

# AUTHOR ACCEPTED MANUSCRIPT

## FINAL PUBLICATION INFORMATION

Oil Prices and the Global Economy

The definitive version of the text was subsequently published in

Energy Economics, 49 (May 2015), 2015-03-23

Published by Elsevier and found at <http://dx.doi.org/10.1016/j.eneco.2015.03.005>

**THE FINAL PUBLISHED VERSION OF THIS ARTICLE  
IS AVAILABLE ON THE PUBLISHER'S PLATFORM**

This Author Accepted Manuscript is copyrighted by the World Bank and published by Elsevier. It is posted here by agreement between them. Changes resulting from the publishing process—such as editing, corrections, structural formatting, and other quality control mechanisms—may not be reflected in this version of the text.

You may download, copy, and distribute this Author Accepted Manuscript for noncommercial purposes. Your license is limited by the following restrictions:

- (1) You may use this Author Accepted Manuscript for noncommercial purposes only under a CC BY-NC-ND 3.0 IGO license <http://creativecommons.org/licenses/by-nc-nd/3.0/igo>.
- (2) The integrity of the work and identification of the author, copyright owner, and publisher must be preserved in any copy.
- (3) You must attribute this Author Accepted Manuscript in the following format: This is an Author Accepted Manuscript of an Article by Timilsina, Govinda R. *Oil Prices and the Global Economy* © World Bank, published in the Energy Economics 49 (May 2015) 2015-03-23 CC BY-NC-ND 3.0 IGO <http://creativecommons.org/licenses/by-nc-nd/3.0/igo> <http://dx.doi.org/10.1016/j.eneco.2015.03.005>

# **Oil Prices and the Global Economy: A General Equilibrium Analysis<sup>1</sup>**

Govinda R. Timilsina

Senior Economist, Development Research Group, The World Bank. 1818 H Street, NW.  
Washington, DC 20433, Tel: 1 202 473 2767. Fax: 1 202 522 1151. E-mail:

[gtimilsina@worldbank.org](mailto:gtimilsina@worldbank.org)

Revised Manuscript

Submitted on January 15, 2015

---

<sup>1</sup> We acknowledge the Knowledge for Change (KCP) Trust Fund of the World Bank for financial support. The views and findings are those of the authors and do not necessarily reflect those of the World Bank. All remaining errors are our own.

# **Oil Prices and the Global Economy: A General Equilibrium Analysis**

## **Abstract**

A global computable general equilibrium model is used to analyze the economic impacts of rising oil prices with endogenously determined availability of biofuels to mitigate those impacts. The negative effects on the global economy are comparable to those found in other studies, but the impacts are unevenly distributed across countries/regions or sectors. The agricultural sectors of high-income countries, which are relatively energy intensive, would suffer more from a rising oil prices than that in lower-income countries, whereas the reverse is true for the impacts across manufacturing sectors. The impacts are especially strong for oil importers with relatively energy-intensive manufacturing and trade, such as India and China. While the availability of biofuels does mitigate some of the negative impacts of rising oil prices, the benefit is small because capacity of biofuels to economically substitute for fossil fuels on a large scale remains limited.

**Key words:** Oil price, CGE model, Global economy, International trade

**JEL Classification:** Q43

## 1. Introduction

A good understanding of adverse impacts of oil price rise in an economy is essential to design policy responses to reduce those impacts. However, the impact of oil price shocks on global economy is debated in the literature. Several studies, such as Hamilton (1983, 1996, 2008), Barsky and Kilian (2004), Kilian (2009), Morana (2013) present a good account of this debate. Using data since World War II until the first oil crisis in 1973, Hamilton (1983) finds that oil shocks contributed to some of the US recession prior to 1972. Similarly, analyzing data since the first oil crisis until 2000, Barsky and Kilian (2004) show that oil price increases contributed to US recessions although the impacts were not as large as commonly thought. Recently, Morana (2013) shows that oil prices increases exacerbated economic recessions during the Gulf wars and also financial crisis in 2008. Other key studies investigating the impacts of oil price increases on macroeconomy includes Hamilton (2011), Killian and Vigfusson (2011), Blanchard and Riggi (2013), Herrera and Pesavento (2009), Jimenez-Rodriguez and Sanchez (2005), Lee and Ni (2002), Lee et al. (1995) and Mork (1989). Most of these studies use econometric approach to establish the relationship between changes in oil prices and GDP based on historical data. One limitation of this approach is that the correlation between oil prices and GDP could be just a statistical coincidence (Hamilton, 1983). Kilian (2008) argues based on time series estimates that the GDP impacts of oil price shocks depend significantly on whether the observed oil price changes were exogenous or endogenously induced by other factors.

A few studies have examined the impacts of oil price rise on GDP using structural models, particularly the computable general equilibrium (CGE) models. For example, Sanchez (2011) shows, using a dynamic CGE model, that the oil price rise during 2002-2008 period would have caused 2% to 3% loss of GDP annually in six oil importing countries (Bangladesh, El Salvador, Kenya, Nicaragua, Tanzania and Thailand). Using a CGE model, Aydın and Acar (2011) finds that higher oil prices would have a significant adverse impact on Turkish economy in the short run, though the economy would adjust in the long-run and the impacts would be milder. A higher oil price path reaching to US\$185 per barrel in 2020 would cause 1.3% of GDP annually as compared to the baseline where oil price was expected to reach US\$108 per barrel in 2020. The analysis was carried out for 2010-2020 period and the GDP impacts in the short-run (2011 and

2012) were 2.3% and 2.3% respectively. Using a stochastic dynamic general equilibrium model, Balke et al. (2008) find a relatively weaker impact of oil prices on US GDP since the 1990s compared to earlier years in the 1970s and 1980s. They conclude that domestic drivers rather than oil price shocks are primarily responsible for explaining US GDP fluctuations more recently.

