Green Growth and Sustainable Development Symposium

IIASA – Laxenburg – 9-10 December, 2011

Abstracts of Presentations

Understanding Food Inflation In Emerging Economies: The Case Of India

Pradeep Agrawal

Sustainable development requires price stability. But over the last several years, persistent food inflation has become a serious problem in several emerging countries such as India. Efforts to control inflation have lead to monetary tightening that is threatening to slow down growth considerably. This paper attempts to understand the causes of one important contributing factor to inflation in India, namely food inflation. We estimate demand for food for various sub-categories of food (cereals, pulses, vegetables, fruits, dairy, meat etc) using data for last 40 years and the ARDL co-integration methodology. A major finding is that with rising income levels, the per capita demand for cereals and pulses is slightly declining (with income elasticity being -0.05 and -0.2 respectively) while it is rising rather rapidly for fruits, vegetables, oilseeds, dairy products and meat (with income elasticities of 0.5 to 0.68). For per capita income growth rates of around 7%, and current population growth rate of around 1.5%, this means per capita demand is virtually static for cereals and pulses while it is increasing rapidly at 5% to 6.5% for fruits, vegetables, oilseeds, dairy and meat. Yet, government support policies (including minimum support prices) have focused on cereals while ignoring fruits and vegetables and meat etc. (which the agriculture minister said are historically not considered by his ministry) As a result, production is not growing sufficiently for later categories. Some crucial problems are their perishable nature and poor availability of (refrigerated) storage and transportation facilities leading to large wastage and risk and inadequate marketing infrastructure that leaves farmers at the mercy of the traders and middlemen. This makes farmers reluctant to take to growing fruits and vegetables etc as viable business proposition as they are perceived to be too risky. This situation has caused the prices of fruits, vegetables, dairy and meat products to rise rather rapidly over the last several years in particular as incomes have risen, even as cereals are rotting in government godowns for want of sufficient storage capacity. This increase in the price of fruits, vegetables, dairy and meat etc has contributed significantly to food inflation. Other contributing factors have been increase in the price of cereals in the international markets (that has tended to put some pressure on domestic prices as well), partly as a result of diversions of large amounts of cereals and other crops to ethanol production, especially in USA, China and Brazil.

We also carry out projections for total demand for the next 10 years assuming per capita income growth of 6, 7 and 8 % and population growth of about 1.5% per annum (India's current rate of growth) leading to real GDP growth rates of 7.5, 8.5 and 9.5 % per annum. We find that for 8.5 % GDP growth rate, over the next 10 years the demand

for fruits, vegetables, oilseeds and dairy products will roughly double while demand for meat, fish etc will increase about 60%. On the other hand, demand for pulses will remain about constant and that for cereals will increase only about 12% in 10 years Thus, a medium term solution to food inflation problem lies in policies for considerably improving production of fruits, vegetables, dairy, meat etc. Currently, only about 8% of the cropped agricultural land is used for the production of fruits and vegetables while 60 percent is used for growing cereals and pulses. We will need to divert some of the land from cereals and pulses (by increasing their yield per hectare by 2-3% per year) to fruits and vegetables. To minimize the risk to farmers in growing perishable crops like fruits and vegetables, the government needs to improve refrigerated storage and transportation facilities, improve roads to major centers of fruit and vegetable production and try to create farmer co-operatives (somewhat along the lines of those in the dairy sector) that will help market the perishable produce while assuring reasonable returns to farmers. Such policies will go a long way to solve the problem of food inflation over the medium to long term horizon.

Where does the money of urban households go? – exploring the impact of the age structure, income distribution and industrial structure on China's consumption

Gui-ying Cao and Xiao-ying Zheng

Consumption is an important and pressing intrinsically intertwined within the framework for sustainable development. The consumption has greatly increased in the emerging economies during their industrial transition in recent decades. Taking a case of China, the aim of this paper are: 1) to analyze the changing of urban household consumption during the economic transition; 2) to forecast what the consumption structure will be likely in next 10 years; 3) to discuss how the demographic age structural change has affected and will affect consumption patterns and sustainable economic growth. In order to evaluate the urban private consumption change, we use variables of age structure, household expenditure and industrial structure, based on the household survey, population census, income distribution and industrial structure data. The baseline for scenarios for consumption structure change is based on the age structure, industrial outputs, and income distribution of household. For both analysis and forecast, the quintile regression model QR model is employed.

