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## **EU BIOFUEL POLICIES: A CLOSER LOOK AT SOME COLLATERAL IMPACTS**

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**Paper prepared for presentation at the 14th ICABR Conference**  
***“Bioeconomy Governance: Policy, Environmental and Health Regulation, and Public***  
***Investments in Research”***  
**Ravello, Italy, June 16-18, 2010**

\*The views expressed are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

Paper to be considered for special issue of AgBioForum: **No**

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## **EU biofuel policies: A closer look at some collateral impacts**

Aikaterini Kavallari, S. Hubertsu Gay and Alison Burrell<sup>1</sup>

### **Abstract**

The EU's Renewable Energy Directive (2009/28) set an overall target to source 20% of EU energy needs from renewables by 2020. As part of this target, each member state has to achieve at least 10% of their transport fuel consumption from biofuels. The Renewable Energy Directive (2009/28) and the Fuel Quality Directive (2009/30) set out sustainability criteria for biofuel production and procedures for verifying that these criteria are met. Sustainability can be more easily monitored, the greater the share of the land use impacts occur within the EU. This paper investigates two impacts of the biofuel target using the AGLINK-COSIMO model. First, we quantify the net global increase in cropped land resulting from this policy, and examine how its size and geographic changes with the elimination of EU biofuel tariffs. Second, the complex interaction between world price volatility, higher biomass demand and a global stock management is explored.

Keywords: Indirect land use change, global distribution, sustainability, price volatility, stock management

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<sup>1</sup> Senior authorship is not assigned. The views expressed are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

## 1. Introduction

Given the growing world population and new demands for biomass for industrial use, it is expected that an increasing share of the world's surface will come under pressure from agricultural use<sup>2</sup>. A major concern in this context is the potential encroachment of cropping activities into biodiverse areas (forests and certain types of grassland) and fragile ecosystems. In regions where land used for agriculture has been declining, it is often assumed that this land can be restored to agricultural use, although this may not always be the case. In parts of the world where land used for agriculture has been increasing, new non-food demands for biomass are almost certain to lead to conversion of non-agricultural land to agricultural use. A number of studies have attempted to quantify and localise these impacts (see, for example, Al-Riffai et al., 1020; FAO, 2008; IPTS, 2010; OECD, 2008; Taheripour et al., 2008).

Biofuel production has grown rapidly since 2000, driven by concessionary public policies. Between 2005 and 2008, world ethanol and biodiesel production increased by 78% and 200% respectively, the rapid growth in the latter due in particular to the emergence of producing countries in South East Asia. In 2008, the EU accounted for about half global biodiesel production and 7% of global ethanol output (OECD, 2009).

Recently, various governments have increased the stimulus to biofuel production and consumption by setting mandatory levels for biofuel usage<sup>3</sup>. The EU's Renewable Energy Directive (2009/28/EC), which stipulates a 20% share in total energy consumption from

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<sup>2</sup> According to FAO statistics, the global area harvested to all cereals, oilcrops and sugar grew from 921 million hectares in 1999 to 1,004 million hectares in 2008.

renewable sources by 2020, specifies a 10% contribution from biofuels in the transport sector. The same Directive also lays down a set of sustainability criteria (relating *inter alia* to GHG saving and land use impacts) that biofuels must comply with, "irrespective of whether the raw materials were cultivated inside or outside the territory of the Community", in order to qualify as part of the mandatory target. The criteria concerning feedstocks and land use aim to meet concerns about possible negative effects of increasing demand for biomass on biodiversity and existing carbon stocks. The detailed monitoring and enforcement of these criteria within EU territory can be handled by supplementary legislation, whereas the Directive envisages the promotion of sustainability outside the EU through multilateral and bilateral agreements, and voluntary certification schemes. It can be expected that sustainability criteria are easier to verify and enforce when the complete biofuel production cycle takes place within the EU.