This study intends to shed some lights on this debate. We use a multi-country, multi-sector, recursive dynamic, global CGE model to examine the impact of projected oil price increases on the global economy as well as specific regional/national economies. The model differs from existing ones in that it models the land-use sector in depth by disaggregating land supply in each country or region into 18 agro-ecological zones. It also explicitly represents major biofuels and their feedstock, and explicitly models the tradeoff between fossil fuels and biofuels so that the indirect effects of oil price on the agricultural sector through changes in biofuel production are captured.<sup>2</sup> The study first projects the price of crude oil up to year 2020 and posits alternative scenarios where that price is 25%, 50% and 100% higher, then examines the impact of increased oil price on various economic indicators in 2020. Our study finds that GDP elasticity with respect to world oil price (i.e., ratio between percentage change in GDP and percentage change in world oil price) are roughly comparable with that of existing studies which also use CGE models to analyze macroeconomic impacts of oil price increases (e.g., Sanchez, 2011; Aydin and Acar, 2011). The effect of biofuels in mitigating the impacts of rising oil prices is relatively small because the capacity of biofuels to economically substitute for oil at a global scale remains limited.

The paper is organized as follows. Section 2 briefly presents the CGE model developed for the study. This is followed by the presentation of key results in Section 3, particularly the assessment of the impact of increased oil prices on GDP, sectoral outputs and international trade in Section 4. Finally, Section 5 concludes the paper.

---

<sup>2</sup> This paper however does not discuss the fuel-food controversy caused by biofuels. There exists a large number of studies on that topic. Interested readers could refer to Timilsina (2012), Timilsina and Shrestha (2011), Zilberman et al. (2013).

## 2. Model and Data

We developed a multi-country, multi-sector, recursive dynamic computable general equilibrium model for the purpose of this study. The model has 25 countries/regions with 28 sectors and commodities in each country and region (please see Table 1).

**Table 1: Sector and Countries/Regions Considered in the Model**

<b>Sector/Commodity</b>	<b>Country/Region</b>
1. Paddy rice	1. Australia and New Zealand
2. Wheat	2. Japan
3. Corn	3. Canada
4. Other cereal grains	4. United States
5. Vegetables, fruit	5. France
6. Oilseeds	6. Germany
7. Sugar (cane & beet)	7. Italy
8. Livestock	8. Spain
9. Forestry	9. UK
10. Processed food	10. Rest of EU & EFTA <sup>a</sup>
11. Coal	11. China
12. Crude oil	12. Indonesia
13. Natural gas	13. Malaysia
14. Other mining	14. Thailand
15. Sugar ethanol	15. Rest of East Asia & Pacific (EAP)
16. Corn ethanol	16. India
17. Grains ethanol	17. Rest of South Asia
18. Biodiesel	18. Argentina
19. Gasoline	19. Brazil
20. Diesel	20. Rest of LAC <sup>b</sup>
21. Refined oil	21. Russia
22. Chemicals	22. Rest of ECA <sup>c</sup>
23. Other manufacturing	23. MENA <sup>d</sup>
24. Electricity	24. South Africa
25. Gas distribution	25. Rest of Sub-Saharan Africa
26. Construction	
27. Transport services	
28. Other services	

<sup>a</sup> EFTA includes Norway, Switzerland, Iceland and Liechtenstein; <sup>b</sup> LAC refers to Latin America and Caribbean;

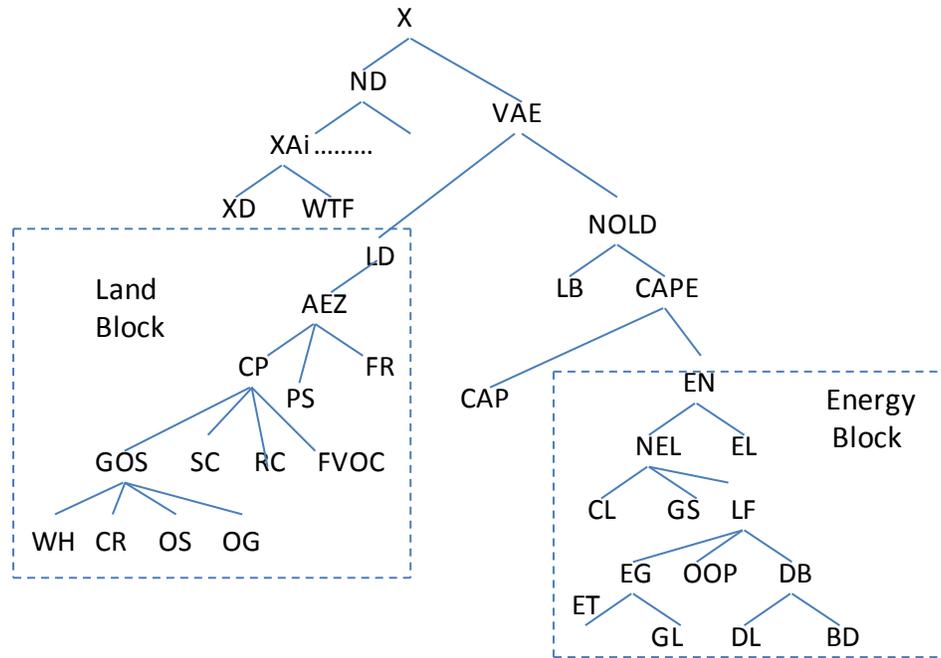
<sup>c</sup> ECA refers to Eastern Europe and Central Asia.

There are some distinct features of this model. First, it explicitly represents biofuels thereby allowing the substitution of petroleum products with biofuels when oil price increases. Most CGE model analyzing macroeconomic impacts of oil price shock do not have this feature and thus might have overestimated impacts of oil price on the economy. Second, to accommodate the interactions between the biofuels and petroleum fuels, the model also represent various land-use type that is not present in most existing CGE models analyzing energy issues. Third, it represents various petroleum products explicitly, whereas most existing models represent petroleum fuels as an aggregated output from petroleum refineries. This is very important as different biofuels (e.g., ethanol and biodiesel) compete with different petroleum fuels (e.g., gasoline and diesel).

