

Brazil's Sugarcane Sector

A Case of Lost Opportunity

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The result of inappropriate policy interventions in Brazil's sugarcane and ethanol industry: lost opportunities, reduced industry profitability, and billions of dollars annually in forgone income to the state.



Summary findings

The Brazilian sugar and ethanol story goes like this: Direct market intervention overrides market forces. Markets undergo dramatic change. Intervention establishes vested interests. Rent-seeking blocks adjustment to market change. Economic objectives become blurred behind political objectives. Opportunities go begging. Industry profitability suffers. And national income is forgone.

Borrell, Bianco, and Bale use a simple economic model of the Brazilian sugarcane sector and policy interventions to measure the costs of existing policies and to develop better policies.

Brazil is an efficient producer of sugar, but policy intervention has caused:

- Underproduction of sugarcane.
- The wrong mix of sugar and ethanol from cane (too much ethanol, not enough sugar).
- Missed opportunities to market ethanol in high-value uses (as an octane enhancer and clean fuel).
- Missed opportunities to make the world sugar market more competitive.

Adopting more market-based policies could be worth billions of additional dollars annually to Brazil.

This paper — a product of the Latin America and the Caribbean, Country Department I, Natural Resources and Rural Poverty Division — is part of a larger effort in the region to analyze economic and sectoral policies in Brazil. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Malcolm Bale, room Q7-167, extension 31913 (22 pages). October 1994.

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The Brazil sugar and ethanol story is as follows: direct government intervention overrides market forces, markets undergo dramatic change, intervention establishes vested interests, rent-seeking blocks adjustment to market change, economic objectives become blurred behind political objectives, opportunities go begging, industry profitability suffers, and national income is foregone. A simple economic model of the Brazilian sugarcane sector and policy interventions is used to measure the costs of existing policies and to develop better policies. Brazil is an efficient producer of sugar, but policy intervention causes: underproduction of sugarcane, the wrong mix of sugar and ethanol from cane (too much ethanol, not enough sugar), missed opportunities to market ethanol in high value uses (as an octane enhancer and clean fuel), and missed opportunities to make the world sugar market more competitive. Adopting more market based policies could be worth billions of dollars extra to Brazil annually.

Setting the Scene

Brazil has a clear comparative advantage in producing sugarcane. It is the most efficient and largest producer in the world, producing a massive 230 million tons annually. Brazil is also very efficient at converting cane into sugar, yet only one third of its cane is used for sugar production. The rest is used to produce ethanol as a substitute automotive fuel. This is a poor use of cane. The cost of producing ethanol exceeds the value of fuel it replaces. Brazil may, nonetheless, have a comparative advantage producing ethanol but only if it can market it as a product for higher valued uses; namely as an octane enhancer or as a clean fuel. However, current policy arrangements stop ethanol being marketed for alternative uses. This paper is about what is wrong with existing policies, what they might be costing Brazil and what it needs to do to develop better policies.

But government intervention is blocking change

The oil price shocks of the mid seventies and early eighties led to the Brazilian government's PROALCOOL program. Through this program the government sought to reduce Brazil's reliance on imported automotive fuels by promoting the production and use of ethanol through direct and indirect subsidies to ethanol producers, car manufacturers and ethanol consumers. The PROALCOOL program involves set prices, directives and quota restrictions which override the forces of markets.

The PROALCOOL program was premised on the beliefs that oil prices would remain at the record highs of the 1970s; that Brazil's economy was vulnerable to shortages of automotive fuels; and that sugar prices would remain low. Twenty years later much has changed. Oil prices have fallen

and with them the value of ethanol as a gasoline substitute; Brazil has discovered significant oil reserves of its own and established high levels of domestic fuel security; sugar prices are reasonably attractive; and the world demand for ethanol as an environmentally friendly fuel is increasing. Sugarcane sector policy has failed to adapt in order to take advantage of this new commercial environment. The essential instruments of the PROALCOOL program have remained intact. The program has prevented the natural adjustment which would have occurred if Brazilian producers and consumers had faced high oil prices. In other parts of the world the solution to high oil prices was high oil prices.

In the Brazilian sugarcane sector diverse commercial decisions about resource allocation based on personal incentives, competition, commercial risk, and world market prices have been swapped for a few decisions made centrally, by government officials far removed from the realities and opportunities of the market and subject to the rigidity's and non-commercial objectives of political decision making. Such decision making has been unsuited to rapidly changing, uncertain and increasingly competitive international markets.

Through the PROALCOOL program many manifestly bad (though well meant) decisions were made and have not been corrected. The nature of intervention has made changing the policy highly political. Without government intervention, it is unlikely that political decisions would have overridden good commercial ones and, if bad decisions were made, commercial necessity would have dictated that they were soon corrected.

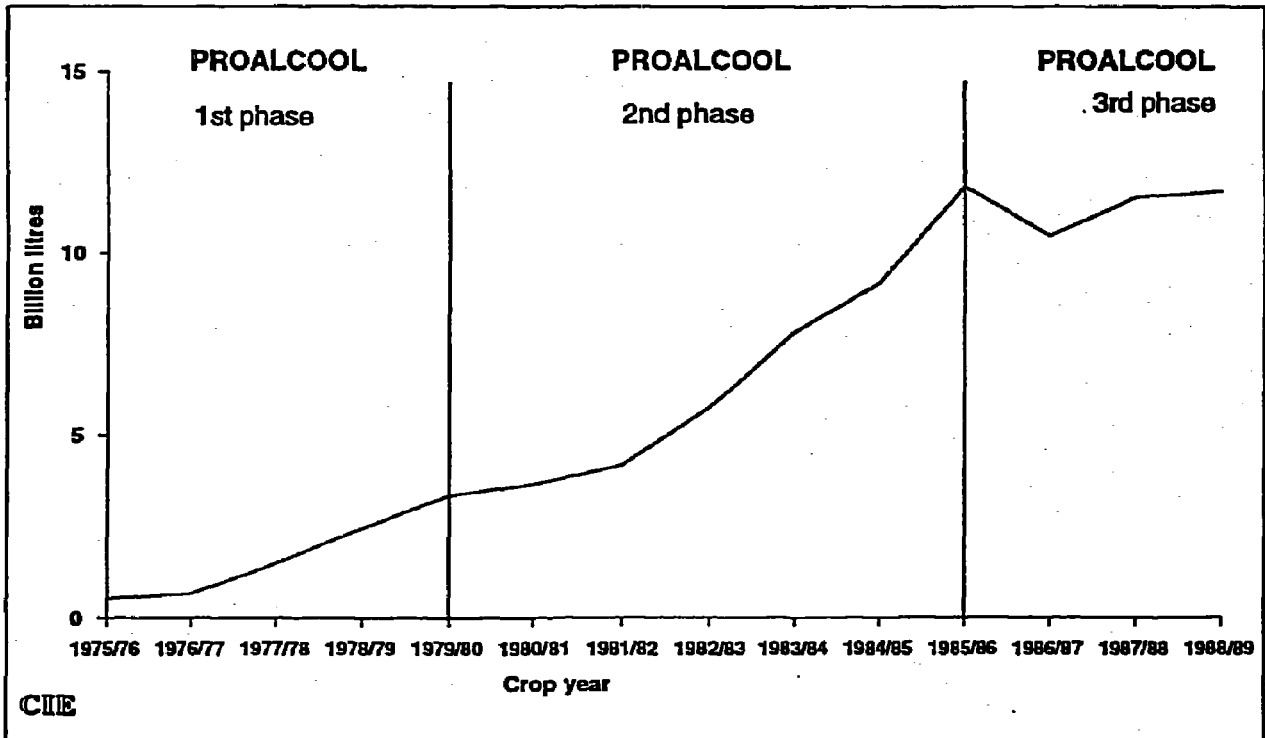
And economic objectives have become politicized and the policy confused