Connecting the Resource-Based View of the Firm and Resource Efficiency: Developing a Framework based on an analysis of firms in Japan and the US

Charla Griffy-Brown

The purpose of this study is to develop an analytical framework connecting the resource-based view of the firm with resource efficiency, a larger conceptual metric for analyzing and understanding the use of resources typically at the national level. The resource-based view of the firm (RBV), is an increasinglyimportant school of thought in the strategic management field, developed to explain why some firms are performing better than others.The RBV holds that corporations compete on the basis of resources that are valuable, rare, difficult to imitate and non-substitutable (Barney, 1991). The theory argues that firms exploit existing resources of the firm to form value-creating strategies to generate above-normal returns (Teece, 1984; Barney, 1991; Bharadwaj, 2000; Barney, 2001). The RBV explains innovation through the lens of scarce resources and is theoretically connected to the notion of dynamic capabilities which aid in the establishment of competitive advantage through the establishment of strategies and how firms attempt to sustain the advantage over time (Grant, 1996; Barney et al., 2001). Because of the combined critical issues of stagnant economic growth and climate change there is a growing need to connect these concepts in order to enable decision-makers to better understand how to support economic growth that is environmentally sustainable.Based on an analysis of firms in the US and Japan, this study will propose a framework establishing a connection of these concepts which could then be used in developing phenomenological models.

Transition towards Renewable Energy Supply - a System Dynamics Approach

Bo Hu, Armin Leopold, Stefan Pickl

There is no doubt that the resources which are daily consumed by modern industrial nations, like fossil fuels of different kinds or the storage capacity of atmosphere for CO_2 and other Greenhouse Gases, are finite. Also indisputable is that all national economies, the developed ones in particular, are all facing their substantial energy transitions. However, there seems to be no consensus about how to shape the structural conditions for this transition.

In Germany the ambitious and surely necessary target to reduce Greenhouse Gas emissions about 40% in 2020 compared to 1990 is considered to be challenging, especially in combination with the decision to phase out nuclear power supply in 2022. The decision is strongly supported by the public, however, it should be assumed that no substantial income loss or even economic down turn will be accepted in the context of the energy transition.

Against this background and based on our previous research in the area of emissions trading under uncertainties we are developing System Dynamics models which should depict the development of energy market in a highly aggregated form and be used to compare different possible pathways of the impeding energy transition. The intention to use System Dynamics is to make the modeling process more transparent and more understandable in approaching the politically active public.

A preliminary version of our model shows that the current direction of development makes the renewable energy supply even more dependent on the conventional energy supply not only financially, in view of the German Renewable Energy Act (EEG), but also technically, since two main kinds of renewable energy – wind and photovoltaic – are both not suitable to deliver time adjustable or even continuous power supply, at least in a national scale. To establish an autonomous renewable energy supply system energy storage must be put onto the top of the agenda of a transition plan.

The problem of optimal endogenous growth with exhaustible resources revisited

Sergey Aseev, Konstantin Besov
and **Serguei Kaniovski**

We study optimal research and extraction policies in an endogenous growth model in which both production and research require an exhaustible resource. It is shown that optimal growth is not sustainable if the accumulation of knowledge depends on the resource as an input, or if the returns to scale in research are decreasing, or the economy is too small. The model is stated as an infinite-horizon optimal control problem with an integral constraint on the control variables. We consider the main mathematical aspects of the problem, establish an existence theorem and derive an appropriate version of the Pontryagin maximum principle. A complete characterization of the optimal transitional dynamics is given.

JEL classification: C61; O38; Q01; Q56

Keywords: optimal economic growth, exhaustible resources, infinite-horizon optimal

Toolbox for Forecasting Optimal Economic Growth

Andrey Krasovskii

The report is devoted to the software toolbox developed in the framework of the IIASA initiative "Driving Forces of Economic Growth". It is based on the proposed methodology for analysis of the long term data using the theory of economic growth. The elaborated software allows the user to analyse time series for production factors, calibrate parameters of the model and simulate scenarios of optimal economic growth. The scenarios of growth converging to unique steady state are based on the solution of the optimal investments problem. The user can make forecasts for various data sets using intuitive step by step procedure in the software interface (see Fig. 1). The toolbox is tested on case studies for data on economies of USA, Japan, UK, Austria.

