First IIASA Mini-Workshop on Green Growth Modeling
Advanced Systems Analysis (ASA) and Risk and Resilience (RISK) Programs

Organizers: Asjad Naqvi & Elena Rovenskaya

Abstracts

Emission Permit Trading with Global Externality Problems

Tapio Palokangas
University of Helsinki, Finland and International Institute for Applied Systems Analysis (IIASA), Austria

This article examines a set of heterogeneous countries where firms produce goods from fixed resources and emitting inputs. Emissions cause global pollution (e.g. GHGs). International environmental policy is run by a benevolent regulator that sets firm-specific emission permits. It is shown that if the firms are allowed to trade in emission permits, then welfare decreases. If the countries selling permits are on the average poorer than those buying permits, then the regulator provides too much permits from the social point of view, aggravating pollution. If vice versa, then the regulator provides too little permits, alleviating pollution.

The Social Cost of Carbon Dioxide - Mitigating Global Warming Whilst Avoiding Economic Collapse

Christopher Kellett
University of Newcastle, Australia

Many governments and international finance organizations use a carbon price in cost-benefit analyses, emissions trading schemes, quantification of energy subsidies, and modelling the impact of climate change on financial assets. The most commonly used value in this context is the social cost of carbon dioxide (SC-CO2). Users of the social cost of carbon dioxide include the US, UK, German, and other governments, as well as organizations such as the World Bank, the International Monetary Fund, and Citigroup. Consequently, the social cost of carbon dioxide is a key factor driving worldwide investment decisions worth many trillions of dollars.
The social cost of carbon dioxide is derived using integrated assessment models that combine simplified models of the climate and the economy. One of three dominant models used in the calculation of the social cost of carbon dioxide is the Dynamic Integrated model of Climate and the Economy, or DICE. DICE contains approximately 70 parameters as well as several "exogenous" driving signals such as population growth and a measure of technological progress. Given the quantity of finance tied up in a figure derived from this simple highly parameterized model, understanding uncertainty in the model and capturing its effects on the social cost of carbon dioxide is of paramount importance. Indeed, in late January this year the US National Academies of Sciences, Engineering, and Medicine released a report calling for discussion on "the various types of uncertainty in the overall SC-CO2 estimation approach" and addressing "how different models used in SC-CO2 estimation capture uncertainty.

A three-phase model of climate change mitigation

Willi Semmler
New School for Social Research, NY, USA
Elena Rovenskaya
International Institute for Applied Systems Analysis (IIASA), Austria and Lomonosov Moscow State University, Moscow, Russia
Julia Puaschunder
Harvard University, USA
Sergey Orlov
Lomonosov Moscow State University, Moscow, Russia and International Institute for Applied Systems Analysis (IIASA), Austria

We consider a three-phase optimal control model of economic growth and climate change mitigation through transiting to low-carbon technologies. In the first phase, companies invest in adopting low-carbon technologies and a part of the required investment is reimbursed through 'climate' bonds issued by the government. The second phase starts when the greenhouse gases' concentration is reduced to a pre-industrial level and firms have fully adopted low-carbon technologies. In this phase, bonds are being repaid through taxation. In the last phase, the economy is accumulating capital and consume enjoying the stabilized climate. The standard consumption based utility function in the logarithmic form is applied over all three phases. We use GPOPS-II software to find a locally optimal solution in the model, including the optimal switching times between phases. We compare the obtained optimal solution with a business-as-usual version of this model, in which no mitigation action is undertaken. The social welfare function in the mitigation policy model turns out to be greater than the one in the business-as-usual model over almost the entire time horizon of consideration with the exception of a short period in the beginning of the first phase.