The main objective of the PROALCOOL program was to reduce Brazil's dependence on expensive imported automotive fuels in order to increase national income. A secondary objective was to increase flexibility of the sugarcane based sector by giving it an alternative product to produce. However, the government's direct intervention froze production patterns and reduces national income. As the economic circumstances and relative prices of oil, fuel and sugar markets changed, various interest groups sought to protect their positions. Sugarcane and ethanol producers sought cost of production pricing of ethanol to protect their investments from the low world oil price and owners of ethanol cars sought to guarantee cheap supplies of fuel at prices not exceeding those of gasoline. Thus, rather than the program changing, new objectives were found to match the policy — the tail wags the dog.

Now, the most pressing objective is to maintain the supply of fuel to ethanol powered cars at a price not exceeding that of gasoline. This entails subsidizing both the production and consumption of ethanol. Meeting this obligation is proving to be costly for Brazil — it is not increasing national income as originally intended. And ironically *flexibility* to switch between

sugar and ethanol is restricted given the constraints imposed by this obligation. The only economic justification given for the program relates to an incidental benefit arising from cleaner air. But because this is an unintended benefit, there can be no assurance that the program properly targets the objective of ensuring clean air nor that it achieves it in the most efficient way. The government now finds itself captive to this increasingly costly program. Since 1986, growth in ethanol production has been arrested but production has been maintained in face of the adverse movement of relative prices of oil and sugar against ethanol (figure 1).

Figure 1: Alcohol production in Brazil has plateaued but not fallen



Source: Borges and Bianco (1989).

Supply is managed and prices are regulated

Quantitative controls and price setting mechanisms have been set up under the program to guarantee the supply of ethanol and sugar to the domestic market and to keep the price of ethanol to motorists at acceptable levels. The domestic price of sugar and gasoline are set in line with the ethanol price. Exports are restricted until domestic requirements are met and prices are controlled so that consumers are insulated from world prices of sugar and fuels.

The main institutions involved in administering the policy are:

- SDR (*Secretaria do Desenvolvimento Regional*) which estimates domestic sugar requirements, controls exports and gives permission for imports, and restricts entry by giving permission to build new units

- Ministry of Finance which sets prices based on the average cost of production for producers and sets fuel prices to ensure costs of all fuels to motorists are covered by the revenue received from motorists
- DNC (*Departamento Nacional de Combustível*) estimates domestic ethanol demand
- PETROBRAS which is the state owned distributor, marketer and virtually exclusive importer of automotive fuels including ethanol.

Based on estimates of domestic sugar and ethanol demand production quotas are set for all mills and distilleries by the SDR. Only when these quotas are filled are mills and distilleries entitled to export their over-quota production. Export licenses are used to control exports. The production quotas are set separately for two regions: North/Northeast and Central/South; based on regional demands for each product. A mill or distillery which increases production for export in any one year has a high proportion of that increase progressively switched to quota in subsequent years and all other units have their quotas marginally decreased. So the incentives for increasing production for export are greatly diminished.

The other main instrument of policy is the price fixing arrangements. To ensure ethanol quotas are filled ethanol prices to producers are set to cover the cost of production of ethanol. To reduce incentives to switch sugarcane from ethanol to sugar, domestic sugar prices are also set in line with the ethanol price and the costs of producing sugar.

Consumer prices for ethanol do not bear a direct relationship to producer prices in the same way as sugar prices. The monopoly status of PETROBRAS makes this possible. The consumer price of ethanol is influenced by the total cost to PETROBRAS for refining and supplying all automotive fuels. Generally profits on the sale of gasoline are used to subsidize losses on other fuels.

Exports of sugar and ethanol receive the world prices less a fixed export tax—currently around 20 percent on the cane price or about 12 percent on the domestic sugar price. The export tax is based on a percentage of the fixed cane price and so it does not vary with the world price of sugar or ethanol.

Export licenses are used to remove the incentive to divert sugar or ethanol to world markets when the world price of either product is above the domestic price and before domestic requirements are met. In most years since 1985 world sugar prices have exceeded those of domestic Brazilian sugar and ethanol prices for producers. The indicator world ethanol price also appears to be above the Brazilian producer price for ethanol although the world ethanol market is small. The imported oil price (measured in sugar equivalents and adjusted for its efficiency advantage compared to ethanol) has

been consistently below the domestic ethanol fuel price through the period under review (1975 to present).

Consumer prices are essentially the same across the country, varying to some extent due to differing costs of marketing. However prices to producers reflect varying production costs across the three main regions. Two main policy interventions are involved. In the case of sugar, an 18 percent tax is levied on sugar producers in the South, a nine percent tax is levied in the Central region and no tax is levied on the higher cost producers in the North/Northeast. At the farm gate the implicit subsidy is around 27 percent rather than 18 percent. In the case of ethanol the taxing and cross-subsidization takes place implicitly through PETROBRAS. A purchase price 18 percent higher is paid to producers in the North Northeast than in the South Central region and a nine percent premium is paid to producers in the Central region.