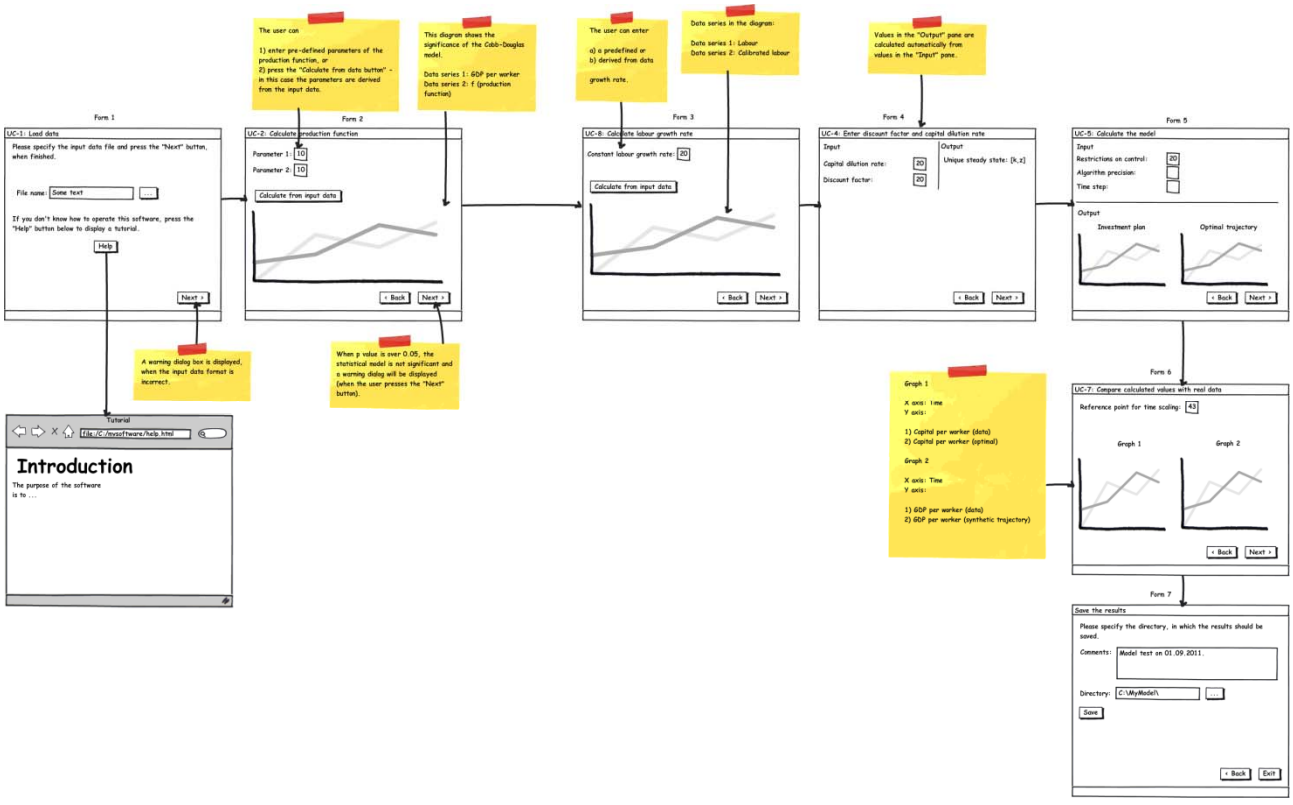

Fig. 1. Scheme of the Toolbox

Ecological Climate Economics. Climate Policy and Economic Growth

Armon Rezai, Lance Taylor and Reinhard Mechler

Conventional climate economics builds on neoclassical models of economic growth taking a supply-side perspective that given the assumption that market prices correctly reflect intertemporal scarcities derive a first best solution. In recent years, this and other assumptions have been heavily discussed and the focus of analyses has shifted to various forms of market imperfections and failures, both static and intertemporal. We propose a different challenge to conventional climate economics and set out a demand-driven model of economic growth. Macroeconomic causality is reversed; demand for investment, consumption, and mitigation expenditure create necessary supply. Abandoning the assumption of full employment broadens the space of possible macroeconomic outcomes, some of which are socially and environmentally undesirable in the absence of accommodating public policy. As well, in this framework, substitutability between factors of production is given up and developments in productivity of capital, labor, and energy drive the system. In such a macroeconomic growth model with a global warming module, we suggest the relationship between per capita income, labor and energy productivity as the relevant nexus between growth and the accumulation of greenhouse gases. We find important policy implications associated with truly meeting the 2 degree warming target, which is the policy objective for many policymakers, and end with broader suggestions for improving economic analysis and integrated assessment modelling. We argue that this view of the economy is more consistent with current thinking respecting earth-system boundaries and absolute limits to growth, thinking which has importantly been coined by ecological economists, yet rarely applied to macroeconomic theory and policy.

