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In its second number for 2008, *Research Update* tackles the thorny topic of bio-fuel, explores the impact of technical advance on productivity and reports on a new approach to achieve more reliable statistical data. Continuing the newsletter's regular "In Short" column on current economic thinking, a UNIDO researcher interprets the often-isolated treatment of productivity in a novel context.

This spring UN Special Rapporteur for the Right to Food Jean Ziegler described bio-fuel as a "crime against humanity". Two UNIDO economists take a hard look at this emotionally charged issue through the perspective of a cost-benefit analysis to suggest a collective way forward that transcends mere national interests.

Drawing on UNIDO's World Productivity Database, whose launch was featured in the last number of *Research Update*, the new Director of the Research and Statistics Branch (RST) presents his views on the key roles of technical efficiency and technological change in productivity growth. They come in a report on the first international Sanjaya Lall conference on the effects of innovation, science and technology on economic growth and development.

The realm of robust statistical analysis is the focus of the latest RST seminar for UNIDO staff. Kris Bouldt, from Catholic University of Leuven, proposes a new approach to dealing with deviations from the general pattern of data in the context of regression techniques on real economic data.

Inspired by the recent European football championship, RST's "In Short" economist draws a cogent parallel between growth in total factor productivity and success in team sports. The analogy pinpoints the direction firms in developing nations need to follow in order to catch up with technological advances in OECD countries and increase their competitiveness.

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Electronic version, containing links to full articles is available at: www.unido.org/doc/3474

Bio-fuel: flawed industrial policy?

Aside from the current financial crisis, the combination of climate change and soaring energy prices top the worldwide development and environmental agendas today. As a response—as well as part of a solution—nations have increasingly started searching for alternative energy sources. In this quest, bio-fuels have come to the forefront in being perceived as reducing greenhouse gas (GHG) emissions and, at the same time, a promising source of energy. Since 2001, world output of bio-fuels has trebled. In particular, this phenomenon has occurred in the United States, Europe, Canada and Brazil. Recently, however, the apparent win-win situation has been questioned. Bio-fuels have been accused of raising food prices, and doubts have emerged as to their claim for contributing to GHG reduction. Are bio-fuels really a silver bullet, or is there reason to take their alleged shortcomings seriously? This article aims to offer an informed view on the issue by trying to put the recent debate in perspective.

In terms of engineering, production of both first generation bio-fuels—from the edible parts of plants—and second generation ones—from both edible and non-edible parts as well as industrial wastes—have proven technically feasible and less environmentally damaging than conventional petrol. However, even for the first generation, so far only Brazil has achieved economic viability in its bio-ethanol production from sugar cane. Current economic loss in many countries does not necessarily mean that they should end production of bio-fuel. Continuation of bio-fuel production with government support is justified if the present value of total future environmental, social and economic benefits outweighs that of cost. While exact estimation of such value is fraught with difficulty, recent studies afford some views of the likely sign (positive or negative) of net current values of such cost-benefit analysis.

Bio-fuels' expected contribution to reduction of GHG varies from 20 to 80 per cent, compared to conventional petrol, depending on the source. However, the contributions of currently unprofitable production of bio-ethanol from wheat, corn and beet or bio-diesel from rapeseed seem to lie in the lower side of the range. Ironically, the greater their dependence on government intervention, the greater their contribution should be to environment and energy security. Compare this situation to that of the economically viable bio-fuel production from sugar cane, which is profitable, contributes substantially to reducing GHG emissions and receives less government support.

The above can be considered as the maximum level of benefits that bio-fuel production can achieve. From that benchmark, the effects of change of land use on carbon storage have to be subtracted in order to reach a reasonable approximation of bio-fuels' actual benefits. These effects include: (1) conversion of forests and grasslands to energy crop land, (2) impact on water and (3) impact on third-country food production. Because forests and permanent grasslands act as repositories of carbon, their conversion can completely outweigh potential reductions in and even increase GHG emissions. Moreover, since the land on which rain forest stands also contains carbon, even more carbon dioxide (CO_2) will be released from its conversion to bio-fuel crops. There are also studies indicating that bio-fuels impact negatively on water, in terms of both quality and quantity, as well as lead to soil acidification. As Western countries shift from food to energy crop production, less food will be supplied globally. To compensate, other countries convert land to produce food. The effect is further release of CO_2.