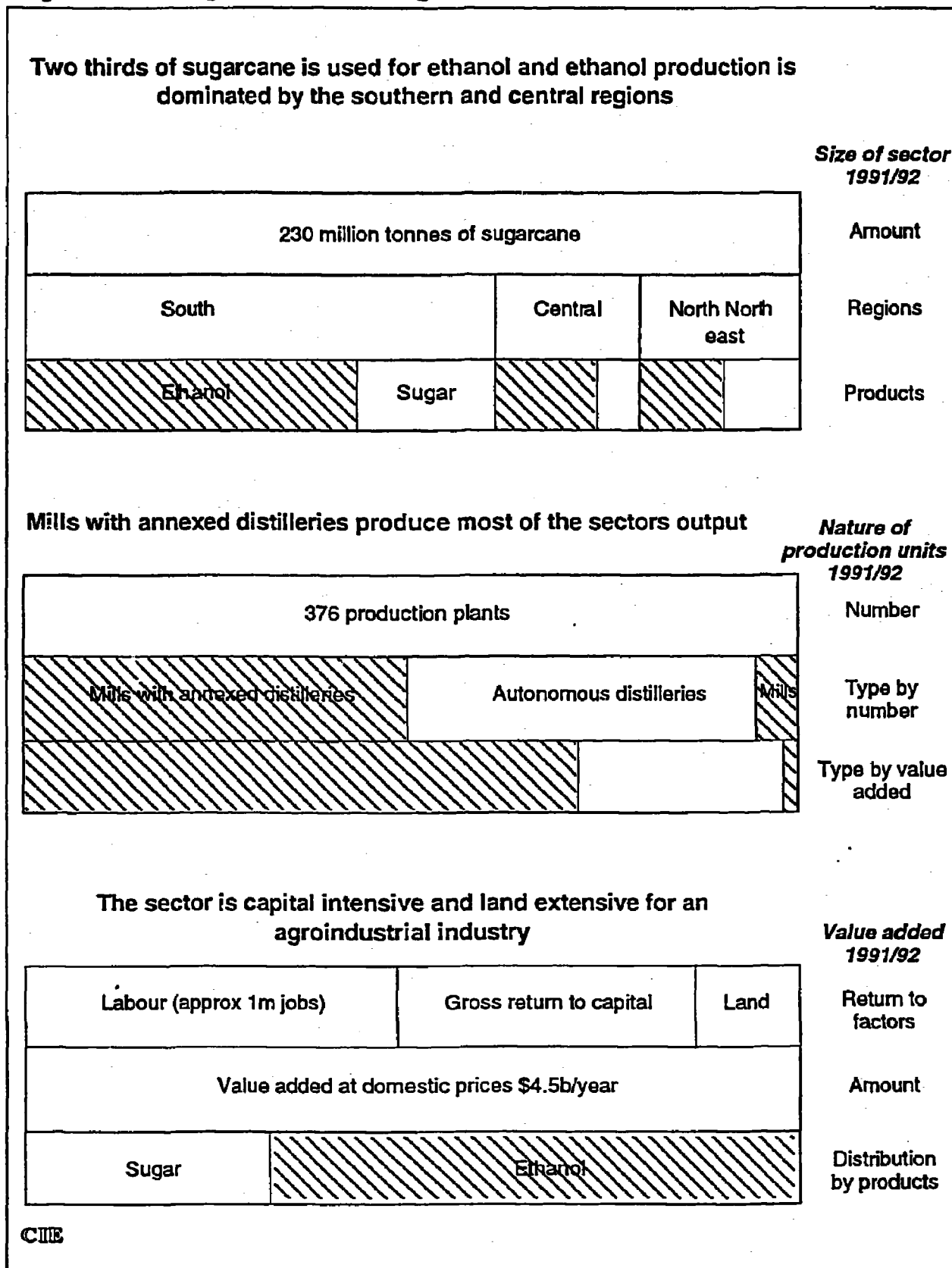
Assessing the Impact of the Policy

The effects of intervention on the industry and Brazil economy depend on a number of important industry parameters. The economic parameters of the sugarcane sector reveal an industry with:

- a huge domestic production base;
- joint products from a single raw material;
- flexibility of production between those products;
- great international competitiveness in several areas;
- limited domestic demand for both products in the long term;
- big international opportunities in both product markets; and
- considerable policy intervention affecting all facets of the industry.

With a value added of around \$4.5 billion annually, the output from the sugarcane sector makes up about 1.5 percent of Brazil's GDP and 15 percent of value added in Brazilian agriculture. About one million people are employed directly but the industry is highly capital intensive (see figure 2). Despite the sector's agricultural base, the industry is not an intensive user of

Figure 2: The sugarcane sector is big



land with returns to land being less than 15 percent. The industry is not highly reliant on fixed factors like many other agricultural industries which suggests it may be highly supply elastic.

The industry is distributed across three main regions with around 60 percent of production in the South in the state of São Paulo. Brazilian sugar production represents about 8 percent of world production. Ethanol production makes up nearly a third of Brazil's automotive fuels supply. In 1991/92 nearly 85 percent or 7.2 million tons of sugar was absorbed domestically and the rest was exported.

Very little ethanol is exported. Larger amounts were exported to the United States until 1986 when the United States imposed hefty tariffs on ethanol imports. Brazil produces five grades of sugar. The *crystal especial* is the main form of sugar produced in the South and is of equal quality to the refined sugar produced in some other countries. Refined sugar generally trades at a premium to raw sugar.

Two types of ethanol are produced: Anhydrous and hydrous. Over eighty percent is hydrous. This is intended as a fuel substitute for gasoline while anhydrous ethanol is an additive to gasoline and an octane enhancer. The production of anhydrous ethanol is slightly more involved and slightly more costly.

In 1991/92 there was a total of 376 industrial plants processing sugarcane. Nearly half were sugar mills with annexed ethanol distilleries. These plants produced about 75 percent of the sector's value added -- virtually all its sugar and 60 percent of the ethanol.

The joint production of sugar and ethanol provides a distinct synergy. Because of the alternative uses for sugarcane juice after cooking, only high quality juice needs to be retained for sugar making. This joint product characteristic reduces sugar production costs and increases sugar quality. Indeed, the sugar produced is similar to refined sugar whereas normally sugar mills produce raw sugar which has higher levels of impurities and requires refining. This sugar commands a premium on the domestic and international markets. The impurities which are passed on to the ethanol making process do not impose costs in a way they would if left in during sugar making.

