Gollier, Christian; Weitzman, Martin L.

Working Paper
How should the distant future be discounted when discount rates are uncertain?

CESifo Working Paper, No. 2863

Provided in Cooperation with:
Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Gollier, Christian; Weitzman, Martin L. (2009) : How should the distant future be discounted when discount rates are uncertain?, CESifo Working Paper, No. 2863

This Version is available at:
http://hdl.handle.net/10419/30687

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.
You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.
If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.
How Should the Distant Future be Discounted when Discount Rates are Uncertain?

Christian Gollier
Martin L. Weitzman

CESifo Working Paper No. 2863
Category 10: Energy and Climate Economics
December 2009

An electronic version of the paper may be downloaded
• from the SSRN website: www.SSRN.com
• from the RePEc website: www.RePEc.org
• from the CESifo website: www.CESifo-group.org/wp
How Should the Distant Future be Discounted when Discount Rates are Uncertain?

Abstract

It is not immediately clear how to discount distant-future events, like climate change, when the distant-future discount rate itself is uncertain. The so-called “Weitzman-Gollier puzzle” is the fact that two seemingly symmetric and equally plausible ways of dealing with uncertain future discount rates appear to give diametrically opposed results with the opposite policy implications. We explain how the “Weitzman-Gollier puzzle” is resolved. When agents optimize their consumption plans and probabilities are adjusted for risk, the two approaches are identical. What we would wish a reader to take away from this paper is the bottom-line message that the appropriate long run discount rate declines over time toward its lowest possible value.

JEL Code: G12, E43, Q51.

Keywords: discount rate, term structure, climate change, cost-benefit analysis.

Christian Gollier  
Toulouse School of Economics  
gollier@cict.fr

Martin L. Weitzman  
Department of Economics  
Harvard University  
mweitzman@harvard.edu

November 7, 2009

The research leading to these results has received funding from the European Research Council under the European Community’s Seventh Framework Programme (FP7/2007-2013) Grant Agreement no. 230589.
1 Introduction

The concept of discounting is central to economics, since it allows effects occurring at different
future times to be compared by converting each future dollar into a common currency of
equivalent present dollars. Because of this centrality, the choice of an appropriate discount
rate is one of the most critical issues in economics. It is an especially acute issue for projects
involving long time horizons because in such situations the results of cost-benefit analysis
(CBA) can be incredibly sensitive to even tiny changes in the discount rate.

The primary motivator for this paper is the economics of climate change. Answers to
questions thrown up by the climate-change CBA hinge critically on the core issue of how
to discount the distant future. There is a high degree of uncertainty about what should
be taken as the appropriate rate of return on capital in the long run, accompanied by much
controversy about its implications for long-run discounting. The investigation of this paper is
focused sharply on the well defined sub-problem of how to perform CBA of small incremental
investments that might alter distant-future events, although the overall ramifications of the
paper are somewhat broader.

The effects of global warming and climate change will be spread out over what might
be called the “distant future” – centuries (or even millennia) from now. The logic of com-
ponding a constant positive interest rate forces us to say that what we might conceptualize
as monumental – even earth-shaking – events do not much matter when they occur in the
distant future. Perhaps yet more disconcerting, when exponential discounting is extended
over very long time periods there is a truly extraordinary dependence of CBA on the choice
of a discount rate. Seemingly insignificant differences in discount rates can make an enor-
mous difference in the present discounted value of distant-future payoffs. In many long-run
situations, including climate change, almost any answer to a CBA question can be defended
by one choice or another of a discount rate.