JEL: Q44

An econometric model of Russian economy and green growth aspects

Sergey Mitsek

This presentation is devoted to an econometric model that links 41 major macroeconomic variables of Russian economy by means of 32 relations (21 equations and 11 identities) and is used to make mid-term forecasts of their values. The model was estimated on quarterly time-series from 1995 to 2009 years (60 observations). Variables that describe fiscal and monetary policy and those that characterize the exogenous conditions for the economy (such as export prices and currency rate) were taken as exogenous.

By means of the model different variants of forecasts were run. They showed that Russian economy is very sensitive to external demand shocks. The export prices' drop can bring it to a serious recession. Russian economy depends strongly on labor force supply. As the latter will decline during next 20 years she should adapt her economic and social institutions to such changes. Russian fiscal policy has a limited effect. Monetary policy can be effective in Russia as her economy still have a shortage of long-term liquidity.

There are also warning signals that environment will limit future economic growth and threatens the quality of life of Russians. Russia has only 8.4 % of clean energy in her total energy balance while 91 % of fossil fuel and she produces only $3.1 of GDP per kg of oil equivalent (2-3 times less than developed countries). Russian total energy production is less on 3 % than in 1990. As 2/3 of Russian export is oil, oil products and gas it limits her export and growth. Russia has 15 per 1000 crude death rate that is near to Africa's one partly because of poor environmental conditions. Russia is expected to lose 13 million of her population in next 20 years.

A Model Of Economic Growth And Related Environmental Quality

Elena Rovenskaya

In this paper we suggest a stylized optimization model of national economic growth and environmental quality control. The AK-model is used to represent the economic growth; the logarithmic instantaneous utility function is used to represent the preference of the central planner to consumption. The environmental quality is modeled proportionally to the production output with some elasticity. That is why it can be increased by lowing the production via higher consumption.

The problem of finding an optimal consumption strategy is formulated on an infinite time horizon and is solved analytically by Pontryagin maximum principle. It is well-known that the PMP for infinite-time horizon problems requires additional analysis in order to make sure that the transversality condition holds. In this case we do not use the transversality condition, i.e., we employ an incomplete set of necessary conditions for optimality, but yet are able to identify a single optimal control. It is a constant fraction of the output to be allocated for consumption.

We carry out the sensitivity analysis with respect to model's parameters. It reveals qualitatively different development trajectories and suggests a concept of sustainable development in the framework of the considered model. It occurs that in this modeling framework if the capital stock grows, the environmental quality falls down and vice versa. The sustainable development is possible, therefore, in the steady state only. Economic growth then can occur via change in the elasticity of the environmental quality with respect to capital. The model is calibrated for Russia.

An Economic Model of Oil Exploration and Extraction

Alfred Greiner and **Willi Semmler**

In this paper we present empirical facts on oil exploitation and a model that can replicate some of these facts. In particular, we show that the time path of the oil price, on the one hand, and the extraction and discovery rate, on the other hand, seem to follow a U-shaped and an inverted U-shaped relationship, respectively, which is confirmed by simple non-parametric estimations. Next, we present a theoretical model where a monopolistic resource owner maximizes inter-temporal profits from exploiting a non-renewable resource where the price of the resource depends on the extraction rate and on cumulated past extraction. The resource is finite and only a part of the resource is known while the rest has not yet been discovered. The analysis of that model demonstrates that the extraction rate and the price of the resource show the empirically observed pattern if the stock of the initially known resource is small. We also indicate some extensions of how this model may work with different specifications of a price formation process and with delays. We also show of how the model may be built into a two sector energy model with fossil as well as renewable energy.

