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vol 39 2008

TIPS Trade & Industry Monitor

TIPS & MONITOR

TRADE & INDUSTRY MONITOR

vol 39 | 2008

TIPS

TRADE & INDUSTRIAL POLICY STRATEGIES

TIPS

TRADE & INDUSTRY

MONITOR

2008

volume 39

TIPS

TRADE & INDUSTRIAL POLICY STRATEGIES

TIPS EXECUTIVE DIRECTOR: STEPHEN HANIVAL

TRADE & INDUSTRY MONITOR EDITOR: LUCILLE GAVERA

ISSN: 1010-438X

Cover photographs: Greatstock/Corbis & X Collection

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WHY OECD COUNTRIES SHOULD REFORM

RULES OF ORIGIN*

BY OLIVIER CADOT† AND JAIME DE MELO‡

With preferential trade agreements (PTAs) on the rise worldwide, rules of origin – which are necessary to prevent trade deflection – are attracting increasing attention. At the same time, preference erosion for Generalized System of Preferences (GSP) recipients is increasing resistance to further multilateral negotiations. Drawing on different approaches, this article shows that the current system of rules of origin that is used by the EU and the US in preferential trade agreements (including the GSP) and that is similar to systems used by other Organisation for Economic Co-operation and Development (OECD) countries should be drastically simplified if developed economies really want to help developing economies integrate into the world trading system. In addition to diverting resources for administrative tasks, current rules of origin carry significant compliance costs. More fundamentally, it is becoming increasingly clear that they are often designed to force developing economies to buy inefficient intermediate products from developed economies to 'pay for' preferential access for the final product. The evidence also suggests that a significant share of the rents associated with market access (net of rules of origin compliance costs) is captured by developed economies. Finally, the restrictiveness of rules of origin is found to be beyond the levels that would be justified to prevent trade deflection, suggesting a capture by special interest groups. The article outlines some alternative paths to reforms.

1. Introduction

RULES OF ORIGIN ARE AN integral part of proliferating free trade agreements—countries belong to an average of six, according to a recent tally by the World Bank (2005, table 2.1)—and nonreciprocal preferential trade agreements such as the Generalized System of Preferences (GSP).[1] Given the lack of progress on harmonization at the World Trade Organization (WTO) and given that regionalism is here to stay, rules of origin are likely to be increasingly important in the world trading system.

The primary justification for rules of origin in preferential trade agreements is to prevent "trade deflection," or taking advantage of low external tariffs or weak customs-monitoring capacities to bring in imports destined for more protected markets in a trading bloc (possibly after superficial conditioning or assembly). In effect, rules of origin are needed to prevent trade deflection for all

* This paper was first published in the World Bank Research Observer, Volume 23 No. 1 (Spring 2008). The authors thank Paul Brenton and Marcelo Olarreaga for many useful suggestions and co-authors Céline Carrère, Antoni Estevadeordal, Alberto Portugal-Perez, Akiko Suwa-Eisenmann, and Bolormaa Tumurchudur for permission to draw on joint work. They also thank three referees for comments on a previous draft.

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preferential trade agreements short of customs unions, where trade deflection is not an issue because members have a common external tariff. Beyond the largely unimportant issue of tariff revenue, what is at stake is the unwanted extension of preferences to out-of-bloc producers, which would erode the value of those preferences to eligible producers. In preferential trade agreements between developed and developing economies, rules of origin are also sometimes justified on "developmental" grounds because they can help foster integrated manufacturing activities in developing economy partners.

However, this article provides evidence that, by their complexity, rules of origin impose substantial compliance costs on preferred producers. For instance, in addition to regime-wide rules, the European Union has more than 500 product-specific rules of origin (Cadot, de Melo, and Pondard 2006). As a result, these rules are increasingly difficult to observe. In the least developed economies the rules divert scarce customs resources from other tasks such as trade facilitation[2]. In preferential trade agreements between developed and developing economies, forcing developing economy producers to source relatively inefficient intermediate goods locally or from developed economy partners rather than from the most price-competitive sources (as in, say, Asia) increases inefficiency and raises costs. The result is reduced value of preferences (compounding preference erosion in particular for least developed economies) and rent creation for developed country producers.

This potential for rules of origin to become a form of "export protection" was first observed by Krueger (1998) during negotiations for the North American Free Trade Agreement (NAFTA). It applies to all preferential trade agreements (including nonreciprocal preferential schemes) granted by Organisation for Economic Co-operation and Development (OECD) countries to developing economies. Moreover, there is an overwhelming evidence that this protectionist effect of rules of origin is not incidental but by design. Because rules of origin, unlike more traditional forms of trade protection such as voluntary export restraints or antidumping provisions, have so far largely escaped WTO disciplines; they are thus potentially a choice instrument for creeping protectionism.

New evidence reported in this article shows that the burden imposed by the rules of origin applied by the two main protagonists in preferential trade agreements, the European Union and the United States, is substantial whenever preferential margins are anything more than negligible. All told, the detailed evidence gathered here suggests that the current system of rules of origin applied by developed economies is out of hand and defeats both the spirit of reforms aimed at bringing greater transparency to the multilateral trading system and the development-friendly intent of preference schemes.

In a recent communication, the European Union decided to consider simplifying its rules of origin.[3] However, other OECD countries have so far refrained from reforming their rules and have opposed any discussion of reform of preferential rules of origin at the WTO. This article is a contribution to an overdue debate on how to design benign, transparent, and WTO-compatible rules of origin.

This article is organized as follows. The first section briefly recounts how product-specific rules of origin are defined in EU and U.S. preferential schemes and proposes an ordinal restrictiveness index summarizing their complexity. This index is shown to be correlated with EU and U.S. most favored nation tariffs (and thus, with the depth of trade preferences). The second section presents a simple framework for quantifying the costs associated with rules of origin: distortionary, administrative, and rent-transfer. The third section provides direct evidence of the effect of rules of origin on preference use and rent sharing using preference utilization rates and unit values. The fourth section qualifies the direct evidence by considering the Asian exception and the natural experiment provided by comparing the EU Everything But Arms initiative and the U.S. African Growth and Opportunity Act (AGOA), which have similar tariff-preference margins but different rules of origin. The fifth section provides further indirect evidence. The sixth section draws policy implications from the article's findings and makes recommendations for simplifying existing rules of origin.

2. Rules of Origin: Definition and Measurement

Rules of origin in preferential trade agreements have two components: a small set of regime-wide rules and a large set of product-specific rules, typically defined at the Harmonized System six-digit level of disaggregation (HS-6). Both rules together are to ensure sufficient transformation. Because the European Union and the United States are the main users of preferential trade schemes among OECD countries, this article follows the approach of Cadot, de Melo, and Portugal-Perez (2005), describing briefly the rules for NAFTA, which have been in place for a long time and correspond closely to those applied by the United States in other preferential trade agreements, and those for the European Union's "Pan-European system (PANEURO), "also called the "single-list" because it covers the common set of product-specific rules of origin that the European Union applies in all its preferential trade agreements (regime-wide rules differ

TABLE 1: EU AND U.S. EXAMPLES OF REGIME-WIDE RULES OF ORIGIN

Preferential trade agreement	De minimis or tolerance rule	Absorption (roll up)	Cumulation	Drawback allowed	Certification method
NAFTA	7 percent (except agricultural and industrial products), 7 percent of weight for goods in chapters 50-63	Yes (except autos)	Bilateral	Not after 7 yrs	Self-certification
United States-Chile	10 percent (except agricultural and processed agricultural products)	Yes	Bilateral	Not mentioned	Self-certification
U. S.-GSP	10 percent. 10 percent of weight for goods in chapters 50-63	Not mentioned	Bilateral limited diagonal	Not mentioned	Self-certification
Cotonou Agreement	15 percent	Yes	Full	Not mentioned	Two-step private and public and limited self- certification
EUGSP	10 percent (except goods in chapters 50-63)[a]	Yes	Bilateral limited diagonal	Not mentioned	Two-step private and public and limited self- certification

Note: Classification is carried out at the six-digit Harmonized System tariff line level. Each cell is the percentage of tariff lines that have the rules of origin in the corresponding row and in the corresponding column.
[a] Goods in chapters 50-63 (textiles and apparel) do not benefit from a de minimis provision.

Source: Cadot, de Melo. and Portugal-Perez 2005, table 1.

across the European Union's preference schemes such as the GSP or Cotonou Agreement). The analysis starts with regime-wide rules then turns to product-specific rules of origin.

2.1 Regime-wide Rules

Regime-wide rules usually include five components (these and other terms are defined in the glossary at the end of the article):

- A de minimis (or tolerance) criterion that stipulates the maximum percentage of nonoriginating materials that can be used without affecting the origin of the final product.
- A cumulation rule.
- A provision on whether "roll-up" applies.
- The status of duty drawbacks.
- The applicable certification method.

Table 1 describes how these regime-wide rules differ between the European Union and the United States.

Even for regime-wide rules, table 1 gives the impression of "made-to-measure" rules. It also shows that regime-wide rules differ across preferential trade agreements for the same developed economy partner, confirming the hub-and-spoke characteristic of preferential trade agreements between developed and developing economies. Certification methods also differ between EU and U.S. preferential trade agreements; certification is easier to carry out in U.S. agreements, at least in principle, than in EU ones.

2.2 Product-Specific Rules of Origin

Devising methods for determining sufficient processing (or substantial transformation) has turned out to be very complex in all existing preferential trade agreements because the Harmonized System was not designed to define the origin of goods. Three criteria are used by the European Union and the United States to determine whether sufficient transformation has taken place in activities requiring processing (that is, anything but crude products):

- A change of tariff classification (at various levels of the Harmonized System), meaning that the final product and its imported components should not belong to the same tariff classification (in other words, that the local processing should be substantial enough to induce a change of tariff classification).
- A critical threshold for value added (in short, a value content rule).
- A specific manufacturing process (a so-called "technical requirement").

For crude products the typical rule is "wholly obtained," which permits no foreign content whatsoever, although other rules apply in special cases, such as fish products.

TABLE 2: PREFERENCES AND UTILIZATION RATES FOR TEXTILES AND APPAREL

Preferential trade agreement	Number of observations	Utilization rate (percent)	Preference margin (percentage points)
NAFTA (2001)	618	79.9	10.4
EU GSP (2004)	16,555 (HS-8) 12.920 (HS-6)	52.2	1.8
Cotonou Agreement (2004)	1,370 (HS-8) 1,175 (HS-6)	50.0	10.4

Note: Averages are unweighted. HS-6 is the six-digit Harmonized System level; HS-8 is the eight-digit Harmonized System level.

Source: Cadot, de Melo, and Portugal-Perez (forthcoming), table 3b.

Both NAFTA (whose rules are also used in other U.S. preferential trade agreements) and PANEURO have a long list of criteria—including such technical requirements as the "triple transformation" requirement in textiles and apparel, which requires apparel to be woven from originating fabric and yarn. Criteria also include exceptions (making them more stringent) and allowances (making them less stringent). NAFTA relies more heavily on changes of tariff classification, though often in combination with other criteria. PANEURO relies mostly on value content and wholly obtained criteria, with wholly obtained criteria prevalent for GSP and African, Caribbean, and Pacific (ACP) exports of primary products with little processing.

As Krishna (2006) points out, when analyzing rules of origin, the devil is in the details because the complexity of rules of origin is what provides an opportunity for special interests to influence their design and administration. While many facets of rules of origin have been explored, rigorous empirical study of their effects has been hampered by two difficulties, one relating to data on utilization rates, the other to measurement of the rules' restrictiveness.

First, data on preference utilization have been made freely available to the public only recently for the United States but not yet for the European Union (for example, Brenton and Manchin 2003 and the studies collected in Cadot, Estevadeordal et al 2006).

Second, because rules of origin are a set of complex, heterogeneous legal rules, it has proved difficult to develop a reliable measure of their restrictiveness to serve as a synthetic indicator (much like effective rates of protection are a synthetic indicator of the restrictiveness of a country's trade regime). Estevadeordal (2000) has proposed an ordinal index of product-specific rules of origin restrictiveness (or R-index), taking values between one and seven, with higher values corresponding to more restrictive rules of origin. The index, constructed from a simple observation rule at the HS-6 level, where rules of origin are defined, is described below.

The observation rule is as follows (Cadot, de Melo, and Portugal-Perez 2005). Let CC stand for a change of chapter, CH for a change of heading, CS for a change of subheading, and CI for a change of item. A change of classification at the item level can be taken as less stringent than one at the subheading level, and so forth. So the criterion for classifying changes of tariff classification criteria is

$$\mathbf{CO\ CH > CS > CI} \qquad \mathbf{(1)}$$

But a change of tariff classification is often accompanied by one or two (in a few cases even three) additional requirements, such as value content rules, technical requirements, exceptions, or allowances. The observation rule assigns higher index values to changes of tariff classification when these requirements are added and lower ones in the case of allowances. For instance, a change of heading is given an index value of four, which rises to a five when accompanied by a technical requirement or exception but shrinks to three when accompanied by an allowance.

Though not amenable to quantification as effective rates of protection, the R-index plays the same analytical role; it is intended as an overall indicator of how trade-inhibiting the requirements that must be met by a product to obtain originating status. There is preliminary evidence that preferences have hidden compliance costs and that those compliance costs may be related to rules of origin. Table 2 shows evidence for the textile and apparel sector under NAFTA, the EU GSE and the Cotonou Agreement (which grants tariff-free access for most ACP products to the EU market).[4] Although NAFTAs and Cotonou's preference margins are equal, at 10.4 percentage points, their utilization rates vary widely: 50 percent for Cotonou compared with 79.9 for NAFTA. Cotonou's low rate of uptake despite deep preferences suggests hidden barriers. ACP countries benefit from full rather than diagonal cumulation (that is, intermediate purchases from all partners qualify as originating) and a 15 percent tolerance rule

TABLE 3: PREFERENCES AND UTILIZATION RATES, ALL GOODS

Preferential trade agreement	Preference margin		
	T > 4 percent[a]	r>8 percent[a]	T> 12 percent[a]
North American Free Trade Agreementb	87(1,239)	86.0(558)	82.8 (287)
GSP[c]	50.2(1,297)	52,5 (91)	66.2 (44)
Cotonou Agreement[c]	92.5(1,627)	94.3 (892)	96.4 (566)

Note: Averages are unweighted. Numbers in parentheses are the number of tariff lines.

[a] $\tau_i = (t_i^{MFN} - t_i^{PREF}) / (1 + t_i^{PREF})$ is the preference margin.

[b] Computed at the six-digit Harmonized System tariff-line level with 2001 data.

[c] Computed at the eight-digit Harmonized System tariff-line level with 2004 data for 92 countries (GSP) and 37 countries (Cotonou Agreement) qualifying for preferential market access.

Source: Cadot, de Melo, and Portugal-Perez (forthcoming), table 2.

TABLE 4: TARIFF PEAKS AND THE R-INDEX

	Restrictiveness-Index value	
	North American Free Trade Agreement	PANEURO
Tariff peaks[a]	6.2 (257)	5.2 (780)
Low tariffs[b]	4.8 (1.432)	3.9 (3,241)
Total number of tariff lines	3.555	4.961

Note. Numbers in parentheses are numbers of tariff lines. Restrictiveness indexes are unweighted.

[a] Tariff lines whose tariffts exceed three times the (JSP average.

[b] tariffs lines whose tariffs are less than one-third of the GSP average.

Source: Cadot, de Meio. and Portugal-Perez 200I>, table 3

compared with only 10 for the GSP, which also excludes the textile and apparel sector (chapters 50-63) from the 10 percent tolerance rule.

Table 3 shows that the evidence of hidden costs goes beyond the textile and apparel sector, where differences in uptake at similar margins may reflect composition effects. Define the preferential margin T by the normalized difference between most favored nation and preferential tariffs

$$\tau_i = \frac{t_i^{MFN} - t_i^{PREF}}{1 + t_i^{MFN}} \quad (2)$$

Table 3 shows that, contrary to expectations, when the preferential margin rises, utilization rates fall for NAFTA. This suggests that an omitted variable is positively correlated with tariffs but negatively correlated with preference utilization. Rules of origin are an obvious culprit.

Table 4 shows that lines with tariff peaks (that is, with tariffs more than three times the average), where preferential margins are highest, do have higher R-index values than those with low tariffs. This relationship holds for both NAFTA and PANEURO.

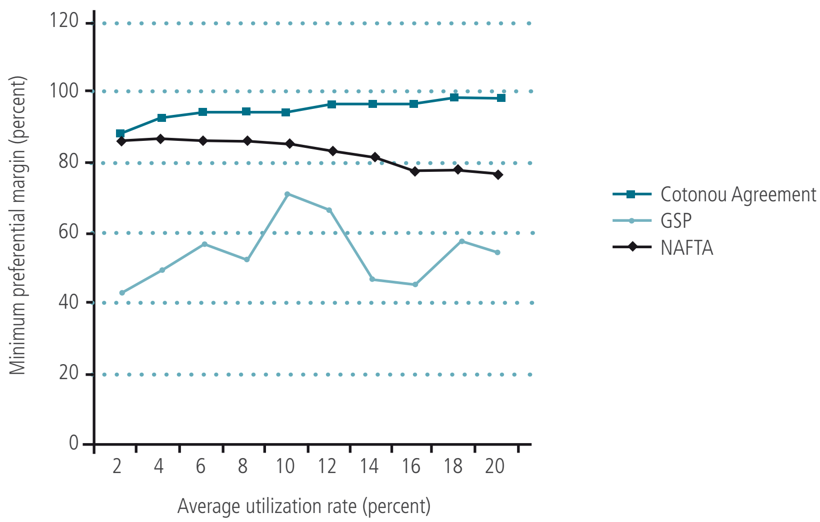
Figure 1 confirms the patterns in tables 2-4; utilization rates do not really increase with tariff-preference margins. For NAFTA, they actually decrease due largely to the influence of the textile and apparel sector, where tariff preferences are deep and rules of origin stringent.

3. Quantifying the Effects of Rules of Origin

Although product-specific rules of origin, as already noted, take a variety of legal forms (changes of tariff classification, value content rules, technical requirement, and the like), they can all be represented conceptually as floors on domestic value added. Suppose that a producer in Madagascar wishes to sell a shirt under preferential access in the European Union, this shirt is made with both originating intermediate goods (that is, intermediate goods that are either local, EU-made, or imported from other qualifying countries, according to cumulation rules) and nonoriginan'ng intermediate goods, say from Bangladesh, China, or India, Now assume that to satisfy origin requirements (whether change of tariff classification, value content rule, or technical requirement), the

FIGURE 1: AVERAGE UTILIZATION RATES FOR DIFFERENT PREFERENTIAL MARGIN THRESHOLDS

GSP	NAFTA
43.7	86.1
50.2	87
56.8	86.4
52.5	86
71.4	84.8
66.2	82.8
46.8	81.9
45.4	77.8
55.9	78.5
54.7	76.6



Note: Cotonou Agreement includes 37 countries, computed at the eight-digit Harmonized System level; GSP includes 92 countries, computed at the eight-digit Harmonized System level: and the NAFM includes 3 countries, computed at the six-digit Harmonized System level. Data are unweighted averages computed at the most disaggregated tariff-line level (table 2). Averages are based on more than 100 observations except for GSP (minimum of 27 observations for preference margins. r_i equal to or greater than 20 percent).

Source: UNDP, 2003: IEA, 2000

Malagasy producer uses a higher proportion of originating inputs than would be the case in the absence of rules of origin (which is precisely the rule's purpose).

Let superscript R denote a choice restricted by rules of origin. Unrestricted value added is va_i, and restricted value added is va_i^R, so rules of origin content reduces to $va_i^R > va_i$. whether or not it explicitly takes the form of a value content rule. Thus, conceptually a value content rule can be thought of as a generic rule that can play the role of all others by quantifying the objective common to all. This principle is important because it underlies an approach to rules of origin reform, discussed later, that substitutes a value content rule—possibly, although not necessarily, at differentiated rates across products—for the current array of instruments. It also highlights how information on rules of origin restrictiveness can be aggregated across instruments and subsumed into a single restrict iveness index, which itself can be then aggregated across product lines by averaging.

Five results emerge from the quantitative analysis of the relationship between rules of origin restrictiveness and preference uptake:

- For a given preference margin a higher restrictiveness index translates into a lower utilization rate, all other things being equal.
- For a given restrictiveness index a higher tariff-preference margin translates into a higher utilization rate, all other things being equal.
- The compliance decisions of individual firms are binary; how the decisions aggregate into industry-wide utilization rates depends on the unobserved distribution of compliance costs.
- A lower pass-through of tariff preferences for the least developed economies (due to low bargaining power) implies lower uptake of preferences, all other things being equal.
- Improvements in the uptake of preferences can be obtained either from reductions in the restrictiveness of rules of origin or from cost-reducing administrative simplifications (such as transparent and uniform criterion).

The third result implies that the statistical relationship between K-index values, preference margins, and utilization rates can only be "noisy" (that is, affected by a large unexplained component) at the aggregate (product-line) level. But notwithstanding the noise introduced by unobserved firm characteristics (which could be investigated only with firm-level data that are not currently available), figure 1 suggests an unambiguous relationship between preference margins, rules of origin restrictiveness, compliance costs, and utilization rates. It also suggests that, without a proxy for rules of origin restrictiveness such as the K-index, attempting to evaluate the effect of tariff-preference margins on the uptake of those preferences may lead to omitted-variable bias.

Keeping in mind that this framework captures only some of the effects associated with rules of origin, several observations are in order.[5] First, administrative costs act as a technical barrier to trade; they result in resource waste, and in the welfare calculus of the effects of rules of origin they are more costly than the usual deadweight losses. Second, if costs are associated with certification, requests for preferential status would not be observed when preference margins are low. Third, compliance costs are particularly high for differentiated products, for which there can be quality as well as price differences between eligible (local) and noneligible intermediate goods. Because part of those costs is passed on to consumers in the countries that determine the rules of origin, high utilization rates does not necessarily imply that rules of origin have small effects.

Stiff rules of origin may inhibit or deflect trade altogether, not just the uptake of preferences. This was shown in the case of the Europe Agreements, free-trade agreements signed in 1991 between the European Union and the Central and Eastern European countries. Tumurchudur (2007a) showed that a large share of the exports from Central and Eastern Europe was deflected from EU markets by rules of origin, resulting in heavy losses. Evidence of trade-inhibiting effects is also apparent in the evolution of textile and apparel exports under AGOA and the Everything But Arms initiative, which is discussed in the exception and quasi-natural experiment section below.

4. Direct Evidence

In the absence of firm-level data Carrere and de Melo (2006) assume that the preference utilization rate for product line i (the percent of exports sent under the preferential regime rather than the most favored nation one), referred to as Ui, rises with the tariff-preference margin, τ_i, (which may be just equal to the most favored nation tariff when preferential access means tariff-free access) and shrinks with rules of origin compliance costs c_i^R. That is, $U_i = f(\tau_i - c_i^R)$ where $f(\cdot)$ is an increasing function, and, $c_i^R = (RoO_i)$, where $g(\cdot)$ is an increasing function (true compliance costs are firm-specific and are thus unobserved; all that is observed is the presence of RoO_i). These assumptions lead to an estimable relation of the form

$$u_i = \lambda + \alpha\tilde{\tau}_i + \sum_k \theta_k RoO_{ik} + \varepsilon_i \quad (3)$$

where RoO_{ik} is a set of dummy variables indicating the presence of product-specific rules of origin (change of tariff classifications, exceptions, and so on). Results from estimating equation (3) on NAFTA data confirm that utilization rates rise with preferential margins and shrink in the presence of rules of origin (Cadot, de Melo, and Portugal-Perez 2005 for results using data for the European Union).

Carrere and de Melo (2006) combined their estimates with R-index values to compute an estimated ad valorem equivalent of total rules of origin compliance costs (administrative costs and costs due to higher input costs). Their estimates range from 3.5 percent for a change of chapter to more than 15 percent for combinations of rules of origin involving technical requirements. The strongly inhibiting effect of technical requirements appears to be an empirical regularity.

Even if the estimates are robust to a range of specifications, it is difficult to infer a sense of robustness from estimates derived from a relation like equation (3) because so much heterogeneity and so many "unobservables" influence preference uptake. Estimates have proved fairly sensitive to the inclusion of control variables, in particular when using EU GSP data.

An alternative is to restrict the analysis to products, for which the sole criterion used to determined origin is a value content. Drawing on the variation in EU value content criteria across product lines with value content the sole criterion, Cadot, Carrere, and Strauss-Kahn (2007) 'estimate an equation similar to equation (3), in which however the dummy variables for rules of origin are replaced with the continuous value content rule values.[6] Using dummy variables for Harmonized System sections to control for heterogeneity across sectors and restricting the sample to tariff lines with substantial tariff-preference margins (above 2 or 5 percent), they find that utilization rates rise, all other things being equal, with the maximum foreign content allowed by the value content rule.

TABLE 5: ESTIMATED EFFECTS ON PREFERENCE UTILIZATION AND RENT TRANSFER OF RELAXING A VALUE CONTENT REQUIREMENT

	Preference margin			
	T, > 2% ACP + GSP	Ti > 5% ACP+ GSP	TI > 2% GSP	TI > 5% GSP
Number of observations	19,261	5.958	13,448	4,305
Mean preferential margin (T) (percent)	3.74	5.14	3.79	5.22
Mean utilization rate (percent)	0.12	0.17	0.17	0.22
Mean value content {percent of unit price)	58.8	58.2	58.9	58.6
Mean value of imports (euros)	1,475,182	2,376,301	986,979	159,694
Simulation: local content requirement reduced by 10 percentage points				
Change in preference utilization rate (percentage points)	2.0	5.2	2.5	1.7
Total rent transfer from increased utilization (millions of euros)3	21. 7	37.4	25.3	11.6

Evaluated at the mean value of imports.

Source: Authors' computations based on Cadot, de Melo, and PortugaJ-Perez (forthcoming), table

TABLE 6: EXPORTS, UNIT COSTS, AND PRICES UNDER PREFERENTIAL MARKET ACCESS AND A BINDING MINIMUM LOCAL CONTENT REQUIREMENT

	Simulations				
	(1)	(2)	(3)[a]	(4)	(5)
Preference margin (percent)	10	10	10	10	10
Administrative unit costs (percent of unit price)	0	0	0	2.5	1.0
Unconstrained, minimum local content requirement (percent of unit price)	40	40	40	40	36
Constrained, minimum local content requirement (percent of unit price)		50	50	50	40
Preferential exports (percent change from scenario with no preferential access)	15.9	11.1	-0.15	7.1	10.7
Unit costs (percent change from scenario with no preferential access)	0	1.9	6.7	1.9	0.4
Unit net price (percent change from scenario with no preferential access)	2.9	3.0	3.4	2.2	2.1

Note: Unit net price set equal to], initial output to 100. and value-added to 20. All output is exported (40 percent to preference-receiving destination). For columns 1-4 nonoriginating inputs are set to 75 percent of intermediate good input purchases. This implies that initial (unconstrained) local content is 20 + 0.25 (SO) = 40. Setting the minimum local content requirement at 50 percent implies reducing nonoriginating intermediate goods to 62.5 percent of intermediate good purchases. For column 5 nonoriginating inputs arc set at 80 percent and reduced to 75 percent through the minimum local content rule.

[a] Same as column 2 but with low value for the elasticity of substitution between originating and nonoriginating materials (0.5 instead of 2).

Source: Authors' computations adapted from model in Cadot et al. 2005.

Since a single value content criterion is a serious candidate for reform, at least in the case of the European Union (Stevens et al. 2006 and Cadot, de Melo, and Pondard 2006), table 5 reports two illustrative simulations based on these estimates. The mean local content requirement is 58 percent and preference margin 3-5 percent depending on the sample; mean utilization rates are rather low—between 12 and 22 percent. The bottom of the table shows the first-round effects (no supply response) of reducing the local-content requirement by 10 percentage points. Utilization rates rise by 2-5 percentage points (row 6), raising the rent transfer by €21-37 million, for a mean value of imports of €1.5-3.0 billion.

To fully grasp the welfare effects of rules of origin, the rent distribution between the exporting and importing country must be factored in. This implies estimating the pass-through effect of tariffs on consumer prices (that is, the extent to which preferences translate into a higher producer price for exporters). Estimates for AGOA preferences (Olarreaga and Ozden 2005) and for the Caribbean Community (Ozden and Sharma 2006) are that between one-third and one-half of tariff reductions are passed on to producers.

However, part of the border-price increase could reflect the compliance costs discussed above. Using a monopolistic-competition model with differentiated products in which Mexican exporters can export product; either to the rest of the world (under most favored nation status, at price p_j^M) or to the United States (under NAFTA, at price p_j^N, Cadot et al (2005) estimate the following relationship

$$\text{NAFTA markup} = \alpha_0 + \alpha_1 \tau_j + \alpha_1 CC_j + \alpha_3 TECH_j + \varepsilon_j \qquad (4)$$

where "NAFTA markup" is the percentage by which Mexico's NAFTA shipment prices are raised over comparable most favored nation shipment prices, CC_j is a dummy variable marking a change of tariff classification at the chapter level, and $TECH_j$ is a dummy variable marking a change of a technical requirement.

When estimated at the HS-8 level, equation (4) is the best tool to compare prices in different markets. With complete pass-through ($\mu = 1$ in equation (4) the estimated coefficient for α_1 would be close to one, but Cadot et al. (2005) find it substantially below one. They also obtain negative and significant estimates for (α_2, α_3) indicating that rules of origin costs are at least to some extent passed on to consumers. Once rules of origin are taken into account, the backward pass-through of preferences to producer prices falls from 80 percent of the margins to only 50 percent. They also show, using input-output links, that U.S. producers of intermediate goods are able to retain a substantial share of the rents generated by rules of origin downstream. That is, stiff rules of origin on, say, Mexican shirts exported to the United States significantly raise the price of fabric exported by the United States to Mexico for use in those shirts. This reflects the fact that rules of origin create a captive market for U.S. intermediate goods.

5. An Exception and a Quasi-Natural Experiment

The covariation of utilization rates and margins does not account for all the effects of rules of origin. Case studies such as those reported in Cadot, de Melo, and Pondard (2006) and Stevens et al (2006) provide useful complementary evidence, although they conclude that each case is different, thereby explaining if not justifying the current maze. An exception and a quasi-natural experiment are drawn here, with both suggesting that rules of origin are, as they stand, unnecessarily restrictive.

5.1 Asian Exception

In a world where rules of origin are as cumbersome and complicated as they are (Estevadeordal and Suominen 2006 for a detailed description), Association of Southeast Asian Nations (ASEAN), Free Trade Area (AFTA) and the ASEAN-China Free Trade Area (ACFTA) stand out as exceptions. To obtain originating status (that is, to fulfill the criterion of sufficient processing), either the wholly obtained criterion (for a few agricultural products) or a single-value content rule requiring 40 percent local content (for most products) is used. This rule has been relaxed by allowing a choice between criteria for countries that found it too constraining. For instance, under ACFTA the importer can choose a change of tariff classification can be used as an alternative to the 40 percent local content for obtaining origin for leather goods, and some specific process criteria are also accepted for some textile products.[7]

So why are rules of origin under AFTA less stringent than elsewhere? First, until recently Asian regionalism was more about cooperation than about preferential trade. Under the aegis of the United States, Asia-Pacific Economic Cooperation was set up specifically to avoid preferential trade and the formation of an Asian trade bloc. Much of the region's integration in the world economy has been driven by unilateral tariff reductions. Second, regional trade has made possible the rise of the Asian manufacturing matrix in which labor-intensive stages of production initially carried out in Japan—and later in the Republic of Korea—were outsourced to the region's lower wage countries. The resulting regional production networks have contributed to the price-competitiveness of Asia's exports, which has benefited the whole region. Stiff rules of origin would have jeopardized this successful model.

This 'Asian exception" has been conducive to the successful development of Asian countries that have fully participated in "verticalizing" trade (the development of cross-border supply chains generating trade in intermediate products). In this unusual setup (relative to other global trading patterns), intraregional trade in politically sensitive final products where protection is highest was insignificant. Thus, the political-economy forces that would usually lead to the complex rules of origin observed elsewhere have not been at work so far. As a result, low-income countries such as Cambodia and Lao PDR have been able to participate in the fragmentation of production according to comparative advantage.[8] Arguably, Asia's simple and uniform rules of origin requirement is an example of the kind of rules of origin that would really be development-friendly.

5.2 AGOA and Everything but Arms: a Natural Experiment

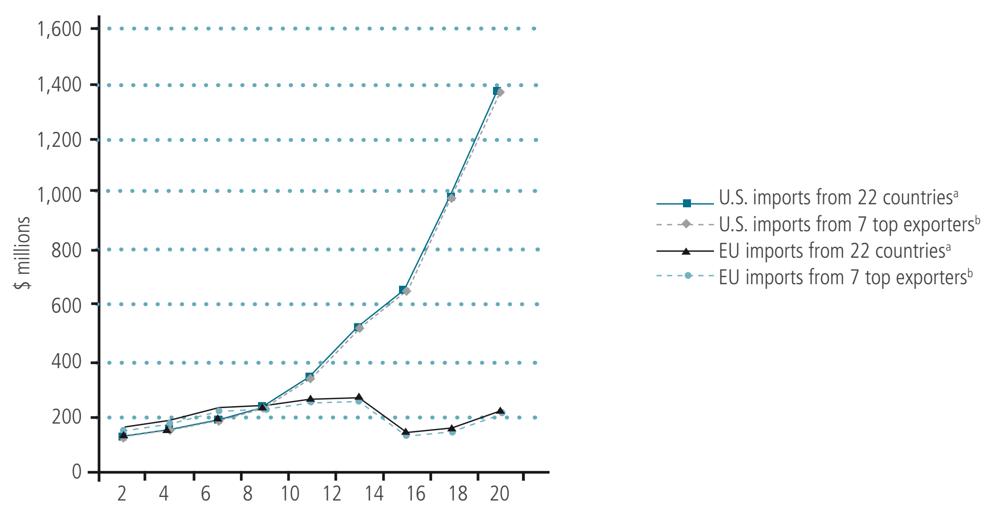
In the textile and apparel sector, the choice area for obscure and trade-inhibiting rules of origin, the one notable exception is the U.S. preferences granted to 22 Sub-Saharan African least developed economies under AGOA. Thus, comparing African apparel exports to the European Union and the United States provides a quasi-experimental situation in which the effects of rules of origin on the uptake of trade preferences are analyzed. This quasi-experimental situation, first studied by Brenton and Ozden (2005), comes from the combination of different rules of origin with very similar rates of preference margins (textiles and apparel receive approximately the same protection in the EU and U.S. markets. In 2001 the EU-15's most favored nation tariff was 10.1 percent compared with 11.7 percent for the United States, and duty-free access applied to both Everything But Arms eligible and the 34 AGOA-eligible African countries).

To qualify for preferential access to the U.S. market, an exporter must prove that the garments are produced, cut, and sewn in the area benefiting from preferential access (here, AGOA). Cotton products must be made from originating fabric, yarn, and thread, with diagonal cumulation somewhat relaxing the requirement, since fabric originating in other member countries qualifies. However, this rule, known as "the triple transformation" rule, was relaxed for 22 least developed economies under AGOA's "special regime," which permits the use of third-country fabric.[9] That is, the special regime reduces the transformation requirement to a single transformation (from fabric to garment).

Fifteen of AGOA's special regime beneficiaries are also eligible for the European Union's Everything But Arms initiative. But no such relaxation applies to exports to the European Union under either the Cotonou Agreement or Every But Arms preferences. EU rules of origin for apparel require production from originating yarn, which implies a "double transformation" from yarn to fabric and from fabric to clothing. The European Union's "double-transformation" rule obviously makes compliance difficult for countries that have no textile industry. Small or poor countries that cannot profitably produce fabric—weaving is a capital-intensive activity involving expensive machinery, particularly for woven products— should not, from an economic-efficiency viewpoint, set up the vertically integrated local value chains that would satisfy the double-transformation rule.

In apparel preference utilization rates are very high under both AGOA (97.36 percent in 2004) and Everything But Arms/Cotonou (94.9 percent). Cotonou has rules similar to those that Everything But Arms has for apparel. However, export volumes evolved quite differently for the 15 least developed economies that benefit from both schemes. Figure 2 shows a substantial increase in the value of apparel exports with AGOAs entry into force in 2000 (in particular for Lesotho and Madagascar). By contrast, the value of exports from this same group of countries did not rise following the adoption of Everything But Arms—in fact it fell slightly. Of course, the exports that remained flat for those countries should come as no surprise since they already benefited from Cotonou preferences, which give almost as much access as Everything But Arms (with slightly more lenient rules on cumulation). In effect, nothing changed for them on this front, and along with other ACP countries they largely continued to request access under Cotonou, with which they were familiar, rather than Everything But Arms. But AGOAs special regime did not merely trigger a catch up of U.S.-bound

FIGURE 2: APPAREL EXPORTS OF 22 COUNTRIES BENEFITING FROM THE AGOA SPECIAL REGIME, 2004



Note: [a]Benin, Botswana, Cameroon, Cape Verde, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senega!, Sierra Leone, Swaziland. Tanzania, Uganda, and Zambia. [b]Botswana, Cameroon, Ghana, Kenya, Lesotho, Madagascar, Namibia, Nigeria, and Swaziland.

Source: Portugal-Perez (2007) based on the WTO Integrated Data Base exports toward already high levels of EU-bound exports; it dwarfed them. Thus, unlike AGOAs special regime neither Cotonou nor Everything But Arms appeared to have offered a preference mix (tariff preferences and rules of origin) conducive to export growth.

Because the data in figure 2 are computed at the HS-6 product level, it is safe to assume that heterogeneity in export composition is largely controlled for. This is confirmed by formal econometric evidence. In a model that controls for differences in preference margins and for demand shifters in the EU and U.S. markets, Portugal-Perez (2007) finds that relaxing rules of origin for apparel (captured by a dummy variable corresponding to the introduction of the AGOA's special regime) raised apparel exports significantly for beneficiary countries. Because the special regime was not introduced in the same year for all countries, its effects are well identified statistically, and Portugal-Perez' results strongly suggest that the difference in performance apparent in figure 2 is indeed attributable to differences in rules of origin regimes.

AGOAs special regime seems to have encouraged growth not only at the "intensive margin" (higher volumes) but also at the "extensive margin" (diversification by addition of new products). As new products were exported to both countries (an active extensive margin), the rate of increase in new products was several orders of magnitude higher for the U.S.-bound goods than for EU-bound ones, which is an important achievement. Product diversification is one measure of industrialization, particularly at early stages of the economic development process (Cadot, Carrere, and Strauss-Kahn 2007 and references therein). Controlling for other factors, countries that have a more diversified industrial base enjoy less volatile growth and are better poised to absorb shocks. Only three countries in Sub-Saharan Africa—Lesotho, Madagascar, and Senegal—export more than 50 products to either the European Union or the United States. Thus, if the development objective of rules of origin is to be taken seriously, encouraging export growth at the extensive margin is important, and in this regard Everything But Arms and Cotonou's performance are again disappointing compared with that of AGOAs special regime.

Taken together, the brief discussion here on the Asian exception and the comparison of AGOA with the Everything But Arms initiative suggests two results:

Limited differences between preferential regimes can have drastic effects on their performance; AGOA's relaxation of the triple transformation rule gave a significant boost to Sub-Saharan African apparel exports.

Utilization rates are an incomplete measure of the performance of preferential regimes, as the inhibiting effect of stiff rules of origin can be felt on trade volumes as well.

