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Ethanolomics: The Think-About's of the Mexican Ethanol Project

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Abstract

The Mexican Ethanol Project has the potential of power up rural economy, improve the environment quality, and substitute the non-renewable fossil energy resources. But the risk of not achieving these is latent: the market distorts that it could unleash can change the expected outcomes. Public policies, such as No Deforestation, Investments in Agricultural Productivity, and Ethanol Manufacture in situ, could help orientate the private incentives to increase social welfare. In a big proportion, PEMEX and the Mexican Federal Government would be directly, or indirectly, affected by the domestic ethanol production, opening a door for them to participate in it and avoid damage on their interests. But there's still a question to answer: how long it would take before these benefits could be felt?

Introduction

Mexico is facing three announced -and global- problems: the lessening of its oil deposits, the deeper rural poverty marginalization, and the vast harming of the worldwide ecology. The scientific consensus says that the latest has been, in big proportion, because of the extensive use of the former issue; that is, because of the large-scale fossil fuel consumption by most nations. But, even though this has been known for many years, Mexico isn't ready to make a switch neither of its main energy source nor of its principal foreign currency entrance. As well, isn't succeeding in its way out of the poverty circle that has trapped more than a quarter of the Mexican population, mostly concentrated in rural areas.

It's well known that the oil is a non-renewable good and that, sooner or latter, it would end. The OPEC (Organization of Petroleum Exporting Countries), according with its webpage, says that their petroleum deposits can satisfy the global demand, with the production rate of 2005, for 80 years more; and assuring that the rest of the countries would only supply it for 30 years, at most. Specifically,

Mexico has proven oil deposits that would last 10 more years, with the production rate of 2006, but having total oil surpluses for 30 years (PEMEX, 2007). In spite of this, both, PEMEX (Petróleos Mexicanos, the Mexican petroleum monopoly) and OPEC, are optimistic that their efficiency, the better use of the energy sources, and their surpluses would increase in the future, extending in this way these figures for more decades (OPEC, 2007; PEMEX, 2007).

Some scientists assure that the global climate change is because of the extensive CO₂ that has been release to the atmosphere because of the fossil fuel combustions. This excessive accumulation makes that part of the heat received from the Sun doesn't return to outer space in form of infrared rays, causing an overheating inside the Earth. Also, the broad deforestation worldwide has worsened the problem, because it means more CO₂ in the air and less O₂; that is, a shortage of photosynthesis processes. It is worth to notice that, even though fossil fuels are widely used, the total consumption of these is not evenly distributed. For instance, in 2005, the United States of America (US) realized around 22% of the CO₂ generated from the global fossil fuels combustions, using around 30% of the world's petroleum production. Mexico, in contrast, realized around 1% of the CO₂ and uses 2% of the petroleum production, for the same year (EIA, 2007).

Many Mexican rural people have been greatly margined and excluded from the market system, forcing them to seed and produce food for their own personal consumption. These have been the roots of some other rural ills such as migration, the eldership of its population, deterioration of their infrastructure, bad medical services, among many others. The main Mexican crops are the maize, tomato, beans, and sorghum, according with its annual productions values, yielding 3, 32.73, 0.8, and 3.45 ton/ha, respectively (SAGARPA, 2007). Mexico grew about 45 million tons of sugarcane in 2005, being the second largest American producer, only behind of Brazil, who produced around 420 million tons (FAO, 2007).

Some countries have made huge investments to explore and use alternative ways of energy, saying that with this, it would lessen their economical dependence and vulnerability to foreign policies and global market prices. Brazil was the first who started this, in the early 70's, switching the gasoline, which was mainly imported, to a domestically produced good. Later, in the current decade, the US has

begun this change too, using these same principles but different renewable source.

The ethanol is, nowadays, the most viable alternative source that could potentially undertake and solve all of the above problems exposed. Supposedly, it could: diminish the global ecological harm that the fossil fuels are making; lessen the economical dependence of some countries with the global markets and foreign policies, because it would be produced domestically; be a renewable energy source, because it would use biomass inputs; and power up rural economical dynamism. Even though, it is worth to ask: to which extent these are true; under which conditions; how it would be; and how long it would take to accomplish the above. Also, it should be clearly drawn out and quantified the direct market impacts (basic grains prices and rural labor changes), as well as the indirect ones (gasoline prices) and secondary ones (meat prices).