Existence of Steady States in Models of Dynamic Optimization of Resource Productivity under Growing Prices

Alexander Tarasyev and Bing Zhu

In this paper, a dynamic optimization model of investment in improvement of the resource productivity index is analyzed for obtaining balanced economic growth trends including both the consumption index and natural resources use. The research is closely connected with the problem of shortages of natural resources stocks, the security of supply of energy and materials, and the environmental effectiveness of their consumption. The main idea of the model is to introduce an integrated environment for elaboration of a control policy for management of the investment process in development of basic production factors such as capital, energy and material consumption. An essential feature of the model is providing the possibility to invest in economy's dematerialization. Another important construction is connected with the price formation mechanism which presumes the rapid growth of prices on exhausting materials. The balance is formed in the consumption index which negatively depends on growing prices on materials. The optimal control problem for the investment process is posed and solved within the Pontryagin maximum principle. Specifically, the growth and decline trends of the Hamiltonian trajectories are examined for the optimal solution. It is proved that for specific range of the model parameters there exists the unique steady state of the Hamiltonian system. The steady state can be interpreted as the optimal steady trajectory along which investments in improving resource productivity provide raising resource efficiency and balancing this trend with growth of the consumption index. As a result of system analysis and modeling, one can elaborate investment strategies in economy's dematerialization, resource and environmental management for improving the resource productivity index and, consequently, for shifting the economic system from nonoptimal paths to the trajectory of sustainable "green growth" development.

Global Warming and the Behaviour of Economic Agents

Thierry Brechet, Carmen Camacho
and **Vladimir M. Veliov**

There are striking distinctions in the attitude of different economic agents (countries or regional group of countries) towards possible policy measures in view of the global climate change. The purpose of the talk is twofold. First, to formalize the causes of these distinctions in a unified model able to explain dfferent types of agent's behaviour by differences in a few quantitative agent's parameters. The model has also to explain the evolutionary change of the agent's behaviour due to accumulation of experience and knowledge or economic wealth. Second, to investigate the ways of efficient co-existence of different economic agents by game-theoretic considerations.

The basic agent-specific factors that determine to what degree an agent is concerned by the un-favorable change of the global temperature and is willing to take costly measures are: the rate of discounting the future, the evaluation of the damage caused by potential temperature increase, the way the future temperature is calculated (predicted), the assessment of (and the uncertainty in) the natural emission of greenhouse gases or other factors influencing the temperature. The discount rate will be endogenous and depending on the wealth of the agent. The knowledge of the agent about the damage function will change with time due to learning by experience. The methodology employed by the agent for prediction of the future temperature will depend on the opinion of the agent about the reliability of the scientific methods for prediction and the uncertainty in the natural emissions. In order to determine her optimal investment/abatement policy the agent needs also to know what will be the emission of the rest of the economic agents in the future. Having (hypothetically) all this, we define the time-path of the agent by employing ideas from the model predictive control.

The results of the investment/abatement policy of an agent depend, through the environment, on the policies of all other agents, which may behave in different ways as explained above. Therefore the issue of formation and stability of coalitions of agents arises and will be discussed in the second part of the presentation.

Utmost Fear Hypothesis Explores Green Technology Driven Energy for Sustainable Growth

Chihiro Watanabe

Japan has constructed a sophisticated co-evolutionary dynamism between innovation and institutional systems by transforming external crises into a springboard for new innovation. This can largely be attributed to the unique features of the nation such as having a strong motivation to overcoming fear based on xenophobia and uncertainty avoidance as well as abundant curiosity, assimilation proficiency, and thoroughness in learning and absorption. Such explicit dynamism was typically demonstrated by technology substitution for energy in the 1970s leading Japan to achieve a high-technology miracle in the 1980s.

While this dynamism shifted to the opposite direction in the 1990s due to a system conflict with the rise of the information society, recent increase in oil prices and also March 11 catastrophe have signaled the increasing significance of environmentally friendly technology driven energy for sustainable growth. In addition, global economic stagnation resulted from excessive consumption has been inducing customers supra-functionality beyond economic value.

These trends inevitably lead a way to exploring high efficient photo-voltaic (PV) system incorporating supra functionality beyond economic value.

By means of an empirical analysis utilizing optimal trajectory analysis and taking Japan’s PV development as green technology driven energy to which Japan maintains institutional advantage, the foregoing hypothetical views are demonstrated thereby new postulate toward green growth for sustainable development is suggested.

Energy Balance Climate Models and General Equilibrium Optimal Mitigation Policies

W. Brock, G. Engstrom and **A. Xepapadeas**

We develop a spatial energy balance climate model (EBCM) with thermal transport across latitudes which is integrated with a general equilibrium economic growth model where firms produce consumption goods and mine fossil fuels from a finite global fossil fuels stock.