6. Indirect Evidence

Taking inspiration from the early work by Herin (1986) for EFTA, Cadot, de Melo, and Portugal-Perez (forthcoming) applied revealed-preference arguments to estimate upper and lower bounds of compliance costs. Arguably, this nonparametric approach could be more robust than the parametric evidence reported above. By revealed preference, for products with 100 percent utilization rates the net benefit of preferences is positive for all firms. Since everyone uses the preferences, the ad valorem equivalent of compliance costs cannot be larger than the tariff-preference margin. Conversely, for products with zero percent utilization rates, since no one uses the preferences, the compliance cost cannot be smaller than the preference margin.

For remaining sectors (those with utilization rates between 0 and 100 percent) the story is more complicated because of firm heterogeneity, so assumptions must be made. Cadot, de Melo, and Portugal-Perez (forthcoming) argue that, firm heterogeneity notwithstanding, the average exporter (in terms of compliance costs) is not too far from indifference between the preferential and the most favored nation regimes, which means that the compliance cost is about equal to the tariff-preference margin. Applying this reasoning gives trade-weighted ad valorem estimates of 4.7-8.2 percent depending on sectors for PANEURO and 1.8-1.9 percent for NAFTA—values in line with the econometric estimates of Carrere and de Melo (2006) reported earlier.

How then should requests for preferential status be interpreted when tariff preferences are nil? Beyond (likely) errors in data transcription, the logical possibility would be that administrative costs are negligible, but this contradicts the evidence (the nonparametric approach described in the previous paragraph gave estimates of pure administrative costs slightly above 3 percent in ad valorem form). Francois, Hoekman, and Manchin (2006) elegantly addressed this problem by modeling the determinants of utilization rates for EU trade with ACP countries in a switching-regression framework where the relationship between the variable of interest (utilization rates) and explanatory variables varies between two regimes: one for low-margin sectors and the other for high-margin ones. The dividing point between the two regimes is determined by the data using an algorithm developed by Hansen (2000).[10] They found that exporters start requesting preferences when preferential margins are in the 4.0-4.5 percent range, a result that is also broadly consistent with the nonparametric estimates of compliance costs reported above.

Other studies using aggregate bilateral trade data also suggest costs associated with the presence of rules of origin. Using a gravity model of bilateral trade, Anson et al (2005) find that after controlling for the other determinants of the volume of bilateral trade, including the presence of free trade agreements, the intensity of bilateral trade is inversely related to the values taken by the R-index. Using a similar framework, Augier, Gasiorek, and Tang (2005) find that the volume of bilateral trade is lower when cumulation is on a bilateral rather than a full basis, leading them to suggest that rules of origin should be relaxed to allow for full cumulation.

The evidence reported so far in this article is overwhelming: rules of origin are burdensome and foster economic inefficiency. But this article also argues that they have a role in combating trade deflection, so calling them trade barriers is not enough. To make progress in designing "clean" rules of origin, a key part of the argument is to tell apart, in their current characteristics (and in particular their restrictiveness), how much is attributable to their antideflection role compared with how much is simply capture by special interests. Portugal-Perez (2006) tries to address this issue by decomposing variations in the .R-index into a component attributable to trade deflection and one associated with lobbying or political-economy motives. He estimates this decomposition for Mexican textile and apparel exports to the United States under NAFTA using the following equation

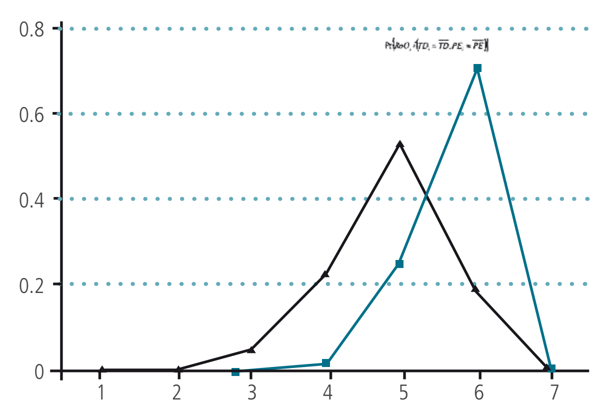
$$RoO_i = \beta\left[TD_i\right] + \gamma\left[PE_i\right] + \varepsilon_i \qquad (5)$$

where (RoO_i) is R-index values at the HS-6 level. The regressors are the trade deflection vector, which includes a proxy for the extent of product differentiation (the more homogeneous the product, the more there is to gain from arbitraging even small differences in external tariffs), and differences in external tariffs (the larger these differences the more there is to arbitrage). Political-economy variables including the level of the United States' most favored nation tariff (a proxy for lobbying power) revealed comparative-advantage indexes and the value of Mexican exports to the rest of the world (a proxy for potential penetration of the U.S. market).

Portugal-Perez finds strong and quite robust correlations, suggesting that both sets of factors are at work in explaining cross-sectoral variations in rules of origin restrictiveness. Using estimated parameter values, he constructs a counterfactual distribution of R-index values across goods in the absence of political-economy correlates (that is, by setting $\gamma = 0$ in equation (5). The two distributions (actual and counterfactual) are reported in figure 3. They show that political-economy concerns (which shift the actual distribution to the right of the counterfactual) contribute to the overall restrictiveness of rules of origin. Drawing on the estimates discussed earlier by Carrere and de Melo (2006), he concludes that capture by special interests may have raised the costs of rules of origin an average of 3.5-11 percent of good value, a very steep increase in the face of the shallow preferences that are generally granted.

Simulation methods provide another way of obtaining orders of magnitude of rules of origin effects on trade. Francois, Hoekraan, and Manchin (2006) use their estimate of compliance costs to simulate the effects of trade liberalization by developed economies on low-income countries

FIGURE 3: COUNTERFACTUAL DISTRIBUTION FOR R-INDEX



Source: Portugat-Pferez 2006, figure 3 in a multiregional trade model. Despite preference erosion, low-income countries gain instead of losing from trade liberalization by the European Union because the "rectangle" deadweight losses associated with compliance costs are eliminated.

Table 6 provides alternative estimates from a partial-equilibrium perspective, taking as an example a GSP country benefiting from a 10 percent preferential margin in the EU (or U.S.) market (row 1) but forced to raise its minimum local content from the value in row 3 (40 percent, except in column 5) to the value in row 4 (50 percent, except in column 5). When present, administrative costs, also expressed as a percentage of the unit price, are given in row 2. The table's bottom three rows show the effect of rules of origin on equilibrium exports and prices.

Column 1 shows the benefits that accrue to the GSP producer from receiving a 10 percent preference margin with no constraint on the sourcing of inputs. For this constellation of elasticity (all are on the high side to reflect the likelihood that products from different origin are close substitutes, whether at the intermediate- or final-good level), the pass-through is 2.9 percent (row 7) out of a preference margin of 10 percent, in line with econometric estimates mentioned in the section on direct evidence. Exports increase by 16 percent, but costs do not increase because inputs are bought at constant world prices.

Column 2 shows what happens when the producer must reduce the use of nonoriginating materials to meet a value content rule of 50 percent (a 25 percent increase from column 1). For the example, where value added is 20 percent and unconstrained purchases of nonoriginating intermediate goods equal 75 percent of the value of total intermediate good purchases, raising the minimum local content from 40 to 50 percent implies that purchases of nonoriginating intermediate goods must be reduced to 62.5 percent. The result of forcing producers to shift away from preferred intermediate goods is a higher unit production cost resulting in lower export volume, with the 1.9 percent increase in unit cost passed on to EU and U.S. consumers. Matters get worse if substitution possibilities for materials from different origins are low (column 3), which might be the representative of industries with a lot of transformation and many production stages.[11]

Column 4 mirrors column 2 but adds administrative compliance costs of 2.5 percent. This further penalizes the GSP producer, even though part of this cost increase can again be passed on to consumers in the importing country. Of course, if GSP producers were competing with close substitutes, they would be unable to pass on the price increase. Finally, column 5 considers a simulation that might be fairly representative of an industry with enough originating intermediate good purchases that the shift to a 40 percent minimum local content would not affect producers much. In this case, the net price to producers might go up by about one-third of the preference margin, resulting in a modest supply response of about 10 percent.

7. Implications for Reform

If rules of origin are a legitimate way to prevent trade deflection by mandating that sufficient processing take place in the preferential zone, the accumulated evidence reported in this article indicates that;they have gone vastly beyond that role, becoming akin to technical barriers to trade. Various estimates suggest that the compliance costs associated with meeting origin requirements in preferential trade agreements range between 3 and 5 percent of final product prices—a very stiff price tag for preference margins that are often thin, given that most favored nation tariffs are low in most sectors except textiles and apparel. Controlling for preferential margins, utilization rates are lower in product lines with more restrictive rules of origin and when producers are limited in the sourcing of their intermediate good purchases.

Because of their trade-inhibiting effects, rules of origin hinder the integration of preference-receiving least developed economies in the world economy and thus work at cross-purposes with the development-policy goals of EU and U.S. preferences. For Sub-Saharan African countries supplying apparel products to the European Union, even high utilization rates hide obstacles to export growth caused by the double-transformation requirement imposed on those products.

This article also shows that in the case of the European Union and the United States, the two largest users of preferential trade agreements, rules of origin are stricter for products with tariff peaks where preferences could be most valuable. The correlation between the presence of tariff peaks and that of highly restrictive rules of origin suggests capture by protectionist interests, a hypothesis largely confirmed by political-economy theory and evidence. Moreover, because rules of origin have so far escaped WTO disciplines—whereas other, more traditional trade-policy instruments are brought under increasingly stringent ones—they stand as a choice candidate for creeping protectionism.

Despite the prevalence of capture by special interests, two quasi-natural experiments point to broad directions for reform. First, the relaxation of the U.S. triple-transformation requirement in textile and apparel for Sub-

Saharan African producers under AGOA has proved to strongly encourage export diversification and growth compared with exports destined to the European Union, which are subject to stricter rules under the Everything But Arms initiative (which otherwise features similar preference margins), Second, low-income Asian countries operating under simple and benign rules of origin have been able to rapidly integrate themselves into cross-border supply chains and have, as a result, tremendously benefited from the verticalization of world trade.

These observations suggest that a multilateral agenda for preferential rules of origin reform, a key step in bringing preferential trade agreements under WTO disciplines, would have to move along three dimensions: harmonization, simplification, and relaxation. Harmonization between trading blocs, although unlikely to be attained anytime soon, is desirable in view of the "spaghetti bowl" of preferential trade agreements and is a prerequisite for simple and mutually consistent cumulation rules. The European Union has set an example in this regard with the PANEURO system, designed precisely to facilitate cumulation across preferential zones.

For simplification arguments in favor of a single across-the-board rule are much like those in favor of uniform tariffs—that is, simplification fosters transparency and mitigates capture. Clearly, technical requirements should be targeted for elimination first because they are the most opaque, difficult to harmonize, and capture-prone instruments. Leaving aside agricultural products that could still operate under the wholly obtained criterion and keeping in mind that any uniform rule will affect industries and countries differently, two avenues could be considered; a simple change of tariff classification, say at the subheading (HS-6) level so that it is not too restrictive or a uniform value-content rule.

Some information can be gleaned in this regard from the European Union's recent review. The change of tariff classification has the advantage of simplicity, transparency, and low administrative costs. But the Harmonized System tariff nomenclature was designed to collect trade statistics, not to separate products and confer origin, so defining the change of tariff classification at a uniform level would produce erratic results across sectors. This would call for exceptions to uniformity, opening up a Pandora's Box of special deals. Moreover, a change of tariff classification that would not easily lend itself to differential treatment for least developed economies should be an objective (see below).

Notwithstanding conceptual clarity, a value content rule may be less than straightforward to apply in practice.[12] It may increase producer risk due to the sensitivity of costs to exchange-rate, wage, and commodity-price fluctuations and is also burdensome to apply for customs officials. However, it is simple to specify and transparent, and it allows for differential treatment of least developed economies. AH told, if properly specified, it is the best candidate for an across-the-board criterion, ideally in combination, at the exporter's choice, with a change of tariff classification. In this spirit Tumurchudur (200 7b) estimated for each good the maximum foreign content that would make a value content rule equivalent to the current array of NAFTA's rules of origin. Her method consisted of three steps.

First, she estimated the statistical relationship between utilization rates and rules of origin, including value content rules. Second, she inverted that relationship to find the rate of a value content rule that would give a utilization rate equal to the current one. Third, she calculated the trade-weighted average of that maximum content. This neutral average turns out to be a very low 21 percent of the good's value in maximum foreign content, confirming the diagnosis that NAFTA's rules of origin are very restrictive. More important, this rate provides a transparent and fully comparable benchmark which is to base discussions of reform and harmonization.

If the slow pace of harmonization talks at the WTO is any indication, the reform agenda described above may be overambitious by several orders of magnitude; even if the European Commission manages to complete the agenda, competition between systems may trigger similar rounds of simplification elsewhere, including in free trade agreements between developing economies in Africa and Latin America, whose rules of origin are often directly inspired by NAFTA and PANEURO. However, the outcome of the EU reform process is highly uncertain at this stage; moreover, even if the plan to adopt an across-the-board value content criterion survives, it is not clear that the rate of this value content rule would be uniform. Nor is it certain (perhaps even less) that it would relax the restrictive-ness of the current system.

More immediate, win-win steps may be a better way to proceed. A simple first step would consist of eliminating rules of origin requirements for tariff lines with preferential margins below 3 or perhaps even 5 percent (the rate could be agreed upon in the context of multilateral negotiations at the WTO). This would be an all-around winning proposition since resources would be freed for other purposes, especially in developing economies, but also for consumers in developed economies, who would no longer bear part of the increased costs associated with compliance. A second step would be to allow for differential treatment not across sectors, but across beneficiaries, with low value content requirements for least developed economies reflecting the empirical observation that the "slices" of value added in least developed economies through cross-border production networks are generally thin. In this regard, the experience with the U.S. special regime granted in textile and apparel to African producers under AGOA is most encouraging.

Glossary of Terms

Harmonized System. A system of classification for traded goods in which all countries belonging to the World Customs Organization participate. It classifies traded goods into (by increasing order of disaggregation) 21 sections (one digit), 99 chapters (two digits), 1,417 items (four digits), and 4,998 subitems (six digits). Beyond that (eight- and ten-digit), classification systems are no longer harmonized across countries and are subject to frequent classification changes.

Preference Margin. The difference between most favored nation and preferential tariffs.

Preference Pass-Through. The percentage of a tariff-preference margin that is "appropriated" by exporters in the form of an increase in the export price. It is inversely related to the bargaining power of importers.

Preferential Status. Whether a good is eligible for the preferential tariff rate.

Technical Requirement Rule of origin that imposes a certain type of production process or the use of certain specified technology or standard.

Trade Deflection. Use of the country with the lowest external tariff by importers in a free trade agreement (which reduces tariff revenue for others). This notion is distinct from Vinerian "trade diversion."

Utilization Rate. Share of exports shipped under the preferential (as opposed to most favored nation) regime.

Regime-wide Rules of Origin

Absorption or Roll-up. Principle that allows nonoriginating materials that have acquired origin by meeting specific processing requirements to maintain this origin when used as input in a subsequent transformation. In other words, the nonoriginating materials are no longer taken into account in calculating value added. The roll-up or absorption principle is used in most preferential trade agreements (in particular, the EU GSP and the Cotonou Agreement), although a few have exceptions for the automotive sector.

Cumulation. Principle that allows producers from one member country in a preferential trade agreement to import nonoriginating materials from another member country without affecting the final product's originating status. There are three types of cumulation rules: bilateral, diagonal, and full Bilateral cumulation. It is the most common type and applies to trade between two partners in a preferential trade agreement. It stipulates that producers in country A can use inputs from country B without affecting the final good's originating status as long as the inputs satisfy the area's rules of origin.

Diagonal Cumulation. Under diagonal cumulation (the basic principle of the EU's PANEURO system), countries in a preferential trade agreement can use materials that originate in any member country as if the materials originated in the country where the processing is undertaken. Under full cumulation all stages of processing or transformation of a product within countries in a preferential trade agreement can be counted as qualifying content regardless of whether the processing is sufficient to confer originating status to the materials themselves. Full cumulation allows for greater fragmentation of the production process than bilateral and diagonal cumulation.

Duty Drawbacks. Refunds to exporters of tariffs paid on imported intermediate good inputs. Many preferential trade agreements, especially in the Americas, mandate the elimination of duty-drawback schemes for exports to partner countries on the grounds that a duty drawback claimed by a producer in country A to export to country B would put that producer at a competitive advantage compared with domestic producers in country B given that the producer in country A already benefits from the elimination of intrabloc tariffs. Eliminating duty drawbacks as part of a preferential trade agreement can harm the profitability of final-good assembly for export to partner countries in the area, although tariff escalation, when present, already provides some protection for final-assembly operations (because it implies lower tariffs on intermediate goods than on final ones).

Product-Specific Rules of Origin

Allowance. An amendment to a mandated change of tariff classification that excludes some categories from noneligibility (that is, a final good belonging to, say, chapter 11 can embody imported inputs belonging to any other chapter or from chapter 11 itself but between headings Xand Y).

Change of Tariff Classification. Rule of origin requiring that a final good made with imported inputs belong to a Harmonized System category that differs from that of its imported inputs (as proof of transformation). The mandated change of tariff classification can be specified at the chapter (two digits), heading (four digits), subheading (six digits), or item (eight digits) level.

Exception. An amendment to a mandated change of tariff classification that excludes some categories from eligibility (that is, a final good belonging to, say, chapter 11 can embody imported inputs belonging to any other chapter except headings X to Y).

Value Content. Rule of origin requiring a minimum percentage of local value (materials or value added) or a maximum percentage of foreign value.

Notes

1. According to this same tally, 45 developing economies having signed bilateral trade agreements with a developed country, and 90 of the 109 preferential trade agreements between developed and developing economies have been created since 1990.

2. According to a survey administered by the World Customs Organization to customs officials in developing economies {as reported by Brenton and Imawaga 2004), 67 percent of respondents in Sub-Saharan Africa agree that dealing with rules of origin under overlapping trade agreements causes problems, and a majority also agrees that rules of origin are more labor-intensive. Administering rules of origin detracts from other objectives of tax collection and trade facilitation

3. Because meeting the requirements is difficult and appears unnecessarily complex, in view of the European Commission's objective to grant some preferential access to its market for GSP-eligible countries, on 16 March 2004 the commission adopted Communication COM (2005) on "The Rules of Origin in Preferential Trade Arrangements." The communication explores alternative rules of origin that would be simpler and more development friendly. A key proposal under consideration is to replace the current product-specific rules of origin with a single rule based on a minimum of originating value added.

4. By comparison, the average preferential margin (computed over tariff lines with positive tariffs) was 4.5 percent for NAFTA (almost all tariffs had been eliminated on NAFTA trade by 2001), 2.4 percent for GSP-eligible countries, and 4.6 for ACP countries (not eligible for Everything But Arms status). Data for the European Union are for 2004, when 62 percent of trade for GSP-eligible countries and over 80 percent of trade for ACP countries took place at zero tariffs (some ACP also benefited from Everything But Arms status at zero tariffs in the EU market).

5. Krishna (2006) discusses other effects that are more difficult to quantify: effects such as rules of origin-jumping investment and effects on intermediate prices. Thoenig and Verdier (2006) also consider the implications of rules of origin for multinationals confronted with outward-processing decisions.

6. The United States rarely uses a value content criterion as the sole requirement for origin, and when it does it tends to rely on a single 40 percent foreign content requirement. The European Union has value content criteria ranging from 50 to 15 percent of domestic value added.

7. Cumulation is, in principle, only diagonal (see the glossary in the appendix), but the domestic content can be calculated as an aggregate of value added in any ASEAN member state; so in effect AFTA provides for full cumulation, although, as noted by Brenton (2006), the rules stipulate that the final stage of manufacture must be carried out in the exporting member state (what constitutes "the final stage" is not defined). Because vertical links and outsourcing are very important in Asia, full cumulation considerably relaxes the requirements of satisfying origin.

8. To drive home the importance of trade in intermediate goods, consider the following example. On the basis of the input-output data in Baldwin (2006, table 1 for Indonesia, Malaysia. Philippines, and Thailand (middle-income Asian countries), an average of 35-40 percent of intermediate goods are sourced outside AFTA. For example, take an activity with 10 percent value-added and 40 percent nonoriginating intermediate goods—that is, 36 percent of the final unit product price is nonoriginating. Originating value for this activity would be 64 percent. Then take the plausible example of an activity with the same value added but with 60 percent of materials nonoriginating; originating value falls to 46 percent, barely above the 40 percent minimum currently stipulated in AFTA.

9. The special regime was recently extended until 2015. Figure 2 lists the 22 beneficiary countries.

10. The algorithm is in essence a grid search over cutoffs whose criterion is the minimization of the concentrated sum of squared errors of the ordinary least squares regressions in the two regimes.

11. The decline in exports to the preferential-giving destination suggests that producers would choose to export under most favored nation status. In the illustrative simulations reported here, with constant elasticity throughout and smooth substitution possibilities across the origin for intermediate good purchases and export destination sales, producers pass on cost increases to consumers.

12. The authors of this article are aware of concerns voiced by the private sector in the course of the EU review about the practical difficulty of a value content criterion for small firms and, if based on costs, its potential to force unwanted disclosure of strategic information to powerful EU buyers that would enhance their ability to squeeze rents from developing country producers.

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GLOBAL TRADE MODELS AND ECONOMIC POLICY ANALYSES:

RELEVANCE, RISKS AND REPERCUSSIONS FOR AFRICA[1]

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1. Introduction

Since the Uruguay Round, computable general equilibrium (CGE) models have frequently formed the basis for policy advice and recommendations to developing countries on the potential impact of multilateral trade liberalisation on their economies. Such models allow researchers to provide a quantitative estimate of the potential economic consequences of different trade liberalisation scenarios, including the impact on welfare, trade flows, prices, consumption and production. Because they adopt a multi-sector and multi-region general equilibrium framework, they are also able to capture interactions of different sectors and markets in a given economy and at the international level.[3] This ability to provide a systematic representation of national economies and their links and interactions with the global economy explains their attraction and widespread use for trade policy analysis.

Computable general equilibrium (CGE) models are widely used for trade policy analyses and recommendations. There is, however, increasing discomfort with the use of these models, especially in Africa. This article demonstrates that the results of several such studies of the impact of trade reforms in Africa differ drastically in terms of both magnitude and direction, failing to take account of key features of African economies. It also outlines potential consequences of the misuse of CGE models for policy evaluation and suggests pitfalls to be avoided.

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[3] *It should be noted that not all CGE models are multi-region. Country-specific models have also been used to assess the impact of trade liberalisation. See, for example, Stifel and Thorbecke (2003).*

Various global CGE models have been used, including the Global Trade Analysis Project (GTAP) model developed by the Center for Global Trade Analysis at Purdue University (Hertel, 1997); the MIRAGE model developed by CEPII – the Centre d'Etudes Prospectives et d'Informations Internationales (see Bchir et al., 2002); the LINKAGE model of the World Bank (van der Mensbrugghe, 2005); the Michigan model of world production and trade (Deardorff and Stern, 1986); and the G-Cubed model (McKibbin and Wilcoxen, 1992). Clearly, there are differences between these models in terms of structure, assumptions, database and choice of model parameters. In recent years, however, there has been an attempt to minimise the differences through the development of a database from the same source. For example, simulations of the GTAP, LINKAGE and CEPII models are now based on the Market Access Map (MAcMap) dataset developed by CEPII and the International Trade Center (ITC). This has increased the ability to compare results of simulations based on these models.

Although there is a long history of the use of CGE models for policy analysis in developed countries, their use and importance in economic policy analysis and formulation in Africa are relatively recent, increasing since the Uruguay Round. Several factors are behind this development. The first is the increasing acknowledgement by policy-makers of the role and importance of trade in African economies. Unlike in the 1970s, several countries have recognised that trade has an important role to play in the economic development of the continent and are curious to know how various aspects of international trade rules and policies will impact on their economies. The second reason is that African governments are increasingly searching for ways to improve the design of economic policy in the region and have recognised the importance of research as an aid to policy formulation and implementation. This recognition has led to an increase in interest in quantitative techniques that would enhance their ability to evaluate the impact of economic policies on their economies. The third reason is that there has been an improvement in the country coverage of CGE models. For example, unlike in the past, the current GTAP database (version 6) includes 11 countries in sub-Saharan Africa, and this has made it possible to conduct quantitative studies of the impact of trade reforms on these countries. Finally, the use of CGE models in Africa could also be explained by the increasing importance of African countries in multilateral trade negotiations. Before the 1999 WTO Ministerial conference in Seattle, African countries were passive participants; since then, they have played a more proactive role in the negotiations. This has led to an increase in the demand for technical tools to help them define their positions and also assess the impact of the different reform proposals put forward by other WTO members on Africa.

There is no doubt that CGE models can contribute and have contributed to economic policy formulation and analysis (see Devarajan and Robinson, 2005). However, in recent years they have been subjected to serious criticisms (Gunter, Cohen and Lofgren, 2005; Ackerman, 2005; Kehoe, 2003; McKitrick, 1998). This reflects the growing concern about their poor performance and the fact that their results are highly sensitive to the assumptions made – which often do not capture key features of the structure of the economies being analysed. It also reflects the fact that CGE models often have weak econometric foundations. The discomfort is all the greater when it comes to Africa, because there are discrepancies between the results of different CGE simulations even when they are based on models using the same dataset. This has led to some confusion and uncertainty among policy-makers on the possible outcomes of the Doha Round for African countries. Clearly, some of the discrepancies could be explained by the use of different datasets, choice of parameters, and assumptions regarding market structure as well as the functioning of the labour market.

These criticisms raise questions and concerns about the credibility of simulation results from CGE models. This article examines selected but key aspects of the CGE methodology with a view to determining the extent to which they take account of important features of African economies and their implications for trade policy analysis in the region. The article is organised as follows. Section 2 compares the results of major CGE studies that examined the impact of the Doha Round reforms on Africa and shows that the results differ in both the magnitude and the direction of welfare changes. Section 3 focuses on aspects of the CGE methodology. Three are emphasised: the theoretical framework, the database, and the choice of model parameters. Section 4 discusses the need for validation of CGE models and makes suggestions on how this could be done. Section 5 discusses the potential consequences of the misuse of CGE models for policy analysis and formulation in Africa and outlines pitfalls to avoid if they are to be taken seriously by African policy-makers.

2 Africa and CGE Simulation Results

In this section, we present a listing and an analysis of representative studies that provide estimates of the impact of multilateral trade reforms on Africa since the launch of the Doha Round. The list is not exhaustive and is intended to give an idea of the wide range of results that have been obtained from various models (Table 1). The key point to note here is that the estimates vary depending on whether the models are static or dynamic, and also the scenario or experiment performed. They also differ depending on whether or not the database used takes account of preferences and differences between bound and applied tariffs (often referred to as binding overhang).

The studies by Anderson et al. (2005), Hertel and Keeney (2006), and Achterbosch et al. (2004) examined the impact of full liberalisation of merchandise trade and arrived at the following conclusions. Anderson et al. (2005) suggest that full liberalisation would lead to global gains of $287 billion per year by 2015. They estimate that the gain to sub-Saharan Africa (SSA) would be $4.8 bn (about 1.1% of income). Achterbosch et al. (2004) also report positive welfare gains from full liberalisation for the global economy and SSA, but their numbers are very much smaller than those of Anderson et al. For example, for the global economy they report gains of $84 bn and for SSA their estimate is $704 m. Hertel and Keeney (2006), on the other hand, while estimating similar global gains to those of Achterbosch et al. ($84.3 bn), suggest that the five countries of the Southern African Customs Union (SACU) would derive gains of $1.1bn with the group classified as 'Other SSA' incurring losses of $1.03bn (0.08% of income). It should be noted that Achterbosch et al. also reported losses for SSA from moderate trade reforms, as are likely under the Doha Round. They attribute this to the combined impact of preference erosion and binding overhang.

There are several reasons for these huge discrepancies. First, the Anderson study is based on the LINKAGE model which is dynamic, and we know that dynamic models tend to yield much larger gains than those based on static analysis. Secondly, the Anderson study also uses much larger Armington or trade elasticities than those used in GTAP models. The use of high Armington elasticities reduces the negative terms-of-trade effects associated with reforms and increases welfare gains. When these differences are taken into account, the global gains from the three studies are much closer.

TABLE 1: COMPARISON OF RESULTS OF CGE MODELS

Study/model	Sectors	Reform scenario	Results
WORLD BANK Anderson et al. (2005) • LINKAGE Model (Version 6) (dynamic) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing	Full liberalisation of merchandise trade over 2005-10	• Global gains of $287 bn p.a. in 2015 • Gain to SSA $4.8 bn (1.1% of income) Static version • Global gain of $127.4 bn • Gain to SSA $0.7 bn GTAP elasticities and land fixed • Global gain $77.8 bn • Loss to SSA is $0.1 bn
Hertel and Keeney (2006) • GTAP-AGR model (static) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing Services	Full liberalisation of merchandise trade	Merchandise trade liberalisation • Global gain $84.3 bn • SACU gains $1.1 bn • Loss to the group 'Other SSA' $1.03 bn (0.8 % of income) Agriculture liberalisation • Global gains $55 bn • SACU gains $529 m. • group 'Other SSA' incurs $167 m. loss
CARNEGIE Polaski (2006) • GTAP Model (static) • GTAP 6 database (preferences included) • base year 2001 • incorporates unemployment in developing countries	Agriculture Manufacturing	Full liberalisation and partial reforms reflecting plausible Doha Round scenarios	Full liberalisation • Global gain $168.1 bn (0.5% of GDP) Doha scenarios • Global gain $59 bn • East Africa will lose about $0.1 bn and 'Rest of SSA' $0.2 bn.
OECD Lippoldt and Kowalski (2005) • GTAP Model (static) • GTAP 6 database (preferences included) • base year 2001	Agriculture Manufacturing	50% cut in ad-valorem equivalent measures of tariff protection	• 0.16% change in per capita welfare for 'Rest of SSA'
IFPRI Diao et al. (2005) • Static CGE model • Variable employment • GTAP 5 database • base year 1997	Agriculture	Full liberalisation of agricultural trade	• Gain to SSA $1.2 bn • With productivity effects gain is $1.7bn • GDP expands in SSA by $1.7 bn and $2.1 bn with productivity effects

UNECA/LEI Achterbosch et al. (2004) • GTAP model (static and dynamic) • GTAP 5 database with tariffs adjusted for preferences and binding overhang • variable employment	Agriculture Manufacturing	Full liberalisation Moderate reform involving 50% reduction in all forms of protection	• Global gains $84 bn (0.3% of income) • Gain to SSA $704 m. (0.3% of income) Moderate reform • Global gains $40 bn (0.1% of income) • Loss to SSA $502 m. (0.2% of income)
CEPII Bouet et al. (2004) • MIRAGE model (static) • Imperfect competition in nonagricultural sector • Dual labour markets (efficiency wages) • MAcMap database (preferences included) • base year 2001	Agriculture	50% cut in domestic support, elimination of export subsidies, 40% cut in small tariffs (<15%), and 60% cut in high tariffs (>90%)	• Global gains 0.08% of income • Loss to SSA 0.03% of income
UNECA Ben Hammouda et al. (2005) • GTAP model (static) • GTAP 5 Database	Agriculture	Scenario 1: 3 bands for tariff reduction in developed countries. 40% for tariffs less than 15%; 50% for tariffs (15-90%); and 60% for tariffs greater than 90%. 4 bands for tariff reduction in developing countries If tariff is in range (0 < 20%) apply 25%. In range (20 < 60%) apply 30%. For (60 < 120%) apply 35% and for (>120%) apply 40% 50% reduction in domestic support and complete elimination of export subsidies Scenario 2: same as scenario 1 but with 5% of tariff lines in developed countries treated as Sensitive Products	Scenario 1 • Gains to SSA $943 m. and for North Africa $2.4 bn • GDP expands by 0.47% in SSA and by 1.47% in North Africa Scenario 2 • Gains to SSA $977 m. and for North Africa $2.47 bn • GDP expands by 0.41% in SSA and by 1.51% in North Africa
UNECA Sadni-Jallab et al. (2005) • GTAP model (static) • GTAP 6 Database (preferences included)	Manufacturing	Scenario 1: Girard Formula used for tariff reduction with the B coefficient set at 1 for all countries. For developing countries 5% of tariff lines excluded. Also for 10% of tariff lines in developing countries, only 50% reduction specified by Girard formula applied. Scenario 2: Same as in scenario 1 but with B equal to 3	Scenario 1 • Gains to SSA $489 m. and for North Africa $3.5 bn • GDP expands by 0.37% in SSA and by 1.7% in North Africa Scenario 2 • Gains to SSA $337 m. and for North Africa $2.79 bn • GDP expands by 0.21% in SSA and by 1.28% in North Africa

The study by Polaski (2006) found that full liberalisation of merchandise trade would increase global welfare by $168.1 bn. It also showed that, with plausible Doha Round reform scenarios, East Africa and the group 'Rest of SSA' would incur losses of $0.1 bn and $0.2 bn respectively. This is attributed to preference erosion, low agricultural productivity and lack of export competitiveness. What is striking about Polaski's findings is that the welfare gains she reports are larger than those of researchers using similar GTAP models and databases and it is not clear what accounts for these huge differences in results (see for example, Hertel and Keeney, 2006).

Lippoldt and Kowalski (2005) also focused on liberalisation of merchandise trade. However, they considered the impact of a 50% cut in ad-valorem equivalent measures of tariff protection. The key result of their study is that there will be a 0.16% decrease in per capita welfare for the group 'Rest of SSA' as a result of this type of reform. This is attributed to preference erosion.

Three of the studies listed in Table 1 focused on liberalisation of agricultural trade. Diao et al. (2005) examined the impact of its full liberalisation. Their results suggest that the welfare benefits to SSA are $1.2 bn and that output (GDP) in the region will expand by $1.7 bn. Ben Hammouda et al. (2005) focused on the impact of partial liberalisation of agricultural trade. Their results suggest that, if there are no exemptions for Sensitive Products, partial liberalisation will increase welfare in SSA by $2.4 bn and in North Africa by $943 m., with output expanding by 0.47% in SSA and by 1.47% in North Africa. Bouet et al. (2004) also examined the effect of another type of partial agricultural trade liberalisation. They estimate that this will increase global welfare by 0.08% of income but that SSA will incur losses equivalent to 0.03% of income.

Although these three studies examined agricultural trade liberalisation, they focused on different scenarios of reforms with varying degrees of ambition, and it is therefore difficult to compare the results to find out what is responsible for the differences. Having said that, it appears that the welfare loss estimated for SSA by Bouet et al. arises from the fact that their model takes account of preference erosion, which is absent in the other two studies.

The article by Sadni-jallab et al. (2005) deals with the impact of liberalisation of trade in manufactured goods on Africa. It assumes that tariff reduction will be accomplished using the Girard Formula and examines how Africa will be affected by the use of different coefficients and considerations for Special and Differential Treatment. The key result is that in the first scenario SSA gains by $489 m. and North Africa by $3.5 bn. In addition, the study suggests that output (GDP) in SSA will expand by 0.37% and in North Africa by 1.7%.

What can be inferred from these results as well as others in the literature? In summary, our reading of the results of simulation experiments examining the potential impact of multilateral trade reforms is as follows.

- there are global gains to be derived from multilateral trade liberalisation, the precise magnitude of which depends on the nature and degree of liberalisation as well as the sectors covered;
- agricultural trade liberalisation is expected to account for a substantial share of the gains from multilateral trade liberalisation;
- of the three pillars identified in the Doha Round negotiations on agriculture – domestic support, market access and export competition – market access seems to be the most important source of gains from agricultural trade liberalisation;
- there are bound to be winners and losers. Whether or not a country derives benefits would depend on the extent to which it relies on trade tax revenue, the type of goods it exports, and its ability to respond to potential market opportunities to be created by liberalisation. More specifically, countries that are net food importers after reform as well as those that face severe supply constraints are likely to incur welfare losses. In this regard, African countries are highly vulnerable to reforms;
- preference erosion is also important in determining gains and losses. Countries that benefit from preferences are likely to incur losses from liberalisation if the nature of the reform is such that they are exposed to competition in markets where they receive preferences but do not gain additional market access in other countries to compensate for the loss.

3 Features of African Economies and the CGE Methodology

This section highlights issues that need to be addressed in the design of CGE models so that they can capture important features and dynamics of African economies and increase the likelihood of obtaining realistic results from the simulations. For ease of exposition, our analysis will focus on three areas: the theoretical framework or structure of the models; the database used in simulations and calibration; and the choice of key model parameters.

3.1 Theoretical Issues

Most CGE models of trade introduce product differentiation by assuming that imports and domestic goods are imperfect substitutes in demand. This follows the work of Armington (1969) and has the implication that each country or firm is the sole supplier of its products and so can affect the price of the product. Clearly, the assumption that countries are large enough to affect the market price of their exports is at variance with what we know about African economies. With the exception of a few products and countries (such as cocoa exported by Ghana and Côte d'Ivoire, bauxite exported by Guinea, and groundnut oil exported by Senegal), most African exports represent only a small fraction of world exports and so cannot affect world prices. The large-country assumption implicit in the Armington structure of CGE models does not reflect African realities and has serious implications for the impact of trade liberalisation on economies in the region, since it is well known that results of CGE models are very sensitive to the Armington assumption and parameters (Valenzuela et al., 2006). Consequently, there is the need for CGE modellers to revisit this assumption to capture more accurately the features of African economies.

Trade negotiation is a bargaining game and so the power relations among countries as well as the nature of interactions and the availability of information affect its outcome. Strategic behaviour among countries and agents is completely ignored in CGE models of trade policy and multilateral negotiations. This is particularly important, given the lop-sided power structure between countries in the WTO. Clearly big countries or groups such as the US and the European Union are in a better position to influence the agenda and pace of the negotiations and this has serious implications for the outcome (Osakwe, 2007). Models of game theory have emphasised the importance of first-mover advantages in negotiations, and to the extent that big countries control the manner in which the negotiations are conducted, it has serious consequences for the ability of weak African nations to protect their interests (Myerson, 1991; Brander and Spencer, 1992). These issues therefore need to be taken into account if the true impact of multilateral trade reforms on African countries is to be captured.

The role and importance of market imperfections in determining macroeconomic outcomes in modern economies have been recognised in the economics literature and several models of trade now incorporate market imperfection and scale economies (Francois, 1998; Grossman, 1992). Although some CGE models incorporate market imperfection, the main motivation for this is the need to generate intra-industry trade, especially in the manufacturing sector. This focus has led to the neglect of other forms of market imperfections such as those in the input and credit markets of developing countries. For example, consumers and producers in these countries face severe borrowing constraints and this limits their ability to be effective participants in the market economy (Eswaran and Kotwal, 1990; Ray, 1998). These constraints are particularly serious in rural communities where peasants have limited or no access to the banking system. It is also one of the reasons for interlocking factor markets in several developing countries (Bardhan and Rudra 1978; Goetz 1993). These market imperfections have serious implications for the ability of firms and countries to take advantage of potential trading opportunities created in the multilateral trading system and should be taken into account in the modelling exercises. The presumed economic benefits of free trade are unlikely to be realised in developing countries if product markets are liberalised without addressing input-market imperfections.

One of the key assumptions made in CGE models is that trade liberalisation has no impact on government revenue. This is typically implemented by altering domestic taxes in response to changes in trade tax revenue so as to leave total government revenue unchanged after trade reforms. While this may be analytically convenient, it raises two issues or problems. The first is that it is based on the unrealistic assumption that governments can fully recover lost tariff revenue by switching to domestic taxes. Recent empirical evidence shows that poor countries that adopted trade reforms failed to recover most of the lost revenue by switching to domestic taxes (Baunsgaard and Keen, 2005; Khattry and Mohan Rao, 2002). Emran and Stiglitz (2005) provide theoretical explanations for this result.