Added to this unsavoury scenario, use of fertilizers on newly farmed land implies release of nitrogen, which develops into nitrogen dioxide (N_2O). Over the course of a century, N_2O is 300 times stronger then CO_2 in GHG emissions. In short, an analysis that takes into account the indirect as well as the direct effects of bio-fuel production reveals that the process as a whole is likely to reduce significantly, if not eliminate, the benefits of potential GHG emission reduction or, as some studies show, increase GHG emissions relative to conventional fuels.

Current cost-benefit analyses suggest that national benefits fail to outweigh such national costs as for investment and production, subsidies, trade barriers and use mandates for most of the countries producing first generation bio-fuels. In the end, it is up to national policy-makers to assign values to the seemingly limited benefits based on their normative judgments. In certain geographical, social and political contexts, some countries might still value the potential benefits sufficiently to justify the costs, despite evidence pointing in a different direction.

Government decisions based on national cost-benefit analysis can be justified if the benefits and costs accrue to the producing countries. However, in the case of bio-fuel production, global, rather than national, cost-benefit analysis is more appropriate due to its substantial externality to non-producing countries. The impact on food prices, which tend to increase more in the poorest countries and disproportionately affect the poor due to their higher share of food expenditure from income, is felt more acutely in developing than in Western countries. Since this cost is unlikely to figure high in the production decisions of Western bio-fuel producing countries, bio-fuel production will be carried out on a scale greater than that required for global welfare. If world bio-fuel production is undertaken based on a global cost-benefit analysis, it seems unlikely that much of first generation bio-fuel production should continue.

If second generation bio-fuel production is going to be restricted to non-food sources and, hence, less material inputs, then, the extent to which bio-fuels constitute a serious alternative to conventional energy sources is questionable. In short, will a sufficient volume of bio-fuels be produced? The engineering challenge is to increase the efficiency extraction of energy from materials. Based on considerations of food security and environment, this seems to be the course to follow, as, for example, Sweden has chosen. The paradox is, though, that such investments are largely irreversible and fixed costs may take time to recover. So, even if better alternatives emerge, countries may be locked into disadvantageous positions. This suggests that more time and resources should be spent on research and analysis of bio-fuels themselves but, also, relative to other alternatives.

This type of analysis undescores the urgent need for global coordination in world bio-fuel production. Since the impact of bio-fuel production transcends national considerations, global welfare needs to be configured into the current scenario. Because national governments are unlikely to adopt such a perspective in their production decisions, it is the most vulnerable on this planet who have to bear the lion's share of the costs—in the worst case, paying with their lives.

Equally important, second generation bio-fuels look much more promising, from the perspective of production as well as their environmental and social impact. But, at this point, too little is known with certainty about their impact to warrant premature production decisions. Much more research into their effect as well as into such alternative energy sources as solar and wind needs to be undertaken before reaching the conclusion—with a good conscience—that bio-fuels represent the solution.

Nobuya Haraguchi
Anders Isaksson

Presentation on long-term productivity trends

Capital deepening and technical efficiency followed by technological change and innovation were essential to long-term productivity, according to a keynote presentation by Ludovico Alcorta. He was addressing the first annual Conference of the Sanjaya Lall Programme for Technology and Management for Development, organized by Oxford University and supported by UNIDO (29-30 May 2008).

The Conference brought together more than a hundred leading academics and researchers to explore the effects of innovation, science and technology on economic growth and development, in the context of Brazil, China, India, Russia and South Africa (BRICS).

A leading development economist, the late Professor Lall focused his research at Oxford on competitiveness, industrial development, investment and technological capabilities. He made decisive contributions to UNIDO's work and was instrumental in the production of its Industrial Development Scoreboard and *Industrial Development Report 2002/03*, on competing through innovation and learning.

Focusing on the challenge of technology for development, the Conference illustrated how the emerging economies of BRICS have used different mixes of key determinants of structural change to boost economic growth and catch up with industrialized countries. The leading role played by information and communications technology, foreign direct investment (FDI), innovation, science, technology and trade in underpinning structural change and boosting industrial and economic development constituted the core issues under discussion.