The following paper intents to explore the ethanol impacts on the stated direct and secondary market effects, exposing possible public policies that the Mexican government could establish with workable outcomes.

A Brief Review

Brazil, after the oil crisis in the 1970's, made a pioneer decision about their internal energy supplying: it decided to not being economical dependent with the global oil market and started to domestically produce the ethanol in substitution of the gasoline. They started to run national programs to power up the internal sugarcane (the main input) market and to spur up its production so there could be enough to transform it to this biofuel. They started to give subsidies to the sugarcane producers and to gas stations that would use ethanol as part of their gasoline blend. This went on until 1997, when they started to free the market and took out the monopoly distribution of ethanol that Petrobras (Brazilian oil monopoly) had. After 30 years of this change, the Brazilian State only has control over the gasoline-ethanol blend proportion, leaving everything else up to the market -supposedly- (Koizumi, 2003). Actually, Brazil exports around 2.38 billions barrels per year, and about 45% of their energy comes from renewable sources, representing ethanol around 17% of the total fuels used in 2005 (MAPA, 2006).

The US has also entered into this energy source change, trying to substitute fossil gasoline with biomass ethanol. Because of their big maize surplus, being the biggest worldwide producer, they are trying to use it as the ethanol's main input. The US Energy Department says that in 2012, the ethanol production would rise up to 11.2 billion barrels, which would represent a 7.5% substitution of the gasoline available in the US. In 2006, it used about 20% of the total maize production, having 54 ethanol plants nationwide -being many of them brand new. Actually, gasoline prices are lower than ethanol ones; because of these, the US federal government has given a "tax credit" for the blenders, making in this way ethanol's prices cheaper (DOE/EIA, 2007).

But still, there are big differences between the US and Brazilian ethanol. For instance, the former makes it from maize, and the latter from sugarcane, which has already been told. This means that the ethanol yield per acre per year be radically different: 870 ethanol gallons for the Brazilian producers versus less than 400 gallons for the US ones. Besides, the energy balance for the sugarcane ethanol is of 9:1, in contrast with the 1.3:1 for the maize based. And also, the gasoline needed for the US automobiles are substantially bigger because, besides they use larger cars, they have around 230 millions cars on the road, being around 10 times larger than the figure for Brazil, who has about 28 millions (Maciel, 2006).

Ethanol's Expected Advantages

There is still no consensus about how harmless or aggressive the ethanol production is for the environment, the human health, and the rural economy. And it is not a concern for this work to prove technical details, leaving space to just list the minimum advantages that should be expected from the ethanol so it would worth the substitute effort of the gasoline as the main fuel of an economy. After doing so, we will try to predict how Mexico could meet this requirements, so it could accomplish the named goals: to substitute fossil fuels, to improve its -and global- environment, and to spur Mexican rural economy.

The Dutch Energy Transition, along with the Food and Agriculture Organization (FAO), stated the following minimum requirements for a

correct use and production of the ethanol as the new alternative fuel, divided in 6 main issues: greenhouse emissions, competition with food or other local applications, biodiversity, environment, prosperity, and social well-being. These were board as follows:

- 1. Over the whole chain, the use of biomass should produce fewer emissions of greenhouse gases net than on average with fossil fuel.*
- 2. Production of biomass for energy must not endanger the food supply and other local applications (such as for medicines or building materials).*
- 3. Biomass production must not affect protected or vulnerable biodiversity and will, where possible, have to strengthen biodiversity.*
- 4. In the production and processing of biomass, the quality of soil, surface and ground water and air must be retained or even increased.*
- 5. The production of biomass must contribute towards local prosperity.*
- 6. The production of biomass must contribute towards the social well being of the employees and the local population.*

Adding to the previous statements one more, whose could be considered not so theoretical but practical, so it could be feasible and viable the exposed substitution:

- 7. The overall ethanol production costs should be cheaper and more accessible than that of the fossil fuels, or at least the same level, excluding all the subsidies or tax benefits to the producers or distributors.*

This is fundamental for the rest of the work because, even though the previous points are fulfilled, the consumers -both industrials and households- would still be attracted to spend more in cheaper fuels, no matter the negative externalities that these may have; as told by the "tragedy of the commons" game theory. The economical consumers' rationality should not be diminished or ignore with an altruistic or ecological concepts.