The second problem with the treatment of the revenue effects of trade reform is that it is typically assumed that trade taxes (which are distortionary) will be replaced with lump-sum taxes. To the extent that these are non-distortionary and do not reflect the kinds of taxes that can be imposed by African governments, this assumption overstates the welfare gains to the region from liberalisation. Osakwe (2007) shows that African countries are heavily dependent on trade taxes. For example, in countries such as Benin, Lesotho, Madagascar, Mali, Sierra Leone, Togo and Uganda trade taxes represented more than 40% of government revenue over the 2000-3 period. Given this degree of dependence, any realistic assessment of the impact of multilateral trade reforms on Africa has to take account of the impact on government revenue. Assuming tax neutrality trivialises an important issue of concern to African countries in the negotiations.

It is well-known in the economics literature that there are short-run costs associated with trade liberalisation (Laird and Fernandez de Cordoba, 2005). However, CGE models do not take adjustment costs into account. This arises partly from the fact that most of the models tend to be static and assume flexible prices and full employment of labour. In a static model it is not possible to model the process of adjustment to trade reform and so the costs of the adjustment process cannot be taken into account. In addition, the full employment assumption in most CGE models is problematic because it is inconsistent with empirical evidence and also does not allow researchers to ask important questions such as how the reform process would impact on unemployment (Polaski, 2006; Gunter, Taylor and Yeldan, 2005). The assumption of full employment trivialises this question because, in a market-clearing world, trade liberalisation simply leads to reallocation of existing labour across sectors and the short-run adjustment costs would therefore be insignificant. On the other hand, in economies characterised by high unemployment, the reallocation may involve some people moving from employment to unemployment and so the adjustment costs will be higher.

Recently, attempts have been made to make employment variable in GTAP models by fixing the nominal or real wage. While this is an improvement on the fullemployment assumption, it is not an appropriate way to take account of unemployment in developing countries because it does not capture the process of wage determination in these countries. There are several ways to introduce unemployment endogenously in the literature that could be adapted to capture this phenomenon. This includes efficiency wages and labour turnover models which have been used by several authors in the economics literature (Stiglitz, 1974; Swamy, 1997).

Most CGE models of trade are deterministic and so do not address issues related to risk and uncertainty. However, one of the key concerns of African countries in the negotiations is that liberalisation would expose them to external shocks, thereby increasing the volatility of macroeconomic variables with potential consequences for growth and development. African countries are vulnerable to trade shocks because they export a relatively small number of products with very volatile prices. To the extent that liberalisation increases their exposure to risks, this should to be taken into account in the models as it will definitely affect welfare changes to African countries in the model.

3.2 Database Issues

The availability of a high-quality and comprehensive dataset is crucial to CGE analysis. Therefore, if the database used for simulation experiments does not accurately capture the current structure of economies, it is difficult to have confidence in the results of the analysis. In the past, researchers used datasets from different sources and this was in part responsible for some of the discrepancies in the results of CGE simulations of trade liberalisation. Currently, most of the key CGE models are run using the MAcMap dataset developed by CEPII. For example, version 6 of both the GTAP and LINKAGE models uses a database based on information from this source. There are, however, several problems with the GTAP 6 database that make it difficult to get a realistic assessment of the impact of multilateral trade liberalisation on African economies.

The first is that, due to data limitations, only a few African countries are included in the database. For example, in the GTAP 6 database only 11 of the 48 countries in sub-Saharan Africa are included.[4] The other countries in the region are classified into the composite group 'Rest of SSA'. This level of aggregation does not recognise the heterogeneity among African countries and does not permit researchers to measure the impact of trade liberalisation or the WTO negotiations at the national level. This is a major issue for African countries because there is a wide diversity among them. For example, several are net food-importing countries while others are net food exporters (Osakwe, 2007). Similarly, some are net oil exporters and others net oil importers. This high heterogeneity implies that we should be cautious in making general statements about the impact of reforms on African countries since aggregate results can be quite misleading.

Related to the above point is the fact that most of the commodities exported by African countries are not sectors in the GTAP database, but are aggregated and lumped into much larger sectors. For example, coffee and cocoa as well as other commodities with very different production structures and price dynamics are included together in the composite sector 'Crops nec'. Valenzuela et al. (2006) show that product aggregation is important in determining the estimated gains from trade reform. Deaton (1999) also points out that supply conditions differ across commodities. Furthermore, their prices do not move in parallel and relative prices are not constant. Given the heterogeneity among commodities lumped together, it is difficult to get a realistic assessment of the impact of trade liberalisation on the key commodities of interest to African countries.

The third problem with the GTAP 6 database is that the measures of protection reported for African countries in the database seem to be different from those computed directly using the MAcMaP dataset. Table 2 shows tariffs applied to the GTAP groups 'Rest of SSA' and 'Rest of North Africa' by the EU25 based on the GTAP 6 database and on MAcMAP, showing that the GTAP tariffs are much lower than those computed directly from the HS6 level. The aggregation method is clearly responsible for this huge discrepancy. Generally, tariff data are computed from countries' official notifications to the WTO. In MAcMAP, data from these notifications are aggregated at the HS6 level. The product of this first-level aggregation is then used by the different researchers and models to build their own database.

This usually involves aggregation at a second level which drastically reduces the number of sectors available in the database.[5] The most widely used method of aggregation is the trade-weighted method. However, this method underestimates the tariffs facing African countries because it implicitly assumes that protection is zero for tariff lines where trade does not occur between two countries. As a result of the problems with the trade-weighted approach, there has been a shift towards using a 'reference group' methodology where the imports of a reference group, rather than those of an individual country in the group, are used as weights. Statistics on trade openness and GDP per capita (calculated on the basis of purchasing power parity) are used to classify countries into reference groups. This new methodology has led to an improvement in the database, although it has not eliminated the difference in the tariff structure between GTAP 6 and MAcMAP. There is therefore a need to revisit the methods of aggregation to make sure that the database, and especially the tariff structure, reflects the real tariffs that African countries are facing.

Another data-related problem is that there are large differences between the tax rates used in GTAP and those based on tax receipts. It is difficult to find reliable data on actual tax rates in several African countries and so we demonstrate this discrepancy from data for advanced countries. Using

4 *These countries are : South Africa, Botswana, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Madagascar, Uganda, Tunisia and Morocco. The Economic Commission for Africa and the African Trade Policy Center are working closely with GTAP to introduce more African countries.*

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TABLE 2: EU 25 TARIFFS APPLIED TO GTAP GROUPS, 'REST OF SSA' AND 'REST OF NORTH AFRICA'

Sector	Code	MAcMAP (direct aggregation)	GTAP 6
Rest of SSA			
Dairy products	mil	39.0	13.4
Processed rice	pcr	31.5	14.1
Cereal grains nec	gro	21.1	3.4
Beverages and tobacco products	b_t	14.4	9.1
Paddy rice	pdr	12.0	0
Sugar cane, sugar beet	c_b	7.5	0.9
Meat products nec	omt	6.0	4.4
Wheat	wht	5.9	0.1
Food products nec	ofd	3.4	1.6
Cattle, sheep, goats, horses	ctl	2.3	0.5
Ferrous metals	i_s	2.2	1.8
Wearing apparel	wap	1.5	0.5
Textiles	tex	1.3	0.5
Gas manufacture. distribution	gdt	1.1	0
Rest of North Africa			
Dairy products	mil	42.3	14.7
Vegetable oils and fats	vol	34.2	31.5
Meat products nec	omt	22.2	2.7
Cereal grains nec	gro	16.2	7.5
Cattle, sheep, goats, horses	ctl	14.6	9.8
Beverages and tobacco products	b_t	14.4	11.2
Vegetables. fruit. nuts	v_f	12.4	11.9

TABLE 3: COMPARISON OF TAX RATES FOR 2001 (%)

	Consumption			Labour		Capital		Land	Natural resources
Country									
	GMR	GTAP6 domestic	GTAP6 imports	GMR	GTAP6	GMR	GTAP6	GTAP6	GTAP6
Denmark	36.1	25.2	16.1	52.1	5.2	46.6	1.7	-61.6	2.0
Finland	27.3	26.9	26.3	49.5	8.4	36.0	0.0	-75.9	0.8
France	18.2	11.6	24.6	45.4	79.5	38.4	2.5	-64.3	3.0
Germany	15.5	13.2	14.1	41.8	45.7	21.5	0.8	-62.6	1.0
Britain	15.7	2.0	0.9	28.0	18.1	54.1	4.0	-58.0	4.4
Italy	15.1	11.4	19.6	45.5	44.1	34.4	0.5	-51.4	0.8
Japan	6.9	4.3	4.7	28.4	18.8	40.4	3.3	-8.5	3.3
Netherlands	21.0	2.8	14.3	41.6	64.0	34.5	1.9	-21.6	2.3
Spain	14.2	3.5	0.8	29.3	34.3	22.4	1.5	-54.4	2.2
Sweden	26.0	17.5	14.4	56.6	40.8	50.4	1.7	-79.7	2.0
US	4.7	0.4	1.0	29.5	15.9	36.0	3.0	-34.5	3.0

Source: Gurgel et al. (2006).

OECD data, Gurgel et al. (2006) show that the tax rates used in the GTAP database are quite different from those computed based on reported tax receipts. They also suggest that these differences cannot be attributed to the method of aggregation. Table 3 presents tax rates computed for selected countries using this approach (GMR method) and those in GTAP 6, showing large differences. For example, based on GTAP 6 labour tax in Denmark is 5.2%, while the GMR method suggests it is 52.1%. The discrepancies are even greater with capital taxes. Differences of this magnitude will certainly affect the outcome of any simulation experiment and efforts should therefore be made to reconcile these differences.

3.3 Behavioural Parameters

One of the key drivers of CGE model results is the choice of parameters. There are two key parameters in these models, the first representing share parameters such as consumer expenditure shares, and import and export shares, and government expenditure shares, and the second the structural parameters which are basically elasticities describing the curvature of production, utility, import-demand and exportsupply functions. Despite the importance of these parameters, they are rarely estimated by CGE researchers, who either make choices of these parameters based on subjective judgements or take them from econometric estimates obtained using data not related to the period covered by their simulation experiments (FAO, 2005). Furthermore, in some instances the estimates are based on studies more than a decade old and so do not reflect the current structure of the economies under consideration.

Liu et al. (2003) have tried to address this concern by updating estimates used for the GTAP model. Their analysis suggests that elasticities used in previous versions of GTAP tend to be too small for processed food, motor vehicles and electronic machinery. In addition, they tend to be too large for agriculture, clothing and textile products, fuels and minerals, and basic manufactures (see Table 4). This is an interesting finding because it indicates that the sectors of export interest to African countries are precisely those in which the current elasticities are too high. This has implications for the impact of trade reforms on Africa, since high trade elasticities tend to lead to higher welfare gains. The high degree of uncertainty surrounding estimates of these key parameters suggests that we should be careful about making firm and unqualified statements regarding the impact of multilateral trade reforms on economies.

4 Validation of CGE Models

Models are in general an abstraction from reality in the sense that they usually cannot capture all aspects and features of modern economies. Despite this abstraction, they can sharpen our understanding of reality by providing important insights into the functioning of the complex economic environment in which we live. For a model to play this role, however, it has to be designed in such a way that it reflects important aspects of the economy and phenomena under investigation. In particular, the ability of a model to make realistic predictions is likely to be higher if its key results are not dependent on subjective assumptions about the economic environment. In designing economic models for use in policy formulation it is therefore important that researchers make simplifying assumptions that are either grounded in reality or do not have any significant impact on the results.

In recent years, there has been a proliferation of models for global trade-policy analysis. These differ in terms of structure and often give different answers to the same questions. This is a source of confusion for policy-makers, especially in developing countries where there is lack of adequate analytical capacity to evaluate the results of these studies. In such an environment there is the need for a rigorous method for assessing the validity of these models and their predictions. One of the most serious criticisms

TABLE 4: CURRENT AND ESTIMATED TRADE ELASTICITIES

Industry	GTAP	New Estimate
Agriculture (AGR)	2.44	1.05
Processed food (PAG)	2.40	3.76
Fuels and Minerals (FMN)	2.41	1.08
Clothing and textile (CTX)	3.32	2.54
Light manufactures (OLT)	2.15	2.23
Chemicals (CHM)	1.90	1.98
Motor vehicles and electronic machinery (MEV)	3.10	3.66
Basic manufactures (BAM)	3.47	2.24

Source: Liu et al. (2003).

of CGE trade models is the lack of validation of the models' predictions (Kraev and Akolgo, 2005). In other words, there is no way to tell whether or not the predictions match actual events based on historical data. CGE researchers typically respond to this criticism by stating that ex-post validation of their model is difficult because the income gains reported are measures of social welfare which are unobservable. They also argue that events outside the domain of the model affect or influence the actual behaviour of the global economy and so it would be inappropriate to expect the model's predictions to match historical data (see for example, Whalley, 2000). While these are valid arguments, they also apply to modelling methods used by the Real Business Cycle (RBC) researchers but have not prevented the validation of RBC models.

Kehoe (2003) presents one example of an approach that could be used to validate CGE model predictions. It involves looking at historical data, sorting out stylised facts about the economies under investigation, and then comparing the models' predictions on key macroeconomic variables with those in the data. For example, one can take a CGE model that was used to examine the impact of the Uruguay Round reforms and then run the simulations using only those reforms that have taken place so far and compare the results on changes in key variables with the actual changes we have observed. Valenzuela et al. (2005) suggest a similar but less comprehensive approach to model validation based on replicating observed price volatility in agricultural markets. They applied this to the GTAP model and found that it performs reasonably well for some countries (for example, Canada and Australia) and less so for others. In particular, the model tends to under-predict price volatility for net exporters and over-predict volatility for importing regions. They argue that the incomplete transmission of world price signals into domestic markets is responsible for this result, and that when this is taken into account the model does quite well. These validation efforts are welcome; they will ensure that CGE models capture certain facts about the trading system and increase the credibility of their results.

5 Risks, Challenges and Way Forward

Several African countries lack adequate research capacity to conduct analytical studies on key issues of interest to them in multilateral and regional trade negotiations, and so they often rely on the results of research carried out by international institutions and academics. When researchers present results that differ significantly in terms of both direction and magnitude, and there is no explanation as to why these discrepancies occur, policy-makers find themselves in a very difficult situation because they do not know how seriously to take the results. In particular, they do not know which of the studies is more accurate and relevant to their situation. Unlike academics and developed-country policy-makers who have many trade professionals to deal with technical issues, African policy-makers are often not in a position to evaluate these studies to determine how credible they are and how useful as bases for policy formulation. This can lead to one of two unattractive responses by African policymakers:

(i) They may use the results of these studies for policy formulation even when they are not based on realistic assessments of the structure of their economies. This leads to wrong policy choices and has consequences for the ability of African countries to meet the development challenges facing them.

(ii) They may completely disregard results and recommendations from these studies in policy formulation and base their judgment on political realities and popular attitudes towards trade reform. While this is understandable, it could also lead to wrong policy choices.

Researchers therefore have a responsibility to ensure that policy recommendations are made on the basis of sound and objective assessment of the issues under investigation so that CGE models would be seen as an aid to policy formulation rather than a source of confusion to policy-makers. Clearly, CGE models have an important role to play in economic policy formulation in Africa. When based on a sound theoretical framework, realistic assumptions and objective choice of parameters, they can provide policy-makers with very useful insights into the functioning of their economies as well as forming the basis for advice on the positions countries should adopt in multilateral trade negotiations. African countries should continue to pay attention to CGE models of trade policy but should not base their policy decisions solely on the results of existing models, since they do not take into account important features of their economies and there is so much uncertainty surrounding the parameter estimates used for the simulations. Combining the results of CGE models with those based on other frameworks will provide a better guide to policy decisions and minimise the risks of policy errors.

There is a tendency for researchers to make recommendations to policy-makers based on the results of CGE models with very weak econometric foundations, and this increases the propensity for decision-makers to make wrong policy choices. Given that African countries have very limited resources to address the enormous development challenges facing them, the cost of failures of this sort is very high. There is therefore the need for caution in the use of model results for policy decisions in the region (Gunter, Cohen and Lofgren, 2005).

The credibility of CGE models will improve if researchers using the CGE methodology adopt and follow simple rules and principles. The first is to avoid the temptation to design experiments and choice of parameters to yield results that justify predetermined views on trade policy. The second is to exercise caution in the interpretation of simulation results to avoid sending the wrong message to policymakers. For example, with most of the results from GTAP simulations referring to the aggregate group 'Rest of Sub-Saharan Africa', simulation results suggesting welfare gains for the group are often interpreted as evidence that SSA would benefit from reform. However, given the wide diversity of countries in the group, one cannot rule out the possibility that a number of countries in the group would incur losses. There is therefore the need to exercise caution in the leap from simulation results to policy recommendations.

The third step CGE researchers should take to increase the credibility of their model is to put less emphasis on the welfare results of CGE models and more focus on inter-sectoral and inter-country changes and shifts in resources resulting from trade reforms. Finally, there is the need for a more transparent way of disseminating the results of CGE models. In particular, authors should outline the key features of their model that are important for the results. They should also specify the choice of the key model parameters as well as providing justifications for them. This type of transparency will ensure that results can be reproduced by other researchers and will make comparisons and interpretation of results much easier.

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INDUSTRIAL POLICY IN SOUTH AFRICA:

TARGETS, CONSTRAINTS AND CHALLENGES[1]

BY DAVID KAPLAN[2]

This paper examines industrial policy in Africa's most developed and industrialized economy – South Africa. In the current discussions and deliberations as to how South Africa could significantly raise its rate of growth, industrial policy has moved to center stage. The Accelerated and Shared Growth Initiative for South Africa (ASGISA) outlines a number of key targeted sectors that will receive government support and the National Industrial Strategy (NIS) proposes a new approach and a considerable expansion of industrial policy supports. While focused on South Africa, this paper raises number of issues concerning the role of industrial policy generally and it questions a number of issues that were central to Sanjaya Lall's views on industrial policy. It also addresses a number of additional issues that were not dealt with by Sanjaya, especially the significant institutional capacity constraints facing even the most developed African country, in effecting industrial policy. The paper argues that the institutional requirements for designing and implementing an effective industrial policy are very demanding. The paper then briefly propose a way forward for industrial policy that takes account of and works within these constraints and institutional limitations

1. Introduction

Sanjaya was a firm proponent of industrial policy. He provided a trenchant critique of the view that liberalization could result in genuine and sustained development. For Sanjaya, the heart of the development process was the acquisition of technological capacities. The advance of technological capacities in a developing country setting is subject to ubiquitous market failure, coordination problems and strong informational uncertainties. Government has accordingly an essential role to play. Government intervention could take three forms – selectivity, focused on "picking winners" (these "winners" might be sectors or activities); functionality, focused on improving the functioning of markets and finally the horizontal approach, focused on improving activities in certain selected activities. Sanjaya argued that '…technology development generally involves a mixture of function, horizontal and vertical policies, the exact mix varying with country context and the capabilities of its policy makers.' (Lall, 2001:32)

[1] *This paper was presented at the United Nations Conference on Trade and Development's (UNCTAD's) Meeting of Experts on "FDI, Technology and Competitiveness" Conference convened in honour of Sanjaya Lall, March 2007, Geneva. The views expressed in this paper are solely those of the author(s) and do not represent those of the United Nations, the University of Oxford or the Asian Development Bank.*

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Two other aspects of Sanjaya's approach are also important. First, for Sanjaya, industrial policy was aimed almost exclusively at the manufacturing sector. Sanjaya regarded manufacturing as "the only sector of the economy that appears to be able to act as a catalyst of economic development and modernization" (Lall and Pietrobelli, 2003:2). Second, Sanjaya argued that policy support should be aimed at exports. For Sanjaya, a central plank of industrial policy was to push, indeed even more emphatically, to "force", firms into global markets (Lall, 203:29). Apart from the economic advantages of exports, notably scale and learning, Sanjaya regarded fiercely competitive global markets as critical to disciplining both firms and bureaucrats (Lall, 2003:29).

This approach - an active state led industrial policy employing a mix of selective, functional and horizontal interventions in order to advance technological capabilities and particularly focused on manufacturing exports - Sanjaya regarded as applicable to all developing regions and countries. This included Africa, the region that has the weakest endowments in respect of manufacturing industry. "…manufacturing is the only sector of the economy that appears to be able to act as a catalyst of economic development and modernization. As many other countries have done, Africa must industrialize efficiently in order to achieve growth and competitiveness and reap the benefits of modern technology.' (Lall and Pietrobelli, 2003:2).

Sanjaya noted the continuing tendency of African countries to export unprocessed raw materials and the very low levels of manufactured exports (Lall and Pietrobelli, 203:6). The principal reason that he advanced for this state of affairs was the lack of any coherent industrial policy. "Sub-Saharan Africa does not seem to use any strategy for building technological competitiveness. This region has attracted little FDI into activities that stimulate technological learning; the boom in low-wage-seeking export-oriented FDI has, with the exception of Mauritius, bypassed the region. Industrial policies in the region are generally not coherent…….. and import-substituting industries have yet to develop the minimum base necessary to benefit from trade liberalization. These policy failures are reflected in the region's trade performance at the global level" (Lall and Pietrobelli, 2003:8).[3]

This paper examines industrial policy in Africa's most developed and industrialized economy - South Africa. In the current discussions and deliberations as to how South Africa could significantly raise its rate of growth, industrial policy has moved to center stage. The Accelerated and Shared Growth Initiative for South Africa (ASGISA) outlines a number of key targeted sectors that will receive government support and the National Industrial Strategy (NIS) (at the time of writing still before the Cabinet) proposes a new approach and a considerable expansion of industrial policy supports. An external team of foreign experts engaged by the Treasury to review South Africa's growth policies concurs with the central place accorded industrial policy.

While focused on South Africa, this paper raises number of issues concerning the role of industrial policy generally and it questions a number of issues that were central to Sanjaya's views on industrial policy. It also addresses a number of additional issues that were not dealt with by Sanjaya, especially the significant institutional capacity constraints facing even the most developed African country, in effecting industrial policy. The paper argues that the institutional requirements for designing and implementing an effective industrial policy are very demanding. The paper then goes on to briefly propose a way forward for industrial policy that takes account of and works within these constraints and institutional limitations

2. Industrial Policy and Manufacturing

2.1 South Africa's Manufacturing and Export Performance

A number of recent assessments have found evidence of poor performance of South manufacturing:

- Output. Manufacturing output per capita has been stagnant since 1985 (Haussman and Klinger, 2006: 7). Over the last two decades, South Africa's share of global manufacturing value add and regional (Sub-Saharan Africa) manufacturing value has declined persistently (Kaplan, 2004:623-4).
- Exports. Over the decade 1992-2002, South Africa's manufactured export growth has been somewhat slower than global growth, slower than Latin American and significantly slower than developing country growth (Alves and Kaplan, 2004:3-5). Post-1960, South Africa performed poorly when compared to all countries with a population of over 4 million and a GDP of at least 25% of South Africa's…South Africa is an outlier in terms of export performance, ranking 50th out of 56 countries (Haussman and Klinger, 2006: 3). In terms of exports per capita, South Africa also compares very poorly by comparison with other resource exporters – Argentina, Australia, Canada and Malaysia. Even if the apartheid years are omitted and only the period

3 *"African governments also need to stimulate technological activity in, and relevant to, manufacturing industry." (Lall, 1995:128).*

1991-2004 when South Africa's performance improved significantly is considered, "…South Africa still remains among the poor performers internationally in terms of export growth." (Haussman and Klinger, 2006:6).[4]

- Composition of Exports. South Africa has very low participation in global trade in the most dynamic products and its share is declining (Gibson and van Seventer, 2004; Zalk, 2004). None of the manufacturing sectors are significant net exporters – only in minerals is there any significant next export. Categorized by technological level, South Africa has a very weak presence in high technology products with very little indication of any significant change (Alves and Kaplan, 2004).
- In comparison with its income level, South African exports tend to be unsophisticated i.e. proportionately more of its exports are in the less sophisticated products that tend to be exported by countries with lower levels of income and that the sophistication of South African exports has not increased significantly over time (Haussman and Klinger, 2006:11) In marked contrast, using a different measure of the sophistication of exports, but one also where sophistication of exported products are calculated based on the income levels of the exporting countries, Lall et al find that South Africa's exports are significantly higher than would be predicted by its income level, and that this has increased in the period 1990-2000 (Lall et al 2005:18). There is evidence that the level of sophistication of a country's exports have an effect on its growth (Haussman, Hwang and Rodrik, 2006). Haussma nd Klinger accordingly conclude that "…for much of South Africa's history, GDP has been pulled down by low level of sophistication of its export basket" (Haussman and Klinger, 2006:12).

2.2. A Focus on Manufacturing?

There is a long tradition in development economics that accords with Sanjaya's assessment of manufacturing as the necessary engine of economic growth and central to technological change.[5] Within this tradition, manufacturing is generally conceived of as possessing four sector-specific characteristics that are not held by other sectors. It is these specific characteristics which give manufacturing a particular privileged role in the development process.

- Manufacturing development improves profitability throughout the economypecuniary external economies. Strong backward and forward linkages allow for manufacturing growth to substantially and positively "pull" growth elsewhere in the economy[6]
- Manufacturing enjoys stronger dynamic economies of scale. Combined with learning by doing, this allows for higher productivity change in manufacturing than elsewhere
- Manufacturing is the site of major technological innovation. This then diffuses to other sectors raising their technological capacities and their returns.
- The above characteristics of manufacturing are combined with the historical observation that all the development "successes" have been strongly associated with manufacturing growth. Hence, a growing manufacturing sector and growing manufacturing exports is seen as indispensable to economic development.[7]

Rodrik and Haussman and Klinger see poor manufacturing growth and poor manufacturing export performance as having been central in retarding economic growth in South Africa. Rodrik compares the growth performance of Malaysia with South Africa and attributes Malaysia's higher growth to its superior manufacturing performance (Rodrik, 2006). A similar conception is also evident in ASGISA which identifies as a major imbalance a "hollowing out" whereby non-commodity exporters are unable to compete effectively in global markets (ASGISA, 2006:4). Rodrik, Haussman and Klinger and ASGISA therefore share a common perspective that leads them to a policy focus on manufacturing sectors and especially on manufacturing exports.

From this perspective, increasing manufacturing growth and manufacturing exports will both increase employment since manufacturing is more labour intensive (and especially more unskilled labour intensive) than other sectors and raise output growth, since this will have pecuniary and technological spillovers through the economy. Moreover, growing exports will clearly support the trade balance which is currently in substantial deficit and which currently poses the major constraint to raising the rate of growth.

However appealing the association between growing manufacturing and manufacturing exports and the ASGISA objectives of raising employment and output appear to be, the empirical basis for such a standpoint in

4 *Edwards and Lawrence 2006:7-8 however see substantial growth in South African non-commodity exports post 1990 at approximately the same level as global growth.*

5 *Broadly associated with Kaldor, others in this tradition include Rosenstein-Rodan, irschman, Prebisch, Chenery and Pasinetti.*

6 *"..the presence of complementarities in investment, production and consumption is considered to be greater in manufacturing than in other sectors because manufacturing activities give rise to more and stronger forward and backward linkages." UNCTAD, 2006:153.*

7 *This is exemplified by UNCTAD. "The development of a strong manufacturing sector has been at the core of all successful catch-up experiences over the past 250 years, which suggests that achieving a lasting productivity-based increase in manufacturing is indispensable for a sustained rise in income levels and ultimately the eradication of poverty." UNCTAD, 2006:150*

South Africa is not yet established. Output and employment have been increasing most rapidly in the service sector. While in general, manufacturing tends to have a higher (unskilled) labour intensity than services, there are very significant variations within both the manufacturing and service sectors. Similarly, downstream and upstream linkages vary considerably within the manufacturing and service sectors and while manufacturing as a whole tends to have a higher export ratio, there is again significant variation both between and within the manufacturing and service sectors.[8]

Indeed, some recent, albeit preliminary work, suggests that output, employment and income multipliers may be higher for the services sector (Tregenna, 2006:46). If South Africa's industrial policy is to be in any way selective of particular economic activities, this should include sub-sectors that are located in both the manufacturing and the services sector. Further empirical work will need to be undertaken to assess employment and output multipliers and the contribution to net exports of the different manufacturing and service sub-sectors.

3. Key Constraints on Industrial Policy

Two systemic constraints currently severely constrain industrial policy. The first relates to the domestic macroeconomic framework and the second to international agreements.

3.1. The Macroeconomic Framework

South Africa, in company with a number of other developing countries, particularly in Latin America, has adopted orthodox macroeconomic policies that are focused on ensuring low domestic inflation. These policies have had a considerable measure of success - domestic inflation has declined and there is growing confidence that inflation will remain within the chosen band. However, macroeconomic policies have not brought stability in key prices that matter for investors and particularly for exporters – the interest rate and especially the exchange rate.

South Africa has experienced high real interest rates and significant interest rate movements. This has stifled investment – more particularly on the part of new entrants who tend to rely more heavily on borrowing.[9]

South Africa has also had significant fluctuations in the exchange rate[10] and (arguably) significant periods in which the exchange rate has been over-valued. The level and especially the volatility of the exchange rate has stifled investments. In a World Bank survey, 76% of firms exporting to the US regarded exchange rate instability as a serious problem, as did 57% of exporters to the other OECD countries (World Bank, 2005:97). The exchange rate has been particularly non-conducive to new entrants who have to incur large sunk costs in order to enter export markets.[11]

3.2 Restriction Imposed on Industrial Policy by International Agreements

New rules and regulations governing global trade and intellectual property embodied both at the multilateral level and in many regional and bilateral arrangements, have significantly reduced the freedom of developing countries with respect to industrial policy (Gallagher, 2005). There are three major areas where restrictions occur – Traderelated Investment Measures (TRIMS); the Agreement on Subsidies and Countervailing Measures (SCM) and the Agreement on Trade-related Aspects of Intellectual Property (TRIPS).[12] Currently, of most significance to industrial policy in South Africa is the SCM.

The SCM classifies four types of subsidies: enterprise, industry, regional and prohibited.

Prohibited subsidies, include any form of explicit direct or indirect support to exporters and are immediately actionable. The SCM prohibits granting subsidies based on export performance. Policies that make state support dependent on export performance, such as were applied in Korea or Taiwan, are now prohibited. At present, South African industrial policy has only two explicit targeted sectors – clothing and textiles and autos and auto components. In both sectors, exporters receive support through earning rebates on imports that are proportional to their exports - the Import Rebate Credit Certificates (IRCCs) in respect of autos and auto components[13] and the Duty Credit Certificate Scheme (DCCs) in respect

8 *In their identification of sectors that may warrant particular support, Haussman and Bailey schema relies on export data that are confined to industrial exports and that exclude services. Thus, four of the 14 targeted sectors in the NIS, "..do not enter our international trade data and therefore can't be evaluated." Haussman and Klinger, 2006:31.*

9 *Established South African firms tend to rely heavily on retained earnings – not unexpectedly when real interest rates are high.(World Bank, 2005). But, new firms are much more reliant on borrowing from the banking system.*

10 *According to Gelb, since mid-2001, the Rand has possibly been the most volatile currency openly traded in global markets Gelb, 2004:8.*

11 *For a discussion of the impact of gyrations in the exchange rate in constraining Latin American exporters, see UNCTAD, 2003:Chapter VI*

12 *For an inventory and discussion of these restrictions, see UNCTAD, 2006:166-179*

13 *Introduced in 1995, the MIDP has enjoyed a measure of success. It has unquestionably underpinned a significant expansion in auto and component exports. However, while exports have risen, the main concern in regard to autos and components is the high levels of importation (currently 60% for passenger vehicles) and the low levels of local content, particularly in relation to exports*

of clothing and textiles[14]. These are explicit supports to exporters and are therefore almost certainly open to successful challenge in the WTO.[15]

This concern has led to a reformulation of the support programmes for both the auto and components and the clothing and textile industries. This process has been difficult and drawn out and is still in process.

It is, of course, possible to replace explicit support to exports by more general subsidies such as some form of production allowance and various proposals have been made in this regard. However, general subsidies are certain to be very expensive since they apply to all output. For the same expenditure of resources, the incentive to exporting will be blunted. For example, the DCCS provided a 15% incentive to clothing exporters. Were the same level of support to be granted but now to all output, whether for the export or the domestic market, the incentive to exporters would be only 5%. Since the DCCS had only a very limited impact on exports at 15%, its impact on export is likely to be minimal. Similarly, to provide support to auto and component exports via some form of production or investment allowance applicable to all production will be extremely expensive. This greater expense will certainly strengthen the hand of those who are, in principle, opposed to any form of industrial policy. [16]

For Sanjaya, a central plank of industrial policy was to "force", firms into global markets. He regarded fiercely competitive global markets as critical to discipline both firms and bureaucrats (Lall, 2003:29). But, the disciplining and monitoring standard that linked the level of state support to producers to their successful engagement in the export market has been removed under the SCM, rendering state support, more expensive, less effective and much more difficult to monitor and control.

In reviewing the changes to "the rules of the game" under the aegis of the WTO, Sanjaya posed three critical questions to the development community. "Is the degree of policy freedom left to developing countries sufficient to promote healthy industrial development? If East Asia offers lessons for industrial policy, will the new environment allow them to be implemented? Without strong policy intervention, will persistence with liberalization be sufficient to drive industrialization" (Lall, 2003:34), His answer was not a very optimistic one -"probably not."

Certainly, in the South African context, reformulating export policy supports so as to make them WTO compatible is proving to be very difficult.

4. Institutional and Governance Requirements for Effective Industrial Policy

The institutional arrangements to direct and manage industrial policy effectively are very demanding. Where the institutional basis is weak, the risks of government failure and the squandering of public resources are enhanced.

4.1 Coherence

Effective industrial policy requires coherence in at least two respects. First, there needs to be coherence in terms of the goals and objectives of industrial policy. If industrial policy is defined in terms of desired policy goals and outcomes as aiming to favour/target certain economic sectors or activities,[17] it is important that the selection criteria by which the economic sectors or activities are identified be consistently applied. Inconsistent application of criteria and selection of activities will dissipate effort, cause confusion and clearly be sub-optimal. Secondly, there needs to be coherence in terms of responsibility within government such that industrial policy is effectively overseen and directed.

In South Africa currently a number of governmental policies do indeed very selectively favour certain sectors and activities. There is much that occurs that is effectively industrial policy, albeit that this is disguised as other activity. This "hidden industrial policy" includes the following:

- Direct state support for armaments production – especially subsidies to Denel[18]
- Support to mineral processing – especially subsidized infrastructure and energy to Coega[19]

14 *Introduced in 1995, the MIDP has enjoyed a measure of success. It has unquestionably underpinned a significant expansion in auto and component exports. However, while exports have risen, the main concern in regard to autos and components is the high levels of importation (currently 60% for passenger vehicles) and the low levels of local content, particularly in relation to exports*

15 *Countries classified as 'least developed' (i.e. where GNP per capita is less than $1,000 in 1990) are excluded from the WTO provisions pertaining to prohibited subsidies. Lesotho is the only SACU state that qualifies as a LDC. Lesotho could therefore continue to utilize the DCCS without being in contravention of its commitments to the WTO. But, all other SACU countries are obligated to replace the DCCS with a WTO compliant programme.*

16 *This is playing itself out in South Africa at present where Treasury is resisting the industrial policy formulations of the dti.*

17 *Chang, 1996:60 defines industrial policy "..a policy aimed at particular industries (and firms as their components) to achieve outcomes that are perceived by the state to be efficient for the economy as a whole (original emphases). Similarly Pack and Saggi define industrial policy as "…basically any type of selective intervention or government policy that attempts to alter the sectoral structure of production towards sectors that are expected to offer better prospects for economic growth than would occur in the absence of such intervention i.e. in the market equilibrium." (Pack and Saggi, 2006:196).*

18 *Denel received an allocation of R2billion in the 2006 Budget. A further allocation of R567 million was made in October (National Treasury (2006).*

19 *The full extent of the subsidy will only become evident if and when the aluminium smelter project is confirmed*

- Support to the development and production of nuclear energy plants - direct subsidies to the Pebble Bed Modular Reactor (PBMR)[20]
- Intervention in Upstream Fuel and Chemicals production – the proposed "windfall" tax on SASOL.

All of these policies are highly selective. Collectively, they entail very significant and very direct commitments of state resources. Most importantly, these economic activities embody very different economic characteristics – different from each other and different from the objectives set out in ASGISA and the NIS. To take just two examples:

- The PBMR is very research intensive, very high technology. This project alone absorbs a very large number of South Africa's scientists and engineers. Should government be supporting activities that are highly intensive of the factors that are in most scarce supply? None of the other sectors that are proposed for support in ASGISA or the NIS are near as technology intensive as the PBMR.
- The mineral processing activities, specifically aluminum, that government is attempting to attract to Coega to anchor the project and justify the significant expenditures on infrastructure, are very highly capital intensive. Employment creation is minimal. This choice conflicts with one of the explicit objectives of ASGISA and the NIS, namely that industrial policy has as a central objective an increase in employment.

This is not to argue that any of these selective interventions will not eventually succeed in their own terms. The PBMR or Coega, for example, may prove to be very effective.

However, as a consequence of their absorption of significant scarce skills and capital, the systemic impact of these projects is likely to be distinctly negative. The systemic impact on the effectiveness of these projects on overall industrial policy has not, thus far, been considered.

In addition, it is noteworthy that many of these selective interventions are not driven by dti. Support for armaments, the PBMR and Coega are driven by Public Enterprises. The windfall tax on SASOL is driven by the Treasury. This is not to say that the dti has no "presence" in these areas. But policy is initiated and managed by other departments with little perceived reference to the NIS. The conclusion is stark – institutionally, there is no clear center in government that designs and implements industrial policy. No ministry has oversight and provides direction to the totality of industrial policy presently. Lack of coherency in desired policy goals and outcomes is complemented by a lack of organizational coherency within government.

4.2 Strategic Collaboration

Information problems beset investors in developing countries. In particular, the cost functions of new "non-traditional" activities cannot be determined ex ante, but only after the investment has actually been made. Information failures result in economies staying the same course and not diversifying into new activities with associated spillover effects. Rather than conceiving of industrial policy as a set of outcomes, principally altering the sectoral composition of the economy, industrial policy can be seen as a process that entails discovering the underlying cost structure of an economy. This discovery process requires strategic collaboration between government and business. Government engages in discussion particularly with businesses and also other players, such as research institutions. The purpose of this discussion is for government to understand the opportunities and constraints that face investment and for businesses to understand government's objectives in economic development and restructuring of production and the constraints under which it operates. Structured information exchange between government and business therefore aims at identifying the barriers to diversification and to the determination of policies that are likely to best overcome those barriers (Rodrik, 2004:3). In this conception, rather than the result of autonomous decision making on the part of government, the determination of government policy flows from a process of strategic engagement with business.

Developing a well-functioning structured engagement is not a straightforward matter. Strategic collaboration between government and business can take many forms that will differ as between different national contexts. But, there is little tradition of such engagement in South Africa. Apart from a very few examples such as the Motor Industry Development Council at national level and some important initiatives at the provincial levels (see below), there is currently limited institutional basis for this collaboration. A considerable degree of mutual "suspicion" exists as between business and this manifests in distance and even distrust that is inimical to an effective strategic collaboration. The prevailing model is accordingly one essentially of government making policy albeit often supported by research. Consultation with business generally takes place once government has largely decided on its policy position.