The detailed structure of the model is illustrated in Figure 1. As can be seen from the figure, economic sectors are divided into three groups: non energy manufacturing and service industry, energy industry and agriculture (land-use) industry. The production behaviors of non-agriculture industries are represented with constant elasticity of substitution (CES) production functions because it is more flexible compared to other commonly used functional firms such as Cobb-Douglas. Moreover, the nested structure of CES allows different substitution possibilities between factors of production, between aggregate factors of production and aggregate intermediate goods, and also between different types of intermediate goods. At the top of the nested structure in Figure 1, gross output is the CES composite of non-energy manufacturing and service bundle (ND) and value added-energy bundle (VAE). Any good or service is supplied through domestic production and import. Value added bundle includes land (for agriculture production specifically), capital and labor. The model allows direct substitution between capital and energy.

Since the study is focused on the impacts of oil price shock on the economy, the energy sector is represented in detail. The total demand for energy is a CES composite of electricity and an aggregate of non-electric energy commodities. Non-electric energy bundle includes natural gas, petroleum products and biofuels. The petroleum and biofuel bundle allows direct substitution between ethanol and gasoline and also between diesel and biodiesel.

### **Figure 1: Structure of the Model**



*X* – sectoral output; *ND* – aggregate non energy intermediate consumption; *VAE* – value added and energy composite; *XA<sub>i</sub>* – consumption of non energy intermediate consumption of good and service *i*; *XD* and *WTF* – domestic and imported components of goods and services; *AEZ* – Agro-ecological zones; *CP* – crops; *PS* – pasture; *FR* – forest; *GOS* – grains and oil seeds; *SC* – sugar crops; *RC* – rice; *FVOC* – fruits, vegetables and other non-grain crops; *WH* – wheat; *CR* – corn; *OS* – oil seeds; *OG* – other grains; *LB* – labor; *CAPE* – capital and energy composite; *NOLD* – composite of *LB* and *CAPE*; *CAP* – capital; *EN* – energy aggregate; *EL* – electricity; *NEL* – non electric energy; *CL* – coal; *GS* – gas; *LF* – liquid fuel; *EG* – ethanol & gasoline composite; *DB* – diesel & biodiesel composite; *OOP* – other petroleum products; *ET* – ethanol; *GL* – gasoline; *DL* – diesel and *BD* – biodiesel.

We followed Timilsina et al. (2012) while modeling the land use. We replaced the CES functional form with a constant elasticity of transformation (CET) function form because a land could be used to produce various crops, pasture or forests. This is a standard approach in the literature (see, e.g., Banse et al. 2008; Huang et al. 2004; Birur et al. 2008 and Hertel et al. 2010). The total land area is divided into 18 agro-ecological zones (AEZ) in every country/region so that economic substitution possibilities between different land-use type do not violate physical realities of such a substitution. In each of the CET nest of our land module, agents maximize payoffs by optimally allocating the fixed land area for this nest to various competing uses.

We assume that a representative household maximizes its utility, using a non-homothetic Constant Difference of Elasticities (CDE) function, subject to the budget constraint. The key

advantage of using a CDE demand system is that it can be easily parameterized to better represent the policy scenarios. For the details of this functional form Surry (1993) could be a good reference.

As usual, the government revenue is collected through indirect taxes, tariffs and a direct tax on households. Total government expenditure is exogenously determined keeping it as a fixed share of nominal GDP. The allocation of government expenditures across goods and services follows the same rule as was in the base year.

International trade is modeled following Armington assumption that states that same good or service might have different quality if it originates from different sources. Thus, the domestically produced and imported components of a good are aggregated through a CES functional form. Export supply is depicted by a two tier CET function, where, on the first tier, the total output of a sector is designated to the total exports and total domestic supply. In the second tier, total exports are partitioned to individual commodities according to their destinations.

The old and new stocks of capital build the total capital stocks, where new corresponds to the capital investments at the beginning of the period and old corresponds to the capital installed in previous periods. New capital is assumed to be perfectly mobile across sectors, whereas the old capital stock is not.

The dynamics of the model is determined by two main factors: (i) population growth and (ii) change in sectoral productivity. Both factors are exogenous to the model. Population growth is taken from the projections made by the United Nations. Labor force growth corresponds to the growth of the population aged 15-64 years. Productivity growth is modeled as exogenous and factor neutral for agricultural sectors and labor augmenting for industrial and service sectors. Productivity of energy follows an autonomous energy efficiency improvement (AEEI) path so that there is no endogenous technological change in the model.

Three sets of market clearing conditions are satisfied to ensure general equilibrium in the model. First, total production of each commodity equals the sum of domestic consumption and export so that the goods and services markets clear. Second, total investment equals total saving, where savings are composed of private (household) savings, public (government) savings and exogenously fixed foreign savings. Third, factor markets clear, implying full employment.

Like in any CGE model, the main data requirements are: (i) social accounting matrix (SAM) and (ii) elasticity parameters. For the SAM, the model uses the GTAP database (Narayanan

and Walmsley, 2008)<sup>3</sup>. However, the database has been updated for the purpose of this study. First, we have introduced corn as a separate sector/commodity, whereas it was included in “other cereal grains” in the GTAP database. Second, the GTAP database does not have biofuel sectors, so we specified sectors for ethanol and biodiesel including three sub-sectors for ethanol: corn based, sugar-based ethanol (i.e., ethanol produced from sugar cane and sugar beet); and other grains-based ethanol (i.e., ethanol produced from wheat and other cereal grains). Most of the elasticity parameters are taken from the literature including Burniaux and Chateau (2010); Jarrett and Torres (1987); Ma et al. (2010); Narayanan and Walmsley (2008); Timilsina and Shrestha (2006) and van der Werf (2008).

### 3. Definitions of baseline and scenarios

We use historical data and projections from the U.S. Energy Information Administration (EIA) on the average price of crude oil. According EIA reference case projection made in 2010, oil price would reach \$107 per barrel (in 2009US\$) in 2020. We also assumed the EIA projection of oil price in our baseline case. We then considered three alternative scenarios to represent an increase in oil prices by 25%, 50% and 100% from the corresponding baseline values starting from 2012. Besides EIA, other organizations, such International Energy Agency (IEA) also project energy prices. However, the projection between EIA and IEA do not vary much. Moreover, the reference case oil price, which is exogenous to our model, is not very important in our study because we are measuring the impacts of deviations of oil prices from the reference case.