And last, an open question just to open a debate:

- 8. Should the ethanol used in Mexico needs to be domestically produced? By which extent?*

This is relevant when we are concerned with the economical independence of fuels and food that some governments may want to achieve. But that would only be exposed and left out as an open question for future discussion.

How Mexico Could Meet These Requirements?

Requirement 1. Over the whole chain, the use of biomass should produce fewer emissions of greenhouse gases net than on average with fossil fuel.

The greenhouse gases are basically CO₂, H₂O, CH₄, N₂O, CFC, and O₃, which has the capability of capturing inside the atmosphere the heat received from the sun, precluding it to return to the outer space and cool down the Earth's temperature. Most of these gases are released after volcanoes eruptions, fire combustions, aerobic processes, organic decompositions, etc.; which means that are part of the normal ecological cycle of the planet. But, the deforestation and the extensive use of energy sources, such as fossil fuels, have increased the presence of the greenhouse gases in the environment changing the global climate and altering world's temperatures and cycles.

It is believed that ethanol releases fewer amounts of these gases: but it is not exactly true. Any kind of combustion emits and throws out, as waste, CO₂, the one that has been heavily increased in the atmosphere in the last century. So, this fewer greenhouse gases emissions issue, is actually about better quality of these and about where they come from. That is, if this CO₂ released would be reabsorbed by (theoretically) the same crops that would be planted for future ethanol production -hopefully netted to zero, because every atom of the gas would be recycled- or if it would be discharge from a (fossil) fuel that was buried thousand of years ago outside the ecosystem. It's also about toxic gases, besides the greenhouse ones, that are damaging humans' health worldwide.

POSSIBLE PUBLIC POLICY: NO DEFORESTATION FOR ETHANOL PRODUCTION.

This policy could be established in order to help the preservation of actual forests, woods, jungles, and other biodiversity zones, so the ethanol production could be a real environment-friendly fuel, and not the exact opposite. Because, even when the biomass cleared out is

exactly equal to the new planted, which would certainly not be the case, it would just be pointless to take out organisms that absorbs CO₂ in order to grow up other plants that would do exactly the same. In other words, if a greenhouse gas is emitted, it should be processed more efficiently by photosynthesis of a perennial tree than by a temporal plant such as maize or a semi-perennial such as sugarcane; besides the fact that the deforestation, by itself, is the cause of up to 30% of the total greenhouse emission present in the planet.

This policy could also help to achieve, in a sense, the next requirement:

Requirement 3. Biomass production must not affect protected or vulnerable biodiversity and will, where possible, have to strengthen biodiversity.

In this way, wild life and native plants would not be subordinated or displaced by biomass production, whose main intention is to preserve and improve environmental air, soil, and water quality. Still, there should be made some efforts for the hundreds of Mexican native maize seeds that may be replaced for a better ethanol production ones, and that could damage the biodiversity.

Requirement 2. Production of biomass for energy must not endanger the food supply and other local applications (such as for medicines or building materials).

The main reason behind this second statement is to answer the economical and ethical dilemma of: fuel vs. food. It was inserted in response of some international voices that rejects the fact of using human comestible crops in order to make biofuel. A massive use of US maize in ethanol production, for instance, could unchain a food crisis in Mexico, because of its net grain importer condition and because of its daily diet. This could be seen in the early months of 2007, when the tortilla prices soared up, hurting the poorest families welfare and causing that the Mexican federal government take some actions to stabilize it; a problem that could be easily replied for other net food importer countries.

The FAO and the OECD (Organization for Economic Co-operation and Development), in their agricultural outlook 2007-2016, said that has been structural changes in the agricultural market, such as feedstock demand increase for biofuel production, and public policies for surpluses reductions, that may keep prices of these commodities above its historic equilibrium during the next 10 years. The US and the European Union (EU) has lately established policies in favor of ethanol and biodiesel productions, increasing substantially the demand for maize and wheat, and causing a high price speculation for these. In the year 2005, the US used 40 millions tons of maize, intending to increase it up to 110 millions in 2016. The EU projects the usage of 17 million tons of wheat and 5 million of maize for biofuel productions, such as ethanol and biodiesel, for the same future (FAO/OECD, 2007).