Joint production potentially also provides production and marketing flexibility which could provide various managerial, marketing and operational advantages. To some extent this flexibility will depend on the extent of surplus capacity available in each process and the marginal cost of additional capacity. Given the large economies of scale reported for both processes, it is likely that the marginal cost of additional capacity--especially at the time of construction--is low. Presently there is around 35 percent additional capacity in milling and 25 percent in distilleries across the industry. Further, to the extent that the joint product operation of an annexed mill allows the higher

total sugarcane throughput than would be the case for a stand-alone mill--especially given the advantages afforded by its flexibility--there may be economies of scale in crushing and cooking.

Brazil is an efficient sugar producer and could easily expand

Brazil has a vast supply of arable flat land in the Center South which give the region the flexibility to increase and decrease sugarcane and sugar production with changes in prices over the medium to long-term--see box 1. The Center-South has a number of advantages over the North/Northeast. The World Bank (1989) attributes the advantages of the Center-South over the North/Northeast to superior climate, topography and technology.

Box 1: The price elasticity of supply

With current government control over production and price, the Brazilian elasticity of supply in response to the world price is estimated by Wong, Sturgiss and Borrell (1989) at 0.1. Typically medium to long term elasticities of supply for agricultural industries generally are in the range 2.0 to 5.0, to where industries with a high proportion of purchased inputs are the most elastic. In the case of sugar, estimates of supply elasticities for other countries which are less constrained by policy factors than Brazil, such as Thailand, have estimated elasticities of around 1.0. The vast supply of land in Brazil for sugarcane production and the high proportion of purchased inputs in value added leads to the conclusion that the potential elasticity of supply in the Center South could exceed that of producers in other countries. Assuming an elasticity of 2.0 would imply that the Center-South was a highly elastic sugar supplier by world standards. In the North/Northeast the elasticity of supply is more likely to be below that of other countries -- perhaps 0.5.

And Brazil's sugar producing potential could influence world price

Although most of Brazil's sugar is absorbed domestically, it is the world market price of sugar that sets the opportunity cost of that output to the Brazilian economy. And among commodity markets, the world sugar market is the most volatile. It is destabilized by the protectionist sugar policies of many other countries.

The average world price of sugar since 1951, in 1990 values, is US\$18.4c/lb. The average price for the decade 1981-90 is US\$11.6c/lb. This is about double the Brazilian domestic producer price.

Despite changes occurring in the market, intermittent peaks and large troughs are likely to continue, although extreme highs and lows are less likely (Borrell and Duncan 1990). Any trade negotiation which made OECD sugar producers and consumers more responsive to the world price would help stabilize the market (Bale and Lutz). However, there is little optimism that trade liberalization will occur quickly. So Brazil's producers and consumers must be flexible in order to cope with the risks arising from

instability in the world market. But because changes in Brazil's sugarcane sector policies have the potential to release great amounts of sugar on to the world market, Brazil also has the potential to influence the world price and needs to consider how it uses this influence to best effect.

Estimates of export demand elasticities provide a measure of the impact an increase in exports of a product could have on world price¹. Borrel (1991) estimates Brazil's price elasticity of export demand at between -3.0 and -14.0. Under the most likely set of assumptions and assuming efficient policies, the estimate is around -9.0. One interpretation of this is for a one percent increase in Brazil's exports the world price would decline by 0.11 percent (Houck 1965). Although this degree of influence seems insufficient to allow Brazil to affect the world price to its advantage, the vast amounts of sugar Brazil could potentially divert to the world market (perhaps an increase in excess of 500%) would have a big impact on the world price. Another finding of Borrell is that because of Brazil's potential impact on the world market, it has the potential to reduce world price variability. This has significant policy implications that will be discussed later.

The price of gasoline determines the value of ethanol -- or does it?

Since ethanol is being used as a substitute for gasoline, its value should be assessed relative to the cost of the gasoline it displaces. Presently the imported price of oil plus refining cost is around \$25 to \$29 per barrel. Ethanol, meanwhile, costs around \$40 per barrel to produce in the Center-South and around 18 percent more in the North/Northeast, in energy equivalent terms. The net contribution of ethanol to the Brazilian economy appears to be highly negative.

But ethanol has other product attributes which may make its potential value to the economy greater than its value as a fuel substitute. Present policies force ethanol to be marketed as a fuel substitute. In the absence of these policies it could be marketed to exploit more fully its other attributes.

Its attributes include:

- a torque advantage which may compensate for its lesser efficiency than gasoline and which could mean a smaller ethanol engine could be used in place of a gasoline engine
- an exhaust emission advantage as alcohol cars produce 57 percent less carbon monoxide, 64 percent less hydrocarbons, 13 percent less nitrogen oxides and no lead emissions compared to gasoline engines (World Bank, 1989)

1 There are many problems with making estimates of export elasticities of demand (see Orcutt 1950) and there are good reasons for believing most estimates overstate the impact.

- unlike fossil fuels which add carbon dioxide to the atmosphere, ethanol only recycles it as next year's crop of sugarcane absorbs carbon dioxide emissions from ethanol burned last year
- anhydrous ethanol can be used as an octane enhancer and contains about twice as much oxygen by weight as other competing oxygenates.

The undistorted demand for ethanol could be affected by all these factors, and there is *prima facie* evidence at least, that international demand is fairly elastic and strong relative to Brazil's long term domestic demand. Exhaust emission control standards are tightening in many parts of the world and carbon taxes have been imposed in some countries (Finland, Netherlands and Sweden) and are being discussed in others (countries of the European Union). Already 40,000 barrels of ethanol are consumed daily in the United States as octane enhancers or oxygenates and the total daily US demand for oxygenates is 190,000 barrels. This consumption approximately equals Brazil's daily output of ethanol. Indeed, Brazil once exported 300,000 to 700,000 liters a year to the United States, but the volume of all ethanol exports fell dramatically when the US imposed tariffs on ethanol in 1986. The United States also heavily subsidizes the production of ethanol which reduces US import demand and may lower the world price, although it is also likely that the price and relative efficiency of other oxygenates sets the price of ethanol.

There are many unknowns about the world demand for ethanol and oxygenates more generally. Not only do tariffs such as those in the United States distort the market but Brazil's marketing restrictions prevent it effectively developing the market. Further, because the demand is relatively new, there is a range of views about the merits and economics of various oxygenates which have not been widely tested in undistorted markets. What is clear is that ethanol is likely to be more valuable as a value-adding component of fuel than as an outright substitute for gasoline, and Brazil is a low cost producer of ethanol relative to the United States.