This context motivates the first research question addressed in this paper. In a globalised world economy, where consumption targets for processed commodities set in one region can have strong repercussions on production and/or processing in other parts of the world, thereby altering trade flows in raw materials or finished goods, we investigate how the EU's present tariff structure for biofuels impacts on the sourcing of biofuels and biofuel feedstocks for consumption in the EU under the 2020 target. The particular focus is on the geographic location of land use changes and on their spatial redistribution if the EU eliminated its tariffs on imported biofuels. The question of the EU's future tariff regime for biofuels is open as long as the Doha Development Round remains without a conclusion. It has gained in relevance with the announced re-opening of trade talks between the EU and Mercosur. Specifically, we ask whether it would be more difficult for the EU to monitor and enforce its sustainability criteria for EU-

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<sup>3</sup> As well as the EU, FAO (2008) reports six non-EU countries, including China and the US, with

consumed biofuels under a no-tariff regime. We extend recent analysis performed with the AGLINK-COSIMO model, published in IPTS (2010), in order to gain more insight into this question.

Independently of sustainability issues, the surge in world prices of food grains in 2008 has fuelled concerns about the impact of biofuel production on world food prices and stocks. There is still little consensus about the extent of the role played in this episode by the emerging biofuel industry (see, for example, Carter et al (2008), Gilbert (2008), Mitchell (2008), Rosegrant (2008), Meyers and Meyer (2009), Watsa (2009)), and about whether the higher price volatility observed for both food and non-food commodities in the first decade of this century will persist or even increase in coming years. Greater volatility in food prices has been speculatively linked to lower stock-to-use ratios for food grains, possibly due in part to higher demand for biofuel feedstocks. However, there is no consensus on this hypothesis (see, for example, Dawe (2009)) or on the likelihood of a permanently higher degree of price volatility in the future (ref).

This debate motivates the second research question addressed in our paper. In an adapted version of the AGLINK-COSIMO model that allows for volatility in commodity prices, we examine the impacts of setting bounds to world market price fluctuations for the main biodiesel feedstocks by adopting a coordinated mechanism for global buffer stock management to reduce observed price volatility in a context characterised by fixed biofuel use targets.

The paper is organised as follows. Section 2 describes the AGLINK-COSIMO model, the scenarios simulated for this study and the way AGLINK-COSIMO was adapted and extended in

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mandatory targets for biofuel use, and several others that were considering adopting such targets.

order to run these scenarios. Section 3 reports the results relating to the first research question, namely the extent of the land use change redistribution following removal of EU biofuel tariffs. Section 4 presents the analysis of the effect on world market price volatility of higher stock-to-use levels and more coordinated stock management in the presence of biofuel policies.

## **2. Model Description and Adaptation**

### *2.1. The Model and the Baseline Scenario*

AGLINK-COSIMO is a global recursive-dynamic, partial equilibrium, supply-demand model covering the main agricultural products (see OECD, 2006). It has been developed by the OECD Secretariat<sup>4</sup> in close co-operation with OECD member countries and, via its linkage with FAO's COSIMO model, it incorporates the major non-member countries and other regions of the world. The version of the model used for this report identifies a total of 52 countries or regional blocs. It covers 39 agricultural primary and processed commodities, each considered to be homogeneous. Trade is modelled as net trade (given as the difference of supply and demand). Although both imports and exports of each commodity are represented in the model, one of the two is generally calculated residually and bilateral trade flows between trading partners are not modelled.

Demand and supply of ethanol and biodiesel, and of the main by-products of this production (dried distillers grains (DDG), oil meals), are modelled for the main producing and consuming countries, and trade in biofuels is included<sup>5</sup>.

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<sup>4</sup> The results of any analysis based on the use of the AGLINK-COSIMO model by parties outside the OECD are not endorsed by the Secretariat, and the Secretariat cannot be held responsible for them. Conclusions derived by third-party users of AGLINK/COSIMO should not be attributed to the OECD or its member governments.

<sup>5</sup> For more details of how biofuels are handled in AGLINK-COSIMO, see IPTS (2010).

In this study, the baseline projection (Scenario 0) assumes that, *except for the EU*, the biofuel policies of individual countries that were already in place or announced by end-2008<sup>6</sup> are implemented up to 2020, the end of the simulation period. For the EU, it is assumed that there are no internal policies (tax exemptions, processing subsidies or consumption targets) in place, but that EU tariffs on imported ethanol and biodiesel are maintained at current levels. Specifically, this involves an MFN tariff of EUR 0.192 per litre on imported undenatured ethanol<sup>7</sup>, and 6.5% on ethanol-gasoline blends. Biodiesel imports are subject to a 6.5% tariff. The different orders of magnitude of the two tariff rates reflect the EU's classification of ethanol and biodiesel as agricultural and industrial products, respectively.