We think it is important to begin by recognizing that there is no deep reason of principle
that allows us to extrapolate past rates of return on capital into the distant future. The
seeming trendlessness of some past rates of return is a purely empirical reduced-form obser-
vation, which is not based on any underlying theory that would confidently allow projecting
the past far into the future. There are a great many fundamental non-extrapolatable fac-
tors, just one example of which is the unknown future rate of technological progress. Even
leaving aside the question of how to project future interest rates, additional issues for climate
change involve which interest rate to choose out of a multitude of different average rates of
return that are out there in the past and present real world. Furthermore, there is an ethical
dimension to discounting climate change across many future generations that is difficult to
evaluate and incorporate into standard CBA. A very large number of additional examples of economic and non-economic features could be given that are currently unknown but would be highly relevant to determining the distant-future discount rate. The fundamental point is that there is enormous uncertainty and controversy about choosing an appropriate rate of return for discounting distant-future events, like climate change. Moreover, the great uncertainty about discounting the distant future is not just an academic curiosity, but it has critically important implications for climate change policy. This disturbing ambiguity has given rise to a great deal of controversy and a variety of proposed solutions. Our purpose here is to focus sharply on clarifying this particularly thorny issue by using a crisp formulation that abstracts away from all other elements of CBA.

In this paper we construct the simplest possible model for analyzing how to discount the distant future for a CBA decision that must be made now, when future discount rates are uncertain. We do not defend this model for its realism and immediate applicability to such long-term issues as CBA of climate change. Rather, we defend our abstract optimizing model for its ability to isolate, clarify, and hopefully bring some closure to a set of controversial issues that have bedeviled the discounting of distant-future events like climate change.

The bottom line message we want a reader to take away from this paper: there exists a rigorous generic argument that the future should be discounted at a declining rate that approaches asymptotically its lowest possible value.

2 Background: the “Weitzman-Gollier Puzzle”

In this section we focus on a paradoxical issue, whose proposed resolution has featured prominently in a number of papers on discounting the distant future. We do not mean to imply that this is the only important issue in long-term discounting, or that our own resolution of the puzzle is the final word. We are primarily using this alleged paradox as a way of grabbing a reader’s attention in order to motivate the rigorous analysis that comes with the next section of the paper.

In the highly stylized model of this paper, time $t = 0, 1, 2, ..., n$ is measured in discrete periods of unit length. To state loosely the issue at hand, a decision must be taken now, just before time zero (call it time $0^-$), whether or not to invest a marginal cost $\delta$ that will yield a marginal benefit $\epsilon$ at future time $t$. Right now, at time $0^-$, it is unknown what will be the appropriate future rate of return on capital in the economy. There are $n$ possible future states of the economy, indexed by $i = 1, 2, ..., n$. As of now (time $0^-$), future state $i$ is viewed as having marginal product of capital $r_i$ with probability $p_i > 0$, where $\Sigma p_i = 1$. A decision must be made now (at time $0^-$, just before the “true” state of the world is revealed
at time $t = 0$) about whether or not to invest $\delta$ now in order to gain payoff $\epsilon$ at future time $t$. To pose the problem sharply, it is assumed that immediately after the investment decision is made, at time $0$, the true state of the world $i$ is revealed and the marginal product of capital will thenceforth be $r_i$, from time $t = 0$ to time $t = \infty$. The idea that productivity shocks are permanent seems an appropriate abstraction for analyzing the distant-future discount rate. Even if we thought of interest rates as being a mean-reverting random variable, our best statistical estimate of this mean is itself a random variable, which makes the reduced-form overall stochastic process be non-mean-reverting.

In a pair of articles, Weitzman\textsuperscript{1} proposed the idea that what should be probability-averaged at various times is not future discount rates, but future discount factors. In other words, one should not apply the average discount rate $\sum p_i r_i$ as if it were a time-independent constant. Instead one should apply the time-dependent average discount factor $A(t) = \sum p_i \exp(-r_i t)$, whose corresponding time-dependent “effective” discount rate $R_W(t)$ satisfies

$$\exp(-R_W(t)t) = \sum_{i=1}^{n} p_i \exp(-r_i t),$$  \hspace{1cm} (1)

which can be rewritten as

$$R_W(t) = -\frac{1}{t} \ln \left( \sum_{i=1}^{n} p_i \exp(-r_i t) \right).$$ \hspace{1cm} (2)

