

- 2010/1 Degree of coordination in market-coupling and counter-trading  
Giorgia OGGIONI and Yves SMEERS

Cross-border trade remains a contentious issue in the restructuring of the European electricity market. Difficulties stem from the lack of a common market design, the separation between energy and transmission markets and the insufficient coordination between Transmission System Operators (TSOs). This paper analyzes the cross-border trade problem through a set of models that represent different degrees of coordination both between the energy and transmission markets and among national TSOs.

We first present the optimal organisation, not implemented in Europe, where energy and transmission are integrated according to the nodal price paradigm and Power Exchanges (PXs) and TSOs are integrated. This is our reference case. We then move to a more realistic representation of the European electricity market based on the so-called market-coupling design where energy and transmission are operated separately by PXs and TSOs. When considering different degrees of coordination of the national TSOs' activities, we unexpectedly find that some arrangements are more efficient than the lack of coordination might suggest. Specifically we find that even without a formal coordination of the TSOs' counter-trading operations, non discriminatory access to common counter-trading resources for all TSOs may lead to a partial implicit coordination of these TSOs. In other words, an internal market of counter-trading resources partially substitutes the lack of integration of the TSOs. While a full access to counter-trading resources is a weaker requirement than the horizontal integration of the TSO, it is still quite demanding. We show that quantitative limitations to the access of these resources decrease the efficiency of counter-trading. The paper supposes price taking agents and hence leaves aside the incentive to game the system induced by zonal systems.

**Keywords:** Cross-Border Energy Trade, Market-Coupling, Counter-Trading, Coordination, Generalized Nash Equilibrium.

- 2010/2 Efficiency of coordinate descent methods on huge-scale optimization problems  
Yu. NESTEROV

In this paper we propose new methods for solving huge-scale optimization problems. For problems of this size, even the simplest full-dimensional vector operations are very expensive. Hence, we propose to apply an optimization technique based on random partial update of decision variables. For these methods, we prove the global estimates for the rate of convergence. Surprisingly enough, for certain classes of objective functions, our results are better than the standard worst-case bounds for deterministic algorithms. We present constrained and unconstrained versions of the method, and its accelerated variant. Our numerical test confirms a high efficiency of this technique on problems of very big size.

**Keywords:** Convex optimization, coordinate relaxation, worst-case efficiency estimates, fast gradient schemes, Google problem.

- 2010/3 Split-panel jackknife estimation of fixed-effect models  
Geert DHAENE and Koen JOCHMANS

We propose a jackknife for reducing the order of the bias of maximum likelihood estimates of nonlinear dynamic fixed-effect panel models. In its simplest form, the half-panel jackknife, the estimator is just  $2\hat{\theta} - \bar{\theta}_{1/2}$ , where  $\hat{\theta}$  is the MLE from the full panel and  $\bar{\theta}_{1/2}$  is the average of the two half-panel MLEs, each using  $T/2$  time periods and all  $N$  cross-sectional units. This estimator eliminates the first-order bias

of  $\hat{\theta}$ . The order of the bias is further reduced if two partitions of the panel are used, for example, two half-panels and three 1/3-panels, and the corresponding MLEs. On further partitioning the panel, any order of bias reduction can be achieved. The split-panel jackknife estimators are asymptotically normal, centered at the true value, with variance equal to that of the MLE under asymptotics where  $T$  is allowed to grow slowly with  $N$ . In analogous fashion, the split-panel jackknife reduces the bias of the profile likelihood and the bias of marginal-effect estimates. Simulations in fixed-effect dynamic discrete-choice models with small  $T$  show that the split-panel jackknife effectively reduces the bias and mean squared error of the MLE, and yields confidence intervals with much better coverage.

**JEL Classification:** C13, C14, C22, C23

**Keywords:** jackknife, asymptotic bias correction, dynamic panel data, fixed effects.

2010/4 Cores of games with positive externalities  
Parkash CHANDER

This paper introduces a core concept, called the  $\gamma$ -core, in the primitive framework of a strategic game. For a certain class of strategic games, it is a weaker concept than the strong Nash equilibrium, but in general stronger than the conventional  $\alpha$ - and  $\beta$ -cores. We argue that the coalition formation process is an infinitely repeated game and show that the grand coalition forms if the  $\gamma$ -core is nonempty. This is a weaker sufficient condition than the previous such condition (Maskin (2003, Theorem 4)). As an application of this result, it is shown that the  $\gamma$ -core of an oligopolistic market is nonempty and thus the grand coalition forms.

**JEL Classification:** C7, D62

**Keywords:** positive externalities, strategic game, core, repeated game, coalition formation.

2010/5 Liquidity risks on power exchanges  
Gauthier DE MAERE D'AERTRYCKE and Yves SMEERS

Financial derivatives are important hedging tool for asset's manager. Electricity is by its very nature the most volatile commodity, which creates big incentive to share the risk among the market participants through financial contracts. But, even if volume of derivatives contracts traded on Power Exchanges has been growing since the beginning of the restructuring of the sector, electricity markets continue to be considerably less liquid than other commodities. This paper tries to quantify the effect of this insufficient liquidity on power exchange, by introducing a pricing equilibrium model for power derivatives where agents can not hedge up to their desired level. Mathematically, the problem is a two stage stochastic Generalized Nash Equilibrium and its solution is not unique. Computing a large panel of solutions, we show how the risk premium and player's profit are affected by the illiquidity.

**JEL Classification:** C61, G13

**Keywords:** illiquidity, electricity, power exchange, arbitrage, generalized Nash Equilibrium, equilibrium based model, coherent risk valuation.

2010/6 Equivalent income and the economic evaluation of health care  
Marc FLEURBAEY, Stéphane LUCHINI, Christophe MULLER and Erik SCHOKKAERT

We argue that the economic evaluation of health care (cost-benefit analysis) should

respect individual preferences and should incorporate distributional considerations. Relying on individual preferences does not imply subjective welfarism. We propose a particular non-welfarist approach, based on the concept of equivalent income, and show how it helps to define distributional weights. We illustrate the feasibility of our approach with empirical results from a pilot survey.

**JEL Classification:** D63, H21, H51, I18

**Keywords:** cost-benefit analysis, cost-effectiveness analysis, willingness-to-pay, social welfare function, equivalent income.

2010/7 The stability of the roommate problem revisited  
Elena IÑARRA, Conchi LARREA and Elena MOLIS

The lack of stability in some matching problems suggests that alternative solution concepts to the core might be a step towards furthering our understanding of matching market performance. We propose absorbing sets as a solution for the class of roommate problems with strict preferences. This solution, which always exists, either gives the matchings in the core or predicts other matchings when the core is empty. Furthermore, it satisfies the interesting property of outer stability. We also determine the matchings in absorbing sets and find that in the case of multiple absorbing sets a similar structure is shared by all.

**JEL Classification:** C78

**Keywords:** roommate problem, core, absorbing sets.

2010/8 Locating fire-stations: an integrated approach for Belgium  
Philippe CHEVALIER, Isabelle THOMAS and David GERAETS, Els GOETGHEBEUR, Olivier JANSSENS, Dominique PEETERS and Frank PLASTRIA

This paper demonstrates the potential of a decision-support system developed for Belgium by a consortium of universities and a private firm, in the framework of a public call by the Ministry of the Interior. The system is designed to provide the Belgian emergency management administration with a complete decision-aid tool for the location of fire-stations. The originality of the project is that it includes a risk-modeling approach developed at a national scale. This analysis involves a multiscale GIS system which includes a thorough representation of the physical, human and economic spatial realities, a risk modeling approach, an adequate optimal location and allocation model (taking into account both queuing and staffing problems). The final result is an interactive operational tool for defining locations, equipment allocations, staffing, response times, the cost/efficiency trade-off, etc. which can be used in an assessment as well as a prospective context. It has numerous functionalities including rapid modification of the modeling conditions to allow for quick scenario analysis, multiscale analysis, and prospective analysis.

**JEL Classification:** C61, R53

**Keywords:** location-allocations, GIS, fire-stations, Belgium.

2010/9 Design of a network of reusable logistic containers  
Jean-Charles LANGE and Pierre SEMAL

In this paper, we consider the management of the return flows of empty logistic containers that accumulate at the customer's sites. These containers must be brought back to the factories in order to sustain future expeditions. We consider a network composed of several factories and several customers in which the return flows are independent of the delivery flows. The models and their solutions aim at

finding to which factory the containers have to be brought back and at which frequency. These frequencies directly define the volume of logistic containers to hold in the network. We consider fixed transportation costs depending on the locations of the customers and of the factories and linear holding costs for the inventory of logistic containers. The analysis also provides insight on the benefit of pooling the containers among different customers and/or factories.

**Keywords:** supply chain management, returnable items, reverse logistic, economic order quantity, network design.

2010/10 Nested potentials and robust equilibria  
Hiroshi UNO

This paper introduces the notion of nested best response potentials for complete information games. It is shown that a unique maximizer of such a potential is a Nash equilibrium that is robust to incomplete information in the sense of Kajii and Morris (1997, mimeo).

**JEL Classification:** C72, C73

**Keywords:** incomplete information, potential games, robustness, refinements.

2010/11 Experimental results on the roommate problem  
Elena MOLIS and Róbert F. VESZTEG

We use laboratory experiments to analyze decentralized decision-making in one-sided matching markets. We find that subjects tend to make decisions in line with theoretical models, as their offering and accepting decisions are only guided by the objective of improving upon the status quo. However, isolated individual mistakes, that do not disappear with experience or time, often make theoretically-stable matchings unstable in the laboratory. Markets with incomplete information are especially prone to this problem.

**JEL Classification:** C78, C91, D82

**Keywords:** convergence, experiments, one-sided matching, stability.

2010/12 Copula-based orderings of multivariate dependence  
Koen DECANCO

In this paper I investigate the problem of defining a multivariate dependence ordering. First, I provide a characterization of the concordance dependence ordering between multivariate random vectors with fixed margins. Central to the characterization is a multivariate generalization of a well-known bivariate elementary dependence increasing rearrangement. Second, to order multivariate random vectors with non-fixed margins, I impose a scale invariance principle which leads to a copula-based concordance dependence ordering. Finally, a wide family of copula-based measures of dependence is characterized to which Spearman's rank correlation coefficient belongs.