And costs of producing ethanol are falling

Costs of ethanol production have fallen 20 percent since the PROALCOOL program began. Recall that the average cost of production in the Center-South is around \$40 per barrel. An alternative view on the costs of production is that reported in Rask (1992). He uses a social cost-benefit analysis based on shadow prices for all inputs and outputs after correcting for tariffs and quotas, interest subsidies, distortions in the labor market and overvaluation of exchange rate.

Rask finds that the resource cost to Brazil of producing ethanol in the Center-South region were between \$18 and \$22 per barrel in 1987 and between \$48 and \$55 in the North/Northeast. Based on his findings ethanol would be a viable alternative to gasoline in the Center-South. His analysis

suggests that the distortions in the economy discriminate strongly against the sector and that in a more liberal open trading economy, the competitiveness of ethanol (and sugar) would be enhanced.

But the short-term demand for ethanol is fairly tight

About a third of Brazil's fleet of ethanol cars run on alcohol while the others run on a gasohol blend with 22 percent ethanol and 78 percent gasoline. To some extent this locks Brazil's demand for ethanol, at least over the life of these vehicles. However, there is some flexibility in demand by blending different types of fuel -- in particular methanol can be used in place of ethanol.

Methanol can be imported more cheaply than ethanol can be produced for in Brazil. So substituting methanol for ethanol lowers the cost of supplying alcohol fuel. However, there seems to remain a political preference for ethanol. Cane growers in particular are concerned that while switching sugarcane to sugar production and to exports of sugar might increase their returns, if the world price of sugar fell they may not be free to switch back to the domestic ethanol market.

An Economic Model of the Sugarcane Sector

A four subsector model of the industry is constructed and the economic parameters and policy instruments of the sector can be represented as shown in figure 3. Prices in the graph are shown in sugar equivalent terms. The four panels represent the four main markets affecting the sector.

Because of the predominance of the Center South, Brazil has a large and elastic supply of sugar or ethanol. This is represented in panel one. Although the supply curve is used to represent both products, at the margin it probably represents the product in which Brazil has the greatest comparative advantage: sugar. Panel one also shows that there is a small domestic demand for sugar relative to the total supply potential.

In panel two the short and long term demand for domestic ethanol is represented. The short term demand is shown as inelastic because of the limited options of owners of ethanol powered cars to switch to alternative fuels and considering that ethanol is simply demanded as a fuel. The long term demand is more elastic and represents the fact that there are many substitute fuels for consumers given time to switch. The positioning of the long term variant reflects the fact that past policies have promoted the sale of ethanol cars. This has added greatly to the proportion of ethanol cars in the nation's fleet. Without these policies the proportion of ethanol cars would decline. Further, without existing marketing arrangements the nature of demand for ethanol could change from demand for a substitute for gasoline to a demand for ethanol for other purposes such as an octane enhancer.

The displacement of the horizontal axes of panels two and three is to take account of the fact that Brazil's comparative advantage lies in sugar production. So sugar equivalent prices for ethanol must be higher than sugar prices to make producers indifferent to supplying either commodity.

Panels three and four represent, respectively, the world ethanol and world sugar markets.

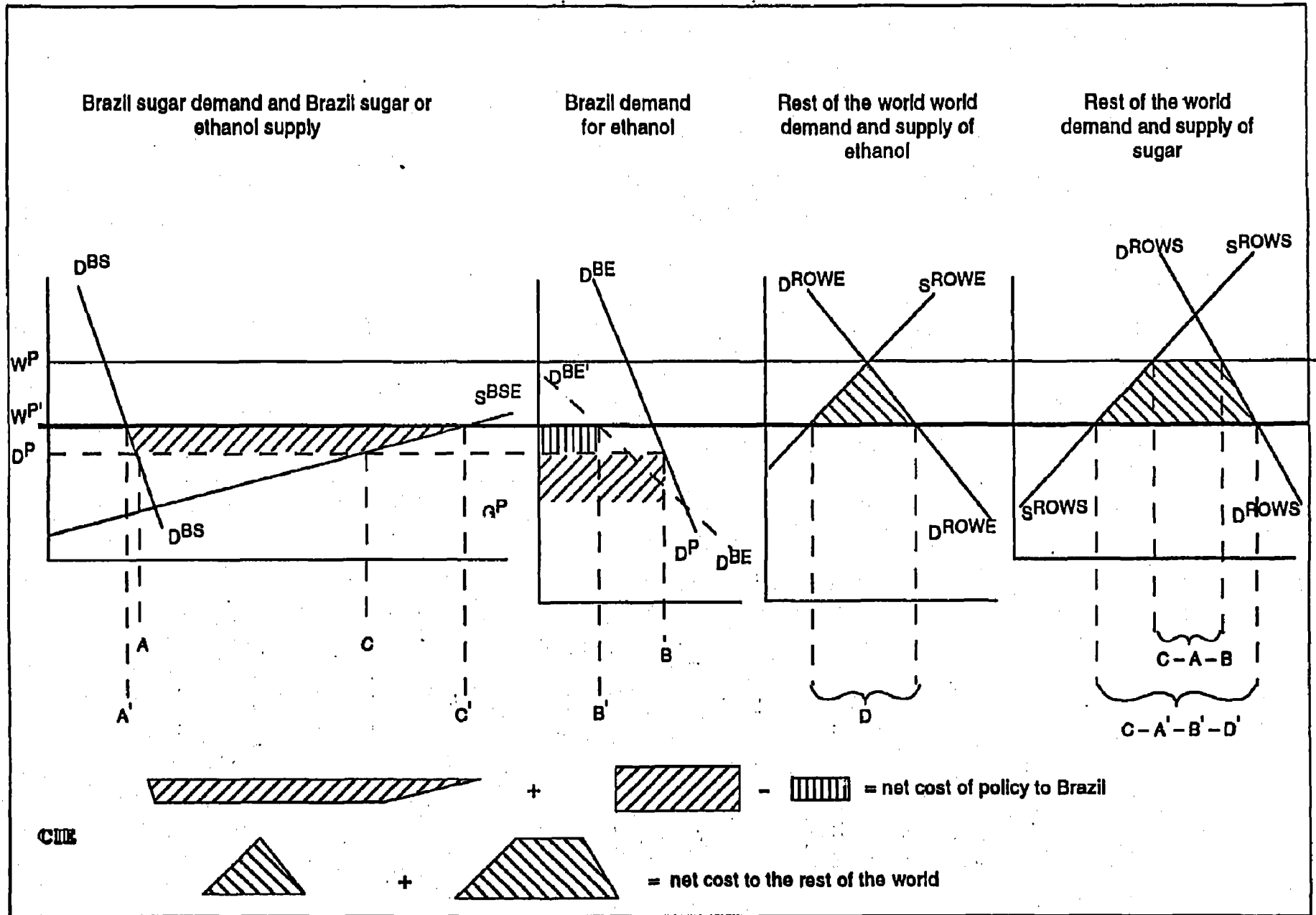
Presently the domestic sugar and ethanol prices to producers (DP) are set by government below the world prices (WP) for these products. At DP a quantity of sugar and ethanol equivalent in sugar terms to C is produced. An amount of sugar equal to A is consumed domestically. A quantity B of ethanol is consumed domestically and C-A-B of sugar is exported to the world market. Although gasoline could be purchased by Brazil at the price GP, the government's arrangement to buy ethanol at DP guarantees the sales of ethanol producers at the set price.