Thermal transport implies that the coupled climate economic model is an infinite dimensional optimal control problem, since climate dynamics are driven by a partial differential equation. We introduce approximation methods that allow the solution of the problem as a finite dimensional optimal control problem, where dynamics are driven by ordinary differential equations.

We introduce the concept of potential world GDP at time t, and we introduce spatial characteristics into the damage functions associated with output production and utility, by making them dependent on the temperature at a given latitude. We solve the social planner's problem and characterize competitive equilibrium. By comparing the socially optimal solution with the equilibrium solution, we define optimal profit taxes on firms that extract fossil fuels and optimal unit taxes on fossil fuels. We show that optimal mitigation policies imply a rapid ramp-up initially and then decreasing over time profit taxes on fossil fuel firms, and unit taxes on fuels which grow over time less than the rate of return on capital. By employing the properties of the spatial model and the approximating solution, we also study the impact of thermal transport across latitudes on welfare inequality across latitudes under the social optimum versus laissez faire and the impact of different tax schemes on this inequality.

Research on Green Indicator System and Evaluation Method of Coal Mining in West Region of China

(Detailed Abstract)

Xu Xiangyang

1. Introduction about WRC

The WRC（West Region of China）includes the 12 provinces and municipality directly under the Central Government of Chong Qing, Sichuan, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia and GuangXi (see Fig. 1). The total area of WRC is 5.38 Million km^2, occupying 56 % of China. By the July of 2011, the total population of WRC was 287.000 million, some 22.99 % of total population in China. From south to north of WRC, it spans 28 latitudes and from east to west, it across 37 longitudes. The geography location is far from ocean and deep located in the inner land.

The territory of WRC is vast, while the population density is low, it is the under developed region of China, most poverty people without enough to eat and wear are living in WRC, it is also the minority people inhabited region

Fig.1 Map of West Region of China

WRC (WRC) has abundant energy resources, especially for the coal resources. China coal resources distributes extensively in various provinces and cities besides Shanghai, among the 2100 countries of China, more than 1200 counties have coal reserves, there are 1100 counties have explored coal resources. The coal reserves in WRC accounts 30.39% of China total coal reserves, which ranks 2nd biggest reserves regions of China.
With the decline of coal resources in East and South region of China, the development of coal resources in WRC became the big energy development strategy in China, many big and key coal enterprises have established in WRC, most of the big coal production bases of China are distributed in WRC.
The most entironment fragility area of China locates in WRC, it is in the North-West part of China where is dry and lack of water resources, vegetation cover rate is very low, in Inner Mongolia of WRC, the vegetation cover rate is only around 11%. The upper vegetation degenerated severity. Due to the fragility entironment conditions, the big scale coal mining activity will aggravate the existing contradiction of environment protection and water supply. If continue the traditional coal mining method, it will cause austere environmental damage.

2. Environmental Damage Caused by Coal Mining and Utilization

There are two categories of coal mining, one is open pit mining, the other is underground mining. For open pit mining method, it must peel off the rock-soil above the coal seam, for those rock-soil peed off will occupy vast land, at the same time, the emission of harmful substance in the waste materials will damage environment. For underground mining, it will cause land substance and engineering geological disaster, damage natural zoology system and natural landscapes. Coal mining activity not only damage the natural environment, but also caused a lot social problems, for the farmer who lost land will became unsafe issue of the local society.
There are five main environmental problems caused by coal mining.
① **Land Subside.** About 95% of China coal production was mined out by underground coal mines, due to long period and intensive mining, most of shallow coal resources have been mined out, the rest coal resources are all in depth reserve, the currently average coal mine depth of China is 400 meters, a lot of coal mines is in 600 meters deep. The deepest coal mine is 1300 meters. By year 2005, there land subside area have already been 700,000 hectares, among them about 2/3 locates in plain regions. In plain regions, there are many industry facilities, railways, buildings and residence on surface.
② **Water Shortage.** Coal mining caused local underground water level decline. Based on China coal industry statistical data, the average water emit out is 2.5 tons per/ton coal, the annual under water let out is about 6 billion tons. This caused the underground water level decline and decreased the runoff of surface rivers. In 98 state owned coal mines of China. 71% of the coal mines are lack of water, among them, 40% of the water shortage coal mines are in severe shortage of water. North-West region is the most dry area of China, the big scale development of coal resources in WRC will aggravate the water shortage.
③ **Coal Wastes Pollution.** The accumulate coal wastes is already 3.0 billion tons.

