hungary is the typical example for the indirect effects of the crisis on the biofuel market; moreover, its ethanol market development stands in contrast with American and German tendencies.

2.3. Databases and methodology

We used the databases of EIA (Energy Information Administration), BAFA (Bundesamt für Wirtschafts- und Ausfuhrkontrolle), Energy Centre Ltd, Hungarian Customs

and Finance Guard, EUROSTAT and FAPRI. We prepared analyses using the MS Office 2010 Excel and SPSS Statistics 17 programmes.

In the course of our research, we applied Pearson's correlation analysis and price elasticity calculation of demand; their methods are briefly introduced, as follows:

- Pearson's correlation: Values of r correlation coefficient can fluctuate between -1 and + 1 depending on the strength and direction of the relation. If r=0, linear relation between X and Y can be excluded, though non-linear relation between variables can be existed as r is inadequate to measure that. The definition of Pearson's correlation coefficient (r) in a supervised n sample, takes place as follows (MALHOTRA, 1999):

$$r = \frac{\sum (X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum (X_i - \overline{X})^2} \sqrt{\sum (Y_i - \overline{Y})^2}}$$

- Price elasticity of demand: we examined the price sensitivity of fuel demand by defining the curve elasticity. Price elasticity gives the percentage change in quantity demanded in response to a one percent change in price. Calculation is by means of the following formula, where Dg is the demand, Pg is the fuel (on the basis BRONS ET AL, 2007):

$$\varepsilon D_g = \frac{\delta D_g}{\delta P_g} * \frac{P_g}{D_g}$$

3. Results and discussion

3.1. Correlation between the change in real GDP and consumption of petroleum products

As we explained in the introduction, some kind of interaction can be observed that is expressed both in prices and consumption. As GDP is the most widely accepted indicators of economic increase, we compared its alterations in the cases of the USA and selected European countries to changes which occurred in petroleum product consumption. *Table 2* contains starting data of the correlation analysis.

The performed correlation analysis has shown significant and relatively strong (r= 0.604 – 0.694) correlation between real GDP and change in petroleum products consumption in 2007 and 2009. It can be stated that strong correlation is not typical of that two indicators, as developed countries are striving for the reduction of CO_2-emissions, consequently for the reduction of petroleum utilization. In this way, less growing or decreasing petroleum utilization can be realised by growing real GDP. However, the world economic crisis diminished the economic operation so much that it resulted in the reduction of petroleum consumption in an expressly verifiable and provable way.

3.2. Analsis of fuel prices and consumption in chosen countries

Since fuels are rather inelastic to price, it is difficult to present any obvious correlation between the prices and

Table 2: Consumption of petroleum products in selected countries (1000 bbl/day)

Country	2007	change% 06/07	real GDP growth rate 06/07 (%)	2008	change% 07/08	real GDP growth rate 07/08 (%)	2009	change% 08/09	real GDP growth rate 08/09 (%)
United States	19964.6	-0.12	*1.90*	18788.2	-5.89	*0.00*	18096.1	-3.68	*-2.60*
Czech Republic	206.6	-0.48	*6.10*	208.6	0.97	*2.50*	203.7	-2.35	*-4.10*
Hungary	159.9	-1.24	*0.80*	160.9	0.63	*0.80*	156.9	-2.49	*-6.70*
Poland	510.4	3.78	*6.80*	533.9	4.60	*5.10*	533.9	0.00	*1.70*
Romania	223.2	4.35	*6.30*	205.1	-8.11	*7.30*	176.9	-13.75	*-7.10*
Slovakia	61.9	5.09	*10.50*	63.4	2.42	*5.80*	59.7	-5.84	*-4.80*
France	1857.3	-0.85	*2.40*	1874.3	0.92	*0.20*	1769.5	-5.59	*-2.60*
Germany	2448.9	-8.21	*2.70*	2546.1	3.97	*1.00*	2415.2	-5.14	*-4.70*
Italy	1650	-3.16	*1.50*	1602.1	-2.90	*-1.30*	1517.1	-5.31	*-5.20*
Nether-lands	671	-1.11	*3.90*	654	-2.53	*1.90*	626.9	-4.14	*-3.90*
Spain	1426.7	1.45	*3.60*	1383.3	-3.04	*0.90*	1312.4	-5.13	*-3.70*
United Kingdom	1555.7	-3.66	*2.70*	1530.6	-1.61	*-0.10*	1493.9	-2.40	*-4.90*

Source: OPEC, 2010; EUROSTAT, 2011, own calculations

consumption within a country; however, in the case of international outlook, it can be proved that in countries (e.g. USA, Canada) applying lower fuel prices, fuel consumption per capita is basically higher than in typically more expensive countries, such as EU Member States (LITMAN, 2011).