Table 2 presents percentage changes in oil prices from the 2009 level under the baseline and various oil price increase scenarios. For example, a 50% increase in oil price from the baseline in 2020 refers to a 147% increase compared to the 2009 level.

**Table 2: Percentage change in oil price from the current (i.e., 2009) price level**

Year	Baseline	Scenario
------	----------	----------

<sup>3</sup> We are aware of the fact that a more recent version of GTAP data (GTAP 8.0) is available now. The new database presents data for year 2007; the version of GTAP database used in this analysis uses data for year 2004. Since there would not be much change in structure of an economy in 3 years; using new version of data is not expected to alter the results significantly.

		+25%	+50%	+100%
2009	0			
2010	19			
2015	54	92	131	208
2020	65	106	147	230

*Note: the scenarios are implemented starting from 2012.*

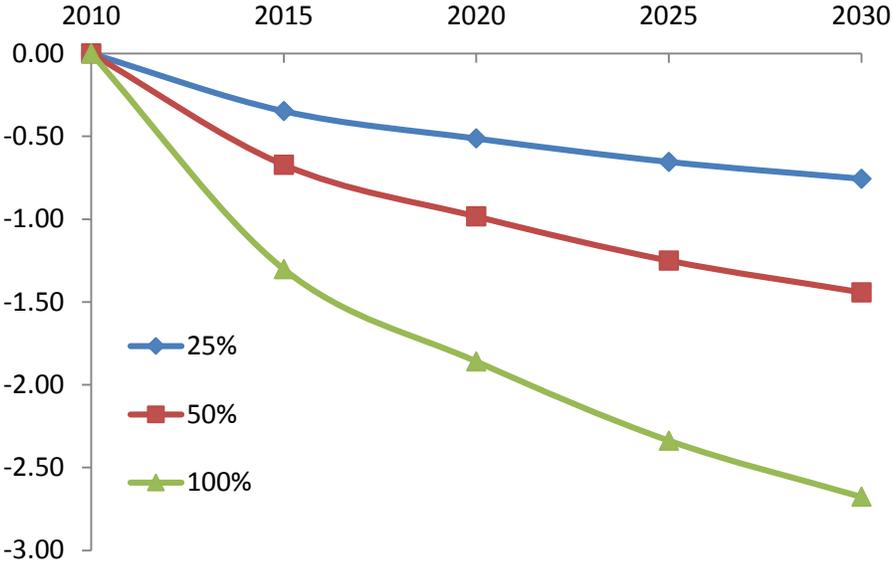
#### **4. Simulation Results**

In this section we present key results obtained from the simulations of increased oil prices. The results include impacts on GDP, sectoral outputs and international trade.

##### **4.1 Impact on Gross Domestic Product (GDP)**

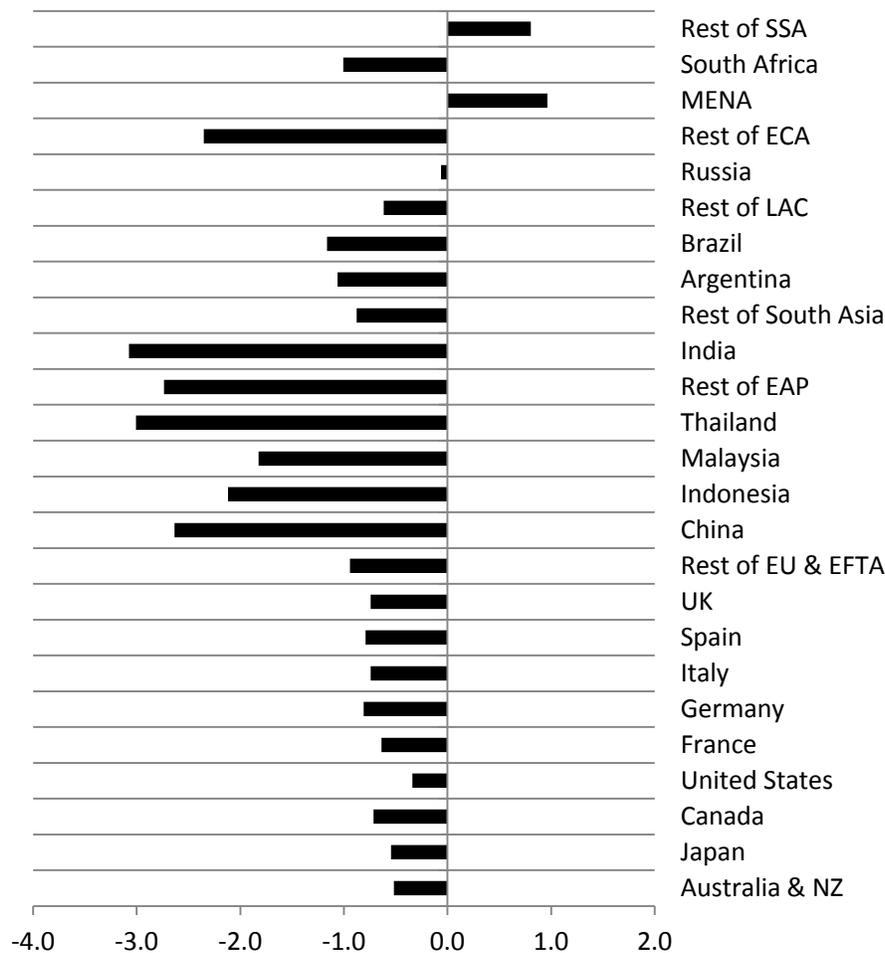
Figure 2 presents the impacts on real global GDP of 25%, 50% and 100% increases in world oil price. The change in global GDP is inversely related to the changes in oil price. In 2020, an increase in world oil price by 25% from the baseline would cause about 0.5% loss of global GDP. The loss increases to about 1% if oil price increase 50% from the baseline. Similarly, the GDP loss would be 1.86% in 2020 when oil price doubles from the baseline. The swiftest reductions in global GDP under all scenarios occur during the early part of the time horizon, given the relatively inelastic demand for oil in the short run. By 2015, global GDP is already 0.35%, 0.67% and 1.3% lower than in the base case when oil price is 25%, 50% and 100% higher, respectively. After 2015, global GDP can be seen to decrease further relative to the baseline but not as quickly as before, indicating adaptation to higher oil prices in the global economy.