Coal Wastes occupies about 7,500 hectares land area, which not only occupies big and valuable land area, but also emit big amount of poison gas to atmosphere due to self-ignite of coal. The coal waste mountains damage the landscape of coal mine regions. The emit poison gas make harm to local residence's health. For example, in Xinjiang province of China, the coal wastes mountains, which is self-igniting everyday around the province.

④ **Sulfur Dioxide(SO_2)and Nitrogen Oxides (NOx) Emission.** More than 80-90% of SO_2 emission is related to coal utilization in China, in year 2007, the emission amount was 24,680,000 tons, which decreased 4.66% than year 2006. Acid rain is close related to SO_2 emission of coal combustion, about one third of China country land area have acid rain frequency which happens more than 50%. Both of the intensity and acidity is increasing. In Beijing, there is acid rain happens. About 67% of Nitrogen Oxides **(**NOx) emission came from coal utilization.

⑤ **Carbon Dioxide (CO2) Emission.** CO_2 Emission is a global environmental problems, in year 2005, the CO_2 emission in China was 5,059.87 Mt, which ranks on top big emission countries of the world. The huge emission amount of China caused China face heavy international pressure.

3. Green Production System

The green production evaluation indicator is the base of green production auditing and green production management policy design, the green production evaluation indicator includes the establish of green production indicator and the evaluation method.

3.1 Evaluation Indicator System of Green Production

For the developed countries, such as U.S.A, Netherlands, Japan, Canada have established some green production evaluation index, the main index are listed as following:

Table 1. Some green production evaluation indicator in developed countries

Index Name	Brief summary	Source and Remarks
Eco-indicator	Based on the view of eco-environment evaluation, take the quantitative evaluation for emit pollution materials to environment influence, establish quantitative Eco-indicator, there are 100 indicators	Completed by National Reuse of Waste Research Program of Netherlands, for regional
Climate Change indicators	Pollution amount including CO_2,CH_4,N_2O CFCS and Halons, all the above will be converted into CO_2 equivalent, to record annually for evaluation the influence to climate change	Developed and used by Netherlands, for GHG emission control in country level
Environment Performance indicator-EPI	For aluminium melting sector, oil and gas exploration and production sector, petroleum refine, oil and chemical, paper making et al sectors. To established the energy indicator, air discharge indicator, waste water discharge indicator, waste material indicator and contingency indicator	Developed by European Green Table, a non profit agency accept the commitment of Norway and Netherlands Environmental Protection Bureau which is suitable for specific sectors
Environment Load Factor-ELF	ELF=Waste weight /production weight production weight: production sell amount	Developed by ICI company of U.S.A, can not reflect the real influence degree to environment
Waste Ratio-WR	WR=Waste weight /output amount	can not reflect the real influence degree to environment
Pollution Prevention Information Clearing House	Compare to the waste weight, material consumption, water consumption and energy consumption between before and after the green production process to judge whether it belongs to green production	EPA of U.S.A, suitable for process improvement in the same factory before and after the improve

The green production evaluation indicators system which was adopted by Europe countries and U.S.A are all quantitative and embodiment, the transverse of the whole system can be classified as raw material and energy, production process and products

indicator, the longitudinally of the whole system can be classified as environment and pollution indicator, technology indicator, management indicator and economy indicator. In practical application, usually select some indicators which can most reflect the green production properties and establish the new green production evaluation indicator system.

3.2 Green Production Evaluation Methods

LCA (Life Cycle Assessment) and LCC(Life Cycle Cost) are two mainly used methods in green production evaluation. LCA (Life Cycle Assessment) can be used in evaluating the environment influence and used resources within the product life cycle. LCA aim at doing quantitative analysis of every environmental problems in different phases of the whole, life cycle for the evaluation object. LCA use mathematical and physical methods and combine with the experiment analysis to determine the environment rationality and environment load of one process, product or phase.

Robert Dole have finished LCA of China coal production.

LCC(Life Cycle Cost) originally came from 40 years of last centuries, it was provided by GE (General Electric) of United State from the concept of value engineering of cost management model, LCC is from the view of Life Cycle to evaluate the cost of products or service including environmental cost.