What is at issue here is a radically different model. If industrial policy is to be effective in South Africa, the role of business in the formulation and development of industrial policy must be considerably expanded and this

20 *The PBMR received an allocation of R580 million in the 2006 Budget. A further allocation of R462 million was made in October (National Treasury, 2006).*

will need to be embodied in new well-defined institutional arrangements. Moreover, where governmental capacities are weak, the optimal role of business in this strategic collaboration will in consequence be enhanced. In South Africa, governmental capacities in relation to industrial policy are indeed very limited.

This is elaborated on below.

4.3 Governmental Capacities

The design and implementation of effective industrial policy is heavily dependent on a strong and competent state bureaucracy (UNCTAD, 2006:215). Ideally, this bureaucracy should be closely connected with the business community and have a good understanding of their situation. This will allow for the interchange of information and facilitate the structured engagement outlined above. At the same time, the government bureaucracy should retain a degree of independence and autonomy such that it does not serve narrow sectoral or other interests. This is best encapsulated in the term "embedded autonomy" (Evans, 1995).

Currently most of those responsible for industrial policies are new recruits to their positions. They have a limited understanding of their sectors. So-called sector specialists have no direct work experience in the sector to which they have been appointed. Indeed, very few personnel have experience of working anywhere in the private sector. In South Africa, there is no "revolving door" as between business and government that, for example, has characterised the Japanese MITI.

It is accordingly critical that government seeks to build and enhance its industrial policy capacities, particularly the capacities of sector specialists. This could be done by requiring governmental personnel to acquire experience working in the sector and/or recruiting into government those with such experience directly from the sector. But, this will take some time to effect. In the interim, governmental capacities to develop and implement industrial policies will necessarily be distinctly limited.

In the context of its own very limited competencies, government will be particularly reliant on business for information and market intelligence and accordingly in the formulation and design of effective industrial policies. Moreover, limited governmental capacities will constrain the scope and the depth of industrial policy. Whereas in Japan for example, high levels of competency and in-depth knowledge allowed for the government bureaucrats to engage directly in proposing a large number of significant large–scale interventions and supports for business, such an approach would be currently far from optimal in South Africa.

4.4 Distributional Conflicts

Industrial policy entails support to firms. The profitability of those firms enjoying support rises above the market level. Thus, at the heart of industrial policy is the creation of rents. Such rents allow these "favoured" firms to grow at rates that exceed what would have been possible in the absence of industrial policy. The management of those rents is central to the effectiveness of industrial policy.

In South Africa, distributional concerns challenge this perspective. Thus, there is opposition to "white" or "well-established" businesses benefiting at the perceived expense of "black" or "emergent" business. Many policy programs to support firms therefore provide enhanced support for black-owned and small firms. Industrial policy in South Africa does not therefore only aim to enhance growth of particular sectors or activities, it also aims to enhance growth of those firms in the designated sector or undertaking the designated activity that are black-owned or small. This can dilute the impact on growth. Export support is a case in point. Smaller firms and black-owned firms currently enjoy privileged access to export support. However, since exporting frequently entails economies of scale and a minimal scale of entry, larger well-established firms will tend to have a higher export potential than smaller firms and newer entrants.

Nor are distributional concerns confined to supporting black or emergent businesses. Industrial policies in South Africa are also configured with the intention of raising employment. This concern for employment is not confined to selecting sectors and activities that are held to be more labour intensive, it often impacts on the determination of the policy instruments themselves.

To take one example, the Strategic Investment Projects (SIP) was developed to encourage large scale so-called "propulsive investments." Government's concern was that South African needed to be able to offer incentives to large investors, more particularly large foreign investors, who were being lured to other countries, at least in part, by attractive investment incentives. The incentives were refashioned such that support was conditional on and proportional to employment criteria.[21] Requiring that firms receiving the SIP, in addition to investment criteria, also met employment criteria, reduced its effectiveness as a support to investment and output.[22]

21 *For details of the SIP see International Marketing Council of South Africa, 2003.*

22 *20 The extent of the SIP support was dependent, in part, on the perceived impact on employment. Moreover, this was monitored such that if the employment criteria were not, in fact realized, the SIP could be withdrawn. The possibility of withdrawal, of course, further reduced the appeal of the SIP to potential investors. For details on the Sip see dti, 2005.*

This is not to question the validity of equity/distributional goals entailed in South Africa's industrial policy. But, these goals do have consequences for output growth, rendering industrial policy, at least as presently applied, more problematic in South Africa than elsewhere where distributional issues are of less concern and where the focus can be exclusively (or almost exclusively) on enhancing output.

4.5 Skills and Training

The central objective of industrial policy is to enhance the productivity and efficiency of firms. Where protection is resorted to, this should only be a temporary measure whereby "space" is given to the protected firms to advance their productivity such that they can, within a defined period, compete without government support.

A number of factors will impact on firm level productivity. Of particular importance in a knowledge driven economy are human resources - the level of skills. The dti's industrial strategy lays stress on the central role of knowledge and knowledge driven activities in securing a competitive edge (dti, 2002). All sectors of the economy, including manufacturing, are becoming increasingly skill intensive, but the supply of skills is severely constrained.

In the World Bank's recent survey of the investment climate, more enterprise managers said that worker skills were a serious obstacle to their enterprises' operations and growth than any other area of the investment climate. Consistent with this, per worker labor costs are very high in South Africa—over three and half times higher than in the most productive areas of China, over two and half times higher than in Brazil and Lithuania and over 75 percent higher than in Malaysia or Poland. Although wages are relatively high for all types of workers in South Africa, they are particularly high for highly skilled workers and managers. An additional year of education is associated with an 11-12 percent increase in wages in South Africa—compared to about 5-7 percent in developed economies. The high premium paid for education results in salaries for skilled workers and managers that are high by international standards). Despite this skill shortage, South African firms invest less in training and were less likely to have training programmes than in most comparator countries (World Bank, 2005:64-66).

Where skills are in short supply, and where in addition training is very limited, industrial policies designed to raise productivity, however well designed and formulated, are likely to have only a very restricted impact.

4.6 Conclusion

The two key institutional requirements for an effective industrial policy are the professionalism and capacities of the government and the effectiveness of the strategic collaboration as between government and business. As outlined above, both are currently very limited in South Africa. Moreover, the limited capacities of the government are currently exacerbated by a lack of focus and cohesion around the objectives, content and conduct of industrial policy. In addition, distributional conflicts make it difficult to develop institutions and practices that manage the rents that are a constituent feature of active industrial policies. Finally, the principal objective of industrial policy, namely to enhance technological capacities and raise firm level productivity, is severely constrained by the current scarcity of skills and the limited training being undertaken.

Two broad conclusions emerge from this analysis. The first is that government should not expect too much of industrial policy. Under current conditions, industrial policy is likely to have only a limited impact on GDP growth. The second conclusion is that the design of industrial policy needs to be fundamentally re-examined. The constraints and institutional limitations outlined above should be factored into a consideration of the scope and content of industrial policy.

5. A Way Forward

What are the implications of the above analysis for the further development of industrial policy?

Industrial support policies should not be confined to manufacturing sectors. Further work needs to be done to determine the likely output and employment gains consequent upon any expansion of sectors and subsectors.

As regards the constraints, first a macroeconomic policy that results in both high real interest rates and an exchange rate regime that is (arguably) overvalued and (definitely) highly variable will severely curtail the impact of any industrial policy.[23] Currently, in South Africa, there is no coherence as between macroeconomic policies and microeconomic policies designed to enhance investment and productivity improvement. This will need to be addressed.

23 This is similar to the situation that has prevailed through much of Latin America. For the impact of unfavourable macroenomic policies on industrial policy in Latin America, see UNCTAD, 2003: Chapter V1.

Second, the constraints imposed by the WTO will require that South Africa's two current sector specific policies – namely those for autos and auto components and for textiles and clothing – will have to be fundamentally re-designed. The MIDP has been widely held as a highly successful policy, although this perspective has been strongly challenged.[24] Whatever perspective is adopted in regard to the MIDP, it is clear is that the MIDP is no "model" to be followed in other sectors. Export-import complementation schemes, such as are currently operative in the autos and auto components and the clothing and textiles sectors, are likely to be successfully challenged in the WTO. What has worked in the past (arguably) provides little guide for the future. Moreover, since it will be difficult to confine any support pogrammes solely to exports, any new programmes are likely to require considerable resources. Assessments of the economy wide implications will need careful consideration – something that has been largely absent from the design of existent support programmes.

As regards institutional and governance requirements, custodianship and system wide responsibility for industrial policy should be clearly demarcated within government. The overriding objective of industrial policy is to raise the productivity and efficiency of firms. This is consonant with the objectives of the dti. Public enterprises and Treasury have other objectives. Responsibility for industrial policy should therefore rest with the dti. While there may be real or perceived weaknesses in the dti currently, attention should be given to enhancing the dti's capacities to manage and direct industrial policy. The proliferation of interventionist industrial policies, albeit under other guises, needs to be carefully reconsidered. The desirability of such policies cannot be assessed solely on their own terms. They should also be assessed in terms of how they contribute systemically to the structural transformations being sought for the South African economy as a whole.

To reiterate, industrial policies are growth policies. They are correctly centrally directed at raising firm level productivity and efficiency. There is a danger that requiring industrial support measures, in addition, to make a substantial contribution to other equity objectives – notably employment creation and the development of black and female owned firms – may serve to blunt the central purpose and efficacy of industrial policy. It Industrial policy supports do necessarily tend to favour certain firms and hence raise returns for recipients. One consequence is that they can therefore entrench existent firms which may impose barriers to entry for new firms. In designing industrial support measures, it is therefore important to attempt to ensure that these measures do not unduly serve to raise the barriers to entry for new firms. Similarly, government will want to safeguard against support measures enhancing capital intensity and resulting in employment loss. Industrial policies should therefore be seen as essentially growth policies. Industrial policies must accord with and can make some, albeit modest, contribution to government's equity objectives. In the main, however equity goals are best addressed through other measures that are specifically targeted to these goals.[25]

The efficacy of industrial policy is heavily dependent on policies implemented elsewhere in government. Of particular importance is the issue of skills. Skills have been identified as currently the key constraint on firm investment and performance. The evidence suggests that the supply of skills is not being augmented and that despite their difficulties in securing skills, firms are nevertheless undertaking very little training.

Perhaps the most important institutional and governance requirement for an effective industrial policy relates to the respective roles of government and the business sector. Governmental capacities to formulate and to implement industrial policy are currently very limited. Where governmental capacities are very limited, the private sector rather than government should play the leading role in the identification of constraints and opportunities for sectors and in the design of policies to address these.

This perspective has informed the approach taken in the development of the provincial microeconomic development strategy (MEDS) in the Western Cape. What is envisaged in the MEDS is that given its near monopoly on information, the proposals for enhancing productivity and efficiency will emanate very largely from business. While the proposals emanate from business, the decision on which proposals to support remains with government. Government should make its decisions on which proposals to support based upon its declared objectives for output particularly and also for equity. Since government's capacities are limited, decision making may well require government having recourse to external advice (Western Cape Government, Department of Economic Development and Tourism, 2005: 135).

Institutionally, strategic collaboration can take a number of forms. Sector associations are one institutional mechanism for the engagement of business. In the Western Cape, a different institutional mechanism is operative. In this province, the provincial government has established a number of special purpose vehicles (SPVs) which are primarily composed of business representatives with some representation of sector specialists from

24 Flatters, 2005.

25 Of course, it will also be important to ensure that policies for employment creation or BEE will need toaccord with industrial policies.

the department of economic development and tourism of the provincial government and other stakeholders with an interest and knowledge of the sector. These SPVs function effectively as sector development organisations. The objective is not merely to develop existing firms, but critically to also enhance opportunities for new entrants – notably small firms and particularly black and female owned and managed firms.

The provincial government supports SPVs that are broadly representative and that have considerable legitimacy within the sector. Ideally, membership of the SPV should be diverse and include small firms. Government can have some confidence that policy proposals that emanate from such associations are likely to have broad legitimacy within the sector. The task of government is to support those proposals that will develop the sector in a manner that accords with governmental objectives of both growth and equity.

The principal role of the SPVs is to institutionalise the exchange of information between the private sector and government. The SPVs allow for government to obtain information as to firms' future investments and the factors that are promoting and restraining investment activity. They are the institutional mechanism through which potential policies to support the sector are discussed and debated and ultimately presented to the provincial government for assistance.

Moreover, the role of the SPVs is not confined to discussing policy proposals. SPVs may well engage directly in implementation. The provincial government may grant funding support for a proposal that emanates from an SPV and task that organisation with ensuring that the programme is carried out and that the funding is spent effectively. Governmental capacities are not solely limited in terms of policy formulation. Arguably, an even more critical constraint lies in government's capacity to implement. SPVs, or other institutional forms of sector organisation, "… can carry much of the burden of industrial policy – both in its design and in its implementation, thus economising on limited governmental capacities." (Kaplan, 2006).

As regards funding, the MEDS favours a co-funding mechanism. Since many of the market failures are partial rather than total, some of the funding support can and should come from the beneficiaries themselves. Thus, in regard to training for example, since firms will gain at least some of the benefits of training expenditures, government support for training programmes can be partial. This limits the deployment of government fiscal resources. At the same time, this gives government a significant measure of security that public monies are being spent in projects to which the intended beneficiaries, who possess far more information than government as to their real development needs, are prepared to commit their own resources (Western Cape Government, Department of Economic Development and Tourism, 2005: 136).

The institutional design proposed here is certainly not free of risk. The capacities required of government are still far from trivial. The danger of governmental capture, always real, may be enhanced where a close relationship is cultivated with business associations and where, in addition, government capacities are weak. But, however this is structured institutionally, in the present context in South Africa, the design and development of effective industrial policy will necessitate a major role for business.

Institutional arrangements will necessarily evolve and change over time. It is of critical importance that the institutional design of industrial policy embodies feedback mechanisms and structured monitoring and evaluation, something that has been largely lacking from previous policies. This will enable governmental capacities to grow with experience - a version of learning by doing (Western Cape Government, Department of Economic Development, 2005: Chapter 6). As its own capacities enhance and develop, government will then be in a position to be more effective and also more adventurous in advancing its industrial policies.

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BIOFUELS, AGRICULTURE

AND POVERTY REDUCTION[1]

BY LEO PESKETT[2], RACHEL SLATER[3], CHRIS STEVENS[4] AND ANNIE DUFEY[5]

The development of biofuels has generated vigorous debate on economic and environmental grounds. Our attention here is on its potential impacts on poverty reduction. The potential is large, whether through employment, wider growth multipliers and energy price effects. But it is also fragile: it will be reduced where feedstock production tends to be large scale, or causes pressure on land access, and its success can be undermined by many of the same policy, regulatory or investment shortcomings as impede agriculture. Whilst some of the factors facilitating, and impacts of, biofuels can be tracked at global level, its distributional impacts are complex, and point to the need for country-by-country analysis of potential poverty impacts.

1. Introduction

Sweeping claims have been made about the role of biofuels in development and poverty reduction (see Peskett et al, 2007 for a review). For example, it has been argued that

- energy crops are beginning a green revolution in Brazil;
- a bioproduct-based agro-revolution can offer a new development paradigm;
- biofuels can provide a solution to the twin problems of poverty and climate change; and
- countries in the tropics have comparative advantage in biofuels production which can play a role in job creation and food security.

[1] *This paper was first published in the Overseas Development Institute's (ODI's) Natural Resource Perspectives Series (June 2007), which presents accessible information on current development issues (www.odi.org.uk). ODI is the UK's leading independent think tank on international development and humanitarian issues. The research on which this paper is based was funded by the Renewable Natural Resources and Agriculture Team of the UK Department for International Development (DFID). The arguments made in this paper are those of the authors alone and are not necessarily those of DFID.*

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But there is also scepticism. Researchers have recently questioned whether the net energy benefits of biofuels production may be negative for many crops because their energy outputs are less than the fossil energy inputs required to produce them. Others (see Peskett et al 2007) suggest that biofuels will be a 'pandora's box' and question whether large-scale biofuel production can be environmentally, socially and economically sustainable and efficient.

This paper does not consider the broader questions about biofuels and energy policy, nor their environmental implications, but is concerned mainly with their potential contribution to agricultural sector development and to rural growth and poverty reduction.

Biofuels are defined here as organic primary and/or secondary fuels derived from biomass which can be used for the generation of thermal energy by combustion or by other technology. They comprise both purpose-grown energy crops, as well as multipurpose plantations and by-products (residues and wastes) (FAO 2000). This paper focuses on two types of liquid biofuels produced from purpose-grown crops:

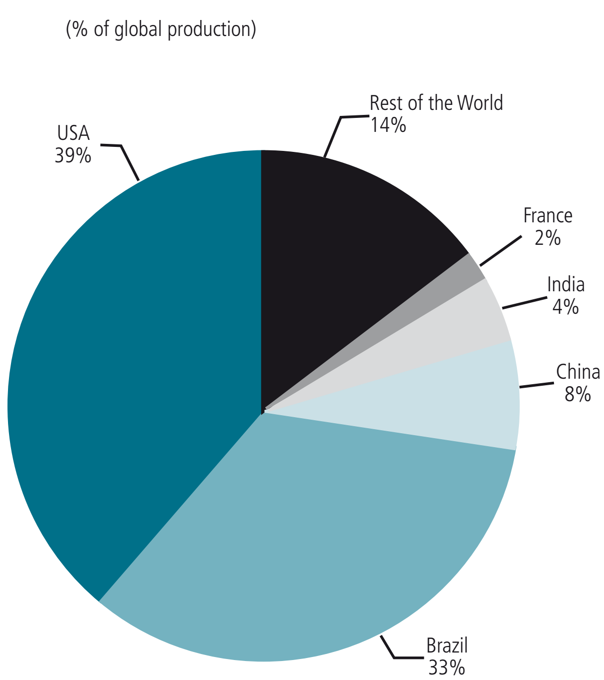
- Bioethanol is an alcohol derived from sugar or starch crops (e.g. sugar beet, sugar cane or corn) by fermentation. Ethanol can be used in either neat form in specially designed engines, or blended with petroleum fuel.
- Biodiesel is derived from vegetable oils (e.g. rapeseed oil, jatropha, soy or palm oil) by reaction of the oil with methanol. Biodiesel can either be burnt directly in diesel engines or blended with diesel derived from fossil fuels.

2. Trends in Production and Trade

Production of biofuels for domestic use and export is dominated by a few countries. Bioethanol, production of which began in the 1970s, is still produced in much larger volumes than biodiesel for which production started in the 1990s. The USA and Brazil are the largest producers of bioethanol by a large margin (Figure 1). The EU produces almost 95% of the world's biodiesel. Global production has increased gradually over time.

The largest increases in production volumes are expected in Brazil, the US, the EU, China, India, Indonesia and Malaysia, with annual global production of bioethanol projected to increase to 120 billion litres by 2020, and that of biodiesel to 12 billion litres (IEA 2004).

FIGURE 1: TOP FIVE ETHANOL PRODUCERS WORLDWIDE



Source: Based on figures from RFA 2007

By 2011 around 20% of Brazilian bioethanol production (5.2 million litres) will be exported, mainly to India and the USA. The most significant increases in biodiesel trade, from a much lower base, will probably be exports from Malaysia and Indonesia to the EU, which aims to reach a 10% blend of biofuels in transport fuel by 2020.

But new producers are coming on stream in Latin America, and Caribbean countries, where the EU sugar import reforms could reduce revenues by 40%, are seizing opportunities derived from biofuels trade to diversify their sugar industry. South East Asian countries such as the Philippines and Thailand have introduced aggressive policies for biofuels and begun production.

Predictions are particularly hazardous, given the rapid development of production and processing technology and effects of environment pricing, which may alter the commercial feasibility of transporting biofuels around the world. Together with rising oil prices, technological improvements may increase global demand for biofuel crops and for farmland, putting upward pressure on world prices for biofuels, food and feed. Broadly speaking, the effect of this would be to increase the incomes of producers (and countries that are in net surplus) and reduce those of consumers (and countries that are net importers).

- Between countries, therefore, there would tend to be a shift, for example, in favour of Argentina and Brazil and against much of Sub-Saharan Africa.
- Within countries there would tend to be a shift in favour of agricultural producers (largely in rural areas) and against consumers (including those in urban areas but also those living in rural areas but with limited ability to participate in agriculture as farmers or labourers) – even in countries that are net importers.

There would be parallel shifts in the cost of energy. These would be less visible: oil prices may simply rise more slowly than they would otherwise have done. Nonetheless, this will tend to benefit countries that are net energy importers and disfavour those net exporters and who do not participate in the biofuel trade (Peskett et al 2007, UN-Energy 2007).

If there are no artificial restrictions on trade the international distribution of production will be determined very broadly by the relative cost of production (including transport to market). This is because, in practice, markets are never perfect and commercial considerations are likely to favour one source of supply over another.

One effect will be that the supply of biofuels increases most in the countries with the lowest constraints on raising their total level of arable production. Few, if any, countries are likely to have limitless capacity (especially in the short to medium term) but the trade-offs between using factors of production either for biofuels or for food / feed will be smaller in some countries than in others. The cost of producing biofuels in the countries where the trade-offs are small will tend to be lower than in countries where they are high.

An increase in biofuel production in the EU, USA or other OECD states is particularly likely to result in substitution for food/feed production and so is likely to drive up global food/feed prices and, hence, increase the potential shock for developing country producers and consumers.

3. Poverty Impacts

It is difficult to generalise about the impacts of biofuels on poor people because of the differing effects of: different feedstocks/production systems; varying downstream (transportation) costs; existing (non-biofuel) crop production and processing patterns; and patterns of land holding.

Will biofuels expansion impede or improve poor people's access to land under different biofuels scenarios? With sugarcane, biofuel yields can be very high, reducing the pressure on land, but the economies of scale sought by producers and subsequent land concentration may reduce access by the poor to land. This is likely to be the case also with palm oil and, to a lesser degree, jatropha.

Notwithstanding the differences between different production systems, feedstocks, or historical patterns of agricultural production and poverty levels, the economics of biofuels production show us that in general:

- Economies of scale are important in biofuels production (though relatively less important in the production of feedstock than in the processing);
- In all current biofuels production systems, feedstock is the largest cost of production;
- Biofuels production can be complementary to other types of agricultural production and create linkages and multipliers; and
- Biofuels production requires a significant labour force.

4. Prospects for Expansion

The challenges related to on-farm and off-farm technical processes and policies are reviewed in Box 1. Those linked to international policies are reviewed in Box 2, which gives an example of the prospects for support under Kyoto.

In terms of adaptation challenges on-farm, economies of scale, especially in ethanol production, are likely to favour large-scale production systems. Adaptation on small farms will depend on outgrower schemes, or on the successful engagement of co-operatives and other producer organisations. In the case of off-farm, how far existing agro-industry will be able to transform to biofuels production, and what roles public and private investment may have, will be context-specific.

The arguments above illustrate how many different dimensions there are to analyse when seeking to understand the impact of biofuels expansion on agricultural growth and poverty. The net implications are difficult to identify, and meaningless unless contextualised – which we attempt to do on the basis of three typical cases in the concluding section. It is clear though that many of the problems that emerge from biofuels are not unique to biofuels but are challenges that have faced agricultural development policy for many decades. However, given the potential rate of increase of biofuels production, it is possible that the sub-sector may provide a new impetus and urgency to efforts to solve some old problems.

MAJOR ADAPTATION CHALLENGES

On-farm

- Institutional structures: adapting to fit production models that allow economies of scale. Large-scale systems are often economically favoured, so smallholder farmers might need to organise into cooperatives and/or outgrower schemes to allow access to markets.
- Environmental impacts: increased/decreased soil fertility; water pollution; downstream effects such as the draining of wetlands.
- Technology: access to farm technology which helps increase yields (e.g. the Brazilian experience suggests that this can be achieved through the selection of better varieties and irrigation).
- Changes in land use affecting: access to land; effects of biofuels on cost of land which are currently poorly understood.
- Need for flexibility to changes in the prices of feedstocks and to changes in the prices of inputs.

Off-farm

- Employment patterns: employment patterns are expected to change as biofuel sectors grow. Much work in the biofuels sector is non-skilled, but requirements for skilled labour are likely to increase.
- Investment: biofuel processing and distribution infrastructure can require substantial up front investment.
- Need for flexibility: converting current production systems into biofuels production systems (e.g. existing legacy of sugar processing plants in Caribbean countries could be a constraint); flexibility within processing plants is also a constraint (e.g. many Brazilian plants are designed to switch between sugar and ethanol production which allows adaptation to price changes).
- Adapting regulations: changing regulation to suit efficient production processes will be needed in some cases. (e.g. in some countries efficiency gains through co-generation is not an option because producers are not allowed to sell into the grid).

Source: Adapted from Peskett et al 2007

IMPLICATIONS OF THE KYOTO PROTOCOL FOR BIOFUELS ADAPTATION

Because biofuels have the potential to reduce greenhouse gas emissions, the Kyoto Protocol's Clean Development Mechanism (CDM) offers potential for funding biofuels projects in developing countries. However, because of the complex rules, processes and politics of the CDM, access to the CDM by the Least Developed Countries is restricted, and smaller producers are bypassed in those countries. For example:

- Biomass projects (a common type of CDM project) are generally large in scale and related to grid-based power systems. Their geographical spread is also limited, with most projects in larger developing countries and few in Africa.
- Rules for land-use related projects in the CDM are restricted to include only afforestation, reforestation and certain biomass related processes (such as methane capture from biodegradation) while the EU Emissions Trading System (EU ETS), the largest functioning carbon market, does not currently accept land-use projects.
- Small farmers are less able to access the carbon market because they lack expertise in implementing complex methodologies, ex-post payment systems mean there is a lack of up front funding for projects and investors are less interested in smaller projects with high risks and long timescales. Small-scale methodologies with simpler requirements and processes for bundling projects have been developed to address some of these issues, but there is currently no small scale methodology for liquid biofuels, and only one large scale methodology based on use of waste cooking oil for biodiesel (CD4CDM 2007) .
- Despite their potential for bringing sustainable development benefits (a core aim of the CDM) biofuel projects are less attractive to investors because of high abatement costs, difficulties in proving additionality for projects and difficulties in calculating reduced greenhouse gas emissions of projects (Bakker 2006).

Negotiations over the next phase of the Kyoto Protocol (post-2012) are considering options for programmatic approaches to the CDM, meaning that developing countries could benefit from finance from developed countries for putting in place biofuels policies. However, perverse incentives could arise, discouraging developing countries from putting in place legislation on biofuels because of rules over 'additionality' under the CDM.

There are alternative carbon markets outside of the Kyoto Protocol that show potential for supporting moves towards biofuels production in developing countries. These voluntary markets are smaller, but tend to focus on smaller projects aimed at reducing greenhouse gases and alleviating poverty. However, the quality of projects, in both environmental and social terms, can also be very variable, implying a need for more universal standards, an issue currently under consideration by the UK Department for Environment and Rural Affairs (Defra).

5. Starving the People to Feed Cars? Debates about Food Security and Biofuels

Whilst de Keyser and Hongo (2005) argue that biofuels production presents a win-win situation for developing countries by creating rural jobs, increasing incomes and thereby improving food security, there are also claims that biofuels will result in increased hunger as maize is diverted away from household food utilisation in developing countries to feed the cars of households in the developed world. In this regard, three critical questions must be explored:

Will biofuels take land from food production?

Monbiot (2004) uses examples of the significant land requirements in the UK of a switch to biofuels. However, examples from parts of the developing world, where there are large areas of suitable land, and conditions for biomass production are up to five times as good as the UK (Johnson et al 2006) are more useful. Thus, de Keyser and Hongo (2005) estimate that in Tanzania around 300,000 ha out of a total of 4.6 million ha currently under crop, would be required to match current fuel imports. Koonin (2006) estimates that biofuels could supply 20-30 per cent of global fuel demand in an environmentally responsible manner without affecting food production. In many developing countries, efforts to increase land and labour productivity will be crucial if biofuels are to avoid competing with the use of land for food staples.

What impact on food prices are likely?

In many developing countries, most poor people are net consumers of food – even on farms in rural areas. So, food prices are as important as food availability. At present, evidence that biofuels are leading to food price increases is only circumstantial. On the positive side, analysis of variation in world grain prices suggests that they have continued to decline in real terms (World Bank 2006), and, of the three main staples – rice, wheat and maize – only maize is currently used for ethanol production. More worrying but somewhat unrelated, global stocks of staples have declined as the major stockholders (USA, EU and China) have reduced their stocks, thereby making global prices more vulnerable to price shocks.

How might biofuels production affect food aid from the USA?

The USA's cheap energy policy is coming under pressure from increased demand for fossil fuels from rapidly-growing economies (China, India). One policy response has been to provide financial incentives for supplying 25% of United States' energy use from renewable resources by 2025. At the same time, US foreign aid is heavily dependent on US agricultural surplus production. Aid is used to manage surpluses and stocks and the farm bill continues to reflect these priorities. The result is a foreign aid programme in which food (either distributed or monetised) plays a major role. It is impossible to predict whether the use of maize for biofuels will result in a switch to monetary aid, and, if it does, whether this will result in more innovative and flexible approaches to aid programming – or simply in a decrease in overall levels of aid.

6. Environmental Impacts of Biofuels

In terms of effects on the agricultural frontier, if the cultivation of energy crops replaces intensive agriculture, impacts can range from neutral to positive; if it replaces natural ecosystems or displaces other crops into protected areas, the effects will be mostly negative.

In terms of energy balances, emissions and air quality, the evidence suggests wide variation in greenhouse gas (GHG) savings from biofuel use depending on feedstock, cultivation methods, conversion technologies, and energy efficiency assumptions. The greatest GHG reductions can be derived from sugarcane-based bioethanol and the forthcoming 'second generation' of biofuels such as lignocellulosic bioethanol and Fischer-Tropsch biodiesel. Maize-derived bioethanol, on the other hand, shows the worst GHG emission performance and, in some cases, the GHG emissions can be even higher than those related to fossil fuels. The use of fire to clear new land, in some cases for biofuels, is problematic in China, Indonesia and Brazil resulting in reduced air quality, and fossil fuels are often used to generate process heat in the production of biofuels.

Regarding soil and water management, the production of some biofuels (e.g. sugarcane) requires large volumes of water, which is problematic in semi-arid areas. In addition, processing of some feedstocks requires large volumes of water and tends to generate effluent. Perennials such as palmoil and jatropha are likely to have more benign impacts on soil quality (and lower levels of agrochemical requirement) than annuals such as maize.

The introduction and enforcement of appropriate technologies, regulations and standards can help to mitigate most of these problems, but will be slow to materialise where policy environments are weak.

7. Drawing together the arguments

This analysis of the impacts of biofuels expansion on agricultural growth and poverty reduction has highlighted many uncertainties about what will happen to global markets and prices, and the opportunities that this may offer for poverty reduction. Overall, it is very difficult to distil net recommendations from biofuels research that will be appropriate for different countries. We agree with Kojima and Johnson's (2005) assessment that:

> Biofuels should be integrated within a broader context of investment in rural infrastructure and human capital formation. Low-income countries should assess whether the underlying conditions for a successful biofuel programme exist or could be developed in the near-term, including infrastructure and essential public services (2005: 3)

The three scenarios presented below generate lessons and more specific country level policy recommendations.

Scenario 1: Biofuels production in a net energy-importing country - Malawi

Whilst maize production accounts for a massive proportion of total agricultural production in Malawi, prospects for ethanol production from maize for export are limited. Transportation costs would be particularly high. At present, options for smallholder farmers to engage in jatropha production appear very limited. There has been some expansion of biodiesel production but mainly among former tobacco growers through outgrower schemes.

In policy terms, making biofuels work for poor people in Malawi would require:

- improved market coordination;
- investments in transport infrastructure;
- decentralised processing capabilities;
- improved storage to reduced the seasonality of employment in biofuels.

None of these challenges are unique to biofuels but are ones which donors and the Government of Malawi have been grappling with for some time. Whether opportunities in biofuels will enable further progress to be made is not clear. A focus on non-staple food feedstocks will lessen the impact on staple food prices in Malawi. Other small, poor and landlocked countries that are currently heavily dependent on a poorly-performing smallholder agriculture sector are likely to require similar policies.

Scenario 2: Biodiesel production in Indonesia for EU consumption

Increasing openness in oil palm fruit markets in recent years has allowed direct sales to mills by smallholders and stimulated growth in the smallholder sector. However, different types of smallholders are likely to win or lose in different ways. Some independent growers, mainly former plantation staff or wealthier local entrepreneurs, have increased market share through high yielding varieties but others still struggle to access markets. Palm oil price increases in the short term are likely to benefit smallholders, but this may not be sustained given increased competition with prices of soy oil and palm oil grown in other areas (e.g. West Africa, South America). Countries likely to have similar experiences include Malaysia, Phillippines and Nigeria. Biodiesel production is raising the risk of conflict between those having commercial and customary land rights.

In policy terms, making biofuels work for poor people in Indonesia would require:

- a continued focus on biodiesel which requires fewer economies of scale, can draw on existing transportation systems and uses familiar crops;
- decentralised milling to reduce producer transportation costs in remote areas;
- improved land tenure for smallholders to avoid potential conflicts;
- support to small farmers – for example quotas for mills that encourage them to buy from smallholders.

Scenario 3: Domestic and export ethanol production in Brazil

Ethanol production from sugarcane has created many jobs in Brazil, and had wider agricultural sector multipliers. However, predominantly migrant labour is employed and low skilled jobs dominate the industry. Increasing economies of scale and land concentration have limited the benefits of ethanol production for small land owners. Countries likely to have similar experiences include South Africa and parts of Latin America.

In policy terms, improving the benefits of biofuels for small farmers would require:

- continued investment in biodiesel which, on the whole, is more pro-poor than ethanol production, does not depend so much on economies of scale, has lower transportation costs and is already a smallholder activity;
- continued pro-smallholder policies – for example quotas for procurement of feedstock from family farms.

8. Knowledge Gaps and Conclusions

The development of biofuels has potentially important roles to play in poverty reduction – through employment effects, wider growth multipliers and energy price effects. There are risks that some of this potential may be lost as economies of large scale operation kick in, especially with bioethanol, and as pressure is increased on land access in some settings. Global environmental incentives to small scale producers remain slight. The distributional effects of biofuel development are crucial – between producers and consumers, and between food/feed/energy deficit and surplus countries. The impacts of biofuels on aid flows from OECD countries – whether financial or as food – remain difficult to predict. There are some important global level knowledge gaps – for example biofuel and food staples prices and stocks need to be tracked, and this data fed into early warning systems for food security; mechanisms need to be identified by which climate change mitigation funds might be used to support 'clean' biofuels production processing; and how WTO negotiations might affect biofuels markets and developing countries needs to be identified. On the whole, however, the types of question outlined in this paper concerning poverty impacts can only be addressed at country level. Without this it will not be possible to identify patterns of appropriate feedstocks, production systems, processing and marketing opportunities, and government roles that will maximise the impacts that biofuel production could have on rural livelihoods and poverty. Donors have significant roles to play at both global and national level with technical and policy support.

POLICY CONCLUSIONS

Of high importance, but unlikely to be achieved in the short term:

- OECD countries need to reduce agricultural support regimes for biofuels to avoid penalising developing countries who already have restricted access to OECD markets.
- Developing countries need to address the same critical policy, regulatory and public investment constraints as affect agricultural production.
- Efforts are needed to make staples markets work better to enable switching between the main staples (maize, rice and wheat) as more maize is used for biofuels production.

Much of the requirement for policy improvement is at country level, and whilst highly context-specific, each context is likely to include several of the following:

- Investment in improved land administration systems to deal with conflicting claims emerging under biofuels expansion.
- Improved market coordination.
- Priority investment for biodiesel which, in many contexts, generates more labour, has lower transportation costs and simpler technology.
- On plantations and in processing mills, identification of additional non-seasonal sources of work to avoid highly seasonal employment in biofuels.
- Improving storage infrastructure (especially in ethanol feedstocks) to lengthen the processing season.
- Investing in feedstocks compatible with existing domestic production patterns to keep down costs of processing.
- Striking a balance in processing capabilities between large, centralised units capturing economies of scale and smaller, decentralised units, impacts strongly on rural employment, incomes and economic diversification.
- In food insecure countries/regions, focus biofuels investment on non-staple food crops.
- Provide support for small farmers to increase productivity to cope with downward pressure on biofuels producer prices – for example through improved varieties – and set quotas for procurement from them.
- Depending on context, invest in biofuels feedstocks with higher yields that result in less competition over land; in those that can be cultivated on marginal lands and have net benefits for soil rehabilitation; and/or in those that generate the best multipliers with the wider agricultural and rural economy.
- Ensure enforcement of regulations, standards and appropriate technologies to improve the contribution of biofuels production to climate change mitigation.

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COMMERCIALISATION OF BIOFUEL INDUSTRY IN AFRICA:

A REVIEW*

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Diversification of energy sources, agricultural activities and a higher percentage of locally produced energy are goals that can be satisfied by biofuels. Biofuels such as biogas, biodiesel, and bioethanol may be easier to commercialise than other alternative fuels, considering performance, infrastructure and other factors. Lack of a good understanding and application of key concepts of cost estimation—a key to successful project which impacts both the project profitability and influences the technical solutions—is a foremost barrier to its commercialisation in Africa, despite the availability of biomass resources. A plethora of other generic technological and non-technological constrictions has been identified to also hinder biofuels adoption and development. Understanding the economics of the biofuel industry is, therefore, crucial in realising eventual commercialisation. This article provides knowledge-based review for expansion (commercialisation) of biomass-derived fuel (biofuel) through improved understanding of its economics in Africa. In addition, recommendations to overcome the technological and non-technological hurdles to market penetration of biofuels are discussed.

1. Introduction

ENERGY PLAYS A CRITICAL ROLE in the development process, first as a domestic necessity but also as a factor of production whose cost directly affects price of other goods and services[1]. It affects all aspects of development—social, economic, and environmental—including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues. Access to energy has been described as a key factor in industrial development and in providing vital services that improve the quality of life, the engine of economic progress[2].

Ensuring the provision of adequate, affordable, efficient and reliable high-quality energy services with minimum adverse effect on the environment for a sustained period is not only pivotal for development, but crucial for African countries in which most are struggling to meet present energy demands. Further, the continent needs such energy services to be in the position to improve its

* *This paper was first published in Renewable and Sustainable Energy Reviews 12 (2008). The authors are grateful to Dr. Desta Mebratu, the regional DTIE officer, United Nations Environment Programme (UNEP) regional office, Kenya for his inputs.*

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overall net productivity and become a major player in global technological and economic progress. It needs to increase from 10% to 35% or more, access to reliable and affordable commercial energy supply by Africa's population in 20 years[3].

As contained in the New Partnership for African Development (NEPAD) objectives on energy, African countries need to improve the reliability as well as lower the cost of energy supply to productive activities in order to enable economic growth of 6% per annum and to reverse environmental degradation and health impacts that are associated with the use of traditional fuels in rural areas[4,5]. The Millennium Development Goals (MDGs) especially MDG 1, reducing by half the percentage of people living in poverty by 2015 cannot be met without major improvement in the quality and magnitude of energy services in developing countries. A typical report that underscores how energy can be used to eradicate extreme poverty is the United Nation Development Programme in Mali, which initiated the spread of biogas units in peri-urban areas around the city of Bamako through the development of a locally adapted prototype[6]. Wider use of these biogas units would help reduce the demand for firewood in peri-urban areas and would supply high-quality fertilizer for local farming efforts. This initiative will also help in achieving MGD 4–7, reduce child mortality, improve maternal health, combat diseases and ensure environmental sustainability.