**JEL Classification:** C14

**Keywords:** copula, concordance ordering, dependence measures, dependence orderings, multivariate stochastic dominance, supermodular ordering.

2010/13 Signaling and indirect taxation  
Tom TRUYTS

Commodities communicate. Consumers choose a consumption bundle both for its intrinsic characteristics and for what this bundle communicates about their qualities

(or 'identity') to spectators. We investigate optimal indirect taxation when consumption choices are motivated by two sorts of concerns: intrinsic consumption and costly signaling. Optimal indirect taxes are introduced into a monotonic signaling game with a finite typespace of consumers. We provide sufficient conditions for the uniqueness of the D1 sequential equilibrium in terms of strategies. In the case of pure costly signaling, signaling goods can in equilibrium be taxed without burden and the optimal quantity taxes on these goods are infinite. When commodities serve both intrinsic consumption and signaling, optimal taxes can be characterized by a generalization of the Ramsey rule, which also deals with the distortions resulting from signaling.

**JEL Classification:** C720, H210

**Keywords:** optimal taxation, indirect taxation, costly signaling, identity.

2010/14 Currency substitution in the economies of Central Asia: How much does it cost?  
Asel ISAKOVA

Underdeveloped financial markets and periods of high inflation have stimulated dollarization and currency substitution in the economies of Central Asia. Some authors argue that the latter can pose serious obstacles for the effective conduct of monetary policy and can affect households' welfare. This study uses a model with money-in-the-utility function to estimate the elasticity of substitution between domestic and foreign currencies in three economies of Central Asia - Kazakhstan, the Kyrgyz Republic and Tajikistan. Utility derived from holding money balances is represented by a CES function with money holdings denominated in two currencies. The residents are assumed to diversify their monetary holdings due to instability of the domestic currency. The steady state analysis reveals that though currency substitution decreases governments' seigniorage revenue, holding foreign money can be welfare generating if domestic currency depreciates vis-à-vis the currencies in which households' foreign balances holdings are denominated. De-dollarization can only be achieved through further macroeconomic stabilization that will bring price and exchange rate stability. Financial sector development will also decrease currency substitution through the provision of reliable financial instruments and the gaining of public confidence.

**JEL Classification:** E58, P2, E41

**Keywords:** currency substitution, dollarization, monetary policy, seigniorage, welfare, transition economies.

2010/15 Irish firms' productivity and imported inputs  
Emanuelle FORLANI

In this paper, we empirically analyze the evolution of firms' productivity and how the efficiency changes with variations in the inputs' origin. Using firm-level information on a sample of Irish firms, we assess the importance of the imported inputs' quota for a firm's efficiency, as well as starting import activity. The main findings are that an increase in the intensive margin of imports raises firms' efficiency of domestic firms; in addition heterogeneous effects across firms are detected. Unlike the findings of most of the literature, there is weak evidence of self-selection in import activity; differently from previous research when we introduce fixed effects, the self-selection disappears. Instead, the few observed firms that start importing raise their productivity compared to non-importing firms; learning by importing is suspected. The results suggest an important policy implication: policies that favor the imports of intermediates enhance the productivity of domestic firms, making them more competitive in the international

markets.

**JEL Classification:** F10, F14, D24, L25

**Keywords:** firms' productivity, inputs, import, Ireland.

- 2010/16 Model predictive control, the economy, and the issue of global warming  
Thierry BRECHET, Carmen CAMACHO and Vladimir M. VELIOV

This study is motivated by the evidence of global warming, which is caused by human activity but affects the efficiency of the economy. We employ the integrated assessment Nordhaus DICE-2007 model [16]. Generally speaking, the framework is that of dynamic optimization of the discounted inter-temporal utility of consumption, taking into account the economic and the environmental dynamics. The main novelty is that several reasonable types of behavior (policy) of the economic agents, which may be non-optimal from the point of view of the global performance but are reasonable from an individual point of view and exist in reality, are strictly defined and analyzed. These include the concepts of “business as usual”, in which an economic agent ignores her impact on the climate change (although adapting to it), and of “free riding with a perfect foresight”, where some economic agents optimize in an adaptive way their individual performance expecting that the others would perform in a collectively optimal way. These policies are defined in a formal and unified way modifying ideas from the so-called “model predictive control”. The introduced concepts are relevant to many other problems of dynamic optimization, especially in the context of resource economics. However, the numerical analysis in this paper is devoted to the evolution of the world economy and the average temperature in the next 150 years, depending on different scenarios for the behavior of the economic agents. In particular, the results show that the “business as usual”, although adaptive to the change of the atmospheric temperature, may lead within 150 years to increase of temperature by 2°C more than the collectively optimal policy.

**Keywords:** environmental economics, dynamic optimization, optimal control, global warming, model predictive control, integrated assessment.

- 2010/17 Markets for emission permits with free endowment: a vintage capital analysis  
Thierry BRECHET, Tsvetomir TSACHEV and Vladimir M. VELIOV

In this paper we develop a vintage capital model for a firm involved in a market for tradable emission permits. We analyze both the firm's optimal investment plans and the market equilibrium. This allows us to scrutinize how firms use permits free endowment, and to highlight the implications of non-optimal uses both at the firm and at the market level. We provide a new rationale for the market of tradable permits not to be cost-efficient. The novel technical points in this context are the use of a distributed (vintage) optimal control model of the firm, the use of optimality conditions for non-smooth problems, and the involvement of a nonlinear Fredholm integral equation of the first kind for the description of the equilibrium price of permits, and its practical meaning for market regularization.

- 2010/18 Bank secrecy, illicit money and offshore financial centers  
Pierre M. PICARD and Patrice PIERETTI

This paper discusses the effects of pressure policies on offshore financial centers as well as their ability to enforce the compliance of those centers with anti-money laundering regulations. Offshore banks can be encouraged to comply with rigorous monitoring of an investor's identity and the origin of his/her funds when pressure

creates a sufficiently high risk of reputational harm to the investor. We show that such pressure policies harm both offshore and onshore investors and can benefit both the bank industry and tax administrations. We show that social optimal pressure policies are dichotomous decisions between no pressure at all and a pressure great enough to persuade offshore banks to comply. The delegation of pressure policies to onshore tax institutions may be inefficient. Deeper financial integration fosters compliance by the offshore center.

**JEL Classification:** F21, K42

**Keywords:** money laundering, offshore banking, compliance.

2010/19 When frictions favour information revelation  
Tanguy ISAAC

We study information revelation in markets with pairwise meetings. First, we reconsider the one-sided case within constant entry flow model. The same question has been studied in an identical framework in Serrano and Yosha (1993). We prove that there exists an additional equilibrium not detected by Serrano and Yosha (1993). We show that this equilibrium is characterized by incomplete information revelation. Until now, no equilibrium with incomplete revelation of information was known in this model. Our second main result is that, at this new equilibrium, information revelation is worse when frictions are weaker. One prove also that increasing the frictions is a Pareto improvement. Finally, we show that those properties should also characterize some equilibria of the two-sided case studied by Wolinsky (1990).

2010/20 Multivariate option pricing with time varying volatility and correlations  
Jeroen V.K. ROMBOUTS and Lars STENTOFT

In recent years multivariate models for asset returns have received much attention, in particular this is the case for models with time varying volatility. In this paper we consider models of this class and examine their potential when it comes to option pricing. Specifically, we derive the risk neutral dynamics for a general class of multivariate heteroskedastic models, and we provide a feasible way to price options in this framework. Our framework can be used irrespective of the assumed underlying distribution and dynamics, and it nests several important special cases. We provide an application to options on the minimum of two indices. Our results show that not only is correlation important for these options but so is allowing this correlation to be dynamic. Moreover, we show that for the general model exposure to correlation risk carries an important premium, and when this is neglected option prices are estimated with errors. Finally, we show that when neglecting the non-Gaussian features of the data, option prices are also estimated with large errors.

**JEL Classification:** C11, C15, C22, G13

**Keywords:** multivariate risk premia, option pricing, GARCH models.

2010/21 Leniency programs for multimarket firms: The effect of Amnesty Plus on cartel formation  
Yassine LEFOUILI and Catherine ROUX

We examine the effect of the Amnesty Plus policy on the incentives of firms to engage in cartel activities. Amnesty Plus is aimed at attracting amnesty applications by encouraging firms, convicted in one market, to report their collusive agreements in other markets. It has been vigorously advertised that Amnesty Plus weakens cartel stability. We show to the contrary that Amnesty Plus

may not have this desirable effect, and, if improperly designed, may even stabilize a cartel. We suggest a simple discount-setting rule to avoid this anticompetitive effect.

**JEL Classification:** K21, K42, L41

**Keywords:** Amnesty Plus, Leniency program, multimarket contact, antitrust policy.

- 2010/22 Coalition formation among farsighted agents  
P. Jean-Jacques HERINGS, Ana MAULEON and Vincent VANNETELBOSCH

A set of coalition structures  $P$  is farsightedly stable (i) if all possible deviations from any coalition structure  $p$  belonging to  $P$  to a coalition structure outside  $P$  are deterred by the threat of ending worse off or equally well off, (ii) if there exists a farsighted improving path from any coalition structure outside the set leading to some coalition structure in the set, and (iii) if there is no proper subset of  $P$  satisfying the first two conditions. A non-empty farsightedly stable set always exists. We provide a characterization of unique farsightedly stable sets of coalition structures and we study the relationship between farsighted stability and other concepts such as the largest consistent set and the von Neumann-Morgenstern farsightedly stable set. Finally, we illustrate our results by means of coalition formation games with positive spillovers.