In March 2009, the EU imposed an anti-dumping tariff of EUR 68.6-198/tonne net and countervailing duties of EUR 211.2-237/tonne net on US biodiesel, because of high subsidies paid to US producers. Although in July 2009 these duties were made definitive for a 5-year period, this measure is not recognised in any of our scenarios for two reasons. First, it is far from certain that these prohibitive tariffs will continue beyond 2014, whereas the main focus of our scenario comparisons is at the end of the simulation period, 2020. Second, as AGLINK-COSIMO does not distinguish bilateral trade flows, it is impossible to model this differential tariff in a straightforward way; additional and controversial assumptions would have to be adopted in order to 'trick' the model into imposing a higher tariff on imports from the US alone. Ignoring this bilateral trade measure is equivalent to assuming that trade flows readjust among

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<sup>6</sup> See OECD (2008).

<sup>7</sup> This implies a tariff of around 50%, assuming a world market price of USD 0.50 per litre (FAO, 2008). In addition, the EU imposes a tariff of EUR 0.102 per litre on denatured ethanol. However, since only a small share of EU ethanol enters in denatured form, AGLINK-COSIMO assumes the higher tariff for all ethanol imports.



biodiesel importers and exporters so that the EU acquires its biodiesel imports from non-US sources, and US biodiesel exports are re-oriented to other destinations.

Macroeconomic assumptions and other exogenous developments incorporated in the baseline are set out in IPTS (2010). In particular, it is assumed that the world price for crude oil doubles over the simulation period (from USD 52.1 per barrel in 2009 to USD 104.0 in 2020).

## 2.2. *The Biofuel and Trade Scenarios*

Scenario 1 introduces the biofuel-promoting policies of individual EU countries, as well as those (in particular the 10% target for transport fuel use) that are mandated at EU level. Details of how these policies are modelled for the EU can be found in IPTS (2010). The target for the biofuel share of transport fuel specified in the EU's Renewable Energy Directive is assumed to be met, with 7% coming from first-generation biofuels and a further 3% from second-generation biofuels<sup>8</sup>. The fuel demand of the EU transport sector was projected exogenously by PRIMES 2007 (see Caprol, undated). Our simulations take this total fuel demand as given, but allow the shares of ethanol and biodiesel that satisfy the required share to be given endogenously as a function of their relative prices.

Scenario 2 assumes that the EU maintains its biofuel policies as in Scenario 1, but removes its tariffs on ethanol and biodiesel. At the same time, the tariff structure for the agricultural commodities that serve as biofuel feedstocks (including vegetable oils) remains unchanged.

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<sup>8</sup> The Renewable Energy Directive allows the contribution from second-generation biofuels to be counted twice towards the fulfilment of the target. Thus, the assumed 70:30 ratio implies a targeted energy share of 7% from first-generation biofuels, and 1.5% from second-generation biofuels.

The land use changes measured by AGLINK-COSIMO relate to national and global totals of land used for wheat, coarse grains, oilseeds and sugar. When the simulated change in this area is positive, indicating expansion, the model is unable to specify whether the increase is at the expense of cropland hitherto used for other commodities (such as fruit and vegetables), pastureland (whether of high carbon-storage capacity or biodiversity value, or not) and land currently unused for any agricultural production (such as rain forest, peat land). Moreover, the area planted to oleaginous tree fruit (in particular, oil bearing palms) is not included in this total. Second-generation biofuel production is modelled as having no land-use implications. This amounts to the highly optimistic assumption that second-generation biofuels use as their feedstock agricultural waste products or non-land-using biomass (such as algae). These features must be borne in mind when interpreting the results.