It can be stated as a whole that fuel prices in the three examined countries followed the tendency of petroleum prices during the analysed period; primarily, exchange rate fluctuations (USD – EUR; USD – HUF) are responsible for small extent deviation of the shown tendencies. Fuel consumption per capita loosely followed the prices, although the above-mentioned territorial differences (the USA vs. the EU) can be clearly seen in *Figure 3*.

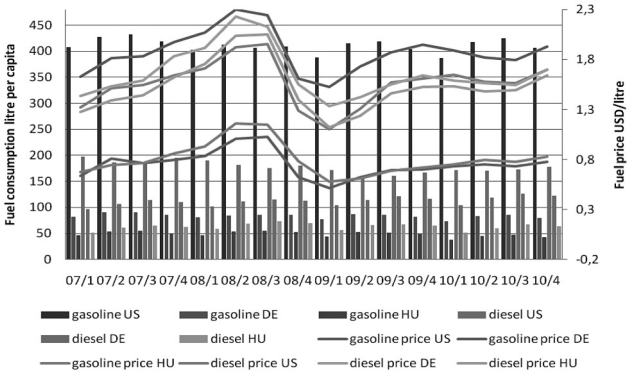

Figure 3: Fuel prices and consumption in the USA, Germany and Hungary
Source: EIA, 2011; BAFA, 2011; VPOP, 2011; Energy Centre Ltd., 2011

Figure 3 demonstrates that, while in the USA, decrease in consumption per capita was primarily significant in 2008, until then, in Germany and Hungary, due to the delayed arrival of the crisis, a significant decline first took place in 2009.

3.3. Evaluation of biofuel consumption

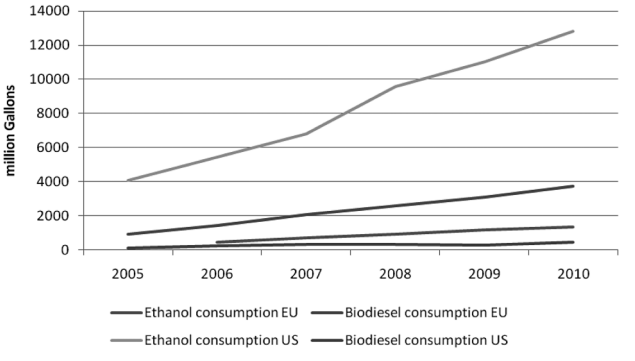

Figure 4: Biofuel consumption of the EU and the USA
Source: FAPRI, 2011

Taken as a whole, biofuel consumption, independent of the crisis, shows a growing tendency both in the USA and in the EU (*Figure 4*); however, significant fluctuation was experienced in consumption on the monthly level during the crisis.

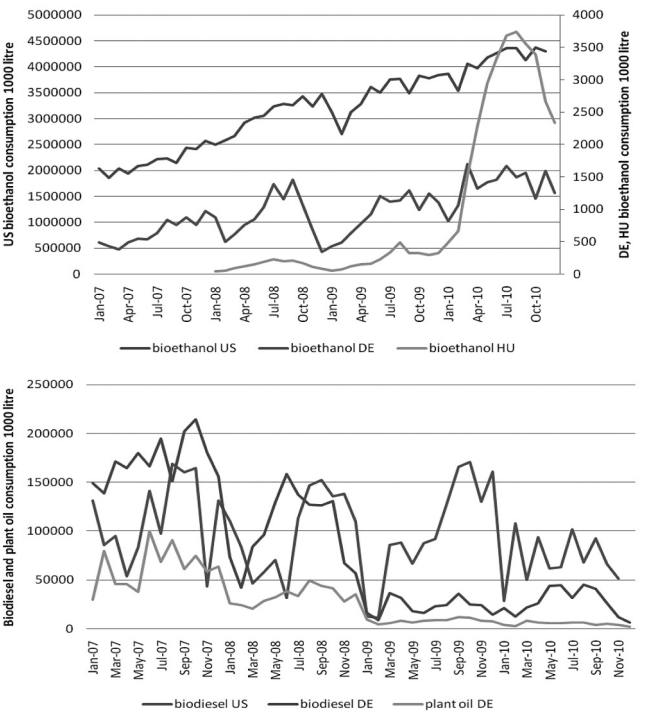

Figure 5: Monthly bioethanol and biodiesel consumption in the examined countries
Source: EIA, 2011; BAFA, 2011; VPOP, 2011

Major fluctuation was experienced on the German market, whereas the Hungarian ethanol market for the major part of the examined period, showed steep growth (the reasons for this are discussed in detail in section 3.5.). Biodiesel and plant oil consumption were the most unstable in the examined period (*Figure 5*). This was due to the extremely high oilseed prices, which had just increased the net cost of biodiesel when petroleum prices hit the historical bottom. Therefore, significant state support was not able to compensate the price difference, either.