**Keywords:** coalition formation, farsighted players, stability.

- 2010/23 Long term care insurance puzzle  
Pierre PESTIEAU and Grégory PONTIERE

The purpose of this paper is to examine the alternative explanatory factors of the so-called long term care insurance puzzle, namely the fact that so few people purchase a long term care insurance whereas this would seem to be a rational conduct given the high probability of dependence and the high costs of long term care. For that purpose, we survey various theoretical and empirical studies of the demand and supply of long term care insurance. We discuss the vicious circle in which the long term care insurance market is stuck: that market is thin because most people find the existing insurance products too expensive, and, at the same time, the products supplied by insurance companies are too expensive because of the thinness of the market. Moreover, we also show that, whereas some explanations of the puzzle involve a perfect rationality of agents on the LTC insurance market, others rely, on the contrary, on various behavioral imperfections.

**JEL Classification:** I18, J14, G22

**Keywords:** long term care insurance, dependence, annuity puzzle.

- 2010/24 On welfare criteria and optimality in an endogenous growth model  
Elena DEL REY and Miguel Angel LOPEZ-GARCIA

In this paper we explore the consequences for optimality of a social planner adopting two different welfare criteria. The framework of analysis is an OLG model with physical and human capital. We first show that, when the SWF is a discounted sum of individual utilities defined over consumption per unit of natural labour, the precise cardinalization of the individual utility function becomes crucial for the characterization of the social optimum. Also, decentralizing the social optimum requires an education subsidy. In contrast, when the SWF is a discounted sum of individual utilities defined over consumption per unit of efficient labour, the precise cardinalization of preferences becomes irrelevant. More strikingly,

along the optimal growth path, education should be taxed.

**JEL Classification:** D90, H21, H52, H55

**Keywords:** endogenous growth, human capital, intergenerational transfers, education policy.

- 2010/25 On the forecasting accuracy of multivariate GARCH models  
Sébastien LAURENT, Jeroen V.K. ROMBOUTS and Francesco VIOLANTE

This paper addresses the question of the selection of multivariate GARCH models in terms of variance matrix forecasting accuracy with a particular focus on relatively large scale problems. We consider 10 assets from NYSE and NASDAQ and compare 125 model based one-step-ahead conditional variance forecasts over a period of 10 years using the model confidence set (MCS) and the Superior Predictive Ability (SPA) tests. Model performances are evaluated using four statistical loss functions which account for different types and degrees of asymmetry with respect to over/under predictions. When considering the full sample, MCS results are strongly driven by short periods of high market instability during which multivariate GARCH models appear to be inaccurate. Over relatively unstable periods, i.e. dot-com bubble, the set of superior models is composed of more sophisticated specifications such as orthogonal and dynamic conditional correlation (DCC), both with leverage effect in the conditional variances. However, unlike the DCC models, our results show that the orthogonal specifications tend to underestimate the conditional variance. Over calm periods, a simple assumption like constant conditional correlation and symmetry in the conditional variances cannot be rejected. Finally, during the 2007-2008 financial crisis, accounting for non-stationarity in the conditional variance process generates superior forecasts. The SPA test suggests that, independently from the period, the best models do not provide significantly better forecasts than the DCC model of Engle (2002) with leverage in the conditional variances of the returns.

**JEL Classification:** C10, C32, C51, C52, C53, G10

**Keywords:** variance matrix, forecasting, multivariate GARCH, loss function, model confidence set, superior predictive ability.

- 2010/26 Cooperative provision of indivisible public goods  
Pierre DEHEZ

A community faces the obligation of providing an indivisible public good. Each member is capable of providing it at a certain cost and the solution is to rely on the player who can do it at the lowest cost. It is then natural that he or she be compensated by the other players. The question is to know how much they should each contribute. We model this compensation problem as a cost sharing game to which standard allocation rules are applied and related to the solution resulting from the auction procedures proposed by Kleindorfer and Sertel (1994).

**JEL Classification:** C71, H41, M41

**Keywords:** public goods, cost sharing core, nucleolus, Shapley value.

- 2010/27 Uncertain long-run emissions targets, CO<sub>2</sub> price and global energy transition: a general equilibrium approach  
Olivier DURAND-LASSERVE, Axel PIERRU and Yves SMEERS

The persistent uncertainty about mid-century CO<sub>2</sub> emissions targets is likely to affect not only the technological choices that energy-producing firms will make in the future but also their current investment decisions. We illustrate this effect on

CO<sub>2</sub> price and global energy transition within a MERGE-type general-equilibrium model framework, by considering simple stochastic CO<sub>2</sub> policy scenarios. In these scenarios, economic agents know that credible long-run CO<sub>2</sub> emissions targets will be set in 2020, with two possible outcomes: either a "hard cap" or a "soft cap". Each scenario is characterized by the relative probabilities of both possible caps. We derive consistent stochastic trajectories - with two branches after 2020 - for prices and quantities of energy commodities and CO<sub>2</sub> emissions permits. The impact of uncertain long-run CO<sub>2</sub> emissions targets on prices and technological trajectories is discussed. In addition, a simple marginal approach allows us to analyze the Hotelling rule with risk premia observed for certain scenarios.

**JEL Classification:** C68, Q41, Q43, Q52

2010/28 Stochastic equilibrium models for generation capacity expansion  
Andreas EHRENMANN and Yves SMEERS

Capacity expansion models in the power sector were among the first applications of operations research to the industry. The models lost some of their appeal at the inception of restructuring even though they still offer a lot of possibilities and are in many respect irreplaceable provided they are adapted to the new environment. We introduce stochastic equilibrium versions of these models that we believe provide a relevant context for looking at the current very risky market where the power industry invests and operates. We then take up different questions raised by the new environment. Some are due to developments of the industry like demand side management: an optimization framework has difficulties accommodating them but the more general equilibrium paradigm offers additional possibilities. We then look at the insertion of risk related investment practices that developed with the new environment and may not be easy to accommodate in an optimization context. Specifically we consider the use of plant specific discount rates that we derive by including stochastic discount rates in the equilibrium model. Linear discount factors only price systematic risk. We therefore complete the discussion by inserting different risk functions (for different agents) in order to account for additional unpriced idiosyncratic risk in investments. These different models can be cast in a single mathematical representation but they do not have the same mathematical properties. We illustrate the impact of these phenomena on a small but realistic example.

**Keywords:** capacity adequacy, risk functions, stochastic equilibrium models, stochastic discount factors.

2010/29 Solving infinite-dimensional optimization problems by polynomial approximation  
Olivier DEVOLDER, François GLINEUR and Yu. NESTEROV

In this paper, we solve a class of convex infinite-dimensional optimization problems using a numerical approximation method that does not rely on discretization. Instead, we restrict the decision variable to a sequence of finite-dimensional linear subspaces of the original infinite-dimensional space and solve the corresponding finite-dimensional problems in a efficient way using structured convex optimization techniques. We prove that, under some reasonable assumptions, the sequence of these optimal values converges to the optimal value of the original infinite-dimensional problem and give an explicit description of the corresponding rate of convergence.

**Keywords:** infinite-dimensional optimization, polynomial approximation, semidefinite programming, positive polynomials, optimization in normed spaces, continuous linear programs, infinite programming.

- 2010/30 The economics of wealth transfer tax  
Helmuth CREMER and Pierre PESTIEAU

This paper discusses the merits of wealth transfer taxation on both efficiency and equity grounds. It first deals with the popular debate that is dominated by American economists. This debate concerns the US estate tax, which is one, among many, types of wealth transfer tax. After addressing the main issues prevailing in this debate and discussing the lack of popular support for such tax, the paper adopts a more theoretical approach to explore the pluses and the minuses of a wealth transfer tax. The main point is that the desirability of a wealth transfer tax depends on the motives of wealth accumulation and transmission.

**JEL Classification:** H21, H24

**Keywords:** estate tax, inheritance tax, bequest motives.

- 2010/31 Technological greening, eco-efficiency, and no-regret strategy  
Thierry BRECHET and Sylvette LY

In this paper we analyze the relationship between technological greening, eco-efficiency and no-regret strategies. By using a simple theoretical model, we evaluate the effects of technological greening on creation value, pollution level, and eco-efficiency. We show three contrasting effects of technological greening. First, technological greening may increase the pollution of a firm, and also of the whole industry. Second, the indicator of eco-efficiency can be misleading because it may improve in situations where pollution increases and/or profit decreases after technological greening. Third, technological greening that induces an improvement of the eco-efficiency indicator does not necessarily lead to a no-regret strategy. As a result, the indicator should not be used for decision making.

**JEL Classification:** L8, M2, Q5

**Keywords:** technological greening, clean technology, eco-efficiency, environmental performance, rebound effect.

- 2010/32 Universal service financing in competitive postal markets: one size does not fit all  
Axel GAUTIER and Dimitri PAOLINI

In the postal sector, the net cost of universal service depends on the content of the service, the postal market characteristics and the country's geographical configuration. These three groups of factors affect both the direct cost of providing the service and the extent of competition on the market. In this paper, we consider countries with different geographical characteristics and we show that the choice of an appropriate mechanism to share the cost of universal service between market participants depends on the country configuration. Thus, for universal service financing, one size does not fit all.

**JEL Classification:** H25, L11, L51, L87

**Keywords:** universal service obligations, compensation fund, market liberalization, cream-skimming.

- 2010/33 Competition and growth: reinterpreting their relationship  
Daria ONORI

In this paper we modify a standard quality ladder model by assuming that R&D is driven by outsider firms and the winners of the race sell licenses over their patents, instead of entering directly the inter- mediate good sector. As a reward they get the aggregate profit of the industry. Moreover, in the intermediate good sector firms

compete à la Cournot and it is assumed that there are spillovers represented by strategic complementarities on costs. Our goal is to prove that there exists an interval of values of the spillover parameter such that the relationship between competition and growth is an inverted-U-shape.

**JEL Classification:** L13, L16, O31, O52

**Keywords:** quality ladder, Cournot oligopoly, strategic complementarities, competition and growth.

- 2010/34 Double smoothing technique for infinite-dimensional optimization problems with applications to optimal control  
Olivier DEVOLDER, François GLINEUR and Yu. NESTEROV

In this paper, we propose an efficient technique for solving some infinite-dimensional problems over the sets of functions of time. In our problem, besides the convex point-wise constraints on state variables, we have convex coupling constraints with finite-dimensional image. Hence, we can formulate a finite-dimensional dual problem, which can be solved by efficient gradient methods. We show that it is possible to reconstruct an approximate primal solution. In order to accelerate our schemes, we apply double-smoothing technique. As a result, our method has complexity  $O(1/\varepsilon \ln 1/\varepsilon)$  gradient iterations, where  $\varepsilon$  is the desired accuracy of the solution of the primal-dual problem. Our approach covers, in particular, the optimal control problems with trajectory governed by a system of ordinary differential equations. The additional requirement could be that the trajectory crosses in certain moments of time some convex sets.