Mr. Alcorta based his presentation on UNIDO's unique empirical evidence, such as the World Productivity Database (see *Research Update*, No. 1, 2008), to examine the key roles of technical efficiency and technological change in productivity growth.

His findings included the following:

■ Capital accumulation and technical efficiency drove early stages of growth.

■ Technological change, which resulted in shifts in the world technological frontier, explained the later stages of growth.

■ Total factor productivity (TFP) declined in the large majority of African and Latin American countries, compared to countries in the Organisation for Economic Cooperation and Development (OECD) and the United States.

■ As well as catching up with OECD countries, the East Asian tiger countries, which were the star performers during the reference period, began to surpass them.

■ Although TFP in BRICS slowly caught up with OECD economies and the United States, the process was erratic, with Brazil and South Africa, for example, deviating from the above-mentioned pattern, while China and India still had far to go to catch up.

UNIDO sponsored eight researchers from developing countries, whose presentations focused on the relationship between FDI and R&D, human capital as a determinant of FDI spillovers, reshaping national innovation systems, technological capabilities to exploit innovation, science and technology policy in South Africa, supporting micro- and small enterprises in Brazil, sustainable village phone model and structural change and domestic capabilities in Latin America.

The Conference concluded by identifying a number of emerging research areas including the increasing importance of grass-roots innovation in developing countries, particularly in LDCs, as a leading source of industrial and economic growth; improved exploitation of natural resources and movement up the development ladder in order to boost economic growth; and targeted and timely policy sequencing to match various stages of industrial and economic development.

Ludovico Alcorta

Presentation on robust statistical analysis

Modernizing statistical methodology to achieve more reliable estimates in economic models was the focus of an interactive seminar for UNIDO staff with Kris Bouldt, doctoral candidate in the Faculty of Business and Economics at Catholic University of Leuven, who is currently serving as a consultant for the Organization.

Outliers, or observations that deviate from the general pattern of the data, are present in virtually every data set in any application domain. Economic data are hardly an exception. In the presence of such outliers, classical estimation techniques and econometrics, which are based on parametric models, are no longer accurate. In some cases, instead of explaining the behaviour of regular observations, they simply describe the outliers. These procedures are optimal when the assumed model is exactly satisfied, but they can be biased or inefficient even in the presence of small deviations. For this purpose, robust methods of estimation have been developed so that outlying observations have little influence on the estimator, while the estimates produced by the robust estimator remain reliable even if the data contain outliers.

In *Econometric Letters*, Rousseeuw *et al*. highlight the reluctance to apply robust regression techniques on real economic data. A search for relevant publications through ECONLIT reveals a remarkably low total of 14 papers published on the subject. The authors posit possible factors for this, such as: (1) the belief that outliers can be detected simply by eye, looking for unusual OLS residuals or sensitivity analysis obviating the need for robust analysis, (2) lack of familiarity with interpretation of results from robust analysis and (3) unawareness of gains available from robust analysis in real data sets.

Mr. Bouldt's presentation had three aims. The first was to introduce a general framework for

outlier detection in univariate and multivariate time series and categorize the type of outliers present in the data. The second was to compare classical with robust estimation techniques. The third was to show the relevance of robust methods for simulated data and real economic time series. He began with some examples of economic time series containing outliers and went on to a general description of outliers in time series in terms of their temporal characteristics (isolated versus patchy outliers) and probability model (additive, replacement and innovation outliers, level shifts). Mr. Bouldt demonstrated the effect of these outliers on the classical autocorrelation estimate and the least squares regression estimator. He, then, presented methods for detecting these outliers in time series as well as methods for robust estimation of time series models.

A key idea of the robust approach is that, rather than deleting outliers, the estimation procedure should down-weight suspicious observations. Mr. Bouldt emphasized that it was important to look for outliers using data exploration methods that are robust, such as the boxplot, in order to avoid outlier masking. If there is suspicion of outliers, robust estimation methods should be applied.

Robust statistics, Mr. Bouldt concluded, went beyond outlier detection and robust regression. For almost each statistical technique constructed under a parametric model, there is a robust alternative, which will work well if the data does not deviate too much from the model.