Because of these, the food crisis problem is arising because actual crops harvested are being used or switched for others better priced and demanded biomass inputs for biofuel production. This is pushing the food prices up more, unchaining a crisis where the more damaged would be the poorest families, whose biggest income proportion is destined to this heading. The US used, in 2005, the 20% of its maize produced, intending to use up to 32% of these in 2016 for biofuel productions (FAO/OECD, 2007). If there is no a substantial change in the productivity, higher yields per ha, could signify a bigger substitution of food for fuel.

The direct impact of these should represent in a bigger income for agricultural producers, selling their commodities in a more demanding market that is willing to pay more for more quantity. In the best of the cases, this could mean an investment injection in rural areas for infrastructure, translating it into higher wages and higher welfare for the communities. Unfortunately, in the most margined zones in Mexico, the products can't be sold out easily if it's not trough an intermediary. In first instance, this could make that the price increase gains of the agro products don't necessarily gets into the producers' pocket, but in the middlemen's.

The maize price increase impacts too on secondary markets such as chicken and cattle meat, shooting up its costs, because the maize is one of most important feedstock inputs. This rise would be distributed, according with the markets elasticities, within the

consumers and producers, causing damage in welfare for the climbing up of the costs for the later or/and for of the prices for the former. If there are no regulations in the ethanol domestic and international productions, there could not only be less maize supply for human consumption, but an increase in prices for other kinds of food such as the meat.

POSSIBLE PUBLIC POLICY: HUGE INVESTMENTS IN FAVOR OF AGRICULTURAL PRODUCTIVITY, SUCH AS INVESTIGATIONS AND INFRASTRUCTURE

One way to secure food production is to implement instruments that yield a larger production -with the same space destined for agro production, helping too to achieve requirement 1-, not compromising human consumption crops in favor for biofuels. This means a preservation of comestible stocks, with a normal increase because of population growth, and a "creation" of new and ready-to-use agro productions for other purposes. Even though, the dilemma is not completely solved, because of the fact that there is still hunger in many countries in the world. But leaving the global hunger issue aside -that it's not a small one at all- and focusing in the status quo food level, the productivity increase could somehow solve the problem.

In Mexico, this policy could represent a governmental and private cash flow for infrastructure such as roads, tractors, irrigation systems, fertilizers, etc.; that is, an increase of machinery per peasant, of irrigated lands, and *in situ* industrial production. And doing so, the productivity of maize or sugarcane will soar up making more likely to meet food and ethanol inputs supply. In this way, if the demand increases along with the supply side, the prices would not be substantially altered, securing not only agro products human consumption, but also those who need these as feedstock.

A potential problem is that, to actually secure the status quo food level, it requires that only the "extra" productions be used for ethanol production, or that the demand and the supply increase in parallel. In other words, and in order to not substitute food for fuel, a long-term project could be needed in order to switch gasoline as the productivity increases. Another way is to take ethanol as part of the blend needed for gasoline substitution and not as the only solution, but as part of an energy sources diversification; that is, extra alternative energy research.

But the main problem is still present: time. How much does it's going to take so the "extra" agricultural production satisfies the food and biofuels demands? More or less than the oil deposit time left? Are the investments really going to get to the rural zones if it means a restriction supply for ethanol productions? The market probably won't be restricted: the sellers would be entitled to sell to the demander that makes them be better off. So, if there is a concern about risk for food supply, and the ethanol production is to be encouraged, investments in productivity are needed.

Requirement 5. The production of biomass must contribute towards local prosperity.

This is the principal statement that wants to interrupt and revert the circle of poverty that has trapped most of the rural people in Mexico. It's the requirement that may avoid the despoiling of natural resources from the zones that poses them, in favor of cities, towns, firms, or industries that reallocate the benefits generated. It's the effort to make agro communities feel and experiment prosperity of their particular abundance, and to make them use this boom as a chance of generating welfare for them and to be more competitive as investments flows in.