**Keywords:** convex optimization, optimal control, fast gradient methods, complexity bounds, smoothing technique.

- 2010/35 The impact of a minimum pension on old age poverty and its budgetary cost. Evidence from Latin America  
Jean-Jacques DETHIER, Pierre PESTIEAU and Rabia ALI

This paper examines the impact on old age poverty and the fiscal cost of universal minimum old age pensions in Latin America using recent household survey data for 18 countries. Alleviating old age poverty requires different approach from other age groups and a minimum pension is likely to be the only alternative available. First we measure old age poverty rates for all countries. Second we discuss the design of minimum pensions schemes, means-tested or not, as well as the disincentive effects that they are expected to have on the economic and social behavior of households including labor supply, saving and family solidarity. Third we use the household surveys to simulate the fiscal cost and the impact on poverty rates of alternative minimum pension schemes in the 18 countries. We show that a universal minimum pension would substantially reduce poverty among the elderly except in Argentina, Brazil, Chile and Uruguay where minimum pension systems already exist and poverty rates are low. Such schemes have much to be commended in terms of incentives, spillover effects and administrative simplicity but have a high fiscal cost. The latter is a function of the age at which benefits are awarded, the prevailing longevity, the generosity of benefits, the efficacy of means testing, and naturally the fiscal capacity of the country.

**JEL Classification:** D190, D310, H300, I380, O150

**Keywords:** old age poverty, income transfer, pension systems, family income, fiscal policies, human development.

- 2010/36 Justifying social discounting: the rank-discounted utilitarian approach  
Stéphane ZUBER

The popular discounted utilitarian criterion for infinite horizon social choice has been criticized on the ground that it treats successive generations unfairly. I propose to evaluate intergenerational welfare with a rank-discounted utilitarian (RDU) criterion instead. The criterion amounts to discounted utilitarianism on non-decreasing paths, but it treats all generations impartially: discounting becomes the mere expression of intergenerational inequality aversion. I show that more inequality averse RDU societies have higher social discount rates when future generations are better-off. I apply the RDU approach in two benchmark economic growth models and I prove that it promotes sustainable policies maximizing discounted utility.

**JEL Classification:** D63, H43, Q56

**Keywords:** intergenerational equity, social discounting, discounted utilitarianism, sustainability.

- 2010/37 Social rationality, separability, and equity under uncertainty  
Marc FLEURBAEY, Thibault GAJDOS and Stéphane ZUBER

Harsanyi (1955) proved that, in the context of uncertainty, social rationality and the Pareto principle impose severe constraints on the degree of priority for the worst-off that can be adopted in the social evaluation. Since then, the literature has hesitated between an ex ante approach that relaxes rationality (Diamond (1967)) and an ex post approach that fails the Pareto principle (Hammond (1983), Broome (1991)). The Hammond-Broome ex post approach conveniently retains the separable form of utilitarianism but does not make it explicit how to give priority to the worst-off, and how much disrespect of individual preferences this implies. Fleurbaey (2008) studies how to incorporate a priority for the worst-off in an explicit formulation, but leaves aside the issue of ex ante equity in lotteries, retaining a restrictive form of consequentialism. We extend the analysis to a framework allowing for ex ante equity considerations to play a role in the ex post approach, and find a richer configuration of possible criteria. But the general outlook of the Harsanyi dilemma is confirmed in this more general setting.

**JEL Classification:** D63, D71, D81

**Keywords:** risk, inequality, social welfare, ex ante, ex post, fairness, Harsanyi theorem.

- 2010/38 Myopia, redistribution and pensions  
Helmuth CREMER and Pierre PESTIEAU

This paper reviews a number of recent contributions that study pension design with myopic individuals. Its objective is to explore how the presence of more or less myopic individuals affects pension design when individuals differ also in productivity. This double heterogeneity gives rise to an interesting interplay between paternalistic and redistributive considerations, which is at the heart of most of the results that are presented. The main part of the paper is devoted to the issue of pension design when myopic individuals do not save “enough” for their retirement because their “myopic self” (with a high discount rate) emerges when labor supply and savings decisions are made. Some extensions and variations are considered in the second part. In particular we deal with situations where labor disutility or preferences for consumption are subject to “habit formation” and where sin goods have a detrimental effect on second period health. Myopic

individuals tend to underestimate the effects of both habit formation and sinful consumption, which complicates public policy.

**JEL Classification:** E6, H55, D91

**Keywords:** myopia, dual self, pensions, sin goods, habit formation.

2010/39 Aggregation of exponential smoothing processes with an application to portfolio risk evaluation

Giacomo SBRANA and Andrea SILVESTRINI

In this paper we propose a unified framework to analyse contemporaneous and temporal aggregation of exponential smoothing (EWMA) models. Focusing on a vector IMA(1,1) model, we obtain a closed form representation for the parameters of the contemporaneously and temporally aggregated process as a function of the parameters of the original one. In the framework of EWMA estimates of volatility, we present an application dealing with Value-at-Risk (VaR) prediction at different sampling frequencies for an equally weighted portfolio composed of multiple indices. We apply the aggregation results by inferring the decay factor in the portfolio volatility equation from the estimated vector IMA(1,1) model of squared returns. Empirical results show that VaR predictions delivered using this suggested approach are at least as accurate as those obtained by applying the standard univariate RiskMetrics<sup>TM</sup> methodology.

**JEL Classification:** C10, C32, C43

**Keywords:** contemporaneous and temporal aggregation, EWMA, volatility, Value-at-Risk.

2010/40 Commodities inventory effect

Jean-François CARPANTIER

Asymmetric GARCH models were developed for equity stocks to take into account the larger response of the conditional variance to negative price shocks. We show that these asymmetric GARCH models are also relevant for modelling commodity prices. Contrary to the equity case, positive shocks are the main contributors to the conditional variance of commodity prices. The theory of storage, by relating the state of the inventories of a commodity to its conditional variance, is a serious candidate to explain the phenomenon, as positive price shocks for commodities usually serve as proxies for the deterioration of the inventories. We find that this inverse leverage effect, or “inventory effect”, is relatively robust, for different subsamples, for diverse types of commodities and for different ways of specifying the asymmetry, though weaker than the leverage effect for equity stocks. Appropriately specifying the asymmetric conditional variance of commodities could improve risk management, hedging strategies or Value-at-Risk estimates. Incidentally, the inventory effect sheds some new light on the debate about the origin of the leverage effect.

**JEL Classification:** C22, G13, Q14

**Keywords:** GARCH, asymmetries, leverage effect, inventory, commodities, Value-at-Risk.

2010/41 Tagging with leisure needs

Pierre PESTIEAU and Maria RACIONERO

We study optimal redistributive taxes when individuals differ in two characteristics - earning ability and leisure needs - assumed to be imperfectly correlated. Individuals have private information about their abilities but needs are observable. With two different levels of observable needs the population can be separated into two groups and needs may be used as a tag. We first assume that the social planner considers individuals should be compensated for their leisure needs and characterize the optimal redistributive policy, and the extent of compensation for needs, with tagging. We also consider an alternative social objective in which

individuals are deemed responsible for their needs.

**JEL Classification:** H21, H41

**Keywords:** optimal non-linear taxation, quasi-linear preferences, tagging needs, responsibility.

- 2010/42 The optimal commodity tax system as a compromise between two objectives  
Knud J. MUNK

Policy analysis in applied fields such as agricultural, trade, environmental and development policy is still often undertaken within a first-best, rather than a more realistic second-best framework. The present paper seeks to contribute to changing this state of affairs by providing an intuitive explanation of what determines the optimal tax system. It derives and interprets an optimal tax formula for an economy with many goods to explain the optimal tax system as reflecting a trade-off between, on the one hand, the objective of encouraging the supply of labour to the market and, on the other hand, the objective of limiting the distortion of the marginal rate of substitution between produced goods. It illustrates this insight by a quantitative general equilibrium model which does not impose separability between consumption and leisure. The analysis clarifies issues of normalisation and deepens the insight due to Corlett and Hague (1953) that goods should be taxed according to their complementarity with leisure.

**JEL Classification:** H2

**Keywords:** public economics, optimal taxation, rules of normalisation, quantitative model of optimal taxation, Antonelli elasticity of complementarity.

- 2010/43 Utilitarianism and unequal longevity: A remedy?  
Marie-Louise LEROUX and Gregory PONTIERE

This paper re-examines a counterintuitive corollary of utilitarianism under unequal longevity: the tendency to redistribute resources from short-lived towards long-lived agents, against any intuition of compensation. It is shown that this corollary prevails not only under time-additive lifetime welfare, but, also, in general, under non-additive lifetime welfare, so that this counterintuitive redistributive corollary is a robust argument against utilitarianism. This paper studies a remedy to that counterintuitive corollary. This consists in imputing, when solving the social planner's problem, the consumption equivalent of a long life to the consumption of long-lived agents. We identify the conditions under which such a modified utilitarian optimum involves a compensation of short-lived agents with respect to the laissez-faire. That remedy is also applied to an economy with risky longevity, where short-lived agents are penalized not only by the limited opportunities to spread resources over time (due to a shorter life), but, also, by lost savings (due to unanticipated death).