Africa is endowed with significant quantities of both fossil and renewable energy (RE) resources. Any strategy to develop these energy resources must be extremely mindful of both the environmental pollution problems (through carbon monoxide, ozone forming hydrocarbons, hazardous particulates, acid rain-causing sulphur dioxide etc.), and the threat of "climate change" associated with the use of fossil fuels, the latter as a result of the accumulation of certain greenhouse gases (GHGs) in the atmosphere (mainly carbon dioxide, methane and nitrous oxide that trap heat in the lower atmosphere and lead to global warming). As adopted by the third conference of parties (COP3) in Kyoto, Japan, attempts have been made to agree to legally binding obligations on most developed countries to reduce their GHG emissions by an average of 5.2% below 1990 levels by 2008–12[4]. These attempts are resulting in the development of financing mechanisms such as the Clean Development Mechanism (CDM) that may be able to leverage significant resources for the development of RE resources on the African continent.

It is also noteworthy that there is an uneven distribution of the fossil energy resources on the African continent, which is reflected in the energy production/consumption patterns.

This poor distribution of fossil fuel resources makes over 70% of countries on the continent dependent on imported energy resources, which again supports the development of abundant RE resources. Africa has significant renewable sources that can, at a minimum, be harnessed for satisfying certain niches in the energy sector. It has been estimated by Marrison and Larson that planting 10% of the total land in Africa that is not forest, not wilderness and not cropland with biomass energy crops would produce 18 exajoules (EJ) of bioenergy[7]. The development of renewable technologies and in particular bioenergy production (conversion of biomass) will help reduce the dependence on non-RE resources as well as minimise the social impacts and environmental degradation problems associated with fossil fuel.

Biomass-derived fuels share many of the same characteristics as their fossil fuel counterparts[8-10]. Once formed, they can be substituted in whole or in part for petroleum-derived products. With the petroleum age nearing its end, biomass fuel relevant to African economy that can at least partly close the prospective gap which is opening between globally rising energy demand and the uncertain expansion of energy supply are gasohol—a mixture of 10% ethanol in gasoline, biogas—produced by means of anaerobic digestion of plant and animal waste to yield methane, and biodiesel (fatty alkyl esters)—a cleaner-burning diesel replacement fuel made from natural renewable sources such as new and used vegetable oil by cracking the triglyceride molecule.

Biofuels, which are realistic contenders as a major low-carbon fuel source for the future present many opportunities. Multi-benefits analysis by the World Bank[11], shows that a biofuels industry in Africa, based on biomass feedstocks, would have substantial environmental, economic, employment and wider social benefits on a national scale—especially for rural and regional sections of Africa among which are:

- Source of foreign exchange saving activity especially for oil-deprived countries (development and use of locally-produced renewable fuel, and reduction of demand for imported petroleum), for example Zimbabwe is embarking on a national biodiesel programme which if properly implemented could contribute to 10% of her fossil diesel consumption per year equivalent to 300,000 l/day.
- Boosting of local agriculture productions and additional markets and revenue to farmers; leading consequently to the increase of rural folks purchasing powers and quality of life. By way of example, an on-going ethanol project in Jigawa state, Nigeria is expected to provide up to US $4 billion investment facility to blend premium motor spirit

(PMS) with ethanol and help cushion fuel price as well as generate up to 7000 jobs[12].

- Beneficial environmental impact through the usage of organic municipal solid waste materials to generating a higher value end-product. The prototype carbon fund (PCF)-supported landfill gas to energy project located in the semi-arid interior of South Africa could reduce emissions related to coal-fired power production which include sulphur oxide, nitrogen oxide and particulates by displacing electricity from the grid.
- Reduced level of carbon dioxide emitted by motor engines and then preservation of the quality of the atmosphere.

In a recent public symposium organised by United Nations Foundation (2006), it was noted that biofuels could also provide opportunities for poverty reduction and for satisfying the energy needs in rural and remote region, help generate employment and local economic development opportunities; it helps curb global warming and contributes to the protection of human health from air pollution; and, it enhances energy security[13].

This paper analyses the energy geography in Africa, the economics of a biofuel process industry in Africa, and limitations to biofuel commercialisation and conclude by suggesting future courses of action to take to speed up biofuels commercialisation. It is believed that this paper will be of benefit to the energy policy makers (planners) and entrepreneurs not only on the continent but also in other developing countries.

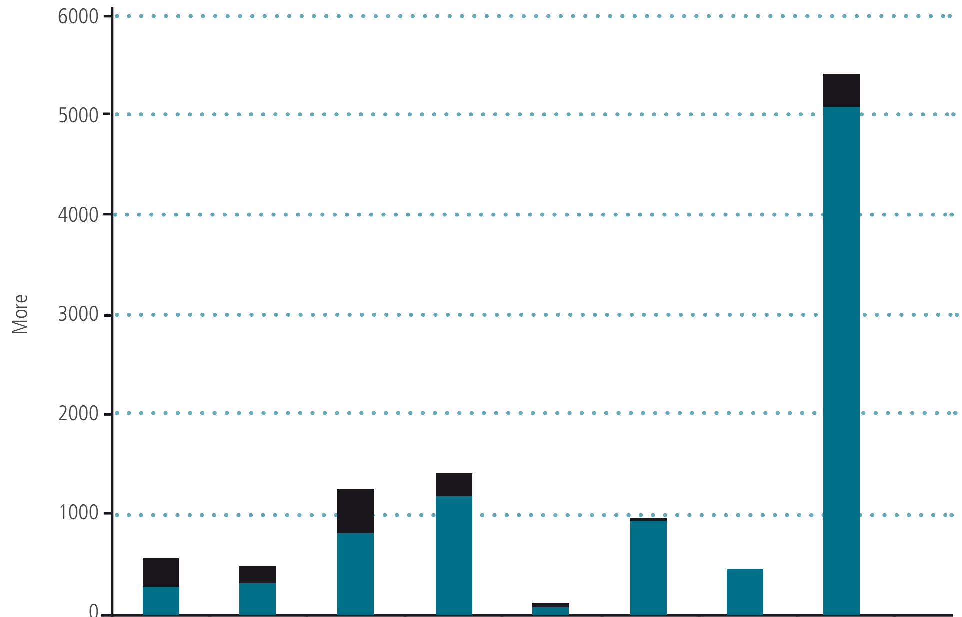
2. Energy Overview in Africa

Africa is the second largest continent after Asia making up only 10% of the world's population, equivalent to about 80% of India's population. It has a total surface area of 30.3 million km2, including several islands, and an estimated total population of 888 million[14]. Its population density in some regions is rather low. This is due in part to the Sahara Desert, which occupies one-fourth of Africa's landmass and is not suitable for habitation. In 1999, the population of sub-saharan Africa was estimated to be 642 million, over 80% of the African continent. Poverty in Africa is mainly rural. Africa is not only the poorest region in the world; it was the only major developing region with negative growth in income per capita during 1980–2000[15]. According to the World Development Indicators of 2006, the growth rate of Sub-Saharan Africa (4.8%) improved drastically in 2004 to exceed the global growth rate (4.1%) of that year. However, this improvement does not detract from the fact that Africa remains the poorest continent in the world with one-third of the population starving[16]. The continent remains fragile with perpetual poverty due to several factors. Among the factors identified include deterioration of ecosystems with 25% of dry lands in Africa carrying degraded soils; 10% of soils in the humid parts of Africa being susceptible to deterioration; and the fast-growing human population. Other factors are poor political and economic management that increases poverty and have resulted in precarious political and economic environments. There is a direct correlation between the poor and the use of traditional biomass where a large proportion of people who live on less than $2 a day use traditional biomass as energy source (Fig. 1).

FIGURE 1: THE LINK BETWEEN POVERTY AND TRADITIONAL ENERGY USE[17]

Source: UNDP, 2003: IEA, 2000

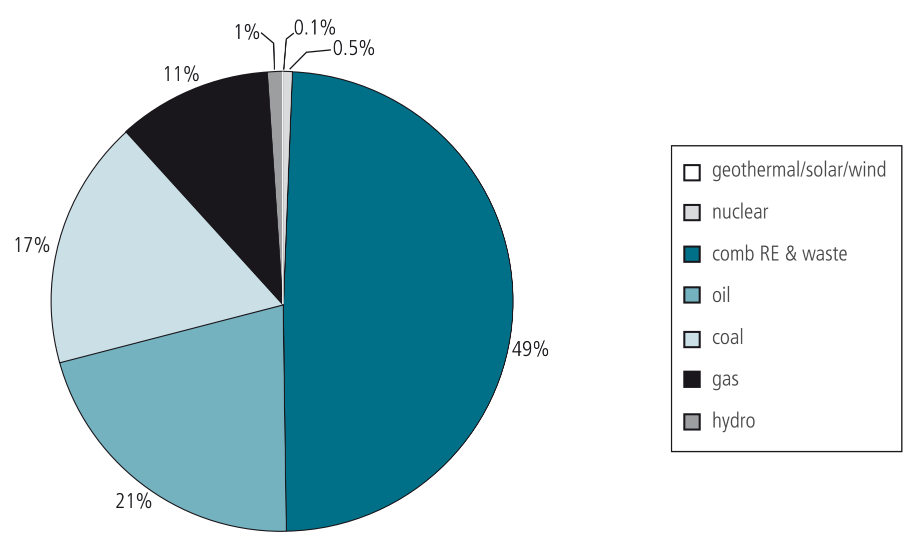
FIGURE 2: RENEWABLES SHARE OF TOTAL ENERGY SUPPLY[14]



	Africa	Latin America	Asia	China	Non-OCED Europe	Former USSR	Middle East	OECD
Share of renewables in total energy supply	279	135	400	243	10	27	3	305
Total primary energy supply	559	464	1224	1426	103	962	446	5395

Africa is an unexploited resource for biofuels development. Although the majority of African nations rely on biomass as a main energy resource, it is inefficiently used and to the detriment of a households' well being. Fig. 2 shows the share of renewables in the total primary energy supply (Africa renewables share is 50.1% in 2003). Tropical sub-Saharan African population is expected to serve as a prerequisite that will underpin the growth of the continent's economy in rural areas. The high poverty level in Africa is revealed in the consumption model of modern energy. Per capita consumption of modern energy in African continent is very low when compared to other continent. Out of the total primary energy supply of 514 Mtoe in the continent in 2001, 48.7% which is largely in traditional form is combined renewable and waste[18].

FIGURE 3: SHARE OF TOTAL PRIMARY ENERGY SUPPLY IN AFRICA IN 2001 [15]



The low levels of modern (commercial) energy consumption prevalent in Africa apart from the heavy usage of traditional (non-commercial) fuels-primarily biomass as indicated in Fig. 3 is also due to massively under-developed energy resources, poorly developed commercial energy infra-structure, widespread and severe poverty which makes it impossible for people to pay for conventional energy resources and landlocked status of some African countries (there are 15 landlocked countries in Africa) which makes the cost of importing commercial energy more expensive[19].

The energy resources distribution in Africa shows that every sub-region of Africa except East Africa is a net exporter of energy, at the same time importing petroleum products at the cost that is crippling the economy. North Africa is by far the largest, with significant oil and gas exports going to Europe and other markets. West Africa's exports are almost exclusively oil, and from one country—Nigeria. Southern Africa's net energy exports are oil (from Angola) and coal (99% of Africa's coal output) mainly from South Africa.

Central Africa is an oil-exporting region due to Cameroon, Congo and Gabon. East Africa is a tiny net energy importer (mainly oil). In 1997, only five countries (South Africa, Egypt, Algeria, Nigeria, and Libya) accounted for 78% (8.9 quads) of all energy consumption, and 84% (22 quads) of all energy production in Africa (Table 1).

Africa suffers from two sets of problems: dependence on export products that are of declining importance in world trade and the loss of market share for primary exports. This underlines the need for energy diversifica-tion, in which biofuel can play a vital role. RE technologies (RETs) of-fer developing countries some prospect of self-reliant energy supplies at national and local levels, with potential economic, ecological, social, and security benefits [21].

3. Biofuel Process Industry and Economics in Africa

The inexhaustible nature of biofuel as energy source is an important as-set for their future potential from the security standpoint. Biofuels, as the name implies, are fuels (solid, liquid and gas) derived from biomass, a renewable resource that can potentially be harvested sustainably. Biofu-els are made from biomass through biochemical (fermentation of sugar to alcohol, and anaerobic digestion or fermentation) or thermochemical processes (gasification, pyrolysis, liquefaction). The growing seriousness of the global energy problem and associated environmental pollution are substantially increasing the importance of the development and com-mercialisation of biofuel industry in Africa. The production and commer-cialisation of biofuels in Africa could provide an opportunity to diversify energy and agricultural activity, reduce dependence on fossil fuels (mainly oil) and contribute to economic growth in a sustainable manner. Several studies have reported significant decline in the unit cost of RET over the past two decades. Further reduction in cost can be expected with techni-

TABLE 1: AFRICAN COUNTRIES WHICH IMPORT AND EXPORT ENERGY[20]

Major energy exporter [a]	Net energy exporter	Importers [b]
Nigeria	Angola	Benin
Algeria	Cameroon	Eritrea
Libya	Congo	Ethiopia
South Africa	Democratic Republic of Congo	Ghana
Egypt	Cote d' Ivoire	Kenya
Gabon	Gabon	Morocco
Congo	Sudan	Mozambique
		Namibia
		Senegal
		Tanzania
		Togo
		Zambia
		Zimbabwe

[a] Major energy exports are in excess of 0.5 quads.
[b] Most of the African countries imports are very small (less than 0.3 quads).

cal progress and market growth[22]. Whilst the topic of "bioenergy" has received significant public and legislative attention in several developed countries such as Germany, Canada, USA and New Zealand and developing countries like Brazil and India, relatively little effort has gone into promoting modern bioenergy in African countries, despite the estimated large resource base in many of them [7]. For example, in South America, Brazil's sugarcane-based ethanol industry now produces about 160,000 barrels (1072 GJ) of oil-equivalent a day, assisting the country in achieving self-sufficiency in oil[23]. Also, in Sweden, bioenergy has grown into the second largest source of energy, contributing to reducing emissions of carbon dioxide and improving energy supply security. The use in 2003 alone was 378 PJ (105 TWh), or 42 GJ/capita[8].

There is lack of coherent biofuel strategy in Africa despite the increase in the price of conventional fuel on a daily basis, and their rising demand mainly due to psychological fear of geopolitical uncertainties compared to the dwindling convertible currency earning and rising evidence of climate change (2006 has been declared by the United Nations as International year of desserts and desertification).

There are very few operational commercial biofuel systems in Africa as that of smallscale systems. Existing bioethanol plants are concentrated mostly in the Southern African Development Community (SADC)-the southern tip of the continent such as South Africa, Malawi, Swaziland, Mauritius, and Zimbabwe. Other commercial ethanol producing countries are Ethiopia and Kenya. By way of example, ethanol programmes that produce a blend of ethanol and gasoline (gasohol) for use in existing fleets of motor vehicles have been implemented in Malawi, Zimbabwe and Kenya. There are strong indications that Nigerian cars may start running with a combination of petrol and 10% ethanol by the end of this year, signalling a breakthrough in efforts to find alternative fuel sources[24].

Available evidence indicates that these programmes have registered important economic benefits. In the case of Zimbabwe ethanol plant (Triangle Ethanol Plant), 60% of the whole plant is locally produced. The building was erected by local workers trained specifically for the job. It is estimated to be the lowest capital cost (the plant was designed to produce 120,000 liters ethanol per day with a capital cost of $6.4 million at 1980 prices) per litre for any ethanol plant at that time. However, in 1994–95, Triangle refinery decided to stop production of ethanol in favour of rectified spirit (an industrial alcohol used widely in printing solvent and capable of being refined to portable alcohol) which is exported to European destinations, and the blending of ethanol with petrol in Zimbabwe stopped at that time. This is attributed mainly to reduced government support [25].

Small-scale biogas plants are located all over the continent but very few of them are operational. It is estimated that only 25% of 300 units installed between 1980 and 1990 in Kenya are operational today. The high failure rate can be traced to the following main reasons[26]:

- Poor design and construction of digesters, wrong operation and lack of maintenance by users.
- Poor dissemination strategy by the promoters.
- Lack of project monitoring and follow-up by promoters.
- Poor ownership responsibility by users.
- Failure by government to support biogas technology through a focused energy policy.

The growth of large-scale anaerobic digestion (biogas) technology in the region is still at embryonic stage, but the potential is promising. The Kigali Institute of Science, Technology and Management (KIST) has developed and installed large-scale biogas (830m3 system in 2003 and 1430m3 system in 2005) plants in prisons in Rwanda to treat toilet wastes and generate biogas for cooking. A recent initiative to tap energy from waste land fills was the US $2.5 million Global Environment Facility (GEF)-financed project in Dar-es-salaam, Tanzania which was expected to utilise an estimated 23,000m3 of methane generated by the process of anaerobic digestion. It was estimated that large-scale replication of the pilot GEF Tanzania biogas project could result in the generation of electricity equivalent to over 10% of the Tanzania's total electricity-generating capacity.

This promising initiative was, however, ended prematurely primarily due to problems of cost escalation which were partially linked to technology selection problems. The project also faced significant institutional constraints[22]. It is pertinent to note that most of the biogas plants in Africa are set up not only for the purpose of producing energy (cooking and lightning, fuel replacement, shaft power) but also as environmental pollution abatement system. Some of these are located in South Africa, Rwanda, Kenya, Tanzania, Burundi and Ghana.

Biodiesel technology can be regarded as an emergent technology in Africa. To date, no commercial biodiesel plant has been built in Africa. In Ghana, a biodiesel plant by Anuannom Industrial Projects Limited (1.2 million-dollar factory, 360,000 ton production/annum), which has been under construction since 2003 would have been the first commercial biodiesel plant in Africa, but the construction was stalled probably due to lack of capital base to complete the construction and dispute[27,28]. There are very few smallscale biodiesel plants in Africa. Biodiesel SA in South Africa created by Daryl Melrose produces biodiesel from used vegetable oil. Efforts are in place to establish one in the nearest future. Presently, most countries in Africa are busy cultivating Jatropha curcas (physic nut), a drought-resistant and frost hardy plant. The seed of J. curcas contain high percentages (30–35%) of oil, which can be extracted for further processing.

There has been a tremendous increase in biofuel technology development and commercialisation in other continents. One of the reasons for this is sustained government support (in France, tax exceptions for biofuels is 0.35 EUR/l for biodiesel and 0.50 EUR/l for bioethanol and America has bioethanol subsidies of US $0.51/gal)[29]. For example, American output of maize-based ethanol is rising by 30% a year; Brazil, long the world leader in bioethanol production, is pushing ahead as fast as the sugar crop from which ethanol is made will allow; China, though late to start investing into bioenergy technology, has already built the world's biggest ethanol plant (The Jilin Tianhe Ethanol Distillery has an initial capacity of 600,000 ton a year—2.5 million liters per day and potential final capacity can be raised to 800,000 ton/year)[30]; Germany, the big producer of biodiesel, is raising output 40–50% a year while France aims to triple output of the two fuels (bioethanol and biodiesel) together by 2007; Britain, taking a backward stance has already embarked on investment into biodiesel industry. Also after a long research on biofuels, a Canadian firm has plans for a full-scale ethanol plant that will replace today's grain or sugar feedstock with straw. China, India, and Nepal have extensively utilised biogas as a source of energy and as liquid fertilizer for soil enhancement since the 1950s[31].

The main contentious problems of biofuel commercialisation in Africa relate to economics and political will. The economics of biofuel production and consumption will depend on a number of factors specific to the local situation. These factors include (a) the cost of biomass materials, which varies among countries, depending on land availability, agricultural productivity, labour costs, etc.; (b) biofuel production costs, which depend on the plant location, size and technology, all of which vary a great deal among countries; (c) the cost of corresponding fossil fuel (e.g., gasoline, diesel) in individual countries, which depends on fluctuating petroleum prices and domestic refining characteristics; and (d) the strategic benefit of substituting imported petroleum with domestic resources. The economics of biofuel production and use, therefore, will depend upon the specific country and project situation[32]. The variation of cost with location is referred to as location factor or index. Location does not only affect the cost of construction plant directly but also indirectly. In considering the cost of constructing a plant in other locations, the effects of perceived, real and to-be investigated factors like different laws, often a different language, the political and social environment, the industrial capability which is a function of availability of bulk materials, construction labour and productivity, cultural and institutional factors, the financial resourcefulness and economic situation in the location needs to be investigated. The effects of these several factors on cost will be very different in a developed country where the existing cost estimation models are concentrated, as compared with a developing country, such as countries in Africa. For biofuels projects to be developed and commercialised in the various African countries, it will thus be important that an indigenous theory of cost prediction, central to economic feasibility studies, be developed. It appears that there is no such theory, and not even a good collection of relevant data.

Economic competitiveness against mainly fossil fuel is a very common argument against RE. The cost of producing very low CO2 biofuels such as cellulosic ethanol and methyl ester (biodiesel) are still higher than the cost of gasoline and conventional diesel. The gap is expected to narrow with the current hike in the price of oil. The costs could also probably decline in the future, especially if new processes being developed for producing cellulosic ethanol are successful, and subsidies as well as tax exemptions, which are currently applied in Europe and USA are used[31].

For many products and services, unit costs decreases with increasing experience. This effect is often referred to as learning by doing, progress curve, experience curve or learning curve. The learning curves are empirical and represent graphically how market experience reduces prices for various technologies and how these reductions influence the dynamic competition among technologies. Until several commercial-scale production facilities are built and more real-world experience is gained, the production costs of these fuels may not change significantly.

In nearly all production operations, some change in cost structure occurs as plant size is changed. Thus the theory of economy of scale presupposes that there exists an optimum size plant for most production operations[33]. Economies of scale and technological advancement can lead to increased competitiveness of these renewable alternatives, thereby reducing the gap with conventional fossil fuel. One of the most important examples is the one provided by Brazilian Alcohol Program (PROALCOOL), established in 1975 with the aim of reducing oil imports by producing ethanol from sugarcane. The programme has positive environmental, economic and social aspects and has become the most important biomass energy programme in the world. The Brazil ethanol production cost is now competitive from close to US $100 a barrel at the initial stage of the programme in 1980.

This increase is measured in terms of progress ratio (PR) of the technology, which is the variation of prices according to cumulative sales. Thus, an efficient technology penetration is one that achieved low PRs. In US dollars, sugarcane ethanol produced in Brazil has shown PR of 93% (1980–85) and 71% (1985–2002)[34].

Nguyen and Prince[35] also consider ways to reduce the cost of ethanol for bioethanol plant (in Australia) by optimising plant capacity. They derive a simple model of general applicability by balancing crop transport costs (which increase with plant size) against the production costs, which decrease as economic of scale. The relationship is generally applicable to all bioenergy conversion plant in general, which requires biomass to be transported from surrounding area. At the optimum, the cost of transporting crop, per unit quantity of fuel, must be a predictable proportion of the unit cost of production, generally in the range of 0.4–0.6. The ratio allows an easy check as to whether a design or operating plant is near the optimum size, and if not what action would improve the economy of the operation. This relation can also be used to predict the consequences of cost changes.

By way of example, in a relatively recent study of biofuel production in Africa[36], which investigated "economics of small-scale ethanol production from breadfruit and cassava flours via plant enzyme and acid hydrolysis" the working capital required for the plant process was estimated with the method reported by Lyda (1972) while the estimation of equipment running costs was based on the method of Degamo et al. (1979) in which case it was assumed that maintenance and repairs costs would increase by a uniform amount (G) and would constitute an arithmetic series. However, the estimation methods used were obsolete and disparate due to difference in location.

Economics of two types of biofuels namely biodiesel and biogas which are among a wide range of sustainable rural energy options will be discussed.

3.1. Biodiesel Economics

The technology of converting vegetable oils and animal fats into biodiesel has been extensively studied[37-39]. Biodiesel can be made from two different chemical processes. The most commonly used and most economical process is called the base-catalysed esterification of the fat with methanol typically referred to as the "methyl ester process". Base esterification is preferred because the reaction is quick and thorough, it occurs at lower temperature and pressure resulting in lower capital and operating cost[40]. This process creates four main products namely: methyl ester (biodiesel), glycerin, feed quality fat and methanol that is recycled back through the system. Most, if not all, existing commercial biodiesel plants use the methyl ester process.

Biodiesel can also be produced using ethanol, oil feedstock, and a catalyst to make an "ethyl biodiesel". The benefits sometimes alluded to ethyl biodiesel include the following: the process does not require an alkali reagent such as sodium hydroxide (NaOH) and also the reaction process is a one step reaction that takes place at ambient temperature (without additional heat). Its drawbacks include sensitivity to water, which can result to quality problem in handling and the relatively high production cost per unit[41,42]. The quality problem and the higher operating costs could make it difficult to compete effectively with the more established methyl biodiesel production process.

A major technological issue in the biodiesel production is the question of whether to construct a batch or a continuous plant. Most plants currently in operation are batch plants and produce discrete "runs" of product. These plants in general vent unused methanol into the air and do not recapture unused catalysts resulting in high operating cost of the plant and serious environmental issue from the disposal of polluted water. Processing in discrete runs can at times create quality and homogeny problems in the final biodiesel product. However, batch operations have the benefit of being feasible on a small scale and also it is an established design. The former benefit of biodiesel will find a better application in the rural areas in Africa due to the financial base from local investors.

Continuous flow plants are not nearly as common as the batch counterpart. It has been studied to have several important operating cost advantages over the batch process. It is possible to reuse excess NaOH that has not become part of the biodiesel and reuse catalysts, which are lost in batch processes. The major obstacle to continuous flow operation appears to be the higher initial investment required. This is due to the fact that continuous flow generally requires a larger scale plant; thus the initial capital outlay to build a continuous flow plant is generally higher. Another issue is the availability of feedstock, which adds to the high initial costs. Price of crops as well as the season of the year will affect the overall cost of the biodiesel. This can be a major problem for a small start-group especially in the developing country Africa where the financial institutions lack understanding of the RE projects and their potential benefits. Also, there are high risks, difficult to be accurately assessed, associated with technological immaturity and unpredictable government energy policies; thus, for the smaller start group, it can be excessively difficult to find financing for a larger biodiesel plant size.

When evaluating technology and process alternatives, it is important to consider not only the capital costs of the initial investments but the operating costs of running the plant. More attentions tend to be focused on the capital expenditure required to build the plant. This is reasonable since it is the first barrier that must be overcome in establishing a biodiesel production plant. However, the long run success of the plant is frequently more dependent on the daily operating performance than on the amount of the initial capital outlay invested. Low quality, inconsistent in the product quality, poor product yield or high operating costs resulting from the day-to-day running cost of the plant can cause low efficiency or total failure of the venture.

The economics analysis of a soybean methyl ester project indicate that the cost could be broken into the following categories: raw material cost, capital cost and operating cost. The single most important factor influencing the economic viability of biodiesel is the feedstock cost. The average cost of raw material for biodiesel plant ranges between 60% and 75% of the total biodiesel production cost[43]. Therefore, economics of biodiesel production should be centred on its working capital.

Investment in plant and equipment (capital cost), while extremely important in establishing biodiesel production capabilities, is much less important than feedstock costs in the final net price of biodiesel. Therefore, the cost of producing feedstock has been the major obstacle to economic feasibility of biodiesel. There is no single cost for biodiesel production, but rather a wide range of costs depending largely on the source of feedstock used and to a lesser extent on the co-product credits for the high protein meal and glycerin. It is observed that biodiesel production facilities are relatively insensitive to economies of scale normally enjoyed by larger plants. This is due to the fact that scale-dependent variables such as labour only constitute a small portion of operating cost[44]. Economics of biodiesel production will also depend greatly on localised variable (site specific). Locations that offer low utility rate (e.g. electricity), existing facilities, and close proximity to large oil seed acreage (farm) would be a good location.

We have investigated the sensitivity of the Nguyen and Prince model (Nguyen and Prince, 2004) outcomes viz throughput tonnage and biodiesel cost to a wide range (250%) in variables such as the capital cost capacity factor, labour costs, depreciation factor, transport cost and seed cost. It was revealed that finding the optimum (least cost) plant capacity is an important element in planning for the establishment of a biodiesel-processing plant as the result showed that the optimal plant size can vary widely in the range (500–5000 kg/h) for the plant sizes explored. Also the results obtained in the study generally show a near flat profile around the optimum plant size (biodiesel cost vs. plant capacity) which indicates that smaller than optimum plant observed for each of the variations in the parameters can be built with only minor cost penalty[45].

3.2. Biogas Economics

Biogas which is produced by the anaerobic fermentation of organic material is distinct from other renewable energies like solar, wind, thermal and hydro sources because of its importance in controlling and collecting organic waste materials which, if untreated, could cause severe public-health and waste pollution problems, and at the same time producing fertiliser and water for use in agricultural irrigation. Unlike other forms of RE, biogas production systems are relatively simple and can operate at small and large scales in urban or very remote rural locations[46], and nor is it monopolistic. Biogas technology, therefore, contributes to control of environmental hazards (preventing air pollution; and mitigating GHG emissions) and recycling of nutrients whilst alleviating dependence on imported fuel. It also reduces the use of forest resources for household energy purpose and thus slows down deforestation, soil degradation and resulting natural catastrophes like flooding and desertification.

The economy of a biogas plant consists of large investments costs, some operation and maintenance costs, mostly free raw materials, e.g. animal dung, aquatic weeds, terrestrial plants, sewage sludge, industrial wastes, poultry litter etc., and income from sale of biogas or electricity and heat. Sometimes, other values can be added, e.g. for improved value of sludge as a fertilizer. The future cost of biomass energy, biogas inclusive, will not only depend on factors such as the extent of technological advances in biomass-energy conversion and feedstock productivity but also on the good understanding of the relation between capital costs and plant size which is an important determinant of the scale of a fixed-proportions enterprise[47,48]. In assessing the economic viability of biogas programmes one should distinguish four major areas of applications: individual household units, community plants, large-scale commercial animal-rearing operations, and industrial plants. In each of these cases, the financial feasibility of the facility depends largely on whether outputs in the form of gas and slurry can substitute for costly fuels, fertilizers or feeds which were previously purchased, while at the same time abating pollution. Economics of biogas technology rest on the following factors[49]: (a) the useful energy content of different fuels, e.g., dung, fuel-wood, kerosene and biogas; (b) the efficiencies with which these fuels are currently being used, or the possible equipment which could lead to higher efficiencies; (c) the NPK contents of different organic fertilizers, and the fertilizeryield response under different agronomic conditions and crop rotations; and (d) behavioural aspects of the energy sources or organic fertilizers such as current use patterns etc.

Our own study of small and institutional scale biogas plants in Africa indicates diseconomies of scale with the cost capacity factor (n) of 1.20. The cost capacity factor obtained is notably greater than the conventionally used 0.6 factor rule[50]. The economics also showed that biogas technology economics is not affected by geographical limitation and location (costal and landlocked locations). This trend collaborates the fact that a biogas technology can be locally produced or built, and locally operated. The cost of the technology is, therefore, largely independent on exchange rate volatility or geographical location of the plant.

3.3. Fuel Ethanol Economics

The use of ethanol dated back to 100 years, but it was the oil shock of the 1970s and the push in the 1980s and 1990s for more environmentally acceptable fuel that has seen its rapid growth of production and consumptions in countries like Brazil, the USA and Europe. The recent interest in ethanol production in Africa is driven partly by the increase in oil price and its low convertible currency earnings. At present, the global ethanol production is over 40 billion accounting for less than 2% of the total petrol consumption. The International Energy Agency (IEA) predicts that ethanol alone has the potential to make up to 10% of world gasoline use by 2025 and 30% in 2050.

Ethanol is produced by both biological and physical process (fermentation of sugar with additional conversion step to fuel grade by distillation). It can be produced in two forms: hydrous (or hydrated) and anhydrous. Hydrous ethanol typically has purity of about 95% plus 5% water. This can be used as a pure form of fuel in specially modified vehicles. Anhydrous alcohol (water-free or "absolute") on the other hand is formed when the last traces of water are removed. Anhydrous ethanol requires a second stage process to produce high-purity ethanol for use in petrol blends; in effect, the 95% pure product is dehydrated using Azeotropic processes or a molecular sieve to remove the water, resulting in 99% pure alcohol. Ethanol can be produced from three main types of biomass rawmaterials: (a) sugar-bearing materials (such as sugarcane-juice, molasses, sorghum, wheat) which contain carbohydrates in sugar form; (b) starches (such as corn, cassava, potatoes) which contain carbohydrates in starch form; and (c) cellulose (such as wood and agricultural residue) whose carbohydrate form is more complex[32]. While all strategic factors such as economics and environment protection favour the use of ethanol as a fuel extender in place of fossil fuels, the major source of deterrence seems to emerge from the alcohol based chemical industry. African countries are amongst the few that have developed significant presence in alcohol-based chemical industry in the world.

It is difficult to provide generally information about ethanol fuel. This is because the production cost of ethanol and its economic value to the consumer and to the country depend on many tangible and intangible factors making the costs very site-specific and variable even from day to day. For example, production costs depend on the location, design and management of the installation, and on whether the facility is an autonomous distillery in a cane plantation dedicated to alcohol production, or a distillery annexed to a plantation primarily engaged in production of sugar for export[51].

There are different economic strategies for co-producing sugar and ethanol. The main choice is whether to produce in fixed or flexible quantities. Fixed quantities production generally means reserving all of the economically extractable sugars for sugar production and using "C" molasses or "final molasses" for ethanol production. C molasses is not valuable for sugar production because the sugar extraction has reached a point of diminishing returns. Such a strategy would be chosen when the market value of sugar is generally higher than that of ethanol in production-equivalent terms, and is expected to remain higher for the foreseeable future. Alternatively, sugar extraction can be halted after the first or second stages, resulting in "A" or "B" molasses, respectively. These molasses steam will have fermentable sugars that can still be economically extracted. However, the presence of additional fermentable sugar increases the efficiency of ethanol conversion. Consequently, if ethanol is expected to have a market value close to or greater than that of sugar, then it makes economic sense to prioritise ethanol production over some sugar production, by using molasses A or B as the ethanol feedstock. Distilleries can benefit from having the flexibility to switch these alternatives balances of molasses use[32].

While the economics for ethanol production is important, the real incentives for fuel ethanol production have been supported by the agricultural sector, national energy security, and environmental benefits. Economies of scale have been shown to exist in construction costs of ethanol plants. Gallagher et al.[48] suggested an estimated power factor of 0.86 for dry mill ethanol industry based in the USA. However, average capital costs for plants of a given size at a particular location is still highly variable due to costs associated with unique circumstances, such as utility access and environmental compliance. Since the production of fuel grade ethanol involves sophisticated and expensive process and equipment, economics of its operation should carefully be examined.

We have investigated the ethanol cost and optimum plant size for bioethanol plant located in Delta and Lagos state of Nigeria using three different types of cassava yield (10, 18 and 25 metric ton/ha). The study established that, both the yield of cassava per unit area and the location of the biomass have a significant impact on the ethanol cost and optimum plant size. The optimum plant size decreases as the agricultural yield of the cassava decreases (increased cost of cassava to meet the production target); 25 metric ton/ha gives the minimum cost of ethanol (112.44 naira/Kl) with optimum plant size (60,000 l/day). The implication is that for low agricultural productivity, it is better to build smaller distilleries. Of significance in this regard is the determination of optimum size of the plant, which will minimise the cost of production.

4. Barriers to Biofuel Commercialisation in Africa

For developed countries, RE sources primarily serve as a means to diversify the national energy supply and a means by which the concept of sustainable development can be implemented and GHG emissions can be reduced. However, for developing countries, renewables in general and biomass energy in particular play a very different role and is used in different ways. There is a great difference of background motives and a resulting performance gap between the South and the North in terms of harnessing RE products such as biodiesel. Therefore, it has become important to fill this gap with experiences gained in the developed world, but adapted to the needs of developing countries.

The fundamental problems to commercialisation of biomass-derived energy exist in both developed countries and developing countries. However, the magnitude and characteristics is more pronounced in developing countries. The multi-dimensional differences among regions and countries make the analysis of the magnitude of these hurdles more complex. Despite national differences, it is possible to generalise some barriers. The table below (Table 1) gives the schematic view of barriers to accelerated adoption and commercialisation of biofuel technology in Africa. A classification of developing countries is made in line with economic and technical development status in line with study carried out by Bhagavan[52].

Various generic barriers currently identified to hinder the adoption and commercialisation of biofuel technologies in Africa apart from the high cost of raw materials and other economics-related constrictions can be categorised as technological and non-technological (policy, legal, financial, institutional, cultural, social etc.) constraints. These barriers are in a way general for RE (Table 2).

- Type A: Technologically advanced developing countries, with well diversified and fairly comprehensive industrial, energy and R&D infrastructures e.g. South Africa.
- Type B: Technologically advancing developing countries, which are industrialising fairly fast, but are still quite limited in the diversification of their industrial, energy and R&D infrastructure e.g., Egypt, Morocco, Algeria.
- Type C: Slowly industrialising developing countries, with still very limited infrastructure in industry, energy and R&D, such as, Nigeria, Mauritius, Libya.
- Type D: Technologically least-developed countries: most sub-Saharan Africa countries, e.g., Ethiopia, Chad, Burundi, Mozambique, Ivory Coast, Niger, Dr Congo, Somalia, Mali, and Sudan.

4.1. Policy, Institutional and Legal Hurdles

The commercialisation of biofuel systems requires adequate institutional support and corroboration. Lack of coordination among institutions involved in RE development and commercialisation (excessive bureaucratic bottleneck) such as government ministries of energy/science and technology, research institutes, and financial institutions, hinders efforts for the accelerated adoption of RETs. Ghana established the National Energy Board (NEB) in 1983 with one of its mandate to develop and demonstrate RE in the country. The NEB ceased to operate in 1991 and the RE activities were later taken on by the Energy Sector Development programme (ESDP)

TABLE 2: SCHEMATIC BARRIERS ASSESSMENT ON A CLASSIFIED COUNTRY BASIS (ADAPTED FROM[52])

	Institutional/policy hurdle	Technical hurdle	Economic hurdle	Financial hurdle	Information hurdle	Capacity hurdle
Type A	**	*	**	**	*	*
Type B	**	**	**	**	**	**
Type C	***	**	***	***	***	**
Type D	***	***	***	***	***	***

Low: *, Medium: **, High: ***.

established in 1996. The ESDP closed down in 2002 and has in its place the DANIDA supported National Renewable Energy Strategy[18].

A major argument against RE in general and biofuel in particular is the large subsidies requirements. Subsidies conceal the commercial energy cost. This badly allocates scarce capital resulting to imbalanced competition between energy sources. Failure on the part of government to extend the subsidies enjoyed by the conventional energy to RE technology is also a hurdle that needs to be resolved. In addition, very few of the African countries have in place clear strategies and targets for RE development generally and specifically. The increase in biofuels utilisation and development in other continents over the past years is due to government policy decision. In North America, policies that help grain-based ethanol compete in the market were extended, and additional strategies to increase biodiesel utilisation are being considered. In 2002, German parliament decided to exempt all biofuels from gasoline tax until the end of 2009. In Europe, guidelines to incorporate certain level of alternative fuels into the existing motor fuel have been established and biofuels are expected to be the primary means of achieving these goals[53].