3.3 Basic Content of China Coal Green Production(GP)

To introduce green production into China coal production is the important approach for sustainable development, the purpose, target, principle and framework can be listed in Table 2.

Table 2. China Coal Green Production Content

Purpose for GP	To improve efficiency, to decrease pollution and promote development
Target of GP	To develop economy, effective and practical new technology, to realize environment protection, energy conservation and to decrease 2nd pollution in coal mining and utilization, to change the one fold production structure in coal production
Principles of GP	To unite the environment and development and pay attention to both social environmental protection benefit and economy benefit.
	To take consideration of coal mining and utilization with coal enterprises management, to take consideration of coal field environment protection and to improve enterprise economy benefit into one plan
	Based on the high clean utilization for coal resources and to develop various advance technologies applicable to different user and different levels
	Take the opportunity for development of green production, to improve economy benefit of China coal sector
Content of GP	Coal wash-dressing and processing: washing and dressing, type coal and water slurry et al.
	Coal combustion and purification technology after combustion: advanced burner, advanced combustion technology, flue gas purification technology
	Coal convert technology: aerification, pyrogenation, special procession et al.
	Mining and utilization pollution control: waste rock, waste air, waste water and harmful air emission treatment et al.

4. AHP method used in green indicator system evaluation of China coal mining

5. Acknowledgements

Thanks for the generous help and support from Dr. Cao GuiYing of International Institute for Applied System Analysis .The study was conducted within the Fundamental Research Funds for the Central Universities of China. project No. 2010YG06.

Key words: West Region of China, coal mining, green, index

Green growth possibilities and current economic patterns in Brazil and Latin America

Carlos Eduardo Frickmann Young

Latin American countries are concentrating their exports in natural resources or industrial goods characterized by relatively high degree of pollution in their production processes. However, this paper shows that an alternative pattern of economic growth is possible: higher expansion of clean economic activities, “greening the economy”, would bring better effects to employment and income generation. This is proved by an input-output model that compares alternative economic growth options. The results show that spurious growth based on natural resource depletion or degradation bring worse results than alternative economic options that concentrate output in higher value added products that are less harmful to the environment: employment and wage creation are higher in the scenarios where the dependence on natural resources depletion and degradation are reduced. More pollution and resource depletion would lead to less, rather than more, inclusive growth, the opposite result expected from the “Environmental Kuznets Curve”.

Keywords: Green growth; green trade; input-output; Latin America

JEL Codes: Q5; F1

Green Technologies for Sustainable Development: Experience of Ukraine

Michael Zgurovsky

The paper considers the peculiarities of Ukraine's transition to the model of "green economy". Ukraine inherited from the USSR power-consuming, nature- and man-unfriendly industry and the soviet mentality characterized by the neglecting attitude to environment.

The structure of major consumers of power resources in Ukrainian industries is as follows: enterprises of mining and smelting complex (27%), food manufacturing industry (16 %), metallurgical enterprises (14%), agrarian branch (12.7%), chemical industry (4.4%). These enterprises provide more than 35% out of all jobs in Ukraine. The industrial equipment of the above enterprises operates inefficiently; first of all, it concerns treatment facilities which do not catch dust; the great concern is caused by emissions of sulfur compounds, carbon monoxide and particulate pollutants. One of critical factors for Ukraine is the index of energy intensity in the country's GDP. By this index Ukraine is 2-4 times inferior to the countries of Western and Central Europe. Ukraine is ranked 89th among 139 countries of the world in competitiveness of its economic sector for goods and services.

The use of 65 macro-indicators allows calculate sustainable development indices in economic, ecological and social coordinate system. By this index in 2010 Ukraine was 69th among 117 countries. In economic dimension Ukraine is ranked 93rd in the world. In ecological component Ukraine is on the 69th position. A group of social indicators determines the 49th position of Ukraine in 2010. Unfortunately, during the last three years Ukraine has worsened its position by 10 points in sustainable development index, by 12 points in economic component of sustainable development, by 8 points in ecological component and by 6 points in social component.

There were defined indicators characterizing obstacles and prospects of Ukraine's transition to the model of "green economy". The major obstacles may be high power consumption by industrial enterprises and the difficulties with getting investments for re-equipment. The group of positive factors for sustainable development includes the education quality, in particular, mathematical, innovation possibilities.