**JEL Classification:** D63, I12, I18, J18

**Keywords:** utilitarianism, differential longevity, compensation, redistribution, consumption equivalent.

- 2010/44 Multivariate concave and convex stochastic dominance  
Michel DENUIT, Louis EECKHOUDT, Ilia TSETLIN and Robert L. WINKLER

Stochastic dominance permits a partial ordering of alternatives (probability distributions on consequences) based only on partial information about a decision maker's utility function. Univariate stochastic dominance has been widely studied and applied, with general agreement on classes of utility functions for dominance

of different degrees. Extensions to the multivariate case have received less attention and have used different classes of utility functions, some of which require strong assumptions about utility. We investigate multivariate stochastic dominance using a class of utility functions that is consistent with a basic preference assumption, can be related to well-known characteristics of utility, and is a natural extension of the stochastic order typically used in the univariate case. These utility functions are multivariate risk averse, and reversing the preference assumption allows us to investigate stochastic dominance for utility functions that are multivariate risk seeking. We provide insight into these two contrasting forms of stochastic dominance, develop some criteria to compare probability distributions (hence alternatives) via multivariate stochastic dominance, and illustrate how this dominance could be used in practice to identify inferior alternatives. Connections between our approach and dominance using different stochastic orders are discussed.

**Subject classifications:** decision analysis: multiple criteria, risk; group decisions; utility/preference: multiattribute utility, stochastic dominance, stochastic orders

- 2010/45 An extension of disjunctive programming and its impact for compact tree formulations  
Rüdiger STEPHAN

In the 1970's, Balas [2, 4] introduced the concept of disjunctive programming, which is optimization over unions of polyhedra. One main result of his theory is that, given linear descriptions for each of the polyhedra to be taken in the union, one can easily derive an extended formulation of the convex hull of the union of these polyhedra. In this paper, we give a generalization of this result by extending the polyhedral structure of the variables coupling the polyhedra taken in the union. Using this generalized concept, we derive polynomial size linear programming formulations (*compact formulations*) of a well-known spanning tree approximation of Steiner trees and flow equivalent trees for node- as well as edge-capacitated undirected networks. We also present a compact formulation for Gomory-Hu trees, and, as a consequence, of the minimum T-cut problem (but not for the associated T-cut polyhedron). Recently, Kaibel and Loos [10] introduced a more involved framework called *polyhedral branching systems* to derive extended formulations. The most of our model can be expressed in terms of their framework. The value of our model can be seen in the fact that it completes their framework with an interesting algorithmic aspect.

**Keywords:** disjunctive programming, compact formulation, flow-equivalent trees, Gomory-Hu trees.

- 2010/46 School system evaluation by value-added analysis under endogeneity  
Jorge MANZI, Ernesto SAN MARTIN and Sébastien VAN BELLEGEM

Value-added analysis is a common tool in analysing school performances. In this paper, we analyse the SIMCE panel data which provides individual scores of about 200,000 students in Chile, and whose aim is to rank schools according to their educational achievement. Based on the data collection procedure and on empirical evidences, we argue that the exogeneity of some covariates is questionable. This means that a nonvanishing correlation appears between the school-specific effect and some covariates. We show the impact of this phenomenon on the calculation of the value-added and on the ranking, and provide an estimation method that is based on instrumental variables in order to correct the bias of endogeneity. Revisiting the definition of the value-added, we propose a new calculation robust to endogeneity

that we illustrate on the SIMCE data.

**JEL Classification:** Primary C33, secondary C51, I21

**Keywords:** value-added, school effectiveness, multilevel model, endogeneity, instrumental variables.

- 2010/47 A multilevel approach for nonnegative matrix factorization  
Nicolas GILLIS and François GLINEUR

Nonnegative Matrix Factorization (NMF) is the problem of approximating a nonnegative matrix with the product of two low-rank nonnegative matrices and has been shown to be particularly useful in many applications, e.g., in text mining, image processing, computational biology, etc. In this paper, we explain how algorithms for NMF can be embedded into the framework of multi-level methods in order to accelerate their convergence. This technique can be applied in situations where data admit a good approximate representation in a lower dimensional space through linear transformations preserving nonnegativity. A simple multilevel strategy is described and is experimentally shown to speed up significantly three popular NMF algorithms (alternating nonnegative least squares, multiplicative updates and hierarchical alternating least squares) on several standard image datasets.

**Keywords:** nonnegative matrix factorization, algorithms, multigrid and multilevel methods, image processing.

- 2010/48 The political economy of derived pension rights  
Marie-Louise LEROUX and Pierre PESTIEAU

Derived pension rights exist in most Social Security systems but with variable generosity. They are mainly targeted towards non-working wives and widows and are viewed as a means to alleviate poverty among older women living alone. The purpose of this paper is to explain how they can emerge from a political economy process when the Social Security is a combination of Bismarckian and Beveridgian pillars. It also shows that derived rights tend to encourage stay-at-home wives thus revealing an unpleasant trade-off between female labor participation and poverty alleviation.

**JEL Classification:** D72, D78, H55

**Keywords:** social security, derived pension rights, majority voting, individualisation of pension rights.

- 2010/49 Option pricing with asymmetric heteroskedastic normal mixture models  
Jeroen V.K. ROMBOUTS and Lars STENTOFT

This paper uses asymmetric heteroskedastic normal mixture models to fit return data and to price options. The models can be estimated straightforwardly by maximum likelihood, have high statistical fit when used on S&P 500 index return data, and allow for substantial negative skewness and time varying higher order moments of the risk neutral distribution. When forecasting out-of-sample a large set of index options between 1996 and 2009, substantial improvements are found compared to several benchmark models in terms of dollar losses and the ability to explain the smirk in implied volatilities. Overall, the dollar root mean squared error of the best performing benchmark component model is 39% larger than for the mixture model. When considering the recent financial crisis this difference increases to 69%.

**JEL Classification:** C11, C15, C22, G13

**Keywords:** asymmetric heteroskedastic models, finite mixture models, option pricing, out-of-sample prediction, statistical fit.

- 2010/50 Nonparametric frontier estimation from noisy data  
Maik SCHWARZ, Sébastien VAN BELLEGEM and Jean-Pierre FLORENS

A new nonparametric estimator of production frontiers is defined and studied when the data set of production units is contaminated by measurement error. The measurement error is assumed to be an additive normal random variable on the input variable, but its variance is unknown. The estimator is a modification of the  $m$ -frontier, which necessitates the computation of a consistent estimator of the conditional survival function of the input variable given the output variable. In this paper, the identification and the consistency of a new estimator of the survival function is proved in the presence of additive noise with unknown variance. The performance of the estimator is also studied through simulated data.

**JEL Classification:** Primary C14, secondary C24, P42

**Keywords:** production frontier, deconvolution, measurement error, efficiency analysis.

- 2010/51 On the geometric interpretation of the nonnegative rank  
Nicolas GILLIS and François GLINEUR

The nonnegative rank of a nonnegative matrix is the minimum number of nonnegative rank-one factors needed to reconstruct it exactly. The problem of determining this rank and computing the corresponding nonnegative factors is difficult; however it has many potential applications, e.g., in data mining, graph theory and computational geometry. In particular, it can be used to characterize the minimal size of any extended reformulation of a given combinatorial optimization program. In this paper, we introduce and study a related quantity, called the restricted nonnegative rank. We show that computing this quantity is equivalent to a problem in polyhedral combinatorics, and fully characterize its computational complexity. This in turn sheds new light on the nonnegative rank problem, and in particular allows us to provide new improved lower bounds based on its geometric interpretation. We apply these results to slack matrices and linear Euclidean distance matrices and obtain counter-examples to two conjectures of Beasley and Laffey, namely we show that the nonnegative rank of linear Euclidean distance matrices is not necessarily equal to their dimension, and that the rank of a matrix is not always greater than the nonnegative rank of its square.

**AMS subject classification:** 15A23, 15B48, 52B05, 52B11, 65D99, 65F30, 90C27

**Keywords:** nonnegative rank, restricted nonnegative rank, nested polytopes, computational complexity, computational geometry, extended formulations, linear Euclidean distance matrices.

- 2010/52 Generalized Nash Equilibrium and market coupling in the European power system  
Yves SMEERS, Giorgia OGGIONI, Elisabetta ALLEVI and Siegfried SCHAIBLE

“Market Coupling” is currently seen as the most advanced market design in the restructuring of the European electricity market. Market coupling, by construction, introduces what is generally referred to as an incomplete market: it leaves several constraints out of the market and hence avoids pricing them. This may or may not have important consequences in practice depending on the case on hand. Quasi-Variational Inequality problems and the associated Generalized Nash Equilibrium can be used for representing incomplete markets. Recent papers propose methods

for finding a set of solutions of Quasi-Variational Inequality problems. We apply one of these methods to a subproblem of market coupling namely the coordination of counter-trading. This problem is an illustration of a more general question encountered for instance in hierarchical planning in production management. We first discuss the economic interpretation of the Quasi-Variational Inequality problem. We then apply the algorithmic approach to a set of stylized case studies in order to illustrate the impact of different organizations of counter-trading. The paper emphasizes the structuring of the problem. A companion paper considers the full problem of market coupling and counter-trading and presents a more extensive numerical analysis.

**JEL Classification:** D52, D58, Q40

**Keywords:** Generalized Nash Equilibrium, Quasi-Variational Inequalities, market coupling, counter-trading, European electricity market.

- 2010/53 Market coupling and the organization of counter-trading: separating energy and transmission again?  
Giorgia OGGIONI and Yves SMEERS

The horizontal integration of the energy market and the organization of transmission services remain two open issues in the restructured European electricity sector. The coupling of the French, Belgian and Dutch electricity markets (the trilateral market) in November 2006 was a real success that the inclusion of Germany to the trilateral market should soon prolong. But the extension of market coupling whether in Central Western Europe or in other European regions encounters several difficulties and the future remains far from clear. The highly meshed grid of continental Europe complicates things and it is now sometimes recognized that the penetration of wind will further exacerbate these difficulties. The nodal system could go a long way towards solving these problems, but its implementation is not yet foreseen in the EU. This paper analyzes versions of market coupling that differ by the organization of counter-trading. While underplayed in current discussions, counter-trading will become a key element of market coupling as its geographic coverage expands and wind penetration develops. We consider a stylized six node example found in the literature and simulate market coupling for different assumptions of zonal decomposition and coordination of TSOs. We show that these assumptions matter: market coupling can be quite vulnerable to the particular situation on hand; counter-trading can work well or completely fail depending on the case and it is not clear beforehand what will prevail. Our analysis relies on standard economic notions such as social welfare, Nash and Generalized Nash equilibrium. But the use of these notions is probably novel. We also simplify matters by assuming away strategic behaviour. The nodal organization is the reference first best scenario: different zonal decompositions and degrees of coordinations are then studied with respect to this first best solution.