3.4. Price elasticity of fuel demand

As fuel prices do not correlate with consumption, price elasticity of demand is the only indicator by which their effects can be quantified. *Tab. 3* contains price elasticities of demand. It is remarkable that values for elasticity are mostly different from bibliographic data (-0.1 – -0.38; GOODWIN ET AL, 2004; DAHL, 2011). The reason for these significant

Table 3: Fuel price elasticities in the USA, Germany and Hungary

Year	gasoline price elasticity			diesel price elasticity		
	US	DE	HU	US	DE	HU
2008	-0.25	0.71	0.22	-0.58	3.05	2.99
2009	0.01	0.84	1.16	0.27	-0.66	-1.04
2010	0.04	-0.10	-0.71	-0.18	0.02	0.81

Source: own calculations

deviations is the chaos caused by the crisis, which disarranged petroleum prices and exchange rates. Furthermore, the crisis has made several enterprises bankrupt and has caused significant increase in unemployment, thus reducing the purchasing power of households. The combined effect of many special factors has disarranged the traditional price-consumption relationship on the fuel market.

3.5. Effects of alteration in regulation systems on the biofuels market

The most important change in the USA was that on 13 October, 2010, when the incorporation rate of bioethanol was increased by 15% for cars and vans manufactured in and after 2007. This change affected approximately 1/3 of the entire fuel consumption (TÓTH, 2010). Change in regulation practically had no impact on the examined period, as it was carried out at the end of that given period. As the regulation system was practically unchanged in the period 2007-2010, fluctuations in the American biofuel market were due to the economic situation.

Development of regulation was completely foreseeable in Germany, too. Bioethanol is tax-free, whereas the tax allowance on biodiesel was lowered from 0.3994 EUR/l to 0.3034 EUR/l in the examined period. It can also be stated that the regulation system did not change in a drastic or unforeseeable way, thus biofuel fluctuation can be traced back to the market conditions. (See chapter 3.3.).

The Hungarian regulation system changed several times during the crisis. Regulation for biofuels was not affected (these were only changed in 2010 (CVII. law of 2010) but due to the crisis, the excise duty rate and VAT-rate were increased. Therefore, the excise duty on fuel has risen from HUF 130.5 to HUF 120, duty on gasoil rose from HUF 88.9 to HUF 97.35 (SZARVAS, 2010). Considering that the excise duty is also the basis of VAT, the effect of this price increase was more significant – in the case of petrol it was HUF 20.6 , regarding gasoil it was HUF 10.6. This sudden price increase prosperously influenced turnover of E-85 in the country (*Figure 5*) as fuel content of E85 is excise duty free.

Figure 6 illustrates the content of fuel prices in the examined period. It can be clearly seen that lower fuel prices in the USA are primarily due to the lower tax rates. The fact that the tax ratio in Hungarian fuel prices did not grow, in spite of the increasing tax rate, is due to the growth of petroleum prices and the HUF-USD rate.

4. Conclusion

Usually, there is no close correlation between the consumption of petroleum products and the change in real GDP, although the interaction between the economy and the petroleum market is well known. However, the crisis influenced the economic processes in 2009 to such an extent that such a correlation became a reality.

Fuel prices, as usually, obviously followed the evaluation of the world price of oil during the examined period, also affected by = differences caused by the fluctuations in the exchange rate (EUR-USD; HUF-USD). The per capita consumption only loosely followed the evaluation of prices, mainly for two reasons. On the one hand, fuels are traditionally inelastic products: price has little effect on their demand in the short term; on the other hand, fluctuations caused by the crisis suppressed all the other effects.

Demand for biofuels, despite the crisis, has shown more steady growth in the USA than in the EU, but monthly, there were very significant fluctuations. These were mainly due to such increases as those seen in raw material prices, which made the substantial part of renewable fuels non-competitive, even under significant state subsidization.

Hungary is an exception to this tendency, where the increase in excise duty rate and VAT-rate occurred within a short time and led to a record increase in fuel prices, thus causing an explosive growth in demand on the E85 fuel market.