**Figure 2: Change in global real GDP under various scenarios (% change from the baseline)**



While the global GDP is expected to decline if oil price were to rise, not all countries or regions are affected in the same manner. Figure 3 presents changes in national/regional GDP in 2020 when oil price increases by 50% from the baseline scenario. For a 50% rise in the world oil price from the baseline in 2020, GDP reductions would be smaller than 1% in most developed countries or regions. However, the GDP loss would be much higher in emerging developing economies, such as China, India, Thailand, Indonesia, Malaysia, and economies transition. This is because oil intensive manufacturing industries account for relatively higher shares in their GDP. On the other hand, service sectors, which are relatively less oil intensive, have relatively higher shares in GDP in most OECD countries, the effect of oil prices in these countries' GDP would be smaller compared to that of emerging developing countries and economies in transition. For the least developing countries, where agriculture sector is the key contributor to GDP and the sector is relatively less oil intensive due to less dependence on agriculture machinery and chemical fertilizers, the GDP impacts of increased world oil price are found relatively smaller compared to that of emerging developing countries. However, the percentage GDP losses in these countries are still higher compared to those of developed countries'.

**Figure 3: Impact of a 50% increase in oil prices on GDP in 2020 (% change from the baseline)**



Although the vast majority of countries/regions will experience a reduction in their GDP, a few countries would see their GDP rise along with higher oil price in 2020. These are the net oil exporting countries and mostly from Middle East and North Africa (MENA) region. This is intuitive as the economy of these countries is highly dependent on oil exports and an increased world oil price is good for them. Note however, the rest of SSA also exhibits an increase in GDP due to the increased oil prices. This phenomenon is caused by two reasons. First, due to the size of Nigerian economy in the Sub-Saharan Africa (excluding South Africa) group, the results for the group is heavily skewed by Nigeria, which being net oil exporting country, gains from an increase in oil prices. Second, Sub-Saharan Africa is also relatively less reliant on oil than most other developing economies, therefore the GDP of this region would be less impacted by oil prices compared to other economies with a higher oil intensity.

In order to further explain the economic impacts of oil price increase, we have also looked into two factors: oil intensity of an economy (total oil consumption per capita GDP) and import dependency of an economy for its oil supply, measured as the share of imports in the total supply. Table 3 presents these indicators for year 2012. These indicators imply that oil intensity is the more important factor than import dependency of oil supply to pass the impacts of an increased oil prices to an economy (GDP). For example, European countries such as France, Germany, Italy and UK depends entirely on imports to meet their oil demand, but the impacts of oil price increase in these countries is lower as compared to that in China, Indonesia, India and Thailand, which are less dependent on imports to meet their oil demand. More interestingly, Canada, Russia and Malaysia suffer with increased oil prices despite the fact they are net exporter of oil because of their high oil intensive economy. The loss in GDP due to increased oil price in these countries would not be offset by increased value of oil exports.

**Table 3: Oil import dependency and oil intensity (2012)**

Country/Region	Import dependency of oil (share of imports in total oil supply, %)	Oil intensity (Kg per thousand USD measured in 2005 PPP)
Australia and New Zealand	60	51
Japan	100	53
Canada	Net Exporter	64
United States	52	54
France	100	37
Germany	100	36
Italy	100	35
Spain	100	41
UK	45	28
Rest of EU & EFTA	69	42
China	66	35
Indonesia	43	40
Malaysia	Net Exporter	50
Thailand	69	61
Rest of East Asia & Pacific	100	52
India	78	32
Rest of South Asia	91	26
Argentina	Net Exporter	44
Brazil	7	46
Rest of LAC	Net Exporter	60
Russia	Net Exporter	78
Rest of ECA	Net Exporter	39
MENA	Net Exporter	73
South Africa	100	37
Rest of Sub-Saharan Africa	Net Exporter	30

Source: IEA (2015)

It would be interesting to compare the results with those of comparable studies (i.e., CGE studies) although studies are not strictly comparable due to difference in assumptions, data, time-horizon and so on. Nevertheless, the rough comparison is possible. Using a CGE model Sanchez (2011) estimates annual GDP loss due to oil price change between 2002 and 2006 for six countries (Bangladesh, El Salvador, Kenya, Nicaragua Tanzania and Thailand). If we calculate average annual GDP elasticity with respect to (w.r.t.) oil price between 2002 and 2006 based on their results (Table 3, p.334) we find that their GDP elasticity would vary between -0.007 (Tanzania) to -0.195 (Nicaragua). Similarly, using a CGE model, Aydın and Acar (2011) show that a doubling of oil prices (i.e., 100% change) could cause a 14% loss of economic outputs in Turkey in 10 years. This implies -0.014 annual average GDP elasticity w.r.t. oil price. Our study finds that the GDP elasticity varying between -0.0064 (U.S.) to -0.0579 (India).<sup>4</sup> While results (GDP elasticities w.r.t. oil price) of our study are comparable to that from existing literature, all studies (this study as well as existing), converge on the fact that the GDP elasticity would vary across countries depending upon their adjustment capacity to oil price shocks. The availability of biofuels to substitute petroleum for transportation in our study implies higher adjustment capacity compared to that in existing studies.<sup>5</sup>

#### **4.2 Impact on sectoral outputs**

Figure 4 presents impacts on sectoral outputs at global level of 50% oil price increase in year 2020. It can be seen that production of crude oil and refined petroleum products derived from it are considerably reduced, whereas ethanol and biodiesel production undergo an almost proportionate increase to the rise in oil price. Some substitution of oil with natural gas is also observed.