**JEL Classification:** D52, D58, Q40

**Keywords:** market coupling, counter-trading, European electricity market, Generalized Nash equilibrium.

- 2010/54 Fertility, human capital accumulation, and the pension system  
Helmuth CREMER, Firouz GAHVARI and Pierre PESTIEAU

This paper provides a unified treatment of externalities associated with fertility and human capital accumulation within pas-as-you-go pension systems. It considers an overlapping generations model in which every generation consists of high earners and low earners with the proportion of types being determined endogenously. The

number of children is deterministically chosen but the children's future ability is in part stochastic, in part determined by the family background, and in part through education. In addition to the customary externality source associated with a change in average fertility rate, this setup highlights another externality source. This is due to the effect of a parent's choice of number and educational attainment of his children on the proportion of high-ability individuals in the steady state. Our other results include: (i) Investments in education of high- and low-ability parents must be subsidized; (ii) direct child subsidies to one or both parent types can be negative; i.e., they can be taxes; (iii) net subsidies to children (direct child subsidies plus education subsidies) to at least one type of parents must be positive; (iv) parents who have a higher number of children should invest less in their education.

**JEL Classification:** H2, H5

**Keywords:** pay-as-you-go social security, endogenous fertility, education, endogenous ratio of high to low ability types, three externality sources, education subsidies, child subsidies.

- 2010/55 Iterative regularization in nonparametric instrumental regression  
Jan JOHANNES, Sébastien VAN BELLEGEM and Anne VANHEMS

We consider the nonparametric regression model with an additive error that is correlated with the explanatory variables. We suppose the existence of instrumental variables that are considered in this model for the identification and the estimation of the regression function. The nonparametric estimation by instrumental variables is an ill-posed linear inverse problem with an unknown but estimable operator. We provide a new estimator of the regression function using an iterative regularization method (the Landweber-Fridman method). The optimal number of iterations and the convergence of the mean square error of the resulting estimator are derived under both mild and severe degrees of ill-posedness. A Monte-Carlo exercise shows the impact of some parameters on the estimator and concludes on the reasonable finite sample performance of the new estimator.

**JEL Classification:** Primary C14, secondary C30

**Keywords:** nonparametric estimation, instrumental variable, ill-posed inverse problem, iterative method, estimation by projection.

- 2010/56 Tradable pollution permits in dynamic general equilibrium: can optimality and acceptability be reconciled?  
Thierry BRECHET, Pierre-André JOUVET and Gilles ROTILLON

In this paper we study the optimal growth path and its decentralization in a two-sector overlapping-generations model with pollution. One sector (power generation) is polluting and the other (final good) is not. Pollution is regulated by tradable emission permits. The issue is whether the optimal growth path can be replicated in equilibrium with pollution permits, given that some permits must be issued free of charge for the sake of political acceptability. We provide a policy rule that allows optimality and acceptability to be reconciled.

**JEL Classification:** D61, D9, Q28

**Keywords:** general equilibrium, optimal growth, pollution, tradable emission permits, acceptability.

- 2010/57 The optimal trade-off between quality and quantity with uncertain child survival  
Thomas BAUDIN

The present paper investigates a standard model of endogenous fertility when child survival to adulthood is uncertain. In this framework, I first show that facing the

risk their children die before reaching adulthood, parents don't always formulate a precautionary demand for children. Indeed, there exists a non-empty set of utility functions for which parents undershoot their number of children rather than overshooting it. Second, the properties of the optimal economic policy will crucially depend on the manner the Social Welfare Function takes uncertainty into account. More precisely, if Social Welfare is evaluated after the resolution of uncertainty, the parental response to uncertainty is a source of social inefficiency. Then, individual decisions have to be corrected through tax or transfer on both births and education. This property becomes crucial to determine the optimal public response to a mortality crisis in presence of positive externalities on education.

**JEL Classification:** D10, H21, J13, J18

**Keywords:** fertility, uncertain child survival, optimality conditions, family policy.

2010/58 Family policies: what does the standard endogenous fertility model tell us?  
Thomas BAUDIN

Very few studies have explored the optimality properties of the "standard model" of fertility where parents must determine their optimal trade-off between quality and quantity. The present paper works to fill that gap and find three main results. First, when there exist positive externalities in the accumulation of human capital, it is optimal to subsidize education and to tax births. Second, when the Social Welfare Function does not consist of the average utility, the social returns on educational investments can be weaker than the private returns when the optimal population growth rate is negative. In this case, the optimal economic policy consists in subsidizing births and taxing education. Finally, when the health expenditure is introduced as another source of positive externalities, it can be optimal to tax the parental health expenditure to decentralize the first-best path even if this expenditure is always too low at the laissez-faire equilibrium.

**JEL Classification:** D10, H21, J13, J18

**Keywords:** fertility, education, family policy, mortality, quality quantity trade-off.

2010/59 Nonnegative factorization and the maximum edge biclique problem  
Nicolas GILLIS and François GLINEUR

Nonnegative matrix factorization (NMF) is a data analysis technique based on the approximation of a nonnegative matrix with a product of two nonnegative factors, which allows compression and interpretation of nonnegative data.

In this paper, we study the case of rank-one factorization and show that when the matrix to be factored is not required to be nonnegative, the corresponding problem (RINF) becomes NP-hard. This sheds new light on the complexity of NMF since any algorithm for fixed-rank NMF must be able to solve at least implicitly such rank-one subproblems.

Our proof relies on a reduction of the maximum edge biclique problem to RINF. We also link stationary points of RINF to feasible solutions of the biclique problem, which allows us to design a new type of biclique finding algorithm based on the application of a block-coordinate descent scheme to RINF. We show that this algorithm, whose algorithmic complexity per iteration is proportional to the number of edges in the graph, is guaranteed to converge to a biclique and that it performs competitively with existing methods on random graphs and text mining datasets.

**JEL Classification:** 15A23, 68Q25, 90C06, 90C27 90C35, 90C59

**Keywords:** nonnegative matrix factorization, rank-one factorization, maximum

edge biclique problem, algorithmic complexity, biclique finding algorithm.

2010/60 Digital piracy: theory  
Paul BELLEFLAMME and Martin PEITZ

This article reviews recent theoretical contributions on digital piracy. It starts by elaborating on the reasons for intellectual property protection, by reporting a few facts about copyright protection, and by examining reasons to become a digital pirate. Next, it provides an exploration of the consequences of digital piracy, using a base model and several extensions (with consumer sampling, network effects, and indirect appropriation). A closer look at market-structure implications of end-user piracy is then taken. After a brief review of commercial piracy, additional legal and private responses to end-user piracy are considered. Finally, a quick look at emerging new business models is taken.

**JEL Classification:** L11, L82, L86

**Keywords:** information good, piracy, copyright, IP protection, internet, peer-to-peer, software, music.

2010/61 Competitively neutral universal service obligations  
Axel GAUTIER and Xavier WAUTHY

Universal service obligations impose specific costs on the universal service provider. The measure of these costs and their financing have been studied along two complementary lines of reasoning: is the universal service obligation sustainable? Who should bear its costs? Most often, a two-step procedure is put forward. In a first step the cost of USO must be assessed; in a second step the USP must be compensated for this cost. In this paper we argue that this procedure is most often problematic because the implementation of the compensation scheme directly affects the effective cost of USO. We therefore put forward an alternative approach to this problem which does not rely on this two-step procedure and fully acknowledges the distortions that result from the compensation mechanism.

**JEL Classification:** L43, L51

**Keywords:** universal service obligations, cost-sharing mechanism, competitive neutrality.

2010/62 The benefits of cooperation under uncertainty: the case of climate change  
Thierry BRECHET, Julien THENIE, Thibaut ZEIMES and Stéphane ZUBER

This article presents an analysis of the behavior of countries defining their climate policies in an uncertain context. The analysis is made using the S-CWS model, a stochastic version of an integrated assessment growth model. The model includes a stochastic definition of the climate sensitivity parameter. We show that the impact of uncertainty on policy design critically depends on the shape of the damage function. We also examine the benefits of cooperation in the context of uncertainty: we highlight the existence of an additional benefit of cooperation, namely risk reduction.

**JEL Classification:** C71, C73, D9, D62, F42, Q2

**Keywords:** cooperation, uncertainty, climate change, integrated assessment model.

2010/63 Mixing sets linked by bidirected paths  
Marco DI SUMMA and Laurence A. WOLSEY

Recently there has been considerable research on simple mixed-integer sets, called mixing sets, and closely related sets arising in uncapacitated and constant capacity

lot-sizing. This in turn has led to study of more general sets, called network-dual sets, for which it is possible to derive extended formulations whose projection gives the convex hull of the network-dual set. Unfortunately this formulation cannot be used (in general) to optimize in polynomial time. Furthermore the inequalities defining the convex hull of a network-dual set in the original space of variables are known only for some special cases.

Here we study two new cases, in which the continuous variables of the network-dual set are linked by a bi-directed path. In the first case, which is motivated by lot-sizing problems with (lost) sales, we provide a description of the convex hull as the intersection of the convex hulls of  $2^n$  mixing sets, where  $n$  is the number of continuous variables of the set. However optimization is polynomial as only  $n + 1$  of the sets are required for any given objective function. In the second case, generalizing single arc flow sets, we describe again the convex hull as an intersection of an exponential number of mixing sets and also give a combinatorial polynomial-time separation algorithm.