It is assumed there are no ethanol exports. The equilibrium world price needed to absorb Brazil's sugar exports is WP. Without government intervention in the domestic sugar and ethanol markets world prices for both products would dominate the domestic market and over the long term the demand for ethanol would shift from D^{bc} to $D^{bc'}$. However, this would result in a change in the allocation of sugarcane between sugar and ethanol as well as some increase in production and exports. The increased exports would impact negatively on the world price and a new equilibrium would be established at WP' , C' , B' , and $C'-A'-B'-D$, where D represents the exports of ethanol that would emerge. Although the world prices of both ethanol and sugar would fall, Brazil would be better off to the extent of the shaded areas in the first two panes.

The first shaded area is the extra income earned by producers from higher prices and increased production, but net of the loss of income to consumers of sugar due to the higher prices. The second shaded area represents the amount Brazil could have on its fuel bill if the government did not underwrite the purchases of ethanol at the set price. The third shaded area is the extra which consumers would have to pay for the ethanol they continued to use and represents a reduction in income. Nonetheless, the net result is likely to be a large net increase in income to the Brazilian economy.

The shaded areas relating to the rest of the world are the benefits to consumers of sugar and ethanol due to lower prices, after allowing for the decrease in income to sugar and ethanol producers in the rest of the world due to lower prices they would receive.

Figure 3: Brazil's Sugarcane Industry Policies are Costly to Brazil



Although it would appear from the model that existing sugarcane sector policy is costly to Brazil, there is an important welfare effect missing. This is the incidental environmental benefit which current policy affords: cleaner air. There is also a positive external benefit to the world not included in the model. This is the reduction in carbon dioxide emissions into the atmosphere from using ethanol instead of a fossil fuel such as gasoline. This is a benefit for which Brazil deserves but does not receive credit because it is not part of a deliberate policy.

Under the new equilibrium world price derived in the model, more ethanol is produced in and exported from Brazil and worldwide, although domestic consumption of ethanol drops. To the extent that this would replace fossil fuels, Brazil's current set of policies might be argued to be holding back this environmental benefit and therefore imposing a cost on the global economy. Moreover, to the extent that the world demand for ethanol reflected the carbon neutral attribute of ethanol, it would be reflected in the price of ethanol and so allow Brazil to internalize some of the benefits of this attribute. Whether the change in policies would cause an increase or a decrease in ethanol production is an empirical question. So whether existing policies provide more or less of this environmental benefit is also an empirical question.

The economic model reveals more

Setting the domestic price for sugarcane based products below the world price for either one of these products lowers producers' incentive to produce sugarcane, sugar and ethanol. Overall output is less than it should be. In the model it should be C' rather than C . Further, the controlling of prices for both products on the domestic market combined with the use of production quotas distorts the mix of ethanol and sugar and the allocation of those products between the various domestic and world markets. In the model proportionally more sugar and less ethanol should be produced and more of both products should be exported. Brazil is paying too much for its automotive fuels and is consuming too much ethanol.

In addition US tariffs on ethanol reduce the capacity of world trade to absorb some of Brazil's sugarcane. Consequently it is redirected to sugar production so lowering the world price of sugar — see figure 4 where the world price is reduced from WP' to WP'' due to the US trade restrictions against ethanol imports.

But the model does not reveal everything

- Quantitative controls over exports unnecessarily limit incentives for producers to develop ethanol markets. Creative marketing of ethanol by competing private firms is stifled because domestic distribution and marketing is controlled by a monopoly state enterprise and supplies for exports are unreliable due to the priority to satisfy domestic demand first.