Many developing countries are characterised by a weak legal system, with problems ranging from lack of appropriate legislation, little respect for the judicial system to weak legal enforcement. Investors may be discouraged by difficulties in upholding and enforcing contracts. Lack of positive legislation that would encourage investors (especially the sugar companies) in Kenya to diversify into alcohol production is a typical example. However, due to the surging crude oil prices (from US $28 to US $62 over the past 14 months) key producers of sugar like Brazil and India have scaled back their sugar production in favour of ethanol, which uses the same raw material. The increase in Germany and Italy in biodiesel production from 450,000 and 210,000 ton in 2002, respectively to 1,088,000 and 419,000 ton is due to favourable legislation[53]. In some African countries, the hostile social climate and political instability prevent opportunities of international collaboration and support.

4.2. Financial Limitation

The high initial cost of production of biofuels and inadequate financing arrangements for biofuel technology has been identified to be an important barrier to biomass energy commercialisation in most African countries. Existing capital markets do not favour smallscale investments as normally required for some biomass energy. This is, however, not peculiar only to African countries[45,55]. Some of the factors contributing to the formation of this barrier are:

- Lack of available credit facility with low interest rate.
- Bias against biomass energy and lack of adequate information of the potentials of biofuels project.
- The perceived risks of biomass energy projects also act as a major barrier to investments.
- Unfavourable government policies.

4.3. Technical/Infrastructure Hurdles

Within the category of technical barriers, different RETs present distinct barriers related to technical issues[54]. The supply of feedstock (feedstock currently used for commercial biofuel production is agricultural crops) is crucial to the success of biofuel industry.

Obtaining agricultural yields predicted to produce a percentage of biofuels for transport in Africa will be problematic. By way of example, to supply 30% by volume of the petrol used in South Africa would require of the order of 5 million tons of maize. This is a large amount as it is only half the maximum available capacity[56]. Another factor is development of biofuel technology is likely to be based on the developed world for the foreseeable future. This is because only industrialised countries (including the BRIC countries—Brazil, Russia, India and China) have the technological base, the capital, infrastructure required to push large-scale new development in the energy sector[57]. This is probably due to lack of technical and marketing infrastructure for the effective unpacking and adaptation of available technologies and effective social marketing of the products. Low to lack of cooperation/partnership with international bodies such as-Renewable Energy and Energy Efficient Partnership (REEEP), a public–private partnership launched by the UK along with other partners at the Johannesburg World Summit on, Sustainable Development in August 2002. This partnership actively structures policyinitiatives through concerted collaboration among its partners for clean energy markets and facilitates financing mechanisms for sustainable energy projects. An example of how the partnership will boost biofuel commercialisation is the recent grant of h70,000 gotten by the Nigerian National Petroleum Corporation (NNPC), from REEEP from Germany to support detailed feasibility study (research analysis on how to achieve improved target yield performance for cassava whose current national average of 15 ton/ha is considered marginal to feed the proposed ethanol plant in the country.) at different target locations[58]. Attempt to import the biofuel technology from the developed countries (technology transfer) to Africa will fail due to lack of proper understanding of peculiar African features (the technology being transferred is not appropriate to the local context and demands, or is not adapted to the local environment). On the positive side, the nascent biofuels industry should look at how the brewing and the sugar industry manage to do well in Africa. Inadequate maintenance and bad quality of products (lack of standardisation and quality control) is due to the fact that the technology and option are not suited to local African resources and need. Technical success of biofuel project will be a function of capacity/ manpower availability to operate and carry out maintenance operation on the plant and of course spare part availability. This is obviously lacking in most African countries. It has been discovered that the capital cost of a plant varies significantly from place to place depending on the infrastructure already in place. The surrounding infrastructure will, therefore, influence the profitability of the project.

4.4. Information Hurdles

Lack of awareness and limited information on the national RE resource base, their benefits both economically and environmentally is a barrier to the market penetration of RE in general and biofuels projects specifically in most African countries. The public is, therefore, not educated to influence the government to begin to take more decisive initiatives in enhancing the development, application, dissemination and diffusion of biomass energy resources and technologies in the national energy market. The fact that the stakeholders and the consumers are not sensitised to the potentials of biomass energy is another issue. This will probably affect the view of investing as risky.

Poor telecommunications infrastructure (especially poor internet access, and lack of adequate telephone access—this is changing with the advent of mobile telecoms) and high cost of services is also a source of barrier to biofuel commercialisation. Among the benefits of telecommunications for improving efficiency and productivity are the following:

- Reduction of travel cost: in many cases telecommunications can be substituted for travel, resulting in savings in personnel time and travel costs.
- Energy savings: telecommunications can be used to increase the efficiency of shipping so that trips are not wasted and consumption of fuel is minimised.
- Decentralisation: availability of telecommunications can help attract industries to rural areas, and allow decentralisation of economic activities away from major urban areas.

There is often no industrial association or other co-ordinating body that can help todevelop networks of actors in the RE sector.

4.5. Capacity/Manpower Hurdles

The limited availability of correctly trained and skilled manpower is one of the most critical requirements to the development and market penetration of biofuels in Africa. This is largely due to the exodus of highly trained manpower from developing countries most especially Africa to industrialised nations. By a way of example, Africa as a whole counts only 20,000 scientists (3.6% of the world total) and its share in the world's scientific output has fallen from 0.5% to 0.3% as it continues to suffer the brain drain of scientists, engineers and technologists[59].

The increased number of this exodus attributed to the deteriorated political, economic, and social conditions in Africa reduces the availability of skilled manpower (human resources) which African countries need so badly for self-reliant and sustainable development. This has led to increased cost of doing business in Africa as expatriates to carry out installation, operation and maintenance of biofuel technology need to be imported.

5. Conclusion

Energy is a key factor in industrial development and in providing vital services that improve the quality of life. However, its production, use, and by-products have resulted in major pressures on the environment, both from a resource use (depletion) and pollution point of view. The decoupling of inefficient, polluting fossil energy use from development represents a major challenge of sustainable development. The long-term aim is for development and prosperity to continue through gains in energy efficiency rather than increased consumption, supported by a transition towards the environmentally friendly use of renewable resources. On the other hand, limited access to energy is a serious constraint to development in the developing world, where the per capita use of energy is less than one-sixth that of the industrialised world.

Renewable energy technologies (RETs) and specifically biofuels offer developing countries some prospect of self-reliant energy supplies at national and local levels, with potential economic, ecological, social, and security benefits (biofuels are a component of the diversification for future energy demand). Achieving the widespread utilisation of biofuels can be realised through proper understanding of its economics. NEPAD and the African Union (AU) both have roles to play in developing rational energy policy and encouraging biofuel investment across the continent. Information exchange and experience sharing should be encouraged amongst institutions and practitioners that are engaged in the promotion of sustainable consumption and production. In this regards, the on-going African Round-table on Sustainable Consumption and Production (ARSCP) sponsored by UNEP and UNIDO is a step in the right direction towards overcoming the commercialisation hurdles. Actions to globalise the production and utilisation of biofuel, including technology sharing between African countries and others should be encouraged. Brazil and the USA can contribute enormously to the commercialisation of bioethanol in Africa, whilst the EU has made significant advances in biodiesel, and India and China have much experience with biogas.

More robust tools are needed for estimating capital and operating costs of biomass to fuel conversion plant in African countries, concentrating on parameters such as plant size, type of feedstock, exchange rate, and other location-specific information, variables, to investigate the applicability of the techniques developed, specifically (to demonstrate how biofuel plant size optimisation will benefit from availability of better capital and operating cost-estimating techniques); to estimate the revenues that may be expected from avoided carbon emissions. The greater the uncertainties of project cost such as capital cost, the more cautious investors are likely to be. Hence the more accurate these factors are, the greater the likelihood of the more marginal projects proceeding, to the benefit of all concerned. There is thus a need to develop cost-estimating tools that can help:

- Generate baseline data for the technological and economic development of biofuel production and utilisation on the African continent. This will also expedite the environmental and economic benefits of renewable energy.
- Map out business opportunities for energy companies and entrepreneurs.
- Assist governments to reform and harmonise biomass-based energy regulations and legislation. For example, efforts are needed to promote a long-term perspective on the total energy system taking into consideration externalities, the depletion of fossil energy sources and the reduction of supply risks through the diversification of the primary energy supply bases.

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CLIMATE CHANGE AND CARBON DIOXIDE (CO_2) SEQUESTRATION:

AN AFRICAN PERSPECTIVE*

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Since 1990 carbon dioxide emissions in Africa have increased by about 50%. The total carbon dioxide emissions of the entire African continent are not, however, anywhere near those of countries such as India or China. Yet certain African countries have per capita emissions comparable to some European countries. What is the outlook for Africa? How should African countries respond as it becomes increasingly likely that climate change is occurring? Increased industrial growth and more foreign investment in Africa, especially in countries that are politically and economically stable, have led to huge commercial developments such as the In Salah gas project in Algeria, which releases more than a million tons of carbon dioxide annually; and synthetic fuel plants and power stations in South Africa that generate more than 350 million tons per year. In this perspective should some African countries be required to limit greenhouse gas emissions or should they be immune to 'environmental taxation'? This paper critically reviews the carbon dioxide problem in some parts of Africa and its role in climate change.

1. Carbon Dioxide: A Global Threat?

Climate change is at the centre of increasing global concern. Average air and sea temperatures have increased appreciably during the last century. The international and scientific communities are in agreement that most of this increase is due to the rising carbon dioxide (CO_2) concentration in the Earth's atmosphere mainly from the burning of coal, oil and natural gas. Amongst possible solutions for the reduction of excessive greenhouse gases in the atmosphere is the capture and sequestration of carbon dioxide[1]. This paper focuses on the extent to which some countries in Africa have contributed to global warming, and explores some of the solutions proposed to sequester carbon dioxide to alleviate the impact of climate change.

* This paper was first published in the International Journal of Environmental Studies, 64:5 (October 2007).

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The recently released Fourth IPCC Assessment Report[2] declares:

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.

This is a definitive statement from the Intergovernmental Panel on Climate Change (IPCC) that global warming is happening. The IPCC also maintain that it is very likely[2] that much of the observed warming since the middle of the 20th century can be directly attributed to increasing concentrations in the atmosphere of anthropogenic greenhouse gases – gases resulting principally from human activities. Extensive studies of ice cores reveal that atmospheric concentrations of three of the principal anthropogenic greenhouse gases – carbon dioxide, methane and nitrous oxide – have been increasing steadily since the beginning of the industrial era[2,3]. Carbon dioxide is the major contributor (between 50 and 60%) to the anthropogenic greenhouse effect, while methane and nitrous oxide, as well as the halocarbons and tropospheric ozone, together contribute the remaining 40–50%[3,4]. Because of this, considerable time and effort are being spent in trying to control emissions of anthropogenic carbon dioxide.

If we consider the source of this anthropogenic carbon dioxide, the majority is due to the use of natural gas, oil and coal to produce energy or, for transportation. For example, global emissions of carbon dioxide resulting from the combustion of fossil fuels[5] in 2003 represented 26.0 Gt (table 1)[6]. The rest of the emissions, estimated to be ~6 Gt per year[3], arise through changes in land use, principally as a result of deforestation to create agricultural land. Although the contribution of anthropogenic carbon dioxide may seem to be insignificant when compared to the ~200 Gt of carbon (> 700 Gt of carbon dioxide) that naturally exchanges each year between the atmosphere, the oceans and the land masses[3,4], it is sufficient to influence the radiation balance of the Earth.

2. Outlook for Africa

When the conclusions of the IPCC[2] are considered within an African perspective, the questions that come to mind are: to what extent is the African continent contributing to the problem of global warming through its emissions of carbon dioxide? And, should some countries in Africa be required to limit their emissions under the Kyoto protocol? It is clear from table 1 that Africa is responsible for only a small part (3.6%) of global carbon dioxide emissions arising from fossil fuel use, despite having a population of close to 900 million – roughly 14% of the world's population[7]. With 0.94 Gt of carbon dioxide, the African continent emits less than single nations such as China, India, Russia, Japan and the USA[8]. In addition, per capita emissions in Africa (1.1 t/year of carbon dioxide), represent 25% of the world average, and a mere 5% of annual per capita emissions in North America (table 1). However, when the data for Africa are further refined, a very different picture emerges. Figure 1 shows that considerable variation in total emissions of carbon dioxide exists in the different regions of Africa, with Northern Africa and Southern Africa being responsible for a significant proportion of the emissions on the African continent[8]. A closer look tells us that South Africa produces 40% of the emissions of the continent, or 356 million tons of carbon dioxide annually, while Egypt, Algeria, Nigeria, Libya and Morocco together provide a further 44%. There is also a significant imbalance when per capita emissions of carbon dioxide for

TABLE 1: CARBON DIOXIDE EMISSIONS FOR THE YEAR 2003 [6].

	Carbon dioxide emissions (Gt of CO_2)[a]	Per capita carbon dioxide emissions (t of CO_2)[a]
World	26.0	4.1
Africa	0.94	1.1
Asia and Pacific	9.72	2.6
Europe	6.80	8.3
Latin America and Caribbean	1.33	2.4
North America	6.43	19.8
Polar	0.001	10.0
West Asia	0.79	7.2

[a] Gt = gigatons; t = tons; 1 Gt = 109 tons.

individual African countries are reviewed[8]. We find that emissions in Libya (9.20 t/year), South Africa (8.18 t/year) and Algeria (5.13 t/year) are all greater than the global average (table 1). Yet, in contrast, approximately half of African countries have annual per capita emissions less than 0.4 t of carbon dioxide (or 10% of the global average).

A similar situation exists when fossil fuel use is considered[9]. The breakdown of fossil fuel use in Africa for the year 2005 appears in table 2. We see that three countries – South Africa, Egypt and Algeria – are responsible for about 70% of total fossil fuel consumption, with South Africa alone accounting for 40%. In other words, the remaining >50 countries use only 30% of the total fossil fuel consumed on the African continent. Clearly, African countries represent a wide spectrum when both fossil fuel use and emissions of carbon dioxide are considered, and also when responsibility for global warming is assigned. And yet, although all African countries have ratified the United Nations Framework Convention on Climate Change (UNFCCC), none is an 'Annex 1' country. They are all considered to be developing countries and, as a result, are not required to control or reduce their emissions of greenhouse gases under the Kyoto Protocol. Bearing in mind the low overall emissions for the African continent, this appears to be a reasonable situation. Nevertheless, when the high per capita emissions in South Africa, Libya and Algeria are considered, some form of action to limit emissions in these countries seems justifiable.

In the coming few decades, can we expect carbon dioxide emissions in Africa to grow to a level that will warrant individual countries introducing measures to limit their emissions? If so, what major factors would contribute to this escalation? Figure 1 reveals that carbon dioxide emissions in Africa have actually increased by almost 50% since 1990, with most of the rise attributable to the trends in Northern and Southern Africa. Two factors suggest that total emissions will continue to rise in the coming decades. First, in the period 2000–2005 Africa experienced a relatively high rate of population growth of 2.2%, compared to a global average of 1.2%[7]. Fertility rates (~ 5 children per woman) are currently among the highest in the world. Although these rates are declining, we can still expect that the African population will increase significantly in the coming decades. Second, the African continent is relatively well endowed with reserves of fossil fuels (table 3)[9]. At present, Africa supplies 12% of the world's oil and 6% of its natural gas. But, only about 25% of the oil and 45% of the natural gas produced in Africa are consumed domestically. As the economies of the African countries grow, partly through revenues from oil and natural gas, and as standards of living increase, we can expect greater domestic consumption of fossil fuels; and therefore, enhanced emissions of carbon dioxide. Further, with proven oil and natural gas reserves of 9.5% and 8.0%, respectively of global reserves, Africa is set to remain a significant provider of fossil fuels for the coming years.

Based on these observations, what kind of response seems appropriate for the African continent?

FIGURE 1: TOTAL CARBON DIOXIDE EMISSIONS FOR THE AFRICAN REGIONS [6].

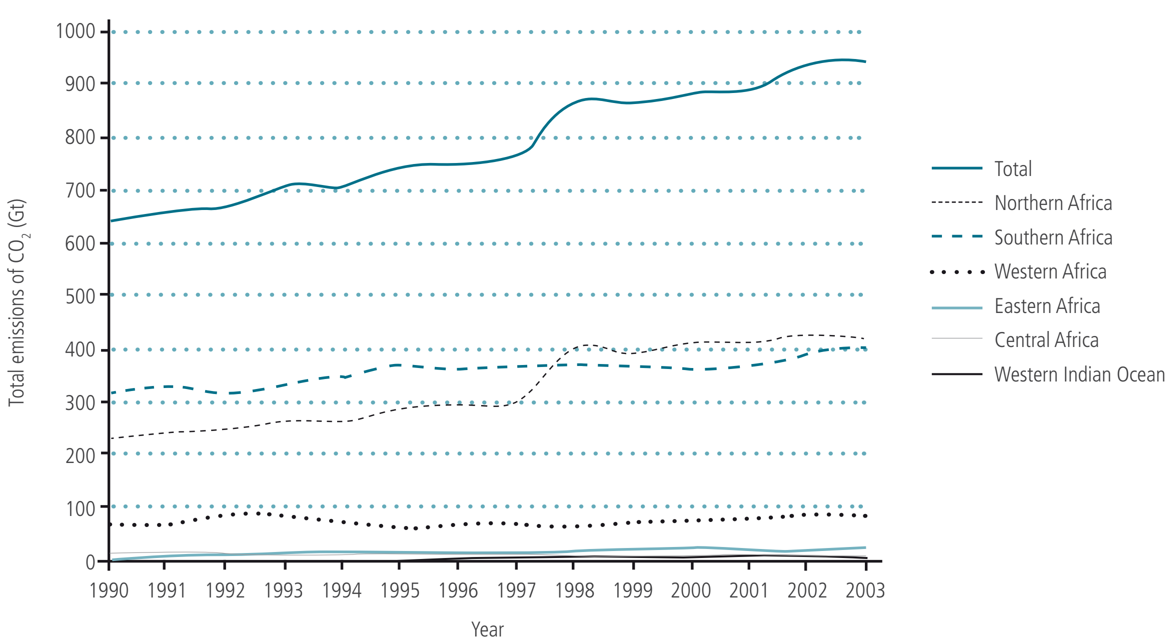


TABLE 2: FOSSIL FUEL CONSUMPTION FOR THE YEAR 2005 (MILLION TONS OIL EQUIVALENT)[9].

	Oil	Natural gas	Coal	Total
Algeria	11.2	21.7	0.9	33.8
Egypt	29.2	23.0	0.5	52.7
South Africa	24.9	–	91.9	116.8
Rest of Africa	64.0	19.4	7.0	90.4
Total Africa	129.3	64.1	100.3	293.7
% of world consumption	3.37%	2.59%	3.42%	3.18%

3. Carbon Management in Africa

It is difficult to prescribe a management plan for Africa because of the widely different stages of development of the countries and because the future of the continent depends largely on its stability. War-torn areas, civil unrest, poverty, disease and famine tend to make its future appear bleak. On the other hand, one can imagine a more optimistic future that will result in greater economic development; and, in the wake of this growth, Africa could indeed seek to develop its own program of carbon management.

One possible scheme that would allow the wide diversity of situations across the African continent to be confronted with respect both to fossil fuel use and deforestation could be similar to that proposed by Socolow, Pacala and co-workers [10,11]. This scheme is designed to consider a range of initiatives to stabilize emissions in the coming 50 years to permit a transition to a (relatively) fossil fuel-free future. They describe a plan (below) for which current technologies exist and propose that, by introducing these measures today and subsequently scaling up activities over the next few decades, carbon dioxide emissions can be capped at current levels (about 26 Gt of carbon dioxide). This would still result in a further increase in atmospheric carbon dioxide concentrations above the current level of 379 ppm, but could be expected to limit concentrations to the range of 500 ± 50 ppm, which is considered to be an acceptable target in order to avoid a significant level of climate change[10]. The following options have been proposed:

- improvements in energy efficiency in areas such as electricity generation and use, and in the transport sector;
- an increased use of renewable energy, including wind and solar (photovoltaic and passive);
- a change in land use to increase natural sinks, such as by reducing deforestation and starting afforestation; and
- the introduction of carbon management measures, such as decarbonization (switching from coal and oil to the lower carbon-content natural gas), and the capture and storage of carbon dioxide (so-called carbon sequestration).

Clearly, under this scheme, the majority of countries in Africa that are currently emitting little fossil-fuel carbon dioxide (both on a per capita and total basis) would focus on avoiding becoming dependent on fossil fuels by appropriate use of renewable energy and better land use management. This would be achievable through use of the Clean Development Mechanism, within the Kyoto Protocol. It is important to remember that, although these countries produce little carbon dioxide from fossil fuel use, they do contribute to global warming through their extensive use of biomass, and in particular wood-derived products, for their energy. Although biomass use is normally considered to be carbon-neutral this only applies if the forest products are renewed. Sadly, this has not been the case in these countries and as a result Africa has traditionally had one of the highest rates of deforestation in the world (~ 0.8% per year during the period 1990–2000[12]).

Turning our focus now to the remaining countries – such as South Africa, Algeria and Libya – who are either major emitters of carbon dioxide or have high per capita emissions, we find that both Algeria and Libya are important producers of oil and natural gas, while South Africa is an important producer (and consumer) of coal. It is clear that these countries need to face the question of their current carbon dioxide emissions. In addition to improved energy efficiency and increased use of renewables, they have the additional possibility to introduce other measures such as decarbonization, in the case of South Africa, or carbon dioxide capture and sequestration[1].

Although there are very few activities in these countries directed to the introduction of carbon dioxide capture and storage, a clear potential should be recognized whenever there are large stationary sources of carbon dioxide emissions, such as where there are thermal power stations, heavy industrial sites or where oil and natural gas production is occurring.

TABLE 3: FOSSIL FUEL PRODUCTION AND RESERVES (2005 DATA) [9].

	Oil		Natural gas		Coal	
	Share of global production	Share of global reserves	Share of global production	Share of global reserves	Share of global production	Share of global reserves
Algeria	2.2%	1.0%	3.2%	2.5%		
Angola	1.6%	0.8%				
Cameroon	0.1%	< 0.1%				
Chad	0.2%	0.1%				
Rep. of Congo (Brazzaville)	0.3%	0.1%				
Egypt	0.9%	0.3%	1.3%	1.1%		
Equatorial Guinea	0.5%	0.1%				
Gabon	0.3%	0.2%				
Libya	2.1%	3.3%	0.4%	0.8%		
Nigeria	3.2%	3.0%	0.8%	2.9%		
South Africa					4.2%	5.4%
Sudan	0.5%	0.5%				
Tunisia	0.1%	0.1%				
Zimbabwe					0.1%	0.1%
Rest of Africa	0.1%	< 0.1%	0.3%	0.7%	< 0.1%	0.1%
Total	12.0%	9.5%	5.9%	8.0%	4.3%	5.6%

4. Saharan Monument: In Salah CO_2 Storage Project

Storing carbon dioxide underground has shown considerable promise[12]. Interring 'global warming', as it is called, has to some extent mitigated the environmental impact of fossil fuel production. As a result, geological sequestration has opened up a vista of opportunities for reducing carbon dioxide emissions to a level that is becoming globally acceptable. There are several reasons for this. Sub-surface storage has diverse and practical geomorphological structures for engulfing millions of tons of carbon dioxide underground. Essentially there are three types of storage facilities underground that are currently implemented for such sequestration purposes: oil and gas reservoirs, intractable coal seams and deep saline aquifers. Each one comes with its own merits and drawbacks. For example, oil and gas reservoirs possess rock formations that can absorb the carbon dioxide, but at the same time dissolution of the rock is possible. In the case of uneconomical coal beds, the gas is adsorbed on to the surface of the seams, but gradual leakage could occur when the adsorbed gas is displaced. The Saharan environment is ideal for long-term sequestration of carbon dioxide because it has sub-surface geological structures that are geochemically stable and highly suitable for this purpose. An outstanding example is the recently developed In Salah project in Algeria (figure 2), which is a unique development in Africa, and an economic boost for the country[13,14]. In Salah bears the name of the nearest settlement to the gas fields, approximately 150 km from the Krechba gas plant. The field uses deep saline aquifers to bury the captured carbon dioxide (figure 3) and is of considerable international interest as it serves as a practical model of industrial-scale carbon dioxide storage for several potential storage sites in the North Sea and North America.

The In Salah gas field is a $3.5 billion project inaugurated by BP 1200 km south of the capital Algiers (figure 2), and is a token of increasing foreign investment in Africa. This includes installation of a 520 km pipeline northwards from Krechba, deep in the Sahara desert, to Hassi R'Mel, which is connected to a natural gas liquefaction plant on the Algerian coast and linked to export pipelines to Europe. The main objective of the project is to market gas from the remote In Salah region and simultaneously develop the Saharan environment. This area is arguably one of the most stringent environments in the world. This mammoth project is a joint venture between BP and its partners Sonatrach and Statoil, and a vital element includes capture of the carbon dioxide produced and its reinjection into the gas reservoir[15,16]. One of the great benefits of sequestering carbon dioxide underground is that it can play a major role in enhanced oil recovery (EOR) and enhanced gas recovery (EGR). The mechanism of such recovery processes is well known and the operation at Krechba clearly has the potential for this[16]. Therefore, future planning of the operation is crucial to take into account all possible factors that could restrict carbon gas emissions.

FIGURE 2: ALGERIA MAP AND IN SALAH FIELD [23].

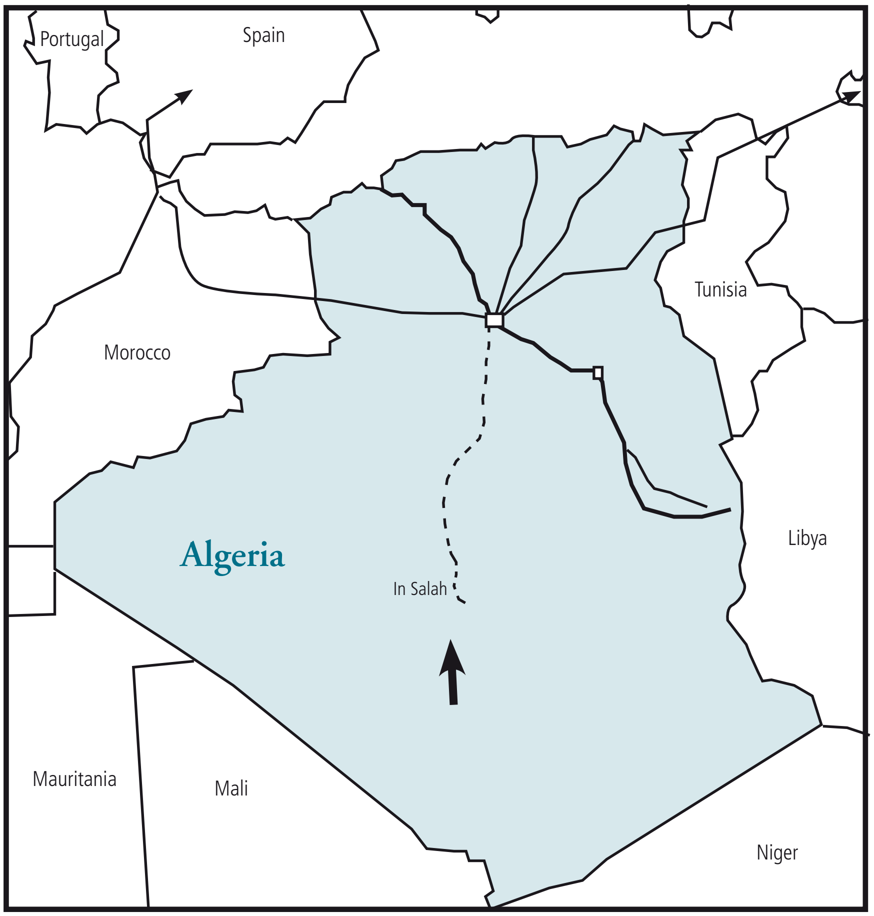
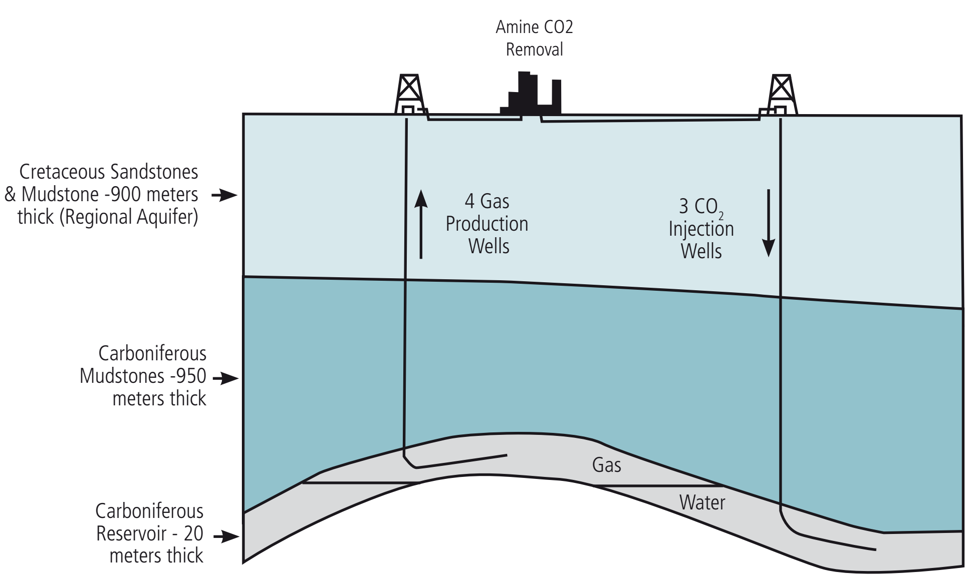


FIGURE 3: IN SALAH GAS AND INJECTION WELLS [23].



The re-injection process is estimated to reduce atmospheric emission of over one million tons of carbon dioxide annually, but this figure is expected to grow with escalating development. In view of this, restrictions on carbon dioxide production should be implemented to keep abreast of regulations governing climate change and sustainable living. No doubt, confident and safe planning of the operation will contribute to ecofriendly conditions and sustainable development. Clearly, the success of the project is linked to controlling carbon dioxide emissions in Algeria. As a gesture in this direction the oil companies themselves could take the initiative to propose measures consistent with the Kyoto Protocol.

5. South Africa: CO_2 Giant

The new South Africa is barely 13 years old and is in the process of attaining political and social equilibrium. It produces roughly 400 million tons of carbon dioxide per annum – the highest in Africa. Yet it is not required to limit its carbon dioxide emissions under the Kyoto Protocol. Nevertheless, pressing environmental and conservation matters are keenly pursued, and restrictions on carbon dioxide emissions will soon be at the forefront of these issues. The country has definitely taken strides in earmarking sites for carbon dioxide sequestration but its progress in this respect has not been widely reported. Therefore, it is worthwhile reviewing some of its future plans and salient options for geological storage[17].

Much of the emissions in South Africa arise from power stations (40%) and synthetic fuel plants, like Sasol (Suid Afrikaanse Steenkool en Olie/ South African Coal and Oil). Minor contributions to the annual carbon dioxide emissions originate from industrial processes (7%), transport (9%) and agriculture (11%). Sequestration plans are at the embryonic stage, where various options for storing the carbon dioxide are being explored. The potential for geologic storage is wide. South Africa is well known for its gold mines, and one storage possibility is abandoned gold mines, a few thousand meters underground. The likelihood of faults in the structures of these mines could, however, result in leakage to the atmosphere – with disruptive effect. Another drawback is the proximity of these abandoned mines to working ones. But, depleted gold mines have the capacity to store roughly 10 million tons of carbon dioxide, and if closely monitored, could be controlled to restrict environmental catastrophes. Coal is another resource that is plentiful in South Africa and with it comes the feasibility of burying carbon dioxide in unused coal mines[18]. This is particularly attractive as it could result in enhancing coal bed methane (ECBM) production. A distinct advantage is that these abandoned coal seams are usually found close to the sites of electricity production plants, and so transport of the emitted carbon dioxide would not be costly. Although the storage capacities of these beds are about 1% of the total annual carbon dioxide emissions, the methane gas obtained in this way could be used for power generation, and plans are underway to commence production in the Waterberg coalfield in the north (figure 4).

Figure 4. Potential sites (shaded areas) for carbon dioxide sequestration in South Africa[17]. Apart from abandoned gold and coal mines, sedimentary basins encompassing saline aquifers have considerable potential, especially the ones located in the Kalahari Karoo and Great Karoo, in the north-west and south-east, respectively (see map in figure 4). The advantages of saline aquifers have been discussed above; but of importance is that these storage areas should be close enough to the source point of the emitted carbon dioxide to prevent exorbitant transport costs. Most of these basins are remote from major point sources, but the Great Karoo basin covers considerable ground and would be the one to exploit for the purpose of geologic sequestration. It possesses the required depth, thickness and extent, and is composed of satisfactory geological structures to be considered for long-term sequestration. A point to consider is that in South Africa conservation of wildlife is a priority and the impact of a sequestration scheme close to wildlife conservation areas would be unfavourable. Hence storage at the Lembombo Karoo site (see map in figure 4), for example, would lead to considerable opposition as it borders the famous Kruger National Park[17]. The use of abandoned coal mines close to residential areas could also be a drawback.

In addition to the storage possibilities discussed above, other options have been reviewed. Deep ocean sequestration and chemical capture of carbon dioxide are alternatives that have been considered[18], but these options need to be extensively explored before they can be implemented. For example, the option of sequestering carbon dioxide under water is not favourable. Explosions in the Cameroon under Lake Monoun and Lake Nyos in 1984 and 1986, respectively, led to the emission of huge masses of carbon dioxide that engulfed these areas causing the death of hundreds of people by asphyxiation[19]. Successful degassing projects were initiated at Lakes Nyos and Monoun to avert similar disasters in the area in uture. The possibility of such a tragedy repeating itself has deterred some countries from considering underwater burial of carbon dioxide.

Clearly, secure and safe storage of the carbon dioxide is an essential requirement[20]. For such technology, safety has been achieved by risk management programmes that make use of information from site characterizations, operational monitoring and scientific and engineering experience. It is most important to monitor subsurface storage, so that leakage at any stage of the operation may be immediately detected. A wide range of monitoring tools is generally implemented such as: seismic profiling, electromagnetic surveys, and CO_2 sensors. Environmental health and safety are of the utmost concern, and the future of carbon dioxide sequestration, in South Africa and elsewhere, depends on efficient and reliable monitoring and risk assessment programmes.

South Africa dominates the emissions of Southern Africa. South Africa's neighbours produce only a fraction of its total carbon dioxide emissions. For example, Zimbabwe, Botswana and Namibia roughly produce: 3.5%, 1% and 0.6%, respectively, of South Africa's total emissions. Therefore, expediting the use of available resources for carbon dioxide sequestration in South Africa cannot be underestimated. As stated above, more than a decade has elapsed since the advent of the new South Africa, and understandably there has been a need to uplift the economy and living standards of the majority of the population. However, it cannot be ignored that South Africa is Africa's biggest carbon dioxide contributor, and immediate attention must be given to carbon dioxide reduction and containment in the race to halt climate change.

6 'Apocalyptic' Future?

In April 2007, the IPCC warned the globe of an 'apocalyptic' future if the projected impact of climate change is not alleviated[21]. Strident voices at the United Nations called for serious reductions in carbon dioxide emissions worldwide. Stringent measures and lower targets in carbon gas emissions are needed or else 'a third of the world's animal and plant species could become extinct'. The sad message also proclaims that in the wake of weather changes such as tempestuous tropical storms, changing rainfall patterns, accelerated melting of Arctic ice and glaciers, drought, flooding and water stress (brought about by enhanced global warming) the poorest countries will be the hardest hit. Africa is the poorest continent in the world and its 'Annex 1' countries should sincerely take responsibility and contribute towards reducing carbon dioxide emissions.

Recent studies have shown that, although the African continent as a whole is responsible for only a small part of the global carbon dioxide emissions, the region is especially vulnerable to the likely impacts of projected climate change[21]. It has been estimated that, by 2020, up to 250 million people in Africa could be affected by water stress due to a combination of climactic change and increasing pressures resulting from rapid population growth. For example, many countries in Africa depend heavily on rain-fed agriculture for their economies as well as for food security, and this is clearly related to the quality of the rainy season and the climate. In addition, some countries in west and central Africa are particularly likely to be affected by sea-level rise, resulting from climate change, due to the rapid growth of urban centres in coastal regions. If the worst effects of climate change should befall these countries, many of which already suffer from poverty, seasonal drought and increasing numbers of HIV patients with resulting very large numbers of orphans, the apocalyptic future will be another mass disaster for Africa. This is what is meant by an earlier IPCC report [22] which concluded:

> The African continent is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution, and overdependence on rain-fed agriculture. Although adaptation options, including traditional coping strategies, theoretically are available, in practice the human, infrastructural, and economic response capacity to effect timely response actions may well be beyond the economic means of some countries.

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RISING FOOD PRICES: A GLOBAL CRISIS[1]

ACTION NEEDED NOW TO AVERT POVERTY AND HUNGER

BY STEVE WIGGINS AND STEPHANIE LEVY[2]

1. Introduction

Soaring food prices pose problems for three groups. First, the poor whose ability to buy food is undermined. Second, governments of low-income countries facing higher import bills, soaring costs for safety net programmes and political unrest. Third, aid agencies juggling increased demands for food, cash and technical advice. High food prices threaten the gains made since the 1960s and highlight the long-term need for investment in, and better management of, the global food supply. This Paper examines the causes of rising food prices, expected trends, the likely impact, and possible policy responses.

2. What is Happening and Why?

Before recent price hikes, the real price of food had been falling since the 1950s. The 'green revolution' that began in the mid-1960s saw developing world farmers planting improved varieties of cereals, prompting extraordinary increases in yields, falling food prices and reductions in poverty.

Food prices have been rising since 2000, spiked in early 2008, and may remain high for another ten year. Prompt action is needed to protect the poorest and support low-income countries faced by surging import bills In the medium term, economic and agricultural growth can offset the damage, but this will require more determined efforts to boost food production.