**Keywords:** mixing sets, extended formulations, mixed integer programming, lot-sizing with sales.

2010/64 Innovation, antidumping and retaliation

Kaz MIYAGIWA, Huasheng SONG and Hylke VANDENBUSSCHE

We study the effect of contingency trade policy in a multi-country oligopoly model with and without R&D opportunities. We show that firms benefit from unilateral protection but initiate antidumping (AD) only against the targets domiciled in substantially smaller countries. Also, AD filings are more likely when firms face R&D opportunities. These results are consistent with recent empirical findings, namely, (1) actions are mostly between industrial and developing countries, (2) developing countries use AD to retaliate against industrial countries, and (3) AD is concentrated in R&D-intensive industries. Interestingly, intellectual property rights violations in developing countries have no connection to AD filings.

**JEL Classification:** F12, F13, L13

**Keywords:** R&D, antidumping, intellectual property rights, reciprocal dumping.

2010/65 Adaptation and mitigation in long-term climate policies

Thierry BRECHET, Natali HRITONENKO and Yuri YATSENKO

The paper analytically explores the optimal policy mix between mitigation and environmental adaptation against climate change at a macroeconomic level. The constructed economic-environmental model is formulated as a social planner problem with the adaptation and abatement investments as separate decision variables. The authors prove the existence of a unique steady state and provide a comparative static analysis of the optimal investment. It leads to essential implications for associated long-term environmental policies. In particular, the dependence of the optimal ratio between abatement and adaptation investments on economic efficiency appears to have an inverted U-shape. Data calibration and numerical simulation are provided to illustrate theoretical outcomes.

**Keywords:** environmental adaptation, mitigation, optimal investment, long-term climate policies.

2010/66 Compensating the dead? Yes we can!

Marc FLEURBAEY, Marie-Louise LEROUX and Gregory PONTIERE

An early death is, undoubtedly, a serious disadvantage. However, the compensation of short-lived individuals has remained so far largely unexplored, probably because

it appears infeasible. Indeed, short-lived agents can hardly be identified *ex ante*, and cannot be compensated *ex post*. We argue that, despite the above difficulties, a compensation can be carried out by encouraging early consumption in the life cycle. In a model with heterogeneous preferences and longevities, we show how a specific social criterion can be derived from intuitive principles, and we study the corresponding optimal policy under various informational assumptions. We also study the robustness of our solution to alternative types of preferences and savings policies.

**JEL Classification:** D63, D71, I18, J18

**Keywords:** compensation, longevity, mortality, fairness, redistribution.

2010/67 Measuring the variability in supply chains with the peakedness

Philippe CHEVALIER, Jean-Christophe VAN DEN SCHRIECK and Ying WEI

This paper introduces a novel way to measure the variability of order flows in supply chains, the peakedness. The peakedness can be used to measure the variability assuming the order flow is a general point process. We show basic properties of the peakedness, and demonstrate its computation from real-time continuous demand processes, and cumulative demand collected at fixed time intervals as well. We also show that the peakedness can be used to characterize demand, forecast, and inventory variables, to effectively manage the variability. Our results hold for both single stage and multistage inventory systems, and can further be extended to a tree-structured supply chain with a single supplier and multiple retailers. Furthermore, the peakedness can be applied to study traditional inventory problems such as quantifying bullwhip effects and determining safety stock levels. Finally, a numerical study based on real life Belgian supermarket data verifies the effectiveness of the peakedness for measuring the order flow variability, as well as estimating the bullwhip effects.

**Keywords:** variability, peakedness, supply chain.

2010/68 Fixed-charge transportation on a path: optimization, LP formulations and separation

Mathieu VAN VYVE

The fixed-charge transportation problem is an interesting problem in its own right. This paper further motivates its study by showing that it is both a special case and a strong relaxation of the big-bucket multi-item lot-sizing problem. We then provide a polyhedral analysis of the polynomially solvable special case in which the associated bipartite graph is a path.

We give a  $O(n^3)$ -time optimization algorithm and two  $O(n^2)$ -size linear programming extended formulation. We describe a new class of inequalities that we call "path-modular" inequalities. We give two distinct proofs of their validity. The first one is direct and crucially relies on sub- and super-modularity of an associated set function. The second proof is by showing that the projection of one of the extended linear programming formulations onto the original variable space yields exactly the polyhedron described by the path-modular inequalities. Thus we also show that these inequalities suffice to describe the convex hull of the set of feasible solutions. We finally report on computational experiments comparing extended LP formulation, valid inequalities separation and a standard MIP solver.

**MSC Classification:** 68Q25, 90C11, 90C27, 90C35, 90B05, 90B06

**Keywords:** mixed-integer programming, lot-sizing, transportation, convex hull, extended formulation.

2010/69 Lower bounds rule!  
Roland Iwan LUTTENS

We propose two axioms that introduce lower bounds into resource monotonicity requirements for rules for the problem of adjudicating conflicting claims. Suppose the amount to divide increases. The first axiom requires that two claimants whose lower bound changes equally experience an equal change in awards. The second axiom requires that extra resources are divided only among those claimants who experience a strictly positive change in their lower bound. We show that, in the two-claimant case, Concede-and-Divide is the only rule that satisfies both axioms when the axioms are defined over a large set of lower bounds that include the minimal rights lower bound and the secured lower bound. We also show that, in the  $n$ -claimant case where at least one claimant claims the total amount, the Minimal Overlap rule is the only rule that satisfies both axioms when the axioms are defined over the secured lower bound.

**JEL Classification:** D63, D74

**Keywords:** claims problems, lower bounds, concede-and-divide, minimal overlap rule.

2010/70 Optimal pricing and capacity choice for a public service under risk of interruption  
Fred SCHROYEN and Adekola OYENUGA

We develop rules for pricing and capacity choice for an interruptible service that recognise the interdependence between consumers' perceptions of system reliability and their market behaviour. Consumers post *ex ante* demands, based on their expectations on aggregate demand. Posted demands are met if *ex post* supply capacity is sufficient. However, if supply is inadequate all *ex ante* demands are proportionally interrupted. Consumers' expectations of aggregate demand are assumed to be rational. Under reasonable values for the consumer's degrees of relative risk aversion and prudence, demand is decreasing in supply reliability. We derive operational expressions for the optimal pricing rule and the capacity expansion rule. We show that the optimal price under uncertainty consists of the optimal price under certainty plus a markup that positively depends on the degrees of relative risk aversion, relative prudence and system reliability. We also show that any reliability enhancing investment - though lowering the operating surplus of the public utility - is socially desirable as long as it covers the cost of investment.

**JEL Classification:** D11, D24, D45, H42, Q25

**Keywords:** service interruption, rationing, system reliability, second-best pricing, capacity choice, prudence.

2010/71 Property rights with biological spillovers: when Hardin meets Meade  
Carlotta BALESTRA, Thierry BRECHET and Stéphane LAMBRECHT

In an overlapping generations setup we address the issue of the optimal number of property rights to allocate over a natural resource when the goal is to maximize the stock of the natural resource at the steady state. We assume that the effect of the property rights regime on the evolution of the resource is twofold: through biological spillovers and through monitoring costs. Property rights are assigned to local communities, which can decide whether to cooperate or not. The outcome in the strategic setting is hence compared to the one in the cooperative setup. A fiscal policy able to decentralize the cooperative outcome is studied.

**JEL Classification:** H21, K11, Q20

**Keywords:** overlapping generations, resource management, common pool

resource, spatial interdependence, strategic behaviour, cooperative behaviour.

- 2010/72 Success: talent, intelligence or beauty?  
Olivier GERGAUD and Victor GINSBURGH

We analyze the Celebrity 100 annual list of the world's most "powerful celebrities" compiled and published by Forbes Magazine. The lists provide an interesting collection of people, that includes their earnings, and the perception of citizens concerning the attributes that made them become celebrities. We analyze the relationship between their earnings and the perceptions on their intelligence, talent, beauty and other attributes, and show that though beauty plays a role, intelligence and talent are more important.

**JEL Classification:** C4, J3, Z1

**Keywords:** earnings, economic success, talent.

- 2010/73 Foreign languages' acquisition: self learning and linguistic schools  
Jean GABSZEWICZ, Victor GINSBURGH, Didier LAUSSEL  
and Shlomo WEBER

We examine patterns of acquiring non-native languages in a model with two linguistic communities with heterogeneous learning skills, where every individual faces the choice of self-learning the foreign language or acquiring it at a profit-maximizing linguistic school. We consider a one-school model with divisions in both communities and various two-school settings with a school in each community. We compare the number of learners and welfare implications under self-learning with those obtained under various schooling contexts. In particular, we show that for communities with similar size, introducing language schools always increases the number of learners with respect to the exclusive self-learning option.

**JEL Classification:** C72, D83, O52, Z13

**Keywords:** communicative benefits, linguistic equilibrium, learning costs.

- 2010/74 Rock and roll bands, (in)complete contracts and creativity  
Cédric CEULEMANS, Victor GINSBURGH and Patrick LEGROS

Members of a rock and roll band are endowed with different creativity. They match and eventually obtain credit for song writing as well as a share of the returns from sales. More creative members increase the probability of success but may also claim a larger share of the pie. In our theoretical model, the nature of matching (positive or negative assortative) as well as the covariation between the probability of having a "hit" and the dispersion of credits given to individual members are a function of the completeness of contracting. When members adopt a "gentleman's agreement" to share credits equally, the covariation between the probability of a hit and the dispersion of credits is negative, which is the consequence of positive assortative matching in creativity. The data show that the relation between dispersion and success is significantly negative, and that rock bands are thus likely to sign incomplete contracts.

**JEL Classification:** H21, K11, Q20

**Keywords:** overlapping generations, resource management, common pool resource, spatial interdependence, strategic behaviour, cooperative behaviour.

- 2010/75 Low-rank matrix approximation with weights or missing data is NP-hard  
Nicolas GILLIS and François GLINEUR

Weighted low-rank approximation (WLRA), a dimensionality reduction technique for data analysis, has been successfully used in several applications, such as in collaborative filtering to design recommender systems or in computer vision to recover structure from motion.

In this paper, we study the computational complexity of WLRA and prove that it is NP-hard to find an approximate solution, even when a rank-one approximation is sought. Our proofs are based on a reduction from the maximum-edge biclique problem, and apply to strictly positive weights as well as binary weights (the latter corresponding to low-rank matrix approximation with missing data).