Optimal Control of "Deviant" Behavior

Gustav Feichtinger
Vienna University of Technology (TU), Austria and International Institute for Applied Systems Analysis (IIASA), Austria

For several decades, Pontryagin's maximum principle has been applied to solve optimal control problems in engineering, economics, or management. Early Operations Research applications of optimal control include problems such as production planning, inventory control, maintenance, marketing, or pollution control. Since the mid-nineties, optimal control models of illicit drug consumption have contributed successfully to a better understanding of drug epidemics and their control via an optimal mix of instruments such as prevention, treatment or law enforcement.
This talk explains why and how tools of dynamic optimization are used to address pressing questions arising in drug policy. Moreover, methodological advances in optimal control theory that have been triggered by solving these problems will be highlighted, e.g., multiple equilibria & SKIBA thresholds. We discuss social interaction mechanisms generating this sort of sensitivity of the optimal solution paths from the initial conditions. Another important type of complex solution structures are persistent limit cycles. A standard two-state production/inventory whose solution consists on a stable oscillation is presented. Surprisingly, it contains several indifference curves and a threefold Skiba point.

Climate financial bubbles: How market sentiments shape the transition to low-carbon capital

Emanuele Campiglio
Vienna University of Economics and Business (WU), Austria

The large-scale transition to low-carbon forms of capital stock is likely to have deep implications on involved companies and the market valuation of their financial assets, with repercussion on financial investors holding the assets and potential disruptive systemic effects. We analyze here the link between finance and the low-carbon transition by means of a multi-sector macroeconomic model with two forms of physical capital - high-carbon and low-carbon - and financial investors allocating their wealth across equities issued by productive sectors. In our baseline scenario the low-carbon transition produces some relevant macroeconomic and financial fluctuations, especially when the high-carbon capital sector defaults. We then study how financial market sentiments might affect the shape of the transition. To emphasize the role of the financial sector, we make the counter-factual assumption that low-carbon technologies are less costly to operate than high-carbon technologies. Despite the cost advantage, investor behavior favours the incumbent technology. We allow investors to develop varying degrees of `apathetic' expectations around the development of the low-carbon sector and to hold limited perceptions regarding its actual size. We show that higher levels of `climate apathy' extend the length of the transition period, possibly to the point of preventing it from happening, and produce larger amounts of both physical and financial stranded assets. Our results support the call for increased climate-related financial disclosures and the implementation of policies to help investors reduce uncertainty.

Title: Could governments support the green transition by phasing out fossil fuels subsidies? A Stock-Flows Consistent model approach

Irene Monasterolo
Vienna University of Economics and Business (WU), Austria
Marco Roberto
University of Genoa, Italy

Meeting the Paris Agreement and limit global temperature increase below 2C above preindustrial levels would require urgent and massive investments in the low-carbon transition. There is growing awareness of the risk that climate change would represent for the real economy and for financial markets as a consequence of carbon stranded assets. Risk transmission from climate change to the financial sector started to be analyzed and appears to be substantial with potential systemic ramifications and cascade effects throughout the entire financial network. However, investors and decision makers appear to be blind to the risk of stranded assets, and capital is flowing in the low-carbon economy at a much slower pace than needed, and capital is still locked-in into carbon-intense assets. In this paper we explore the sources of the 'green market failure' by focusing on how public policies could influence investors' expectations and behavior in the low-carbon transition. By expanding the EIRIN flow-of-funds behavioral model, we simulate scenarios of a gradual phasing out of fossil fuels production subsidies and the introduction of two sets of green public policies, i.e. fiscal measures, and green sovereign bonds. EIRIN is Stock-Flow Consistent and is rooted on a balance sheet approach. It adopts a Leontief production function with no substitution of the three production factors, i.e., Labor, Capital, Raw Materials and Energy. Its sectors are endowed with adaptive behaviors and expectations, and interact with the others and the foreign sector through a set of markets. We display their effects on green firms' investments and green jobs, wages and skills, credit (endogenous money creation) and bonds market. Simulations show that - under the model's conditions – a gradual phasing out of fossil fuels subsidies brings positive externalities: governments could find fiscal space to support green new investments without increasing public debt and deficit, and containing inequality. Green sovereign bonds

contribute the most to develop the green economy and to stabilize the credit market. In addition, scenarios with green public support differ in terms of redistributive effects. Green fiscal policies have higher distributive effects that induce negative feedbacks on the real economy, while green sovereign bonds' trade-offs depend on the final owners and the Central Bank's exposure to moral hazard.