As told before, Mexican peasants, mainly because of their lack of infrastructure, has to sell their products to middlemen or intermediaries, instead of doing so directly to the principal and main markets. This, obviously, reduces considerably the benefit margins, but not the risk. A reseller can make larger profits in less time, with considerably less risk, than a farmer in all the months that he waited to harvest. These because of the monopsonic characteristic that most have, reaching margined zones with hard access into them, and the monopoly force that they can use to sell. As well, with the absence of barns in many communities, many peasants have to sell when the supply side is oversized -that is, when the prices are depressed-, reducing potential gains.

POSSIBLE PUBLIC POLICY: ETHANOL PRODUCTION PRODUCED *IN SITU* WHERE IT IS HARVESTED BY COOPERATIVES, NOT BY PEMEX.

For these to be so, there should be huge investments too in the rural zones to build plants and ethanol distilleries. In these way, the biofuel production would be made in situ -that is, in the same place where the main input is harvested- and it would avoid a mere despoil of the natural resources from their hometown. But also, there should be investments in favor for skilled, qualified, local, and technical handwork, as well as infrastructure to secure an efficient, -eventually- free market, and sustainable production.

The employment increase could help mitigate the migration ill that many rural communities have been experimenting for decades. It could mean an alternative option for the head of households that have to work in other cities, towns, or countries, in order to make money, to work in his/her hometown with their families. Hopefully, a bigger wages, more education, more formal labors -with social securities benefits-, and bigger welfare can be seen because of the multiplicative effects of these policy. But the most important thing is that it could be the inclusion door entrance of agro producers for a more competitive market, where the benefits would be kept for themselves, and where the exclusion would lessen.

And so the boom benefits stays in the hometown, the participation of cooperatives and social firms could help, so the money generated don't flow out or be diluted into other places, in the building of other plants, or in the government's pocket. That's the reason why PEMEX should somehow be left out of the ethanol production, but not necessarily excluding it neither from the distribution nor from the blending. As well, making a local cooperative ethanol firm producer, could help to make a better relationship between employers and employees, instead of the local town and PEMEX, especially with the huge and powerful Union it has. In a cooperative, hopefully, everyone will care and protect it and its natural resources, especially when it's their main income source.

In this way, this policy could also help achieve another important statement:

Requirement 6. The production of biomass must contribute towards the social well being of the employees and the local population.

The main intention is to take the agricultural workers as part of a global change, and not another input for it. It's a way to help them get out of the poverty cycle, with capital and human investment, and national support that could bring, as well, a healthier environment and economy.

A distribution mechanism, for the ethanol to have a nationwide range, could be using all the gas stations that PEMEX have franchised: with all the market information that this implies. That would help to be more efficient in this process and to push up the ethanol consumption. The ethanol production could be dealt out to the nearest PEMEX refinery, in order to make the adequate blend to sell it to the consumers; being this, like Petrobras, the only power over the ethanol market for PEMEX. Though, this could mean a monopsonic power for the governmental company, because will be the only direct consumer and also the only reseller.

But eventually, as the Brazilian experience, this distribution could be made, not only by PEMEX, but also by private firms, like the Gas L.P. stations in Mexico. This method could help increase ethanol's market share and could mean private investments to enter in the energy sector, an issue that is not completely allowed by the Mexican legal framework.

What about Mexican Federal Government?

The economical dependence of Mexico with the oil market, don't comes by the consumption side, but by the selling one, being one of the principal exporter countries. Because of these and of PEMEX's state monopoly condition, whose incomes represent around 35% of the Mexican federal budget (DOF, 2006), makes them to be largely concerned about the global oil market. A substitution of petroleum for alternative fuel sources should also interest both, PEMEX and the Mexican whole government.

How should PEMEX recover the domestic taxes that should be substituted by the use of ethanol? Would the ethanol be charged by the same burden as gasoline? These questions should be answered, but would not be so in this paper. It will be listed just so it could be taken into consideration for future discussions.

What is the ideal crop to produce ethanol for Mexico?