### *2.3. Modelling Price Volatility and Global Stock Management*

AGLINK-COSIMO simulations beyond the base year normally exhibit a smooth path over time. Annual changes in endogenous variables, including world prices, are driven by two types of phenomenon: (a) macroeconomic baseline assumptions, affecting a number of equations, and exogenous trends inserted in individual equations, and (b) lagged effects of previous time periods that are carried over due to the recursive dynamic nature of the model. In the typical absence of any abrupt changes in exogenous assumptions, the endogenous changes of type (b) damp down rather quickly. This means that, in normal forward simulation mode, endogenous series, including prices, follow smooth time paths from which the volatility observed in real data is absent.

In order to generate volatile world market prices over the simulation period, random exogenous shocks were introduced into the supply functions of six commodities for a number of major producing countries. The commodities chosen (wheat, coarse grains, sugar, rice, oilseeds and vegetable oil) were considered the most relevant as being important food commodities as well as, in most cases, biofuel feedstocks. Shocks were introduced so as to generate a degree of world price volatility equal to or in excess of what was observed during the historical period 1993-2008, as measured by the coefficient of variation of world price and the standard deviation of the logged world price. Table 1 summarises the historical and the simulated volatility of the four feedstock series in a typical run. In order to improve the robustness of the results, a number of runs with different patterns of random shocks were run. The conclusions reported are based on the set of these runs.

**Insert Table 1 here**

Three distinct adaptations were required in order to simulate global stock management strategies in AGLINK-COSIMO. First, stocks of three feedstock commodities<sup>9</sup>, which are already endogenously modelled at the level of individual countries, are pooled at the start of the year for each commodity to create a globally available central stock. Second, constraints are placed on the world market prices of these three commodities to force them to lie within  $\pm 30\%$  of their trend price, which is simulated by running the model in the absence of volatility and is treated as an exogenous variable in the with-volatility scenarios. Providing the simulated price for a given commodity lies within the set bounds in a given year, the stock management strategy described in the next paragraph is not activated for that year. However, when the equilibrium price falls

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<sup>9</sup> Sugar was not included in the global stock management scenarios for technical reasons.

outside (above or below) the relevant bound, the stock management strategy is activated and a new equilibrium solution is sought, until all three ‘managed’ prices lie within their bounds for that year. The model then proceeds to find the solution for the following year.

The third adaptation to the model incorporates the global stock management mechanism. When a world price for a given commodity falls outside its upper (lower) bound, the start-of-year global stock is reduced (increased) by placing more of the commodity on the market (taking some of the commodity out of the market) for that year until the equilibrium price has been forced into the required range. Suppose this has required a reduction in the global start-of-year stocks by 5%. The end-of-year stocks of the individual countries, which are calculated endogenously by the model, are reduced by 5% of their start-of-year stock level, so that they begin the following year with the stocks as generated by the previous year's production, consumption and net trade flows plus the adjustment for their contribution to the stabilisation mechanism if it has been activated. A lower (positive) bound is set to global stock levels to ensure that they do not fall to unacceptably low levels. These limits are based on historically observed stock-to-use ratios.<sup>10</sup>

These adaptations to the model imply several behavioural assumptions. First, start-of-year stock levels, already determined at the end of the previous year, are not influenced by same-year world market price, and only stocks that existed at the start of the year are used as the source for price stabilization in the current year. Second, each country contributes to the global price stabilization effort (by providing stocks to the world market or withholding its stocks from the world market)

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<sup>10</sup> There is discussion about the 'safe' level of stock-to-use ratios at world levels. Some commentators have argued that in the 2000s, 'low' world stock levels contributed to the extreme volatility observed in 2006-2009. Others (see for example Dawe, 2009) consider that adjustment should be made for China's lower stockholding in this period, and that once this is done there is little difference between stock-to-use levels

in proportion to its original stock level for the year measured before any stock management takes place. Third, minimum stock-to use ratios are imposed at different levels for the commodities used in the stabilization mechanism.

We define three scenarios for the purpose of examining biofuel-volatility-stock management interactions. All three scenarios incorporate volatility in world market prices. The scenario 0-PV assumes no EU biofuel policies and no global stock management in operation; the scenario 1-PV assumes EU biofuel policies are in operation but there is no global stock management; scenario 2-PV assumes that, in addition to EU biofuel policies, global stock management mechanisms are in operation to mitigate the volatility of world prices for wheat, coarse grains and vegetable oils.