[1] *This paper was first published as an ODI Briefing Paper in April 2008. ODI Briefing Papers present information, analysis and key policy recommendations on important development and humanitarian topics (www.odi.org.uk). The research for this Briefing Paper has been supported by the Future Agricultures Consortium (www.future-agricultures.org) and the Chronic Poverty Research Centre (www.chronicpoverty.org), as well as ODI.*

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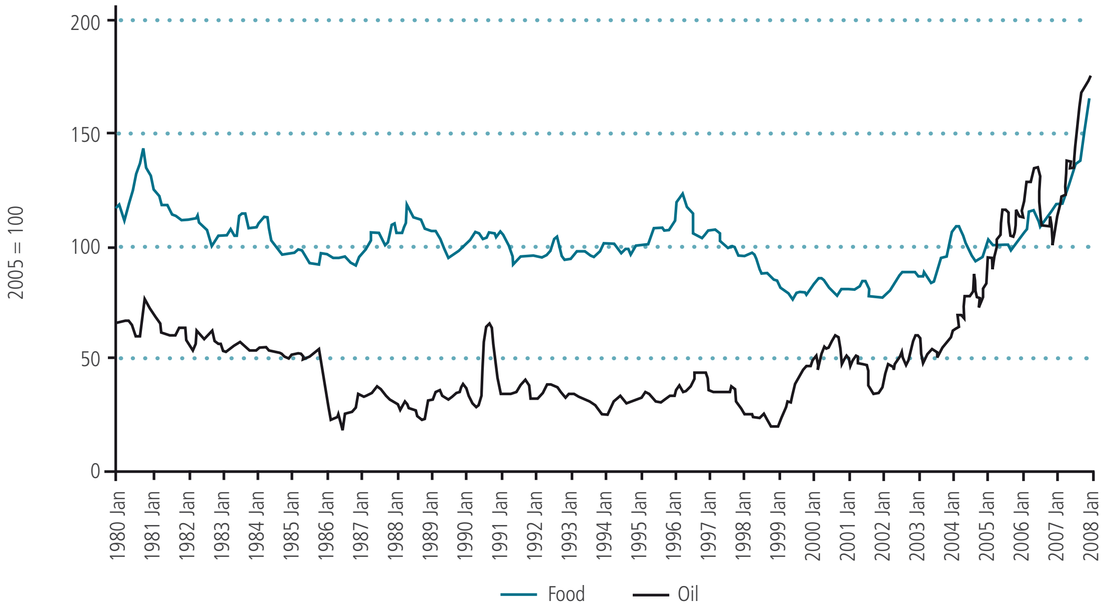
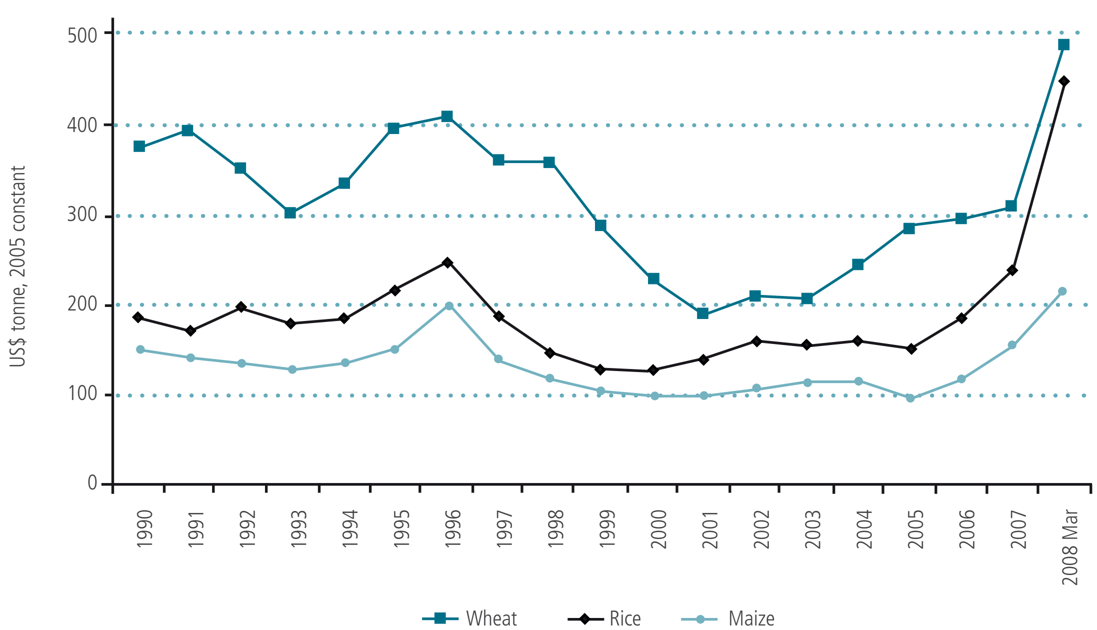
FIGURE 1: FOOD AND OIL PRICE INDICES, 1980 TO EARLY 2008



Commodity Food Price Index, 2005 = 100, includes Cereal, Vegetable Oils, Meat, Seafood, Sugar, Bananas, and Oranges Price Indices Crude Oil (petroleum), Price index, 2005 = 100, simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh.

Source: IMF Commodity Price data, downloaded 12 March 2008 from http://www.imf.org/external/np/res/commod/index.asp.

FIGURE 2: CEREALS PRICES 2000 TO 2007, CONSTANT 2005 VALUE



Source: IMF Commodity Price data, downloaded 12 March 2008 from http://www.imf.org/external/np/res/commod/index.asp. FAO report for Mar 2008. Prices deflated by the US GDP deflator.

But food prices have risen since the early 2000s, and particularly since 2006. The price of a tonne of wheat climbed from $105 in January 2000, to $167 in January 2006, to $481 in March 2008 (IMF Primary Commodity Prices, 2008). Forecasts for the next ten years predict continuing high prices because of structural changes in supply and demand. On the supply side, rising oil prices mean increased costs for fertilisers, machine operations and transport. As Figure 1 shows, oil prices have risen faster than food prices and the price of nitrogen fertilisers has risen with them. In the US the price index for nitrogen fertiliser stood at 118 in 2000 but reached 204 by 2006 (US Department of Agriculture, 2008). USDA expects unit costs of production of cereals to rise by up to 15% between 2006-7 and 2016-17.

Short-term supply shocks include poor harvests in some exporting countries – particularly Australia where drought has hit wheat production – at a time of dwindling world cereal stocks. Speculation in commodity prices by investors may have contributed to price rises, and the falling value of the dollar has not helped. Some exporting countries have imposed taxes, minimum prices, quotas and outright bans on exports of rice and wheat.

On the demand side, growing incomes in countries such as China and India mean rising demand for meat. OECD and FAO forecast that in non-OECD countries consumption of meat and dairy produce will rise by up to 2.4% a year between 2007 and 2016 (von Braun, 2007). Much of the additional meat, and some of the dairy, will be produced by feeding grains to livestock.

Once oil prices top $60 a barrel, biofuels become more competitive and grains may be diverted to biofuel production (Schmidhuber, 2006). With oil now costing over $100 per barrel – and the US and EU trying to reach biofuel targets – grains, sugar and palm oil are increasingly used to produce ethanol and biodiesel. Some 80 million tonnes of maize went to US ethanol refineries in 2007 (OECD-FAO, 2007), against total US maize exports averaging 47 million tonnes a year (2000 to 2005). No wonder maize prices rose in 2007, despite one of the largest maize harvests ever seen.

Rising cereal costs are alarming, as they provide the bulk of the diet for many of the poor in developing countries. Rice and wheat prices soared in late 2007 and early 2008, up 60% and 89% respectively over 2007 levels (see Figure 2).

3. Future Trends

OECD, the Food and Agriculture Organisation (FAO) and USDA predict higher cereal prices over the next 10 years than in the early 2000s, but lower prices than in late 2007. The current high prices are unlikely to last as farmers are expected to increase planting and yields in 2008. However, prices are unlikely to drop to former levels in the medium term. Compared to 2005 levels, the price of maize is likely to be higher by 40% in 2016-17, with wheat prices up by 20%, and rice by 14%.

4. Impact on the Poor

Rising food prices affect the poor directly, as producers and consumers, and indirectly, through the impact on their economies. The greatest concern is the impact on their food consumption. While most of the world's poor live in rural areas, not all are farmers, and even some farmers buy staples. The poor generally spend large fractions of their budgets on food, so rising prices make them more likely to reduce their food consumption (see Box 1). This may not mean as large a fall in calorie intake, as households may spend more on cheaper, calorie-rich staples and less on foods rich in protein and vitamins, such as meat, fish, dairy, fruit and vegetables, reducing the quality of their diet.

The short-term impacts are alarming: incomes fall by more than 25%, and food consumption by almost 20%. Medium-term prospects remain bleak, with incomes and food consumption down by 11% and 8% respectively.

5. Impact on Farming

Higher food prices could raise farmers' incomes if global price movements transmit to local markets, and if farmers can respond. However, transmission can be muted by policies on domestic prices and by transport costs. In inland Africa, for example, the effect of global price movements may be minor. In landlocked Malawi, it costs around $50–60 a tonne to ship maize from the port of Beira, plus at least $25 a tonne to ship maize from the Gulf of Mexico. When global maize prices were around $100 a tonne, the import parity price for Malawi was at least $175 a tonne, raising the value of domestically produced maize. As it costs around $100 to produce a tonne of maize in Malawi, it always made sense for the country to grow as much as possible. With world prices at over $200 a tonne, the incentives are even greater.

High transport costs that push up import parity prices also hold down export parity prices. With maize at $100 a tonne, this would have been around $25, but current price levels push it to $125, so Malawi could conceivably consider export production — although current high levels of maize prices are unlikely to be sustained.

Experience suggests that farmers may lack the credit and inputs needed to respond in the short term. But they could benefit in the medium and long term, as in the Asian green revolutions and in many African countries in the recent past.

6. Impact on Low-income Countries

Low-income countries face inflationary pressure and rising import bills – both of which undermine economic growth and development. FAO estimates that food import bills for developing countries rose by 25% in 2007 (Shapouri and Rosen, 2008).

Many receive food aid that is likely to be reduced just when it is most needed. As food aid is programmed by budget, not volume, rising prices depress supply. With the World Food Programme (WFP) needing another $500 million to sustain current operations, the likely outcome for these countries is that food availability will fall.

However, higher food prices are incentives to produce local food and could stimulate agriculture, cushioning the impact on the poor. In the coastal cities of West Africa, a shift to consumption of bread, rice and pasta based on imported grains at the expense of local yam, cocoyam, cassava, millet and sorghum could be reversed, giving a fillip to domestic farmers.

Outcomes, weighing costs to consumers against gains to farmers, are hard to predict but existing models shed some light (Box 2) on Cambodia. Effects vary, with farming households benefiting, and others losing out. Overall, the economy suffers and reduced consumer spending on other goods and services puts a brake on economic growth.

7. Policy Recommendations

Immediate action is needed to alleviate the distress caused by the price spikes, such as transfers to the poor or general food subsidies. Resources are needed to support WFP and compensate poor countries for higher import bills. Improved coordination across the UN and donors, and greater alignment with national efforts and priorities will be critical. In the medium term, growth can boost incomes to compensate for high food prices, but the right policies are needed to help farmers produce more food.

8. Responding to the Crisis

The main options are compensating transfers and control of food prices. Transfers in the form of cash or vouchers would need to reach those facing under-nutrition. However, this means compensating the poor while the nearly poor, who pay the same prices, are left out. Schemes to raise incomes through public works, with workers receiving wages rather than hand-outs, are more feasible. Examples of innovative schemes include Latin American conditional cash transfers and the introduction of universal old age pensions in India and South Africa.

Price controls can mean setting prices, but can be hard to enforce and could remove incentives for farmers to produce more. Food price subsidies might be wasteful, as wealthier consumers would also benefit. And subsidising 'inferior' foods is less popular, politically, than subsidising favoured items.

Developing countries have tried to manage food price rises through subsidies, reducing tariffs on imported grains, and by limiting or taxing grain exports (FAO, 2008). This last could exacerbate the price spike and depress incentives to farmers to increase output.Many low-income countries face the double shock of rising bills for oil and food imports, hindering growth and pushing up inflation. At the same time, efforts to protect the poor from rising food prices could mean heavy increases in the cost of social programmes.

Countries need compensatory financing to respond to the food price spike. There is a case for the IMF to provide more resources under the Compensatory Financing Facility to help low-income countries that import both oil and food. WFP has identified 30 countries at risk: Afghanistan; Angola; Benin; Burundi; Chad; DRC; Eritrea; Ethiopia; Gambia; Guinea; Guinea-Bissau; Haiti; Kenya; Madagascar; Malawi; Mauritania; Mozambique; Myanmar; Nepal; Niger; OPT; São Tomé and Príncipe; Senegal; Sierra Leone; Somalia; Tajikistan; Timor-Leste; Yemen; Zambia and Zimbabwe.

For donors, priorities include meeting the WFP call for at least $500 million to meet the higher costs of food aid. But there is also scope for more coordination across UN agencies, as part of the 'One-UN' system. In line with the Paris principles, it would help if every country at risk had a national plan that could be financed.

9. The Medium-term Response

Rising incomes from economic growth can compensate for increased food costs in the medium term. Two to four years of growth may be enough to offset real income losses and there is scope to expand food supply and mitigate price rises. Ensuring that small farmers can respond to higher prices is a familiar policy challenge now made all the more pressing . Public investments in infrastructure and agricultural research would pay dividends; as would support for institutions giving small farmers access to finance, inputs and information.

Uncertainty and controversy surround technical agricultural advances. Most agricultural research is by companies that may not prioritise boosting outputs of food grains. Biotechnology promises much, but has delivered relatively little for staple food production. That may change with higher prices for grains and it seems that marker-assisted selection is leading to rising grain yields. Higher prices may make countries more inclined to introduce genetically modified organisms. Furthermore, how much can output be raised given limited land and water, and anxieties over conservation and pollution?

If demand were restricted, food might become cheaper. Controlling food spending is administratively difficult and politically unattractive; but countries, including the UK, have had rationing in the past. In the medium to long term, rising food prices make population control policies more attractive: whether world population stabilises at eight, nine or ten billion matters that much more.

10. Responding in Low-income Countries

Countries should prepare for a world where food and oil imports cost far more than they have in the past. Countries now have an incentive to develop their unused agricultural potential, and investing in food production will pay dividends. Some countries with abundant land could offset higher oil prices through biofuel production, but this needs care if it is not to displace food crops and push food prices higher. Where land and water permit, biofuel production is an option if oil prices stay above $60 a barrel.

DO BIOFUELS LEAD TO HIGHER FOOD PRICES AND HUNGRY PEOPLE?

In the early 2000s, 20 million tonnes of US maize went to ethanol plants. In 2007, 80 million tonnes were delivered – a figure expected to rise to 100 million by 2010, driven in large part by the Renewable Fuel Standard that requires 28 Billion litres of fuel in the US to come from alternative sources by 2012. Similar increases are being seen in Brazil, Canada, China and the EU. In South-East Asia, vast areas are shifting to oil palm, a key feedstock for biodiesel.

Demand for biofuels encourages the use of land for feedstock and it is no coincidence that feedstock prices are rising. Maize prices doubled between 2006 and 2008, while palm oil prices rose 2.5 times. IFPRI's IMPACT model predicts that maize prices will rise by 26% by 2020 under current plans for biofuels production, and by 72% with drastic expansion.

PERCENTAGE CHANGES IN WORLD PRICES BY 2020: TWO SCENARIOS

	Biofuel expansion (a)	Drastic biofuel expansion (b)
Cassava	11	27
Maize	26	72
Oilseeds	18	44
Sugar	11.5	27
Wheat	8.3	20

Notes: (a) Based on actual biofuel production plans/projections in relevant countries and regions; (b) Based on doubling actual biofuel production plans/projections in relevant countries and regions.

Source: IFPRI IMPACT projections (in constant prices) in von Braun 2007.

With current technology (and given US and EU subsidies and targets), it seems that biofuels will push up food prices. This could be offset if poor farmers in developing countries had the same incentives as farmers in North America and Europe, and if technical advances that would allow grasses and woody biomass to be converted to biofuel can be realised. Biofuels could then become an important source of income for poor farmers, but – for now – those who see biofuels as a threat to the hungry have a point.

Sources: OECD FAO (2007), Peskett et al. (2007), von Braun (2007), Schmidhuber (2006).

IMPACT OF RISING FOOD PRICES ON HOUSEHOLDS IN CAMBODIA

A Computable General Equilibrium (CGE) model of the Cambodian economy has simulated the impacts of a 26% increase in rice prices in the medium term. Not surprisingly, a higher rice price stimulates a 13% increase in rice production and rice exports rise by more than 80%. Rice farmers benefit, but the rest of economy suffers. Resources shift from other farm activities to paddy fields, so livestock and fish production decline. Higher rice prices reduce household spending on other goods and services, depressing the economy. GDP falls by around 0.2%. Farming households are better off, with incomes for surplus producers rising by almost 4%; but other households see incomes fall by around 2%.Source: Initial computations using a CGE for Cambodia.

11. Global and Donor Responses

Aid agencies should provide more support to developing country efforts to boost social protection in the short term, and food production in the medium term. If less food aid is available, its use must be prioritised and efforts to close gaps between emergency relief and long-term development become more pressing.

Finally, rising food prices raise questions about global food systems. The conventional wisdom that markets produce efficient outcomes may be right in normal times, but wrong when those times are abnormal. Little consideration has been given to contingency plans to deal with abnormal events, as the run-down food stocks in China, the EU and the US demonstrate. Conventional wisdom needs revisiting and the world's rich nations may need to re-invest in strategic stocks to offset sudden shocks.

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THE WORLD FOOD SITUATION:

NEW DRIVING FORCES AND REQUIRED ACTIONS*

BY JOACHIM VON BRAUN†

The world food situation is currently being rapidly redefined by new driving forces. Income growth, climate change, high energy prices, globalization, and urbanization are transforming food consumption, production, and markets. The influence of the private sector in the world food system, especially the leverage of food retailers, is also rapidly increasing. Changes in food availability, rising commodity prices, and new producer-consumer linkages have crucial implications for the livelihoods of poor and food-insecure people. Analyzing and interpreting recent trends and emerging challenges in the world food situation is essential to provide policymakers with the necessary information to mobilize adequate responses at the local, national, regional, and international levels. A mix of policy actions that avoids damage and fosters positive responses is required, including the following actions that should be undertaken immediately: Developed countries should facilitate flexible responses to drastic price changes by eliminating trade barriers and programs that set aside agriculture resources, except in well-defined conservation areas. A world confronted with more scarcity of food needs to trade more – not less – to spread opportunities fairly. Developing countries should rapidly increase investment in rural infrastructure and market institutions in order to reduce agricultural-input access constraints, since these are hindering a stronger production response.

1. Demand Driven by High Economic Growth and Population Change

Many parts of the developing world have experienced high economic growth in recent years. Developing Asia, especially China and India, continues to show strong sustained growth. Real GDP in the region increased by 9 percent per annum between 2004 and 2006. Sub-Saharan Africa also experienced rapid economic growth of about 6 percent in the same period. Even countries with high incidences and prevalences of hunger reported strong growth rates. Of the world's 34 most food-insecure countries,[1] 22 had average annual growth rates ranging from 5 to 16 percent between 2004 and 2006. Global economic growth, however, is projected to slow from 5.2 percent in 2007 to 4.8 percent in 2008 (IMF 2007a). Beyond 2008, world growth is expected to remain in the 4 percent range while developing-country growth is expected to average 6 percent (Mussa 2007). This growth is a central force of change on the demand side of the world food equation. High income growth in low income countries readily translates into increased consumption of food, as will be further discussed below.

Another major force altering the food equation is shifting rural–urban populations and the resulting impact on spending and consumer preferences. The world's urban population has grown more than the rural population; within the next three decades, 61 percent of the world's populace is expected to live in urban areas (Cohen 2006). However, three-quarters of the poor remain in rural areas, and

* *International Food Policy Research Institute Food Policy Report, December 2007. The research cooperation and assistance for the development of this paper by Bella Nestorova, Tolulope Olofinbiyi, Rajul Pandya-Lorch, Teunis van Rheenen, Mark Rosegrant, Siwa Msangi, and Klaus von Grebmer—all at IFPRI—is gratefully acknowledged.*

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rural poverty will continue to be more prevalent than urban poverty during the next several decades (Ravallion, Chen, and Sangraula 2007).

Agricultural diversification toward high-value agricultural production is a demand-driven process in which the private sector plays a vital role (Gulati, Joshi, and Cummings 2007). Higher incomes, urbanization, and changing preferences are raising domestic consumer demand for high-value products in developing countries. The composition of food budgets is shifting from the consumption of grains and other staple crops to vegetables, fruits, meat, dairy, and fish. The demand for ready-to-cook and ready-to-eat foods is also rising, particularly in urban areas. Consumers in Asia, especially in the cities, are also being exposed to nontraditional foods. Due to diet globalization, the consumption of wheat and wheat-based products, temperate-zone vegetables, and dairy products in Asia has increased (Pingali 2006).

Today's shifting patterns of consumption are expected to be reinforced in the future. With an income growth of 5.5 percent per year in South Asia, annual per capita consumption of rice in the region is projected to decline from its 2000 level by 4 percent by 2025. At the same time, consumption of milk and vegetables is projected to increase by 70 percent and consumption of meat, eggs, and fish is projected to increase by 100 percent (Kumar et al. 2007).

In China, consumers in rural areas continue to be more dependent on grains than consumers in urban areas (Table 1). However, the increase in the consumption of meat, fish and aquatic products, and fruits in rural areas is even greater than in urban areas.

In India, cereal consumption remained unchanged between 1990 and 2005, while consumption of oil crops almost doubled; consumption of meat, milk, fish, fruits, and vegetables also increased (Table 2). In other developing countries, the shift to high-value demand has been less obvious. In Brazil, Kenya, and Nigeria, the consumption of some high-value products declined, which may be due to growing inequality in some of these countries.

1.2. World Food Production and Stock Developments

Wheat, coarse grains (including maize and sorghum), and rice are staple foods for the majority of the world's population. Cereal supply depends on the production and availability of stocks. World cereal production in 2006 was about 2 billion tons—2.4 percent less than in 2005 (Figure 1). Most of the decrease is the result of reduced plantings and adverse weather in some major producing and exporting countries. Between 2004 and 2006,

TABLE 1: CHINA: PER CAPITA ANNUAL HOUSEHOLD CONSUMPTION

	Urban			Rural		
Product	1990 (kg)	2006 (kg)	2006/1990 ratio	1990 (kg)	2006 (kg)	2006/1990 ratio
Grain	131	76	0.6	262	206	0.8
Pork, beef, and mutton	22	24	1.1	11	17	1.5
Poultry	3	8	2.4	1	4	2.8
Milk	5	18	4.0	1	3	2.9
Fish and aquatic products	8	13	1.7	2	5	2.4
Fruits	41	60	1.5	6	19	3.2

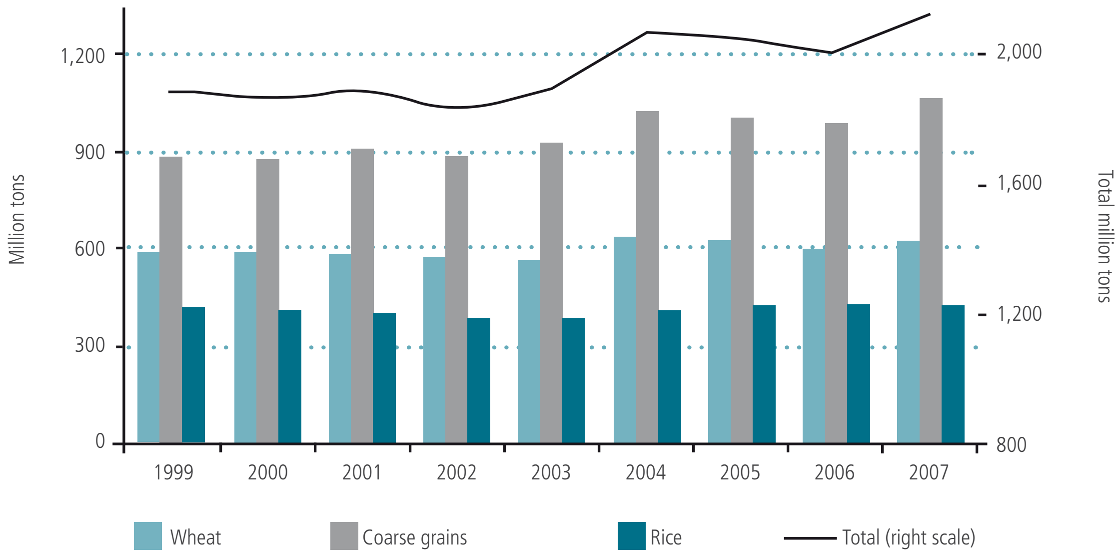
Source: Data from National Bureau of Statistics of China 2007a and 2007b.

TABLE 2: CHANGE IN FOOD-CONSUMPTION QUANTITY, RATIOS 2005/1990

Type	India	China	Brazil	Kenya	Nigeria
Cereals	1.0	0.8	1.2	1.1	1.0
Oil crops	1.7	2.4	1.1	0.8	1.1
Meat	1.2	2.4	1.7	0.9	1.0
Milk	1.2	3.0	1.2	0.9	1.3
Fish	1.2	2.3	0.9	0.4	0.8
Fruits	1.3	3.5	0.8	1.0	1.1
Vegetables	1.3	2.9	1.3	1.0	1.3

Source: Data from FAO 2007a.

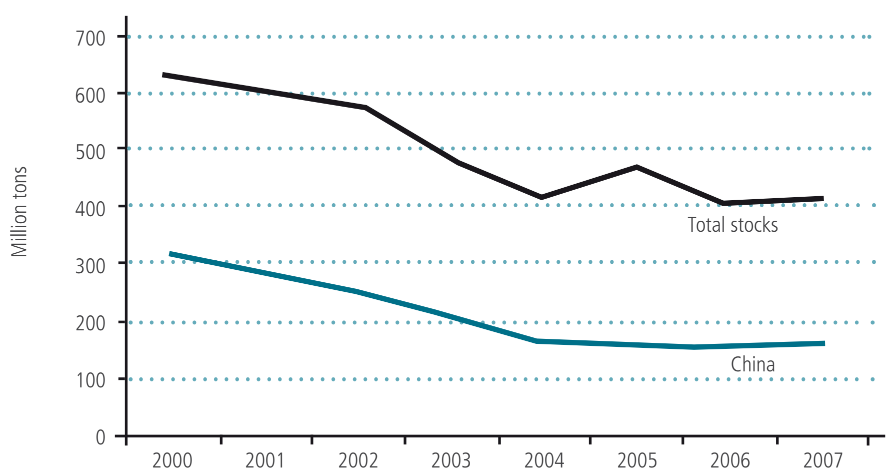
FIGURE 1: WORLD CEREAL PRODUCTION, 2000–2007 (MILLION TONS)



Note: Data for 2007 are forecasts.

Source: Data from FAO 2003, 2005, 2006b, and 2007b.

FIGURE 2: WORLD CEREAL STOCKS, 2000–2007



Note: Data for 2007 are forecasts.

Source: Data from FAO 2003, 2005, 2006b, and 2007b.

wheat and maize production in the European Union and the United States decreased by 12 to 16 percent. On the positive side, coarse grain production in China increased by 12 percent and rice output in India increased by 9 percent (based on data from FAO 2006b and 2007b). In 2007, world cereal production is expected to rise by almost 6 percent due to sharp increases in the production of maize, the main coarse grain.

In 2006, global cereal stocks—especially wheat—were at their lowest levels since the early 1980s. Stocks in China, which constitute about 40 percent of total stocks, declined significantly from 2000 to 2004 and have not recovered in recent years (Figure 2). End-year cereal stocks in 2007 are expected to remain at 2006 levels. [2]

As opposed to cereals, the production of high-value agricultural commodities such as vegetables, fruits, meat, and milk is growing at a fast rate in developing countries (Figure 3).

Climate-change risks will have adverse impacts on food production, compounding the challenge of meeting global food demand. Consequently, food import dependency is projected to rise in many regions of the developing world (IPCC 2007). With the increased risk of droughts and floods due to rising temperatures, crop-yield losses are imminent. In more than 40 developing countries—mainly in Sub-Saharan Africa—cereal yields are expected to decline, with mean losses of about 15 percent by 2080 (Fischer et al. 2005). Other estimates suggest that although the aggregate impact on cereal production between 1990 and 2080 might be small—a decrease in production of less than 1 percent—large reductions of up to 22 percent are likely in South Asia (Table 3). In contrast, developed countries and Latin America are expected to experience absolute gains. Impacts on the production of cereals also differ by crop type. Projections show that land suitable for wheat production may almost disappear in Africa. Nonetheless, global land use due to climate change is estimated to increase minimally by less than 1 percent. In many parts of the developing world, especially in Africa, an expansion of arid lands of up to 8 percent may be anticipated by 2080 (Fischer et al. 2005).

World agricultural GDP is projected to decrease by 16 percent by 2020 due to global warming. Again, the impact on developing countries will be much more severe than on developed countries. Output in developing countries is projected to decline by 20 percent, while output in industrial countries is projected to decline by 6 percent (Cline 2007).

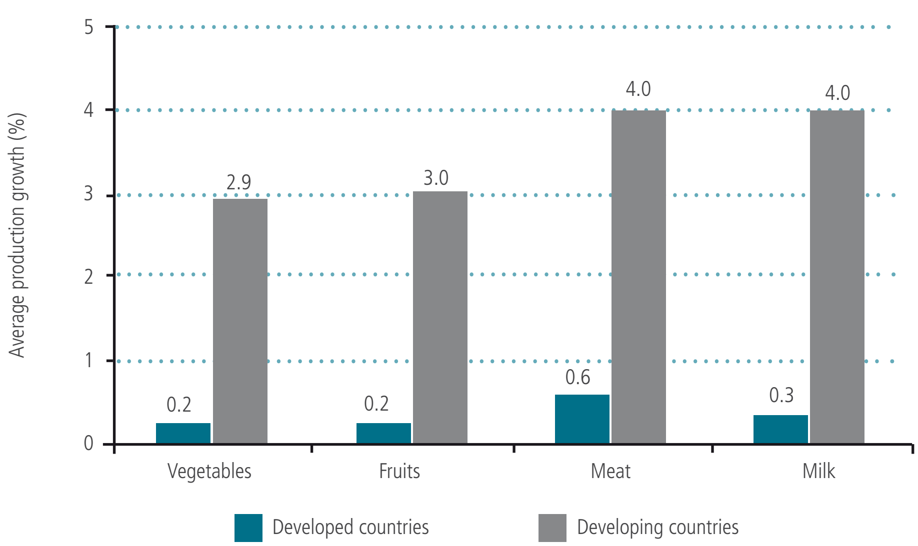
Carbon fertilization[3] could limit the severity of climate-change effects to only 3 percent. However, technological change is not expected to be able to alleviate output losses and increase yields to a rate that would keep up with growing food demand (Cline 2007). Agricultural prices will thus also be affected by climate variability and change. Temperature increases of more than 3°C may cause prices to increase by up to 40 percent (Easterling et al. 2007).

The riskier climate environment that is expected will increase the demand for innovative insurance mechanisms, such as rainfall-indexed insurance schemes that include regions and communities of small farmers. This is an area for new institutional exploration.

1.3. Globalization and Trade

A more open trade regime in agriculture would benefit developing countries in general. Research by the International Food Policy Research Institute (IFPRI) has shown that the benefits of opening up and facilitating market access between member countries of the Organisation for Economic Co-operation and Development (OECD) and developing countries—as well as among developing countries—would bring significant economic gains. However, large advances in poverty reduction would not occur except in some cases (Bouet et al. 2007). Multilateral discussions toward further

FIGURE 3: ANNUAL GROWTH RATE OF 2004–2006 (PERCENT)



Source: Data from FAO 2007a.

trade liberalization and the integration of developing countries into the global economy are currently deadlocked. The conclusion of the World Trade Organization (WTO) Doha Development Round has been delayed due to divisions between developed and developing countries and a lack of political commitment on the part of key negotiating parties. In the area of agriculture, developed countries have been unwilling to make major concessions. The United States has been hesitant to decrease domestic agricultural support in its new farm bill, while the European Union has been hesitant to negotiate on its existing trade restrictions on sensitive farm products. Deep divisions have also emerged regarding the conditions for nonagricultural market access proposed in Potsdam in July 2007.

In reaction to the lack of progress of the Doha Round, many countries are increasingly engaging in regional and bilateral trade agreements. The number of regional arrangements reported to the WTO rose from 86 in 2000 to 159 in 2007 (UNCTAD 2007). Increasingly, South-South and South-North regional initiatives have emerged—such as the Central American Free Trade Agreement (CAFTA) between the United States and Central America and the negotiations between the African, Caribbean, and Pacific (ACP) states and the European Union—and they may create more opportunities for cooperation among developing countries and for opening up their markets.

Another development has been the improvement of the terms of trade for commodity exporters as a result of increases in global prices. The share of developing countries in global exports increased from 32 percent in 2000 to 37 percent in 2006, but there are large regional disparities. Africa's share in global exports, for example, increased only from 2.3 to 2.8 percent in the same period (UNCTAD 2007).

1.4. Changes in the Corporate Food System

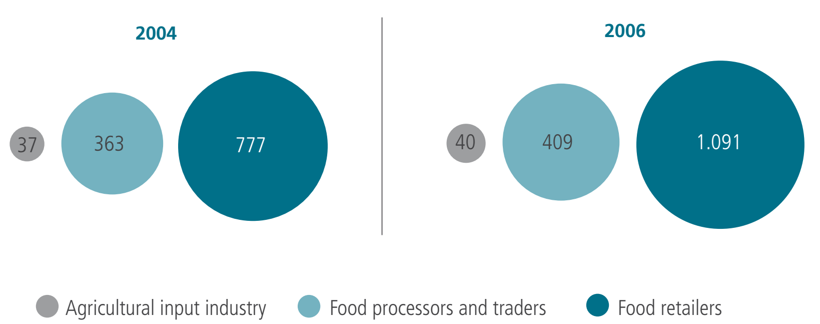
The growing power and leverage of international corporations are transforming the opportunities available to small agricultural producers in developing countries. While new prospects have arisen for some farmers, many others have not been able to take advantage of the new income-generating opportunities since the rigorous safety and quality standards of food processors and food retailers create high barriers to their market entry.

TABLE 3: EXPECTED IMPACTS OF CLIMATE CHANGE ON GLOBAL CEREAL PRODUCTION

Region	1990–2080 (% change)
World	-0.6 to -0.9
Developed countries	2.7 to 9.0
Developing countries	-3.3 to -7.2
Southeast Asia	-2.5 to -7.8
South Asia	-18.2 to -22.1
Sub-Saharan Africa	-3.9 to -7.5
Latin America	5.2 to 12.5

Source: Adapted from Tubiello and Fischer 2007.

FIGURE 4: "CORPORATE VIEW" OF THE WORLD FOOD SYSTEM: SALES OF TOP 10 COMPANIES (IN BILLIONS OF US DOLLARS), 2004 AND 2006



Source: Data from Planet Retail 2007b, Morningstar 2007, von Braun 2005, and companies' financial reports

Transactions along the corporate food chain have increased in the past two years. Between 2004 and 2006, total global food spending grew by 16 percent, from US$5.5 trillion to 6.4 trillion (Planet Retail 2007a). In the same period, the sales of food retailers increased by a disproportionately large amount compared to the sales of food processors and of companies in the food input industry (Figure 4). The sales of the top food processors and traders grew by 13 percent, and the sales of the top 10 companies producing agricultural inputs (agrochemicals, seeds, and traits) increased by 8 percent. The sales of the top food retailers, however, soared by more than 40 percent. While supermarkets account for a large share of retail sales in most developed and many developing countries, independent grocers continue to represent 85 percent of retail sales in Vietnam and 77 percent in India (Euromonitor 2007).

The process of horizontal consolidation in the agricultural-input industry continues on a global scale. The three leading agrochemical companies—Bayer Crop Science, Syngenta, and BASF—account for roughly half of the total market (UNCTAD 2006). In contrast, the top five retailers do not capture more than a 13-percent share of the market. Global data, however, mask substantial differences between countries; while the top five retailers account for 57 percent of grocery sales in Venezuela, they represent less than 4 percent of sales in Indonesia (Euromonitor 2007). Vertical integration of the food supply chain increases the synergies between agricultural inputs, processing, and retail, but overall competition within the different segments of the world food chain remains strong.

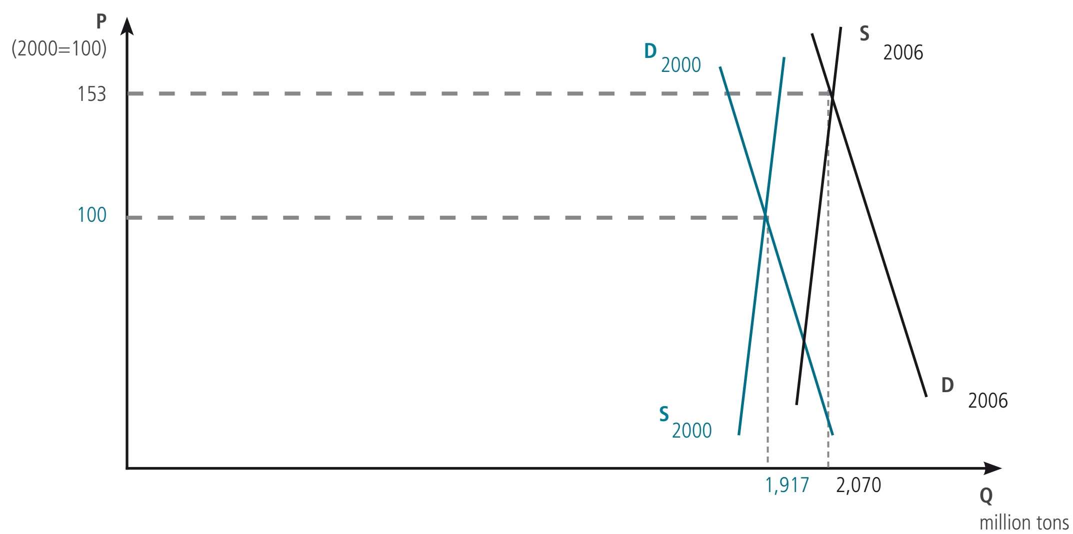
1.5. The Changing Supply-and-Demand Framework of the Food Equation

The above-mentioned changes on the supply and demand side of the world food equation have led to imbalances and drastic price changes. Between 2000 and 2006, world demand for cereals increased by 8 percent while cereal prices increased by about 50 percent (Figure 5).

Thereafter, prices more than doubled by early 2008 (compared to 2000). Supply is very inelastic, which means that it does not respond quickly to price changes. Typically, aggregate agriculture supply increases by 1 to 2 percent when prices increase by 10 percent. That supply response decreases further when farm prices are more volatile, but increases as the result of improved infrastructure and access to technology and rural finance.

The consumption of cereals has been consistently higher than production in recent years and that has reduced stocks. A breakdown of cereal demand by type of use gives insights into the factors that have contributed to the greater increase in consumption. While cereal use for food and feed increased by 4 and 7 percent since 2000, respectively, the use of cereals for industrial purposes—such as biofuel production—increased by more than25 percent (FAO 2003 and 2007b). In the United States alone, the use of corn for ethanol production increased by two and a half times between 2000 and 2006 (Earth Policy Institute 2007).

FIGURE 5: GLOBAL SUPPLY AND DEMAND FOR CEREALS, 2000 AND 2006



Notes: Supply and demand of cereals refer to the production and consumption of wheat, coarse grains, and rice.

Source: Data from FAO 2003, 2005, 2006b, 2007b, and 2007c.

Supply and demand changes do not fully explain the price increases. Financial investors are becoming increasingly interested in rising commodity prices, and speculative transactions are adding to increased commodity-price volatility. In 2006, the volume of traded global agricultural futures and options rose by almost 30 percent. Commodity exchanges can help to make food markets more transparent and efficient.They are becoming more relevant in India and China, and African countries are initiating commodity exchanges as well, as has occurred in Ethiopia, for example (Gabre-Madhin 2006).