Note that while the increase in biofuels output is on the order of 40%, while the decrease in petroleum sector output is only about 15%, the baseline level of petroleum output is much larger than the baseline output of biofuels – roughly 20 times in energy-equivalent terms. These figures

---

<sup>4</sup> Countries with positive GDP impacts due to oil price increase are excluded from this discussion for better comparison with existing studies.

<sup>5</sup> Precisely speaking the GDP elasticities in most countries in our study are slightly lower than that of Sanchez (2011) and Aydın and Acar (2011); this could be the effect of substitution possibilities between biofuels and petroleum products considered in our study.

highlight the limited capacity of biofuels globally to mitigate the effects of rising oil prices. Even with oil prices considerably higher than along the baseline path, the opportunity cost of increases in biofuels becomes uneconomic well before the volume of output is large enough to offset the decline in demand for petroleum products.

**Figure 4: Impacts of a 50% increase in oil prices on sectoral outputs at global level in 2020 (% change from the baseline)**

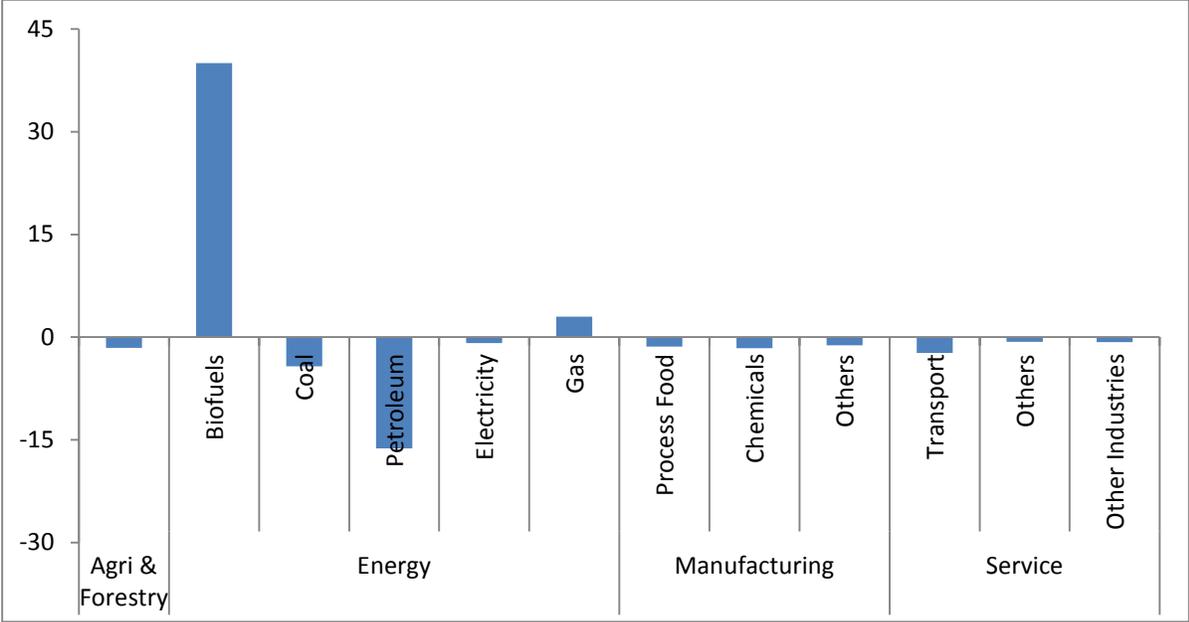


Table 4 presents the impacts of a 50% increase in world oil price on gross outputs of various economic sectors at the country/regional level. As illustrated in the table, the increase in the world oil price affects the output of the industrial and service sector more than the agricultural sector.

The impact of oil price increases on industrial and service sector output is imbalanced in that high-income countries (and South Africa) are only slightly affected, while most middle and low-income countries and regions sustain significant losses as demonstrated in Table 4. One reason that high income countries sustain minor losses in industrial output may be that their industrial infrastructure is relatively energy efficient compared to that of developing countries, and therefore more able to absorb higher oil prices.

The rest of Sub-Saharan Africa and Middle East and North Africa actually would experience an improvement in industrial and service sector outputs when oil price increases. This is because not only do these two regions increase biofuel output like all other regions and countries when oil prices rise, but they also increase their output in other industrial and service subsectors, such as construction and services other than transport.

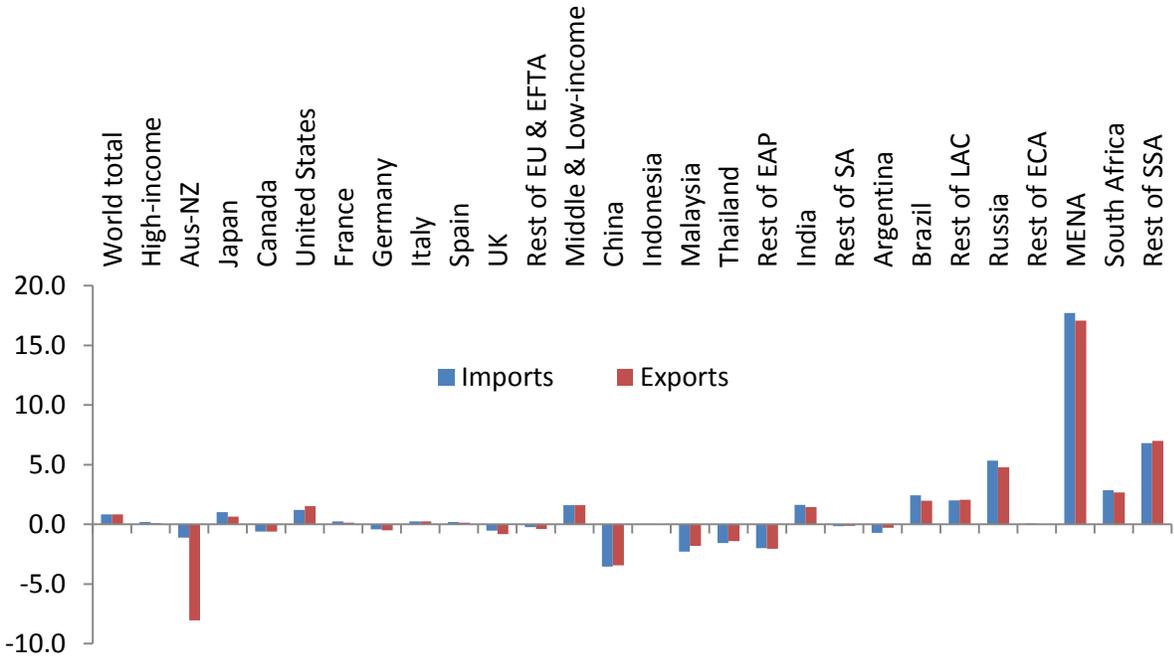
**Table 4: Impacts on sectoral outputs of 50% increase in world oil prices in 2020 (% change from the baseline)**