#### *2.4. Summary of scenario definitions*

Table 2 summarises the scenarios that are described above and reported in the next two sections. Row 1 assumes no EU biofuel policies, Rows 2 and 3 assume that EU biofuel policies are in place. Columns 1 and 2 assume no price volatility (average supply conditions hold from year to year), columns 3 and 4 assume there is price volatility coming from crop supply shocks. Row 3 assumes a further policy change, namely tariff removal (columns 1 & 2) or global stock management (columns 3 & 4).

**Insert Table 2 here**

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in the 1990s and 2000s. The lower limits used in this study are: wheat: 20%; coarse grains: 15%; vegetable

### 3. Tariff Elimination and Land Use Change

This section reports the results for the scenarios on the left hand side of Table 2. The land use results are given in Table 3.

**Insert Table 3 here**

Without EU biofuel policies, the area of wheat, coarse grains, oilseeds and sugar is projected to decline over the period up to 2020 in three regions of the world: the EU, the US and Argentina. These reductions are driven by sectoral policy changes. The introduction of EU biofuel policies reduces the magnitude of these declines but does not reverse them; with the removal of EU biofuel tariffs, the area decline becomes a little greater than with EU tariffs, and in the case of Argentina greater than in the 'no EU policy' scenario. In all other countries and regions shown, the land used for these crops is projected to increase over time even without EU biofuel policies. EU biofuel policies, under the current tariff structure, result in significantly greater land use expansion in the Ukraine, Australia, the Other Asia region and Brazil. Brazil is already a special case in the baseline: even without EU biofuel policies, the cropped area in Brazil is projected to increase by over 29%, indicating a very significant pressure on land expansion over a 12-year period.

When EU tariffs are removed, the impact of the EU policies becomes smaller in the first three countries/regions (although it does not become negative), whereas Brazil continues to be an exception: Brazil is able to take advantage of its comparative advantage in higher-yielding cane

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oil: 8%, which are based on the low end of the range observed in the 1990s.

sugar to expand its ethanol exports to the EU significantly, which brings a further 865 thousand hectares into crop production. This represents a total land use impact of EU policy in Brazil in 2020 of 2.964 million hectares.

At the same time, however, because of this relocation of production in line with comparative yield advantage, the net global land-use change required to fulfil the EU's biofuel target falls by 1.354 million hectares (from an extra 6.325 million hectares under scenario 1 to an extra 4.971 million hectares under scenario 2). At first sight, the result that tariff removal results in a 21% smaller global net increase in land used for these crops suggests that removing biofuel tariffs makes the EU policies more ecologically friendly. However, this conclusion needs some qualification. Over 75% of the reduction in land demand occurs within the EU (that is, a net reduction in EU cropped land of 1.019 million hectares relative to the with-tariff case), lowering its share of the land-use impact from 27.4% to 14.4%. By contrast, Brazil's absolute net expansion of cropped land when EU tariffs are removed increases its share of the land-use impact increases from 33.2% to 59.6%. Thus, without EU tariffs, a greater share of the land-use impact falls outside EU territory, and – most important – a far larger impact in absolute terms occurs in a country with already rapidly expanding demand for agricultural land, and where about a third of the world's remaining tropical rainforest is located.

These results challenge the idea that the EU's sustainability conditions will be enough to guarantee that its biofuel target is met in an ecologically sustainable way, or put in other words, that the extra biofuel supply implied by the 2020 target can be produced in a way that is possible to certify as qualifying for the EU's mandatory target. In particular, they confirm the presence of

the biofuel sector on the list of commodity sectors where trade policy reforms and global or cross-boundary environmental concerns are potentially at loggerheads.

#### **4. Price Volatility Scenarios**

These results will be communicated at the conference.

#### **5. Conclusions**

This paper has looked at several knock-on effects of the EU mandatory biofuel target for 2020. We have focuses on two collateral effects, namely the distribution of land use change within and outside the EU given the possibility of lower trade protection in coming years, and the interaction between world price volatility and higher demand for biofuel feedstocks, with and without efforts to stabilise key prices at global level.