2. Outlook on Global Food Scarcity and Food-Energy Price Links

2.1 Cereal and Energy Price Increases

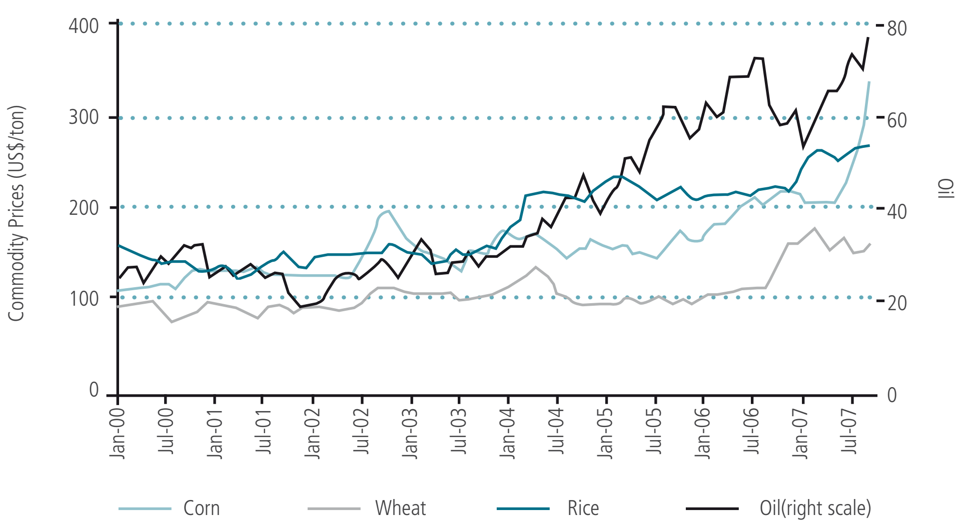
World cereal and energy prices are becoming increasingly linked. Since 2000, the prices of wheat and petroleum have tripled, while the prices of corn and rice have almost doubled (Figure 6). The impact of cereal price increases on food-insecure and poor households is already quite dramatic. For every 1-percent increase in the price of food, food consumption expenditure in developing countries decreases by 0.75 percent (Regmi et al. 2001). Faced with higher prices, the poor switch to foods that have lower nutritional value and lack important micronutrients.

Due to government price policies, trade restrictions, and transportation costs, changes in world commodity prices do not automatically translate into changes in domestic prices. In the case of Mexico, the margin between domestic and world prices for maize has ranged between 0 and 35 percent since the beginning of 2004, and a strong relationship between domestic and world prices is evident (Figure 7). In India, the differences between domestic and international rice prices were greater, averaging more than 100 percent between 2000 and 2006.[4] While domestic pricestabilization policies diminish price volatility, they require fiscal resources and cause additional market imperfections. Government policies also change the relationship between consumer and producer prices. For instance, producer prices of wheat in Ethiopia increased more than consumer prices from 2000 to 2006 (Figure 8).

Though international price changes do not fully translate into equivalent domestic farm and consumer price changes because of the different policies and trade positions adopted by each country, they are in fact transmitted to consumers and producers to a considerable extent.

The prices of commodities used in biofuel production are becoming increasingly linked with energy prices. In Brazil, which has been a pioneer in ethanol production since the 1970s, the price of sugar is very closely connected to the price of ethanol (Figure 9). A worrisome implication of the increasing link between energy and food prices is that high energy-price fluctuations are increasingly translated into high food-price fluctuations.

FIGURE 6: COMMODITY PRICES (US$/TON), JANUARY 2000–SEPTEMBER 2007



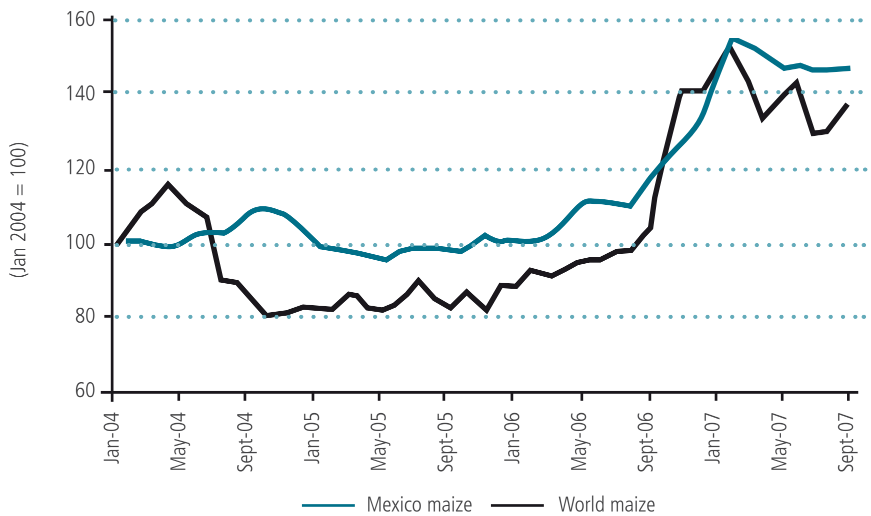
Source: Data from FAO 2007c and IMF 2007b; in current US $.

TABLE 4: CONSUMPTION SPENDING RESPONSE (%) WHEN PRICES CHANGE BY 1% ("ELASTICITY")

	Low-income countries	High-income countries
Food	-0.59	-0.27
Bread and cereals	-0.43	-0.14
Meat	-0.63	-0.29
Dairy	-0.70	-0.31
Fruit and vegetables	-0.51	-0.23

Source: Seale, Regmi, and Bernstein 2003.

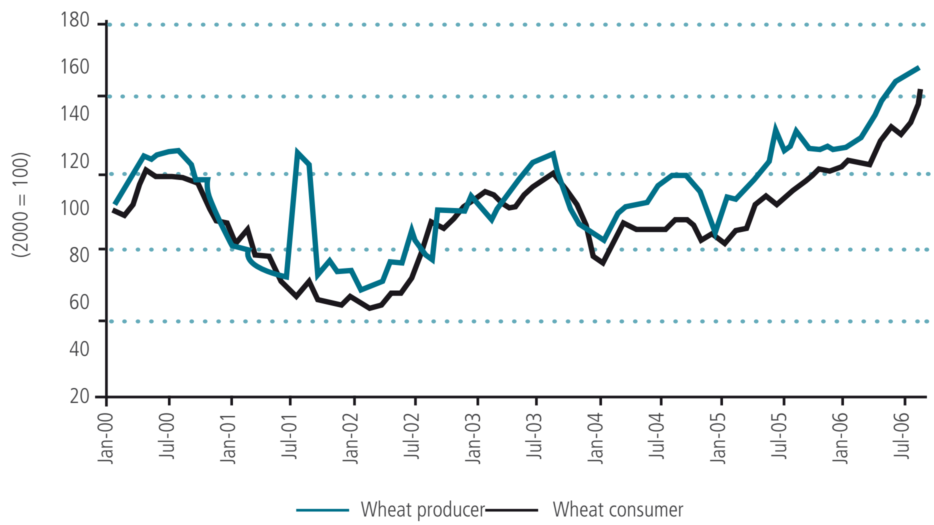
FIGURE 7: DOMESTIC AND WORLD PRICES OF MAIZE IN MEXICO (JANUARY 2004 = 100)



Note: Domestic prices represent producer prices for the national market in Mexico.

Source: Data from Bank of Mexico 2007 and FAO 2007c.

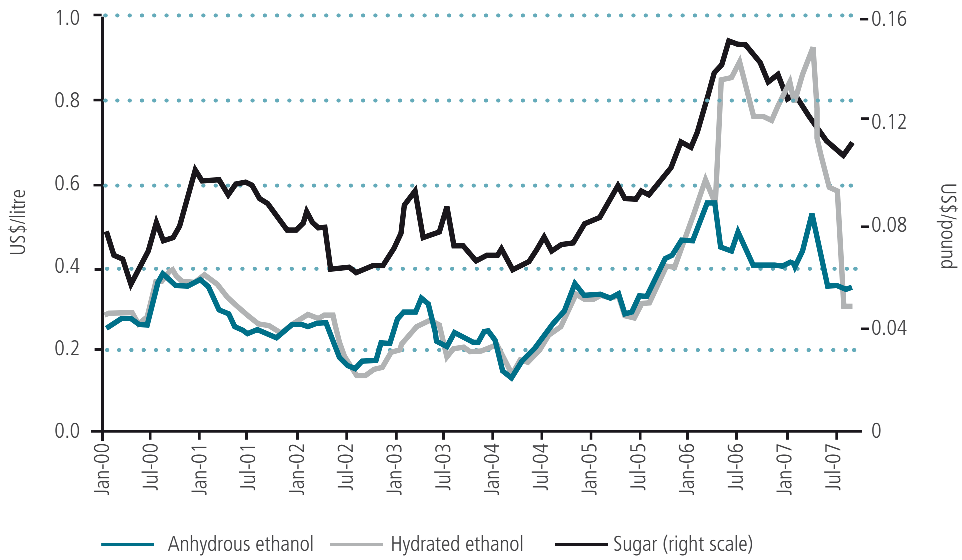
FIGURE 8: PRODUCER AND CONSUMER PRICES OF WHEAT IN ETHIOPIA (2000 = 100)



Note: Consumer prices represent wholesale prices in Addis Ababa, and producer prices are national farmgate prices.

Source: Data from Central Statistical Agency of Ethiopia 2007 and Ethiopian Grain Trade Enterprise 2007.

FIGURE 9: BRAZIL: ETHANOL AND SUGAR PRICES, JANUARY 2000–SEPTEMBER 2007



Notes: Fuel ethanol prices in Brazil refer to averages for the São Paulo market (mills, distilleries, distributors, intermediaries). Hydrous ethanol is used as a substitute for gasoline and Anhydrous ethanol is mixed with gasoline.

Source: Data from CEPEA 2007.

In the past five years, price variations in oilseeds and in wheat and corn have increased to about twice the levels of previous decades.[5]

The increasing demand for high-value commodities has resulted in surging prices for meat and dairy products (Figure 10), and this is driving feed prices upward, too. Since the beginning of 2000, butter and milk prices have tripled and poultry prices have almost doubled.

The effects of price increase on consumption are different across different countries and consumer groups. Consumers in low-income countries are much more responsive to price changes than consumers in high-income countries (Table 4). Also, the demand for meat, dairy, fruits, and vegetables is much more sensitive to price, especially among the poor, than is the demand for bread and cereals.

2.2 Scenario Analyses of the Determinants of Prices and Consumption

The effect of biofuels

When oil prices range between US$60 and $70 a barrel, biofuels are competitive with petroleum in many countries, even with existing technologies. Efficiency benchmarks vary for different biofuels, however, and ultimately, production should be established and expanded where comparative advantages exist. With oil prices above US$90, the competitiveness is of course even stronger.

Feedstock represents the principal share of total biofuel production costs. For ethanol and biodiesel, feedstock accounts for 50–70 percent and 70–80 percent of overall costs, respectively (IEA 2004). Net production costs—which are all costs related to production, including investments—differ widely across countries. For instance, Brazil produces ethanol at about half the cost of Australia and one-third the cost of Germany (Henniges 2005). Significant increases in feedstock costs (by at least 50 percent) in the past few years impinge on comparative advantage and competitiveness. The implication is that while the biofuel sector will contribute to feedstock price changes, it will also be a victim of these price changes.

Food-price projections have not yet been able to fully take into account the impact of biofuels expansion. When assessing potential developments in the biofuels sector and their consequences, the OECD-FAO outlook makes assumptions for a number of countries, including the United States, the European Union, Canada, and China. New biofuel technologies and policies are viewed as uncertainties that could dramatically impact future food prices (OECD-FAO 2007). The Food and Agricultural Policy Research Institute (FAPRI) conducts a detailed analysis of the potential impact of policy on biofuels and links between the ethanol and gasoline markets, but its extensive modeling is limited to the United States.

A new, more comprehensive global scenario analysis using IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) examines current price effects and estimates future ones. In view of the dynamic world food situation and the rapidly changing biofuels sector, IFPRI continuously updates and refines its related models, so the results presented here should be viewed as work in progress. Recently, the IMPACT model has incorporated 2005/06 developments in supply and demand, and has generated two future scenarios based on these developments:

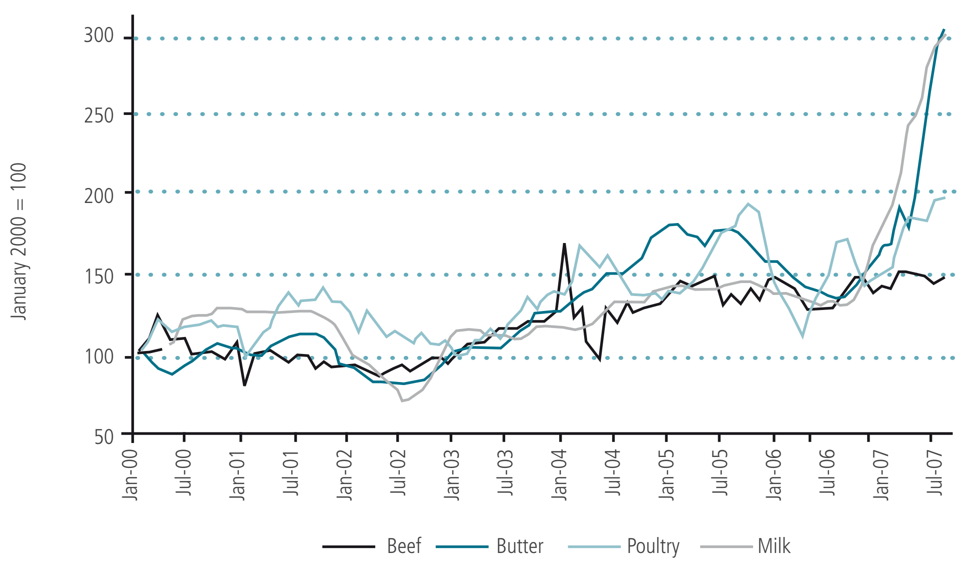
- Scenario 1 is based on the actual biofuel investment plans of many countries that have such plans and assumes biofuel expansions for identified highpotential countries that have not specified their plans.
- Scenario 2 assumes a more drastic expansion of biofuels to double the levels used in Scenario 1.

Under the planned biofuel expansion scenario (Scenario 1), international prices increase by 26 percent for maize and by 18 percent for oilseeds. Under the more drastic biofuel expansion scenario (Scenario 2), maize prices rise by 72 percent and oilseeds by 44 percent (Table 5).

Under both scenarios, the increase in crop prices resulting from expanded biofuel production is also accompanied by a net decrease in the availability of and access to food, with calorie consumption estimated to decrease across all regions compared to baseline levels (Figure 11). Food-calorie consumption decreases the most in Sub-Saharan Africa, where calorie availability is projected to fall by more than 8 percent if biofuels expand drastically.

One of the arguments in favor of biofuels is that they could positively affect net carbon emissions as an alterative to fossil fuels. That added social benefit might justify some level of subsidy and regulation, since these external benefits would not be internalized by markets. However, potential forest conversion for biofuel production and the impact of biofuel production on soil fertility are environmental concerns that require attention. As is the case with any form of agricultural production, biofuel feedstock production can be managed in sustainable or in damaging ways. Clear environment-related efficiency criteria and sound process standards need to be established that internalize the positive and negative externalities of biofuels and ensure that the energy output from biofuel production is greater than the amount of energy used in the process. In general, subsidies for biofuels that use agricultural production resources are extremely antipoor because they implicitly act as a tax on basic food, which represents a large share of poor people's consumption expenditures and becomes even more costly as prices increase, as shown above (von Braun 2007).

FIGURE 10: MEAT AND DAIRY PRICES (JANUARY 2000 = 100)



Notes: Beef = USA beef export unit value; poultry = export unit value of broiler cuts; butter = Oceania indicative export prices, f.o.b. Milk = Oceania whole milk powder indicative export prices, f.o.b.

Source: Data from FAO 2007c.

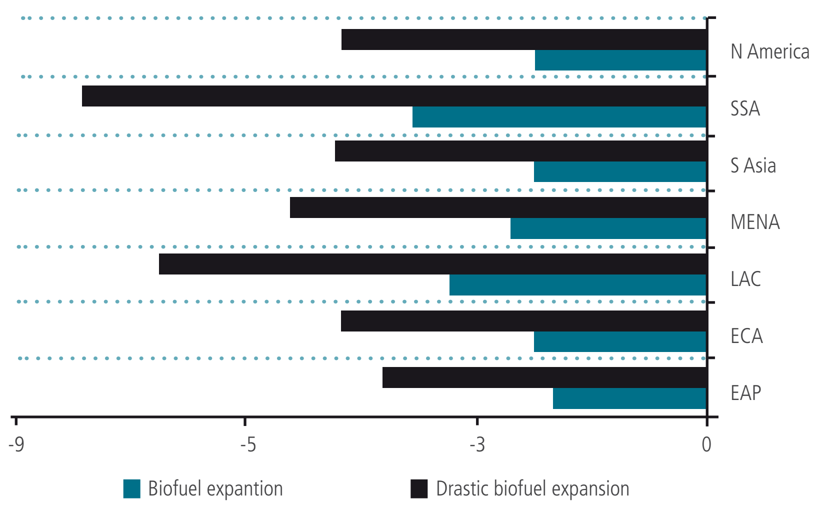
Great technological strides are expected in biofuel production in the coming decades. New technologies converting cellulosic biomass to liquid fuels would create added value by both utilizing waste biomass and by using less land resources. These second-generation technologies, however, are still being developed and third-generation technologies (such as hydrogene) are at an even earlier phase. Even though future technology development will very much determine the competitiveness of the sector, it will not solve the food–fuel competition problem. The trade-offs between food and fuel will actually be accelerated when biofuels become more competitive relative to food and when, consequently, more land, water, and capital are diverted to biofuel production. To soften the trade-offs and mitigate the growing price burden for the poor, it is necessary to accelerate investment in food and agricultural science and technologies, and the CGIAR has a vital role to play in this. For many developing countries, it would be appropriate to wait for the emergence of second-generation technologies, and "leapfrog" onto them later.

Attempts to predict future overall food price changes

How will food prices change in coming years? This is one of the central questions that policymakers, investors, speculators, farmers, and millions of poor people ask. Though the research community does its best to answer this question, the many uncertainties created by supply, demand, market functioning, and policies mean that no straightforward answer can be given. However, a number of studies have analyzed the forces driving the current increases in world food prices and have predicted future price developments.

The Economic Intelligence Unit predicts an 11-percent increase in the price of grains in the next two years and only a 5-percent rise in the price of oilseeds (EIU 2007).The OECDFAO outlook has higher price projections (it expects the prices of coarse grains, wheat, and oilseeds to increase by 34, 20, and 13 percent, respectively, by 2016–17). The Food and Agricultural Policy Research Institute (FAPRI) expects increases in corn demand and prices to last until 2009–10, and thereafter expects corn production growth to be on par with consumption growth. FAPRI does not expect biofuels to have a large impact on wheat markets, and predicts that wheat prices will stay constant due to stable demand as population growth offsets declining per capita consumption. Only the price of palm oil—another biofuel feedstock—is projected to dramatically increase by 29 percent. In cases where demand for agricultural feedstock is large and elastic, some experts expect petroleum prices to act as a price floor for agricultural commodity prices. In the resulting price corridor, agricultural commodity prices are determined by the product's energy equivalency and the energy price (Schmidhuber 2007).

FIGURE 11: CALORIE AVAILABILITY CHANGES IN 2020 COMPARED TO BASELINE (%)



Notes: N America = North America; SSA = Sub-Saharan Africa; S Asia = South Asia; MENA = Middle East & North Africa; LAC = Latin America and the Caribbean; ECA = Europe & Central Asia; EAP = East Asia and Pacific..

Source: IFPRI IMPACT projections.

TABLE 5: CHANGES IN WORLD PRICES OF FEEDSTOCK CROPS AND SUGAR BY 2020 UNDER TWO SCENARIOS COMPARED WITH BASELINE LEVELS (%)

	SCENARIO 1	SCENARIO 2
Crop	Biofuel expansiona	Drastic biofuel expansionb
Cassava	11.2	26.7
Maize	26.3	71.8
Oilseeds	18.1	44.4
Sugar	11.5	26.6
Wheat	8.3	20.0

Source: IFPRI IMPACT projections (in constant prices).
a Assumptions are based on actual biofuel production plans and projections in relevant countries and regions.
b Assumptions are based on doubling actual biofuel production plans and projections in relevant countries and regions.

In order to model recent price developments, changes in supply and demand from 2000 to 2005 as well as biofuel developments were introduced into the IFPRI IMPACT model (see Scenario 1). The results indicate that biofuel production is responsible for only part of the imbalances in the world food equation. Other supply and demand shocks also play important roles. The price changes that resulted from actual supply and demand changes during 2000–2005 capture a fair amount of the noted increase in real prices for grains in those years (Figure 12).[6] For the period from 2006 to 2015, the scenario suggests further increases in cereal prices of about 10 to 20 percent in current U.S. dollars. Continued depreciation of the U.S. dollar—which many expect—may further increase prices in U.S.-dollar terms.

The results suggest that changes on the supply side (including droughts and other shortfalls and the diversion of food for fuel) are powerful forces affecting the price surge at a time when demand is strong due to high income growth in developing countries. Under a scenario of continued high income growth (but no further supply shocks), the preliminary model results indicate that food prices would remain at high levels for quite some time. The usual supply response embedded in the model would not be strong enough to turn matters around in the near future.

2.3 Who Benefits and Who Loses from High Prices?

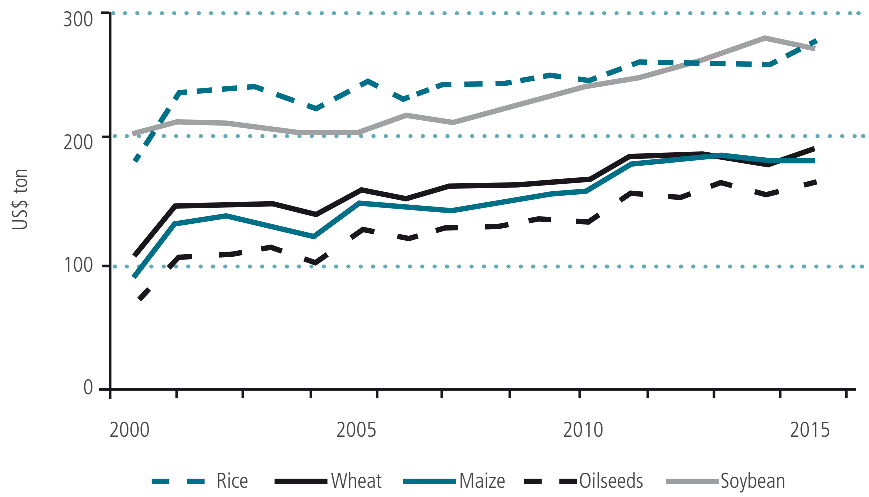
An increase in cereal prices will have uneven impacts across countries and population groups. Net cereal exporters will experience improved terms of trade, while net cereal importers will face increased costs in meeting domestic cereal demand. There are about four times more net cereal-importing countries in the world than net exporters. Even though China is the largest producer of cereals, it is a net importer of cereals due to strong domestic consumption (Table 6). In contrast, India—also a major cereal producer—is a net exporter. Almost all countries in Africa are net importers of cereals.

Price increases also affect the availability of food aid. Global food aid represents less than 7 percent of global official development assistance and less than 0.4 percent of total world food production. [7] Food aid flows, however, have been declining and have reached their lowest level since 1973. In 2006, food aid was 40 percent lower than in 2000 (WFP 2007). Emergency aid continues to constitute the largest portion of food aid. Faced with shrinking resources, food aid is increasingly targeted to fewer countries—mainly in Sub-Saharan Africa—and to specific beneficiary groups.

At the microeconomic level, whether a household will benefit or lose from high food prices depends on whether the household is a net seller or buyer of food. Since food accounts for a large share of the poor's total expenditures, a staple-crop price increase would translate into lower quantity and quality of food consumption. Household surveys provide insights into the potential impact of higher food prices on the poor. Surveys show that poor net buyers in Bolivia, Ethiopia, Bangladesh, and Zambia purchase more staple foods than net sellers sell (Table 7). The impact of a price increase is country and crop specific. For instance, two-thirds of rural households in Java own between 0 and 0.25 hectares of land, and only 10 percent of households would benefit from an increase in rice prices (IFPP 2002).

In sum, in view of the changed farm-production and market situation that the poor face today, there is not much supporting evidence for the idea that higher farm prices would generally cause poor households to gain more on the income side than they would lose on the consumption–expenditure side. Adjustments in the farm and rural economy that might indirectly create new income opportunities due to the changed incentives will take time to reach the poor.

FIGURE 12: MODELING THE ACTUAL PRICE CHANGE OF CEREALS, 2000–2005 AND SCENARIO 2006–2015 (US$/TON)



Source: Preliminary results from the IFPRI IMPACT model, provided by Mark W. Rosegrant (IFPRI). In constant prices.

TABLE 6: NET CEREAL EXPORTS AND IMPORTS FOR SELECTED COUNTRIES (THREE-YEAR AVERAGES 2003–2005)

Country	1000 tons
Japan	-24,986
Mexico	-12,576
Egypt	-10,767
Nigeria	-2,927
Brazil	-2,670
China	-1,331
Ethiopia	-789
Burkina Faso	29
India	3,637
Argentina	20,431
United States	76,653

Source: Data from FAO 2007a.

TABLE 7: PURCHASES AND SALES OF STAPLE FOODS BY THE POOR (% OF TOTAL EXPENDITURE OF ALL POOR)

Staple foods	Bolivia 2002	Ethiopia 2000	Bangladesh 2001	Zambia 1998
Purchases by all poor net buyers	11.3	10.2	22.0	10.3
Sales by all poor net sellers	1.4	2.8	4.0	2.3

Source: Adapted from World Bank 2007a.

3. Poverty and the Food and Nutrition Situation

Many of those who are the poorest and hungriest today will still be poor and hungry in 2015, the target year of the Millennium Development Goals. IFPRI research has shown that 160 million people live in ultra poverty on less than 50 cents a day (Ahmed et al. 2007). The fact that large numbers of people continue to live in intransigent poverty and hunger in an increasingly wealthy global economy is the major ethical, economic, and public health challenge of our time.

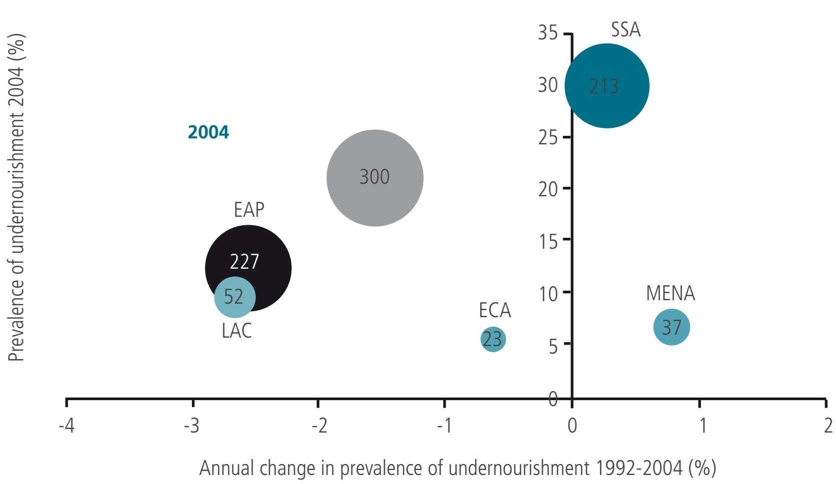
The number of undernourished in the developing world actually increased from 823 million in 1990 to 830 million in 2004 (FAO 2006a). In the same period, the share of undernourished declined by only 3 percentage points—from 20 to 17 percent. The share of the ultra poor—those who live on less than US$0.50 a day—decreased more slowly than the share of the poor who live on US$1 a day (Ahmed et al. 2007). In Sub-Saharan Africa and Latin America, the number of people living on less than US$0.50 a day has actually increased (Ahmed et al. 2007). Clearly, the poorest are being left behind. Behind the global figures on undernourishment, there are also substantial regional differences (Figure 13). In East Asia, the number of food insecure has decreased by more than 18 percent since the early 1990s and the prevalence of undernourishment decreased on average by 2.5 percent per annum, mostly due to economic growth in China. In Sub-Saharan Africa, however, the number of food-insecure people increased by more than 26 percent and the prevalence of undernourishment increased by 0.3 percent per year. South Asia remains the region with the largest number of hungry, accounting for 36 percent of all undernourished in the developing world.

Recent data show that in the developing world, one of every four children under the age of five is still underweight and one of every three is stunted.[8] Children living in rural areas are nearly twice as likely to be underweight as children in urban areas (UNICEF 2006).

An aggregate view on progress—or lack thereof—is given by IFPRI's Global Hunger Index (GHI). It evaluates manifestations of hunger beyond dietary energy availability. The GHI is a combined measure of three equally weighted components: (i) the proportion of undernourished as a percentage of the population, (ii) the prevalence of underweight in children under the age of five, and (iii) the under-five mortality rate. The Index ranks countries on a 100-point scale, with higher scores indicating greater hunger. Scores above 10 are considered serious and scores above 30 are considered extremely alarming.

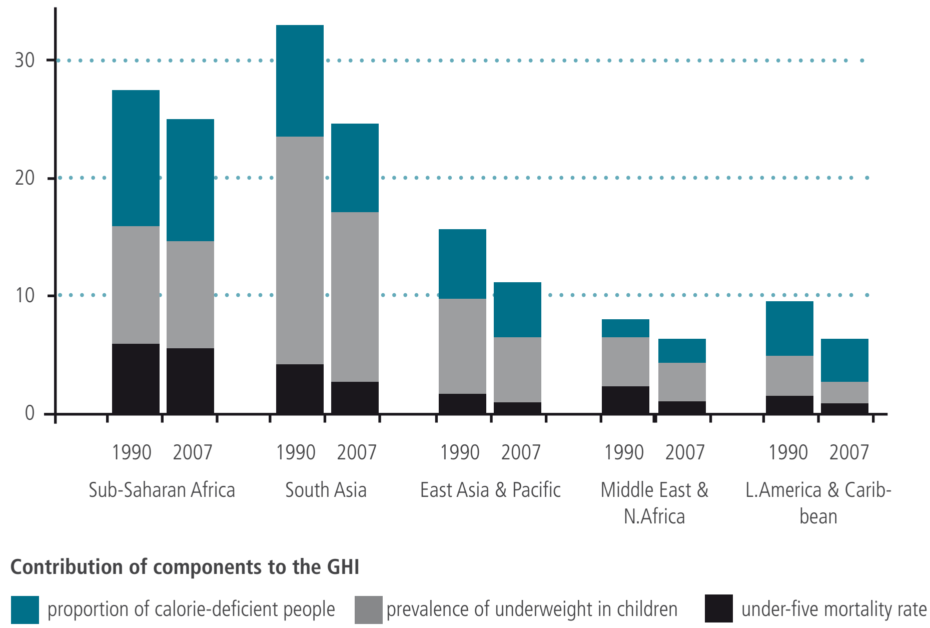
From 1990 to 2007, the GHI improved significantly in South and Southeast Asia, but progress was limited in the Middle East and North Africa and in Sub-Saharan Africa (Figure 14). The causes and manifestations of hunger differ substantially between regions. Although Sub-Saharan Africa and South Asia currently have virtually the same scores, the prevalence of underweight children is much higher in South Asia, while the proportion of calorie-deficient people and child mortality is much more serious in Sub-Saharan Africa.

FIGURE 13: PREVALENCE OF UNDERNOURISHMENT IN DEVELOPING COUNTRIES, 1992–2004 (% OF POPULATION)



Source: Data from FAO 2006a and World Bank 2007b. Note: The size of the bubbles represents millions of undernourished people in 2004. EAP—East Asia and the Pacific, LAC—Latin America and the Caribbean, SA—South Asia, SSA—Sub-Saharan Africa, MENA—Middle East and North Africa, ECA—Eastern Europe and Central Asia.

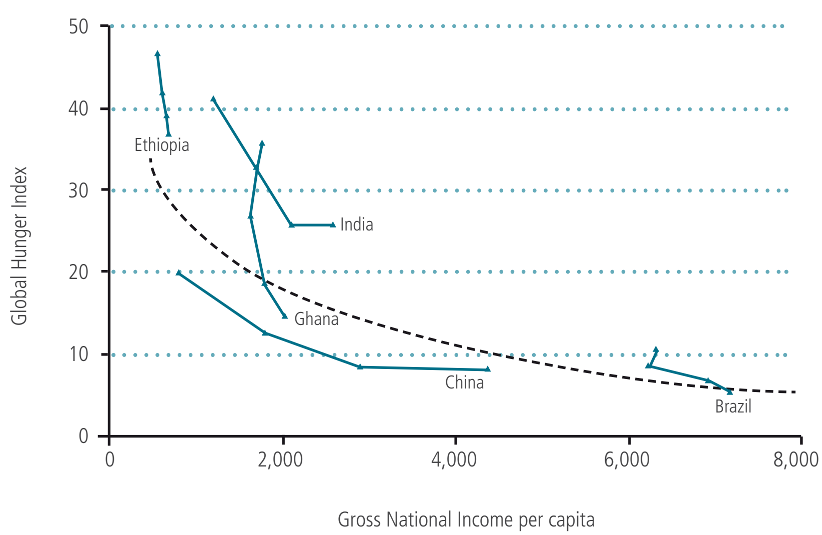
FIGURE 14: CHANGES IN THE GLOBAL HUNGER INDEX (GHI)



Note: GHI 1990 was calculated on the basis of data from 1992 to 1998. GHI 2007 was calculated on the basis of data from 2000 to 2005, and encompasses 97 developing countries and 21 transition countries.

Source: Adapted from Wiesmann et al. 2007.

FIGURE 15: TRENDS IN THE GHI AND GROSS NATIONAL INCOME PER CAPITA (1981, 1992, 1997, 2003)



Note: Gross National Income per capita was calculated for three-year averages (1979–81, 1990–92, 1995–97, and 2001–03, considering purchasing power parity). Each triangle represents one of the four years: 1981, 1992, 1997, and 2003.

Source: Analysis by Doris Wiesmann (IFPRI) based on GHI data from Wiesmann et al. 2007 and gross national income per capita data from World Bank 2007b.

TABLE 8: EXPECTED NUMBER OF UNDERNOURISHED IN MILLIONS, INCORPORATING THE EFFECTS OF CLIMATE CHANGE

Region	1990	2020	2050	2080	2080/1990 ratio
Developing countries	885	772	579	554	0.6
Asia, Developing	659	390	123	73	0.1
Sub-Saharan Africa	138	273	359	410	3.0
Latin America	54	53	40	23	0.4
Middle East & North Africa	33	55	56	48	1.5

Source: Adapted from Tubiello and Fischer 2007.

In recent years, countries' progress toward alleviating hunger has been mixed. For instance, progress slowed in China and India, and accelerated in Brazil and Ghana (Figure 15). Many countries in Sub-Saharan Africa have considerably higher GHI values than countries with similar incomes per capita, largely due to political instability and war. Index scores for Ethiopia moved up and down, increasing during times of war and improving considerably between 1997 and 2003.

Climate change will create new food insecurities in coming decades. Low-income countries with limited adaptive capacities to climate variability and change are faced with significant threats to food security. In many African countries, for example, agricultural production as well as access to food will be negatively affected, thereby increasing food insecurity and malnutrition (Easterling et al. 2007). When taking into account the effects of climate change, the number of undernourished people in Sub-Saharan Africa may triple between 1990 and 2080 under these assumptions (Table 8).

4. Conclusions

The main findings of this update on the world food situation are:

- Strong economic growth in developing countries is a main driver of a changing world food demand toward high-value agricultural products and processed foods.
- Slow-growing supply, low stocks, and supply shocks at a time of surging demand for feed, food, and fuel have led to drastic price increases, and these high prices do not appear likely to fall soon.
- Biofuel production has contributed to the changing world food equation and currently adversely affects the poor through price-level and price-volatility effects.
- Many small farmers would like to take advantage of the new income-generating opportunities presented by high-value products (meat, milk, vegetables, fruits, flowers). There are, however, high barriers to market entry. Therefore, improved capacity is needed to address safety and quality standards as well as the large scales required by food processors and retailers.
- Poor households that are net sellers of food benefit from higher prices, but these are few. Households that are net buyers lose, and they represent the large majority of the poor.
- A number of countries—including countries in Africa—have made good progress in reducing hunger and child malnutrition. But many of the poorest and hungry are still being left behind despite policies that aim to cut poverty and hunger in half by 2015 under the Millennium Development Goals.
- Higher food prices will cause the poor to shift to even less-balanced diets, with adverse impacts on health in the short and long run.

Business as usual could mean increased misery, especially for the world's poorest populations. A mix of policy actions that avoids damage and fosters positive responses is required. While maintaining a focus on longterm challenges is vital, there are five actions that should be undertaken immediately:

1. Developed countries should facilitate flexible responses to drastic price changes by eliminating trade barriers and programs that set aside agriculture resources, except in well-defined conservation areas. A world confronted with more scarcity of food needs to trade more—not less—to spread opportunities fairly.
2. Developing countries should rapidly increase investment in rural infrastructure and market institutions in order to reduce agricultural-input access constraints, since these are hindering a stronger production response.
3. Investment in agricultural science and technology by the Consultative Group on International Agricultural Research (CGIAR) and national research systems could play a key role in facilitating a stronger global production response to the rise in prices.

4. The acute risks facing the poor—reduced food availability and limited access to income-generating opportunities—require expanded social-protection measures. Productive social safety nets should be tailored to country circumstances and should focus on early childhood nutrition.
5. Placing agricultural and food issues onto the national and international climate-change policy agendas is critical for ensuring an efficient and propoor response to the emerging risks.

Notes

1. The most food-insecure countries include the 20 countries with the highest prevalence of undernourishment and the 20 countries with the highest number of undernourished people as reported in FAO 2006a. Six countries overlap across both categories.
2. The data on stocks are estimates that need to be interpreted with caution since not all countries make such data available.
3. Carbon fertilization refers to the influence of higher atmospheric concentrations of carbon dioxide on crop yields.
4. Calculation based on data from Government of India 2007 and FAO 2007b.
5. The coefficient of variation of oilseeds in the past five years was 0.20, compared to typical coefficients in the range of 0.08–0.12 in the past two decades. In the past decade, the coefficient of variation of corn increased from 0.09 to 0.22 (von Braun 2007).
6. The weather variables are partly synthesized because complete data are not available, so turning points on prices will not be precise, but the trend captures significant change.
7. Calculations are for 2006 and are based on data from OECD 2007, FAO 2007a, and WFP 2007.
8. With height less than two standard deviations below the median height-for-age of the reference population.

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   - [ ] Average
   - [ ] Poor

6. Photographs are used in the publication. Do you think there are
   - [ ] Too many
   - [ ] An appropriate number
   - [ ] More needed

7. Do you find the Monitor easy to read?
   - [ ] Yes
   - [ ] No

   Why or why not?..

8. When do you read the Monitor?
   - [ ] Immediately
   - [ ] The day it is received
   - [ ] Within one week
   - [ ] Prior to the next issue
   - [ ] It's in my reading file
   - [ ] Glance and discard

9. Are there other topics you would like to see covered in the newsletter?
   - [ ] Yes
   - [ ] No

   If yes what are they? ....

10. Currently, the Monitor is distributed twice-yearly, is this schedule

☐ Too infrequent and should distribute more often ☐ About right ☐ Too frequent.

I suggest the Monitor be issued

11. Do you share the Monitor with others?

☐ Yes ☐ No If yes, with whom? ....

12. Do you rely on any of the articles for information to discuss with others in the community?

☐ Yes ☐ No

13. Do you save the Monitor?

☐ Yes ☐ No

14. Do you want to continue to receive the publication?

☐ Yes ☐ No

15. If so, in what format

☐ Print ☐ Electronic

16. What is your association with (name of non-profit)? (Check all that apply)

☐ Personal contributor ☐ Corporate contributor ☐ Volunteer ☐ Paid staff member
☐ Vendor ☐ Representative of the media ☐ Government official/employee
☐ Client of non-profit?

Again thank you for your time. Please email or fax this form at you earliest convenience.

Email: ipeleng@tips.org.za Fax: +27(0)12 431 7910

This questionnaire is also accessible online at www.tips.org.za/monitor/questionnaire