In the analysed period, the price elasticity of fuel demand greatly deviated from the bibliographic data. The reason for this is the chaos caused by the crisis, which disarranged petroleum prices and exchange rates, while rendering several enterprises bankrupt and causing a significant increase in unemployment, thus reducing the purchasing power in household sector. The combined effect of many special factors has brought upheaval to the traditional price-consumption relationship on the fuel market.

The biofuel market was not directly affected by the renewable fuel regulation systems of the examined states, since their changes occurred at the end of the analysed period. However, in the near future, they will become significant direct determinant factors.

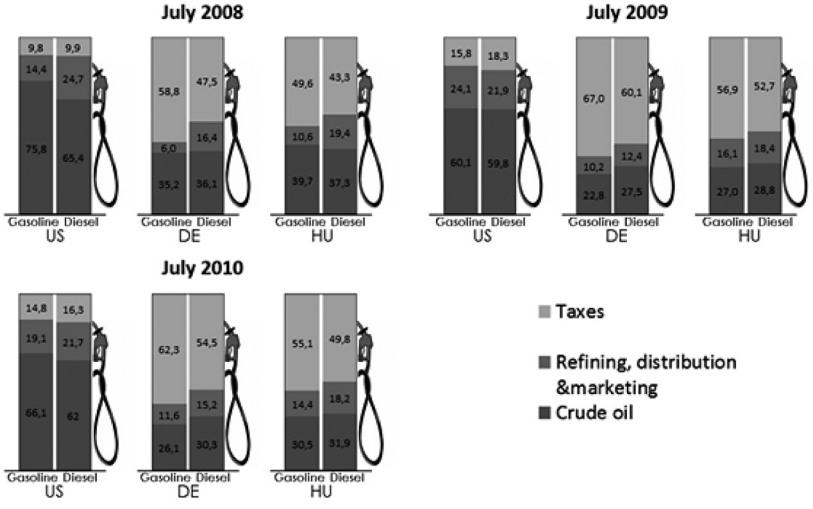

Figure 6: Composition of fuel prices
Source: EIA, 2011; own calculations

References

1. 2010. évi CVII. törvény A megújuló energia közlekedési célú felhasználásának előmozdításáról és a közlekedésben felhasznált energia üvegházhatású gázkibocsátásának csökkentéséről. in Magyar Közlöny, issue 176, Budapest. 2010.
2. **Brons, M; Nijkamp, P; Pels, E; Rietveld, P: (2008)** A meta-analysis of the price elasticity of gasoline demand. A SUR approach. Energy Economics 30 (2008) 2105-2122. doi: 10.1016/j.eneco.2007.08.004
3. **Coyle, W: (2010)** Next-Generation Biofuels. Near-Term Challanges and Implications for Agriculture. BIO-01-01. USDA
4. **Dahl, C A: (2011)** Measuring global gasoline and diesel price and income elasticities. Energy Policy. doi:10.1016/j.enpol. 2010.11.055
5. Erneuerbare Energien Gesetz (EEG): (2009) http://bundesrecht.juris.de/bundesrecht/eeg_2009/gesamt.pdf
6. **Goodwin, P; Dargay, J; Hanly, M: (2004)** Elasticities of road traffic and fuel consumption with respect to price and income: a review. Transport Reviews 24 (3), 275–292.
7. **Litman, T: (2011)** Transportation elasticities, How prices and other factors affect travel behavior. Victoria Tarnsport Policy Institute. http://www.vtpi.org/elasticities.pdf
8. **MALHOTRA, N K: (1999)** Marketing-kutatás. Akadémiai Publishing House, Budapest, 2005. 904 pp.
9. **OPEC: (2010)** Annual Statistical Bulletin 2009. Vienna. 2010. 106p. ISSN 0475-0608
10. **Popp J; Somogyi A; Bíró T: (2010)** Újabb feszültség a láthatáron az élelmiszer- és bioüzemanyag-ipar között? Gazdálkodás, vol. 54, issue 6., pp. 592-603.
11. **Szarvas, Gy: (2010)** Benzinár-hullámvasút – Üzemanyagár-változások és okaik 2007 – 2010 folyamán. http://totalcar.hu/magazin/kozelet/2010/10/21/benzinar-hullamvasut/
12. **Tóth, A: (2010)** Zöld út az E15-ös üzemanyagnak. Hírlevél. http://www.vm.gov.hu/main.php?folderID=2541&articleID=16643&ctag=articlelist&iid=1