Our results challenge the idea that the EU's sustainability conditions will be enough to guarantee that its biofuel target is met in an ecologically sustainable way. Given the distribution of likely land use changes induced by the policy, it will not be easy to monitor and certify that the extra biofuel supply implied by the 2020 target can be produced in a way that satisfies EU sustainability criteria and hence qualifies for the EU's mandatory target. Possible future developments in EU trade policy are likely to make this requirement more difficult to fulfil. In particular, our results confirm the presence of the biofuel sector on the list of commodity sectors where trade policy reforms and global or cross-boundary environmental concerns are potentially at loggerheads.



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**Table 1: Historical and simulated volatility of world prices**

| Commodity/feedstock         | 1993-2008 |         | 2008-2020 |         |
|-----------------------------|-----------|---------|-----------|---------|
|                             | CV        | SD(log) | CV        | SD(log) |
| <b>Wheat</b>                | 0.351     | 0.305   | 0.408     | 0.370   |
| <b>Maize</b>                | 0.302     | 0.266   | 0.473     | 0.398   |
| <b>Raw sugar equivalent</b> | 0.235     | 0.243   | 0.246     | 0.244   |
| <b>Vegetable oil</b>        | 0.352     | 0.314   | 0.436     | 0.344   |

**Table 2: Summary of scenarios**

| Scenario #                 | Scenario description                      | Scenario #  | Scenario description                             |
|----------------------------|---|---|--|
| <b>No price volatility</b> |   | <b>With supply-shock induced price volatility</b> |  |
| 0                          | Baseline – no EU biofuel policies         | 0-PV  | Baseline + PV – no EU biofuel policies           |
| 1                          | + EU biofuel policies                     | 1-PV  | + EU biofuel policies                            |
| 2                          | + EU biofuel policies, no biofuel tariffs | 2-PV  | + EU biofuel policies, + global stock management |

**Table 3: Area of wheat, coarse grains, oilseeds and sugar crops, selected countries, 2008-2020, by scenario and between scenarios**

|                    | 2008   | Change, %, 2008-2020   |                      |                    | Policy impact, %, 2020 |        |
|--------------------|--------|------------------------|----------------------|--------------------|------------------------|--------|
|                    |        | No EU biofuel policies | EU biofuel policies  |                    | 1 vs 0                 | 2 vs 1 |
|                    |        |                        | With biofuel tariffs | No biofuel tariffs |                        |        |
|                    |        | 0                      | 1                    | 2                  |                        |        |
|                    | mn ha  |                        |                      |                    |                        |        |
| EU                 | 71.64  | -8.6                   | -6.2                 | -7.6               | 2.6                    | -1.5   |
| USA                | 91.85  | -1.2                   | -0.8                 | -1.0               | 0.4                    | -0.2   |
| India              | 78.44  | 4.4                    | 4.5                  | 4.5                | 0.1                    | 0.0    |
| China              | 72.41  | 1.4                    | 1.5                  | 1.5                | 0.0                    | 0.0    |
| Russian Federation | 52.37  | 1.0                    | 1.3                  | 1.2                | 0.3                    | -0.1   |
| Brazil             | 46.85  | 29.2                   | 33.7                 | 35.6               | 3.5                    | 1.4    |
| Argentina          | 27.08  | -8.0                   | -7.4                 | -8.2               | 0.7                    | -0.8   |
| Canada             | 24.13  | 5.4                    | 5.8                  | 5.7                | 0.5                    | -0.2   |
| Ukraine            | 22.26  | 14.2                   | 15.0                 | 14.6               | 0.7                    | -0.3   |
| Australia          | 21.82  | 2.6                    | 3.5                  | 3.4                | 0.9                    | -0.1   |
| Indonesia/Malaysia | 4.37   | 7.5                    | 7.4                  | 7.2                | 0.0                    | -0.2   |
| Africa             | 96.94  | 3.2                    | 3.5                  | 3.2                | 0.3                    | -0.2   |
| Other Asia         | 81.12  | 0.6                    | 1.7                  | 1.3                | 1.1                    | -0.4   |
| Other L. America   | 25.72  | 2.4                    | 2.5                  | 2.5                | 0.1                    | -0.1   |
| The Rest           | 4.33   | 4.0                    | 4.0                  | 4.0                | 0.0                    | 0.0    |
| <b>World</b>       | 721.31 | 2.6                    | 3.5                  | 3.3                | 0.9                    | -0.2   |