**Keywords:** low-rank matrix approximation, weighted low-rank approximation, missing data, matrix completion with noise, PCA with missing data, computational complexity, maximum-edge biclique problem.

- 2010/76 Unions' relative concerns and strikes in wage bargaining  
Ana MAULEON, Vincent VANNETELBOSCH and Cecilia VERGARI

We consider a model of wage determination with private information in a duopoly. We investigate the effects of unions having relative concerns on the negotiated wage and the strike activity. We show that an increase of unions' relative concerns has an ambiguous effect on the strike activity.

**JEL Classification:** C70, J50, D60

**Keywords:** relative position, wage bargaining, private information, strike activity.

- 2010/77 Bargaining and delay in patent licensing  
Ana MAULEON, Vincent VANNETELBOSCH and Cecilia VERGARI

We consider a model of licensing of a non-drastic innovation in which the patent holder (an outside innovator) negotiates either up-front fixed fees or per-unit royalties with two firms producing horizontally differentiated brands and competing à la Cournot. We investigate how licensing schemes (fixed fee or per-unit royalty) and the number of licenses sold (exclusive licensing or complete technology diffusion) affect price agreements and delays in reaching an agreement. We show that the patent holder prefers to license by means of up-front fixed fees except if market competition is mild and the innovation size is small. Once there is private information about the relative bargaining power of the parties, the patent holder may prefer licensing by means of per-unit royalties even if market competition is strong. Moreover, the delay in reaching an agreement is greater whenever the patent holder chooses to negotiate up-front fixed fees instead of per-unit royalties.

**JEL Classification:** C78, D43, D45, L13

**Keywords:** patent licensing, fixed fee, royalty, bargaining, private information.

- 2010/78 Product innovation and market acquisition of firms  
Jean J. GABSZEWICZ and Ornella TAROLA

The paper explores the incentives for an incumbent firm to acquire an entrant willing to sell a product innovation, rather than openly compete with this entrant and, in case of acquisition, the incentives to sell simultaneously both the existing products and the new one, rather than specializing on a single variant. We prove that, in some circumstances, an incumbent firm can find it profitable to make an acquisition proposal to the entrant in order to deter entry. Nevertheless, in this

acquisition scenario, a product proliferation strategy is never observed at equilibrium. Rather, the incumbent restricts itself to offer either its own variant or the product innovation produced by the entrant, depending on the quality differential existing between them. It follows that, while being available for sale, sometimes the innovation simply remains unexploited

- 2010/79 Stability and fairness in models with a multiple membership  
Michel LE BRETON, Juan D. MORENO-TERNERO, Alexei SAVVATEEV and Shlomo WEBER

This article studies a model of coalition formation for the joint production (and finance) of public projects, in which agents may belong to multiple coalitions. We show that, if projects are divisible, there always exists a stable (secession-proof) structure, i.e., a structure in which no coalition would reject a proposed arrangement. When projects are in- divisible, stable allocations may fail to exist and, for those cases, we resort to the least core in order to estimate the degree of instability. We also examine the compatibility of stability and fairness on metric environments with indivisible projects. To do so, we explore, among other things, the performance of several well-known solutions (such as the Shapley value, the nucleolus, or the Dutta-Ray value) in these environments.

**JEL Classification:** C71

**Keywords:** stability, fairness, membership, coalition formation.

- 2010/80 Voting over piece-wise linear tax methods  
Juan D. MORENO-TERNERO

We analyze the problem of choosing the most appropriate method for apportioning taxes in a democracy. We consider a simple theoretical model of taxation and restrict our attention to piece-wise linear tax methods, which are almost ubiquitous in advanced democracies world- wide. We show that if we allow agents to vote for any method within a rich domain of piece-wise linear methods, then a majority voting equilibrium exists. Furthermore, if most voters have income below mean income then each method within the domain can be supported in equilibrium.

**JEL Classification:** D72, H24

**Keywords:** voting, taxes, majority, single-crossing, Talmud.

- 2010/81 School tracking, social segregation and educational opportunity: evidence from Belgium  
Jean HINDRIKS, Marijn VERSCHELDE, Glenn RAYP and Koen SCHOORS

Educational tracking is a very controversial issue in education. The tracking debate is about the virtues of uniformity and vertical differentiation in the curriculum and teaching. The pro-tracking group claims that curriculum and teaching better aimed at children's varied interest and skills will foster learning efficacy. The anti-tracking group claims that tracking systems are inefficient and unfair because they hinder learning and distribute learning inequitably. In this paper we provide a detailed within-country analysis of a specific educational system with a long history of early educational tracking between schools, namely the Flemish secondary school system in Belgium. This is interesting place to look because it provides a remarkable mix of excellence and inequality. Indeed the Flemish school system is repeatedly one of the best performer in the international harmonized PISA tests in math, science and reading; whereas it produces some of the most unequal distributions of learning between schools and students. Combining

evidence from the PISA 2006 data set at the student and school level with recent statistical methods, we show first the dramatic impact of tracking on social segregation; and then, the impact of social segregation on equality of educational opportunity (adequately measured). It is shown that tracking, via social segregation, has a major effect on inequality of opportunity. Children of different economic classes will have different access to knowledge.

**JEL Classification:** I28, H52, D63

**Keywords:** tracking, ability grouping, educational performance, social segregation, inequality, PISA.

- 2010/82 School autonomy and educational performance: within-country evidence  
Jean HINDRIKS, Marijn VERSCHELDE, Glenn RAYP and Koen SCHOORS

This paper shows the value of school autonomy for educational performance. To fully capture the informational advantage of local actors, we define school autonomy as the operational empowerment of the principals and teachers. The Flemish secondary school system in Belgium is analyzed as it has a long history of educational school autonomy, but considerable variation between schools in school staff empowerment. Combining detailed school level and pupil level data from the PISA 2006 study with a semiparametric hierarchical model, we find strong indications that operational school autonomy is associated with high educational performance if appropriate accountability systems are active. Sensitivity tests show that both low and high-performers benefit from this kind of school autonomy.

**JEL Classification:** I28, H52

**Keywords:** educational performance, PISA, school autonomy, educational production function, semiparametric.

- 2010/83 Influence networks  
Dunia LOPEZ-PINTADO

Some behaviors, ideas or technologies spread and become persistent in society, whereas others vanish. This paper analyzes the role of social influence in determining such distinct collective outcomes. Agents are assumed to acquire information from others through a certain sampling process that generates an *influence network*, and they use simple rules to decide whether to adopt or not depending on the observed sample. We characterize, as a function of the primitives of the model, the *diffusion threshold* (i.e., the spreading rate above which the adoption of the new behavior becomes persistent in the population) and the *endemic state* (i.e., the fraction of adopters in the stationary state of the dynamics). We find that the new behavior will easily spread in the population if there is a high correlation between how influential (visible) and how easily influenced an agent is, which is determined by the sampling process and the adoption rule. We also analyze how the density and variance of the out-degree distribution affect the diffusion threshold and the endemic state.

**JEL Classification:** C73, L14, O31, O33

**Keywords:** social influence, networks, diffusion threshold, endemic state.

- 2010/84 A theory of soft capture  
Per AGRELL and Axel GAUTIER

In this paper, we propose a model for regulatory capture that is based on information transmission and asymmetric information. In a three-tier model, a

regulator is charged by a political principal to provide a signal for the type of a regulated firm. Only the firm can observe his type and the production of a correlated signal with a given accuracy is costly for the regulator. The firm can costlessly provide an alternative signal of lower accuracy that is presented to the regulator. In a self-enforcing equilibrium, the regulator transmits the firm-produced signal, internalizes its own savings in information cost and the firm enjoys higher information rents. The main feature of soft capture is that it is not based on a reciprocity of favors but on a congruence of interests between the firm and the regulator.

**JEL Classification:** D72, L51

**Keywords:** regulation, capture, information.

- 2010/85 Dynamic joint investments in supply chains under information asymmetry  
Per AGRELL and Roman KASPERZEC

Supply chain management involves the selection, coordination and motivation of independently operated suppliers. However the central planner's perspective in operations management translates poorly to vertically separated chains, where suppliers may have rational myopic reasons to object to full information sharing and centralized decision rights. Particular problems occur when a downstream coordinator demands relation-specific investments (equipment, cost improvements in processes, adaptation of components to downstream processes, allocation of future capacity etc) from upstream suppliers without being able to commit to long-term contracts. In practice and theory, this leads often to a phenomenon of either underinvestment in the chain or costly vertical integration to solve the commitment problem. A two-stage supply chain under stochastic demand and information asymmetry is modelled. A repeated investment-production game with coordinator commitment in supplier's investment addresses the information sharing and asset-specific investment problem. We provide a mitigation of the hold-up problem on the investment cost observed by the supplier and an instrument for truthful revelation of private information by using an investment sharing device. We show that there is an interior solution for the investment sharing parameter and discuss some extensions to the work.

**JEL Classification:** M11, L24

**Keywords:** supply chain management, investment, information.

- 2010/86 The economics of airport noise: how to manage markets for noise licenses  
Thierry BRECHET and Pierre M. PICARD

Noise-induced pollution constitutes a hot and topical societal problem for all major airports. This paper discusses various issues in the implementation of a market for noise licenses as a solution to solve the noise externality between the residents located around airports and the aircrafts moving in and to airports.

**JEL Classification:** Q5, R4, D4, D6, D78, D82, L5, L93

**Keywords:** airport, environment, noise, licenses.

- 2010/87 Fair allocation of indivisible goods among two agents  
Eve RAMAEKERS

One must allocate a finite set of indivisible goods among two agents without monetary compensation. We impose Pareto-efficiency, anonymity, a weak notion of no-envy, a welfare lower bound based on each agent's ranking of the sets of goods, and a monotonicity property relative to changes in agents' preferences. We

prove that there is a rule satisfying these axioms. If there are three goods, it is the only rule, with one of its subcorrespondences, satisfying each fairness axiom and not discriminating between goods. Further, we confirm the clear gap between these economies and those with more than two agents.

**JEL Classification:** D61, D63

**Keywords:** indivisible goods, no monetary compensation, no-envy, lower bound, preference-monotonicity.