Country/Region	Agriculture	Manufacturing	Mining	Service	Others	Total
World total	-1.46	-1.67	-8.22	-0.84	-0.75	-1.29
High-income	-2.28	0.07	-6.03	-0.71	-0.53	-0.50
Australia and New Zealand	-1.98	1.54	-3.80	-0.73	-0.65	-0.30
Japan	-3.19	0.00	-0.29	-0.61	-1.02	-0.47
Canada	-1.57	-0.98	-9.59	-0.33	-0.66	-0.84
United States	-1.61	0.76	-6.96	-0.73	-0.14	-0.31
France	-3.27	0.46	0.74	-0.74	-0.42	-0.35
Germany	-2.05	0.22	0.03	-1.00	-1.15	-0.50
Italy	-3.10	-0.35	-0.47	-0.61	-0.67	-0.57
Spain	-1.23	-0.38	0.65	-0.97	-0.47	-0.70
UK	-0.80	0.45	-14.76	-0.77	0.06	-0.44
Rest of EU & EFTA	-3.06	-1.25	-4.60	-0.62	-0.95	-0.99
Middle & Low-income	-0.82	-3.57	-8.85	-1.14	-1.00	-2.51
China	-0.87	-4.14	-4.23	-2.53	-4.02	-3.55
Indonesia	-0.04	-1.57	-3.68	-3.14	-3.04	-2.31
Malaysia	0.91	-0.66	-15.01	-3.85	-2.91	-1.78
Thailand	-2.87	-2.03	0.24	-3.95	-4.91	-2.88
Rest of East Asia & Pacific	-1.06	-2.80	-0.95	-2.79	-4.70	-2.93
India	-0.87	-3.57	-8.06	-3.37	-4.40	-3.45
Rest of South Asia	-0.45	-1.18	-1.38	-1.35	-0.54	-1.11
Argentina	-3.34	-5.01	-4.99	0.05	-0.26	-1.93
Brazil	-0.64	-0.62	-9.37	-1.40	-1.76	-1.23
Rest of LAC	-0.57	-1.99	-10.65	0.10	1.18	-1.29
Russia	0.22	-8.11	-11.19	2.12	4.05	-1.60
Rest of ECA	-1.89	-3.97	-9.04	-1.85	-1.63	-2.85
MENA	-1.18	-9.60	-12.87	6.71	14.14	0.33
South Africa	-3.18	1.17	-4.29	-1.33	-1.48	-0.47
Rest of Sub-Saharan Africa	1.16	-1.25	-9.95	2.19	3.41	0.42

### 4.3 Impact on international trade

Increases in oil price will have considerable impact on global trade patterns. Figure 5 shows the breakdown of the impact of an increase in oil price by 50% on international trades of various countries/regions. A huge increase in international trade in MENA and SSA observed due to increased oil prices. International trade of high income countries is less affected as they are more less oil intensive service based economies. Middle income countries loose more international trade due to their oil based manufacturing base economy.

**Figure 5: Impact of a 50% oil price increases on international trade in 2020 (% change from the baseline)**



**5. Conclusions**

Given its role as a critical input into so many production processes and its ubiquity in transportation systems, it is to be expected that an increase in the prices of oil would have adverse impacts on the global economy. We apply a multi-country, multi-sector, recursive dynamic, global computable general equilibrium model to simulate various future oil price scenarios and assesses the corresponding impacts on the global economy.

The study shows that global GDP contracts due to higher oil prices, and contracts more in the years close ahead, given the relatively inelastic demand for oil in the short run, and its reduction further out in the horizon is mitigated by adaptations to higher oil prices. Importantly, the role of biofuels in mitigating the effect of rising oil prices is limited because of its economic cost. Whereas, developed countries/regions encounter modest reductions in GDP because of an increased oil prices, the largest GDP losses are borne in emerging economies like China, India and Thailand, as they depend on imports for their oil supply and their economic structures are

manufacturing based. With the increased prices, oil exporting countries in the Middle Eastern and North Africa region would gain the most. The increase oil price would adversely impact the oil demand at the global level and consequently cause to drop outputs from petroleum refinery sector at the global level. Global outputs from oil intensive industries such as transport, chemicals would also drop. On the other hand, the increased oil price would cause to boost the biofuel industry significantly. Natural gas industry would also gain but at lesser scale compared to biofuels. Oil exporting countries, particularly Middle Eastern countries and Nigeria would experience a gain in their international trade. Like existing studies analyzing macroeconomic impacts of oil price shocks using a CGE model, our study also concludes that the impacts of oil price shocks to economic output measured as GDP elasticity with respect to oil price change, would vary significantly across countries depending upon their adjustment capacity to the oil price shocks.

### **Acknowledgements**

The author would like to thank Simon Mevel and Ashish Shrestha for research assistance. Mike Toman, Jean –Jacques Dethier, two anonymous reviewers and participants of the 4th ELAEE Conference, Montevideo, Uruguay (April 8 - 9, 2013) provided constructive and insightful comments. Knowledge for Change Trust Fund is acknowledged for financial support. The views and findings presented here are of authors and should not be attributed to the World Bank.