Kris Bouldt

Productivity championship

How often have your heard demands for higher wages, complaints about high inflation and interest rates and the Organization for Economic Cooperation and Development (OECD) voicing concerns that your country is becoming less competitive? Yes, I thought so; it occurs frequently. Interestingly, the explanation more often than not turns out to relate to issues of productivity. For example, productivity growth has been too low to warrant higher wages or a country's productivity performance has been disappointing, hence competitiveness is suffering. But, what is this productivity that everyone is talking about?

I have come to realize that, in general, the concept is not well understood or how it relates to other observed economic phenomena. With Europe having just emerged from its quadrennial football championship, it occured to me that soccer, as well as other team sports, hold the key to a better understanding of productivity. By productivity, I mean total factor productivity (TFP). Partial measures, such as labour productivity, are straightforward concepts and present no real conceptual challenge. It is useful for assessing, for example, worker performance. But it is silent on overall productivity performance and attendant policies as to whether investment should focus on, for example, equipment or R&D. TFP, on the other hand, is an indicator of how well economic units—firms, industrial sectors and countries—perform with respect to *all* production inputs at the same time. It allows one to learn where the highest pay-off on investment lies. For resource-scarce developing countries, this seems a fundamental consideration.

The objective of TFP is to measure how well production inputs, such as capital and labour, are combined to produce the greatest volume of output possible. Some firms produce more than others with seemingly identical amounts of inputs, yet, the outcome differs. Economists often refer to technology as the source of such difference. But what is technology?

Theoretically, TFP and technology are the same, so there should be no need to repeat the definition at the beginning of this paragraph. Empirically, though, for various reasons, they turn out to be different. Because this is an article about concepts, empirics can be left to a future number of *Research Update*.

To make a somewhat abstract concept such as technology concrete, consider how soccer works. Those who followed Euro 2008 may have noticed that Spain organized its team differently from Germany and Sweden. There are several reasons, ranging from the strength of the team that they played, the philosophy of the coach and, more importantly, the kind of players the coach could draw on. If the players are considered production inputs, the better

the quality of the players, the better they individually perform. A dream team might consist of Kaka, Cristiano Ronaldo, Ronaldinho and their like. Because soccer is a team sport, however, top players cannot perform unless they are supported by "workers" such as Gennaro Gattuso, Makelele and Iniesta. The trick is to find the combination of players that makes the team perform at its best.

Beyond the players, there is the concept of *how* they should play. During the 1990 World Cup, Germany championed a system with three defenders, five midfielders and two attackers (3-5-2). This technology became obsolete when Brazil introduced the so-called diamond of four defenders, one defensive midfielder, two normal midfielders, one offensive midfielder and two attackers (4-1-2-1-2). In other words, the system had advanced, permitting higher performance with the same number of players. In economic terms, disembodied technological progress/TFP growth allows for higher output with the same amount of inputs. Ideas pave the way for future enhanced performance and well-being.

Although this appears obvious, its implementation is often less than straightforward. Players who perform well in the 3-5-2 configuration may not be as able to deliver under the diamond system. Therefore, the quality of players/inputs is a continuous process needed to keep performing at a high level. For example, computers increase in quality, and workers today know more than their predecessors did. The economic concept for this is embodied technological growth. In other words, both inputs and organization continually have to improve, with the former catering to the latter by overcoming learning bottlenecks. With sufficient financial resources, teams such as Chelsea and Real Madrid can buy players and perform instantly. Others less endowed have to rely on training their own players and investing in their capacity to absorb the public good character of technology. This is, essentially, what firms in Africa and other developing regions must do as technology advances in OECD countries. The faster firms in developing countries learn, the faster their catching up capabilities develop and the greater their international competitiveness.

Oh, I nearly forgot productivity, wages and all that. In the long term, higher wages closely relate to higher productivity performance. Productivity also implies that inflationary pressures are kept at bay and central banks do not need to increase interest rates. Rapid technological progress means that firms can produce at lower average costs and, thus, become competitive relative to those enjoying slower TFP growth. Achieving productivity growth is, therefore, key to many development dimensions. But the discussion on how to accomplish it will have to be deferred to the next match.

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