There are plenty agricultural products from which ethanol can be made. Maize and sugarcane are the most popular to think about because the US and Brazil has used them as main inputs, respectively. It can be made with bagasse, miscanthus, sugar beet, sorghum, grain sorghum, switchgrass, and many others, and every one with different ethanol yield per hectare. The most important thing is to decide which one is the best for the Mexican climate conditions and which is the one that is more efficient to grow and that help achieve the requirements above mentioned.

Mexico has 3 big choices to produce ethanol nowadays: maize, sorghum, or sugarcane. Mainly because those are the most important crops it has and because are those who yields more ethanol per ton. Apparently, sugarcane has a larger energy balance than maize, but the land harvested of the former is a tenth that of the latter; even though, the total production in 2005 was of 18 millions tons of maize and of 45 millions of sugarcane and sugar crops. But to get the same level of the Brazilian production, meaning the same level of ethanol production, the sugarcane Mexican figure needs to be increased 10 times more -although its population is 3 times smaller than of Brazil- (FAO, 2007).

The problem of using sorghum is that most of the cattle growing uses it as its main feedstock. So, by employing this crop as main ethanol input, we could enter in a food vs. fuel dilemma or in a negative price impact (increase) of the meat, affecting farmers and national exportations. Besides the fact that is annual production is below 6 million tons per year, almost a third of that of maize and a ninth of sugarcane.

Final Remarks

The environmental policies have been important issues to be cover in most nations' agenda, principally, because of the global warming changes. These have started new discussions about alternative ways of energy that could be cleaner and friendlier to the global ecology. Basically, the ethanol intends to reduce the CO₂ presence in the atmosphere, because the crops planted for these uses the same waist

exploded by its combustion. It means, a recycling of the greenhouse gases and not a mere waister thrown out.

For this recycling to be so, it needs a public policy and social compromise to not clear out forests, woods, jungles, and other lands in favor of biomass cultivation. The photosynthesis is the one in charge of changing the CO₂ molecule, a greenhouse gas, into an O₂ one, a non-greenhouse gas; and if this is shorted by deforestation, the environment issue would not be achieved and the problem would just worsen. The promise of a cleaner air and a reduction of the global heating would need the safeguard for natural biodiversity.

Another important problem to solve is the rural exclusion that Mexico has been experimenting since long time ago. The lack of infrastructure and opportunity to access a competitive market has trapped them in a poverty circle hard to get out of. This agrobusiness boom should help them reduce these problems exposed and make them be participants of these benefits and of their natural resources abundance.

A possible public policy to help rural people improve their social welfare is to impulse in situ cooperatives and distilleries of ethanol. These means that the production and money gained stays in the same community were it came out, among its members, and that the natural resources won't be despoiled from where they belonged. Larger public and private investments can rush into these rural zones, generating more employment, less migration, and, hopefully, a bigger welfare. But not excluding, in first instance, PEMEX's help to blend and distribute the biofuel to the nationwide gas stations, which could help them push up its consumption. But it's not an intention to have a giant monopoly oil industry and a giant monopsonic ethanol buyer too that could distort the energy market. It should be wished to have a market that someday would be competitive.

The biggest potential problem is the dilemma: food vs. fuel. It's the national and international concern to stop hunger first than the energy problem, or at least don't worsen. And these not only on ethical point of view, but also an economic one, because the intensive use of biomass could unleash market distortions in other countries or in the same domestic one. For instance, a shortage of supply of maize, could affect directly to the poorest families

welfare by price increase via of maize-based products, or indirectly by making more expensive the meat prices, because it's its main input.

To solve the last problem, an intensive research and productivity investment should be needed in order to produce more biomass, in a way of not compromising human food consumption. In other words, it should be produced extra crops supply in order to meet both demands: human and industrial. These mean a better infrastructure for the hometown producers that help them yield more production per hectare.

Many topics mentioned in this work has to be further investigated, especially in the most economical relevant questions: who, how, and where. Technical specifications have to be cleared out to decide which crop to seed in which place and how to do it in order to achieve the requirements before mentioned. A lot of issues have to be clarified like: tax-benefits or subsidies policies; how long the agricultural market should be protected before freeing the market; private and governmental investments and research policies; and further discussion about food and biofuel independence. But it's important to remember that this ethanol project has a lot of topics related that could potentially solve one problem, creating another one or that could stop it from achieving its potential benefits or goal for what it was implemented.

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