### **References**

- Aydin, L. and Acar, M. (2011), Economic impact of oil price shocks on the Turkish economy in the coming decades: A dynamic CGE analysis, *Energy Policy*, 39: 1722–1731.
- Balke, N.S, Brown, S.P.A. and Yücel, M.K. (2008), An International Perspective on Oil Price Shocks and U.S. Economic Activity. Working Paper 20, Globalization and Monetary Policy Institute, Federal Reserve Bank of Dallas.
- Banse, M., van Meijl, H., Tabeau, A. and Woltjer, G. (2008), Will EU Biofuel Policies Affect Global Agricultural Markets. *European Review of Agricultural Economics*, 35 (2): 117-141.
- Barsky, R.B. and Kilian, L. (2004), Oil and Macroeconomy Since the 1970s, *Journal of Economic Perspective*, 18(4): 115-134.

- Birur, D., Hertel, T. and Tyner, W. (2008), Impact of Biofuel Production on World Agricultural Markets: A Computable General Equilibrium Analysis. GTAP Working Paper No. 53. Department of Agricultural Economics, Purdue University.
- Blanchard, O. J. and Riggi, M. (2013), Why Are the 2000s So Different from the 1970s? A Structural Interpretation of Changes in the Macroeconomic Effects of Oil Prices, *Journal of the European Economic Association*, 11(5): 1032-52.
- Burniaux, J-M., Chateau, J. (2010), Background Report: An Overview of the OECD ENV-Linkages model. OECD.
- Energy Information Administration (2009), Annual Energy Outlook 2010. United States Department of Energy. <http://www.eia.doe.gov/oiaf/forecasting.html>
- Hamilton, J. D. (1983), Oil and Macroeconomy Since World War II, *Journal of Political Economy*, 91 (21): 228-248.
- Hamilton, J. D. (2011), Nonlinearities and the Macroeconomic Effects of Oil Prices, *Macroeconomic Dynamics*, **15** (Supplement 3): 364–378.
- Herrera, A. M. and Pesavento, E. (2009), Oil Price Shocks, Systematic Monetary Policy, and the 'Great Moderation', *Macroeconomic Dynamics*, 13 (1): 107-37.
- Hertel, T.W., Tyner, W.E. & Birur, D.K. (2010), Global Impacts of Biofuels, *The Energy Journal*, 31(1):75-100.
- Huang, J., van Tongeren, F., Dewbre, J. and van Meijl, H. (2004), A new representation of agricultural production technology in GTAP. Presented at the 7th Annual Conference on Global Economic Analysis, Washington DC, USA.
- International Energy Agency (IEA) (2015). IEA Electronic Database – World Indicators. [http://stats.oecd.org.libproxy-wb.imf.org/BrandedView.aspx?oecd\\_bv\\_id=enstats-data-en&doi=data-00514-en](http://stats.oecd.org.libproxy-wb.imf.org/BrandedView.aspx?oecd_bv_id=enstats-data-en&doi=data-00514-en); Downloaded on January 10, 2015.
- Jarrett, P. and Torres, R. (1987), A revised supply block for the major seven countries in INTERLINK. OECD Department of Economics and Statistics Working Papers No. 41. OECD.

- Jimenez-Rodriguez, R. and Sanchez, M. (2005). Oil price shocks and real GDP growth: empirical evidence for some OECD countries, *Applied Economics*, 37: 201–228.
- Kilian, L. (2008), A Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries, *Journal of the European Economic Association*, 6(1): 78–121.
- Kilian, L. (2009), The Economic Effects of Energy Price Shocks, *Journal of Economic Literature*, 46(4): 871–909.
- Kilian, L. and Vigfusson, R. J. (2011), Are the Responses of the U.S. Economy Asymmetric in Energy Price Increases and Decreases? *Quantitative Economics*, 2(3): 419-53.
- Lee, K. and Ni, S. (2002). On the Dynamic Effects of Oil Price Shocks: A Study Using Industry Level Data. *Journal of Monetary Economics*, 49 (4): 823-52.
- Lee, K., S. Ni and Ratti, R.A. (1995). Oil Shocks and the Macroeconomy: The Role of Price Variability, *The Energy Journal*, 16 (4): 39-56.
- Ma, H., Oxley, L., Gibson, J., 2010. China's energy economy: A survey of the literature. *Economic Systems*, 34(2): 105-132.
- Morana, K. (2013), The Oil Price-Macroeconomy Relationship Since the Mid-1980s: A Global Perspective, *The Energy Journal*, 34 (3):153-190.
- Mork, K. A. (1989), Oil and Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results. *Journal of Political Economy*, 97 (3): 740-44.
- Narayanan, B.G, Walmsley, T.L. (Eds.), (2008), Global Trade, Assistance, and Production: The GTAP 7 Data Base. Center for Global Trade Analysis, Purdue University.
- Sanchez, M. V. (2011), Welfare Effects of Rising Oil Prices in Oil-Importing Developing Countries, *Developing Economies*, 49 (3): 321-46.
- Surry, Y. (1993). Constant difference of elasticities' function with applications to the EC animal feed sector. *Journal of Agricultural Economics*, 44 (1): 110-125.

- Timilsina, G.R., (2012). Biofuels: the Food versus Fuel Debate, *CAB Reviews*, Vol. 7, No. 036, pp. 1-8, 2012.
- Timilsina, G.R., Beghin, J., van der Mensbrugghe, D. and Mevel, S. 2012. The Impacts of Biofuel Targets on Land-Use Change and Food Supply: A Global CGE Assessment, *Agriculture Economics*, Vol. 43, pp. 313-330.
- Timilsina, G.R., Shrestha, A. (2011). How much hope should we have for biofuels? *Energy*, Vol. 36, pp. 2055-2069.
- Timilsina, G.R., Shrestha, R. (2006). General equilibrium effects of a supply side GHG mitigation option under the clean development mechanism. *Journal of Environmental Management*, 80: 327-341.
- Van der Werf, E. (2008), Production functions for climate policy modeling: An empirical analysis. *Energy Economics*, 30: 2964-2979.
- Zilberman, D., Hochman, G., Rajogopal, D., Sexton, S. and Timilsina, G.R. (2013), The Impact of Biofuels on Commodity Food Prices: Assessment of Findings, *American Journal of Agriculture Economics*, Vol. 95, No. 2, pp. 275-281.