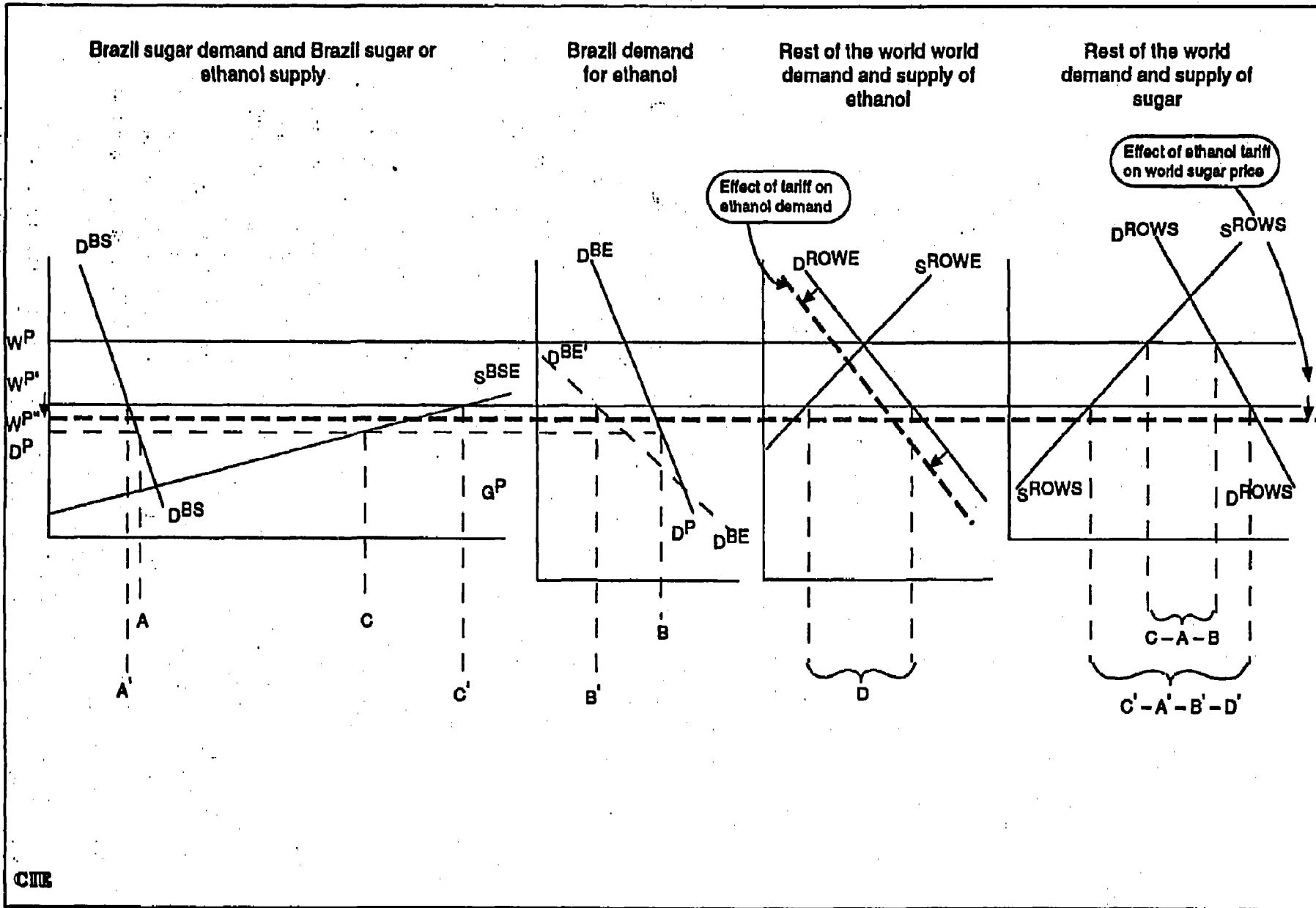
- Brazil has little idea of the value of its ethanol until it uses international markets to test its worth.
- Despite Brazil's well established reputation as an efficient producer of sugarcane and sugar, cost of production pricing for ethanol and sugar insulates producers from competitive forces that would provide incentives to innovate and seek even lower costs of production. There is considerable variability in productive efficiency of industrial units processing cane.
- Quotas on production and restrictions on building new facilities may reduce incentives for adoption of international best practices. A potential new owner of a facility may be discouraged by such restrictions because it may make the adoption of new technology less profitable.
- There are differences in supply potential and fixed prices between the North/Northeast and the Center-South. Because of the lesser competitiveness of the North/Northeast, it may not have the potential for expansion that the country has as a whole.
- Brazil has invested a great deal of resources developing ethanol engine technology for a small domestic market rather than borrowing technology from others. This has added to the costs of the automotive industry. Moreover, economies of scale in vehicle production have been lost by the need to produce three types of engines for many models.

Measuring the Cost and Benefits of the Policy

To measure the broad impacts of Brazil's sugarcane sector policies we developed a computable simulation model embodying those features of the graphical model outlined in figure 3. One exception to figure 3 is that the world ethanol market is not explicitly modelled. More research is required to define the dimensions of this market before it can be meaningfully represented. Instead it is considered implicit. Essentially the existence of the world ethanol market can be regarded as making the export demand for Brazil's sugarcane-based products more elastic. As seen in figure 3, competitive market behavior will ensure prices are equated between the sugar and ethanol markets in sugar equivalents terms. The export demand elasticity is made about 10 percent more elastic to accommodate this.

The model is broadly representative of the sector in 1992. The parameters and prices for the model are based on those discussed in previous sections. The model is used to simulate market outcome under free trade and to compare these with simulated outcomes under existing policies. The results provide a measure of the long term impact of the policy and not the short-term effects.

Figure 4: US Ethanol Tariff Lowers the World Sugar and Ethanol Prices



The results reveal that:

- existing policy costs Brazil between \$660m and \$2500m a year;
- Brazil is producing:
 - too little sugarcane;
 - too much ethanol for the domestic market;
 - not enough sugar and possibly ethanol for export.
- exports of sugar could expand dramatically from around 3 million tons a year to over 20 million tons, making Brazil by far the dominant exporter;
- Brazil's exports could markedly lower the world price for sugar;
- world price would fall toward the existing Brazilian price;
- under some scenarios world price falls by nearly 50 percent;
- nonetheless, price remains higher than the existing Brazilian price by a sufficient margin to induce a marked supply response under most scenarios.

The large impact Brazil's expanded exports have on the world price raises the issue of whether export taxes or other controls over exports could be applied to raise the world price and Brazil's export revenue. In practice to operate such a policy requires having good information about export demand. There are serious difficulties in accurately estimating the nature of demand. Policy makers therefore cannot intervene successfully to ensure that the benefits of their intervention will exceed the costs (Helpman 1990). What is more, the intervention makes the industry vulnerable to political intervention.

Within the range of estimated welfare effects, the higher ones occur when a reasonably optimistic but not unrealistic scenario is assumed about world price were Brazil to leave its policy unchanged. This scenario is roughly consistent with the World Bank's latest long term projection of the world sugar price at around 13c/lb. It also assumes that Brazil's marginal impact on the world market price diminishes with bigger and bigger increases in the levels of Brazil's exports (a constant export elasticity of demand is assumed). The lower numbers in the range occur assuming the long run outlook the world price is for it to stay similar to its present historical low of 9c/lb. Another crucial assumption affecting the lower range figure is that each additional unit of exports lowers the world price by a constant amount — a point elasticity is applied to a large change.

What the numbers do not include are the environmental benefits of ethanol. Were the European Community to progress with plans to impose a

\$70 per ton tax on carbon, one way of evaluating the carbon neutral attribute of ethanol would be to assume this magnitude of saving for every ton of carbon emission ethanol displaces. After allowing for the fossil fuels used up in the production of ethanol, Macedo (1992) has estimated ethanol provides saving in emissions of just under 10 million tons of carbon annually in Brazil. Valued at \$70 per ton, a saving of \$660 million a year is derived.

A change in policy could lead to either a reduction or an increase in ethanol production. Too little is known about the world ethanol market to make a judgement on the likely outcome. Further, other benefits, such as the health benefits deriving from reduced toxic emissions add to the social worth of the policy but remain unquantified.

The model helps highlight the major problem: policy rigidity

As long as Brazil sugarcane policy maintains restrictions which prevent producers responding to the market opportunities, it is likely to produce sub-optimal outcomes for the sector. The net social worth of the policy is sensitive to the outlook for sugar, oil and ethanol prices about which there are many different plausible scenarios. The outlook currently suggests that a continuation of existing policy would be costly for Brazil. But regardless of the price outlook, the policy is still sub-optimal. The problems is that policy rigidity removes all incentive or capacity to respond to changing market circumstances whatever they may bring.

The state monopoly which prevents private marketing of ethanol, the production quotas, the export licenses, and the state fixed prices all play a part in adding to a sub-optimal outcome. The model indicates that the costs of the policy are large and that if there are benefits they are incidental rather than deliberate. Not only do these policies prevent the sugarcane-based sector from adjusting, they make it vulnerable to political interference by creating incentives for rent seeking. This exposes the sector to the uncertainties of politics, the end result of which is to increase the commercial risks and costs of the sector.

A policy is required which allows Brazil's sugarcane sector to adapt to any set of market circumstances as well as allowing ethanol to compete as an environmentally safe fuel additive. Until mechanisms are put in place to exploit the opportunities of changing markets and to use ethanol to achieve explicitly acknowledged environmental targets, existing policy should be presumed to be highly costly.

Getting Brazil's Policy Right

The objectives of government toward the sugarcane based sector should be clear: to maximize the income from the production and sales of sugarcane based products and to ensure that as part of an integrated environmental policy, the environmentally friendly attributes of ethanol can be fully exploited domestically and internationally. But, explicit policy

objectives for the sugarcane based sector should not specify the role of ethanol in meeting environmental targets or benefits. This should be part of a separate environmental policy if necessary. Brazil's sugarcane sector and environmental policies must be entirely independent so that objectives are clearly defined.

Rather, policies should allow markets to work

Although a case might be made for intervention to achieve environmental targets under Brazil's environmental policy, no case can be made for an interventionist sugarcane sector policy. The strongest argument for direct government intervention in the sector relates to Brazil's huge potential to impact the world price of sugar. But as previously discussed intervention is not practical and it is more likely to be costly than successful. The challenge is how to allow unfettered markets for sugar and ethanol to function efficiently. This will require:

- removing all production quotas;
- allowing the unhindered private marketing of ethanol domestically and internationally.

Both these changes would make the fixing of prices redundant and leave private producers free to determine the proportions of sugar, ethanol and by-products they wish to produce and privately market. Domestic sales and export taxes could continue to be applied but only as a revenue raising exercise. The tax should not be applied in deliberate manner to raise the world price. Such taxes may be the most efficient ways to tax the sector.

Regional subsidies provided by sales tax exemptions are not an efficient way to achieve regional or welfare objectives. All exemptions should be lifted. Moreover, with a freeing up of the market and a shift from fixed prices to the world prices, the evidence is that domestic producer prices would rise even in the North/Northeast. So higher world prices would likely compensate for the loss of tax privilege and may indeed more than compensate. Continuation of the subsidy would lead to the wrong mix of production between the North/Northeast and the Center-South regions. Should the government wish to continue to provide support to the North/Northeast region as part of its broader economic strategy, well targeted supports should be provided which do not interfere with producers' incentives to produce sugarcane based products.

And Brazil could be proactive in improving international markets

Of all the initiatives the Brazilian sugarcane based industries could take to reduce protectionism in sugar industries in the rest of the world, the most influential would be to let others in the market know how willing and capable it is of producing more sugar and ethanol at a highly competitive price. In the past, Brazil has concealed its competitiveness. By operating a

system of production controls it has sent a message to the rest of the world that it is not prepared to cater to that market and supply more sugar at world prices. Countries needing more sugar have taken it into their own hands to supply that sugar adopting whatever policies are needed to help and encourage their growers, who invariably are less efficient than Brazilian growers.

The Brazilian government may wish to bolster such an initiative by devoting more resources toward publicizing and demonstrating the competitive strengths of its sugarcane based sector. The industry could sponsor and promote studies on sugar and ethanol trade which reveal the cost to foreign consumers and domestic producers of interventionist policies. By standing ready to supply the world market with low-cost sugar, Brazil will raise the cost of these policies to interventionist countries. Brazil, as a member of the Cairns group, plays an active role in GATT and has made itself visible through the Uruguay Round. It may need to make itself more visible on sugar and ethanol trade issues.

Further, environmental policy should recognize ethanol's attributes

As part of its broader environmental policy, Brazil needs to attempt to quantify the health and environmental benefits of ethanol and develop a separate and explicit policy to ensure it makes the most of those benefits.

But should policy reforms be phased?

Two main arguments have been advanced for why Brazil should move slowly on reforms.

- There are so many ethanol cars that letting the market determine ethanol prices will greatly force up the price of fuel to consumers, reduce the demand for ethanol and leave existing ethanol powered cars underutilized.
- The impact on the world sugar price would be too great if Brazil moved immediately to reform.

If the same taxes were levied on ethanol as on gasoline and the market was left to determine ethanol prices, the ethanol price is likely to rise in line with its costs of production and with the price of sugar on the world market. Demand, however, is not likely to change greatly. In the short term, consumers are locked into buying ethanol as a fuel and registered ethanol powered cars are likely to be discounted on the second hand market to reflect the premium of the ethanol price over gasoline. The demand for new ethanol cars may diminish. However, if cheap methanol is freely imported and blended with ethanol, this may well moderate the price rise in ethanol. What is more, it appears that the current price discount of ethanol to gasoline to reflect its lesser efficiency as a fuel maybe overestimated. Many consumers may well continue to have a preference for ethanol powered

cars given its torque advantage, environmental friendly attributes and its greater efficiency in new cars.

The continuing demand for ethanol in the short to medium term from motorists will raise the price of ethanol enough to limit the extent to which mills with annexed distilleries will switch cane from ethanol to sugar. So the amount of additional sugar produced for export will be only a small proportion of what could be produced in the long term. Moreover, mills with annexed distilleries are limited in their capacity to switch cane in the short term to 3 million tons of additional sugar. Beyond this, new capacity would need to be built. Commercial risk is likely to moderate the speed at which new capacity is installed. It may take a very long time before enough capacity is developed to absorb the majority of sugarcane produced in Brazil. During this time world consumption for sugar will continue to grow. This growth will help absorb Brazil's additional sugar and help moderate declines in the world price of sugar caused by Brazil's additional exports.

So, it is not clear that the cost of fuel will rise by the full amount of the increase in the ethanol price due to methanol substitution, that ethanol demand will be highly disrupted in the short to medium term, or that Brazil will move immediately to switch vast quantities of cane to sugar for export. Change will tend to phase itself without any deliberate need for phasing. Politically it may be considered worthwhile phasing in full taxes on ethanol as a concession to ethanol car owners who bought expecting prices to be controlled.

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