Accepting the above logic, it follows that the investment should be made (incurring a marginal cost $\delta$ now, at time $0^-$, in order to yield a marginal benefit $\epsilon$ at future time $t$) if and only if

$$\epsilon \exp(-R_W(t)t) \geq \delta. \hspace{1cm} (3)$$

It is not difficult to show that $R_W(t)$ defined by (2) has the properties

$$R_W(0) = \sum_{i=1}^{n} p_i r_i, \quad \frac{dR_W(t)}{dt} < 0, \quad R_W(\infty) = \min\{r_i\}. \hspace{1cm} (4)$$

Unfortunately, Weitzman did not provide a rigorous story to accompany the idea that what should be probability-averaged at various times is not discount rates, but discount factors. Instead the argument in his papers was left at the intuitive or heuristic level. A main purpose of this paper is to provide a rigorous justification for an appropriate version of (1)-(4). A simple intuition is derived from observing that one can anticipate the future benefit $\epsilon$ by reducing productive capital by the present value $\epsilon \exp(-r_i t)$ at date $0$. This

\textsuperscript{1}See Weitzman (1998) and Weitzman (2002).
reduction will be fully compensated at date \( t \) by the cash flow \( \varepsilon \) generated by the project, so that all cash flows are concentrated at date 0. In expectation, this net present value is positive if and only if condition (3) is satisfied.

In a series of articles, Gollier\(^2\) inverted Weitzman’s logic to produce a seemingly symmetric discount-rate story with exactly the opposite properties. Gollier reasoned along the following lines. One can transfer the initial cost of the project by diverting \( \delta \) from the productive capital of the economy at date 0. This is offset by investing \( \delta \exp(r \cdot t) \) in the productive capital at date \( t \). This implies that all cash flows are concentrated at date \( t \). In expectation, this net future value is positive if

\[
\varepsilon \geq \delta \exp \left( R^G(t) \cdot t \right),
\]

where the time-dependent internal rate of return \( R^G(t) \) satisfies the condition

\[
\exp(R^G(t) \cdot t) = \sum p_i \exp(r_i \cdot t).
\]

This can be rewritten as

\[
R^G(t) = \frac{1}{t} \ln \left( \sum_{i=1}^{n} p_i \exp(r_i \cdot t) \right).
\]

It is not difficult to show that \( R^G(t) \) defined by (7) has the properties

\[
R^G(0) = \sum_{i=1}^{n} p_i r_i, \quad \frac{dR^G(t)}{dt} > 0, \quad R^G(\infty) = \max\{r_i\}.
\]

Unfortunately, Gollier did not at first provide a rigorous story to accompany his idea of using the internal rate of return defined by (7). Instead, like Weitzman, his argument was initially presented at the intuitive or heuristic level.

Aside from sharing the same initial condition \( R^W(0) = R^G(0) = \sum p_i r_i \), the properties of \( R^G(t) \) and \( R^W(t) \) are diametrically opposed (except for the trivial situation in which there is but one sure future state of the world, in which case the two are criteria are identical). While \( R^W(t) \) declines over time to the smallest value of \( \{r_i\} \), on the contrary \( R^G(t) \) increases over time to the largest value of \( \{r_i\} \).

Both the Weitzman discount rate \( R^W(t) \) and the Gollier discount rate \( R^G(t) \) have a superficial plausibility, but with completely opposite conclusions and policy implications. If the correct discount rate is one of (2) or (7), then of necessity the other one must be wrong and will give the wrong answers to CBA questions. For want of a better name, this seeming

paradox has been dubbed in the literature the “Weitzman-Gollier puzzle,” and it has featured prominently in several papers about long-term discounting. How might a person resolve this distressing paradox by choosing between two such seemingly symmetric formulations, with each one having diametrically opposed implications for distant-future discounting? The answer can only come from a careful rigorous analysis, which follows in the next section.

3 Resolving the “Weitzman-Gollier Puzzle”

As Gollier pointed out early on, and elucidated more carefully later, neither the formula for \( R_W(t) \) given by (2) nor the formula for \( R_G(t) \) given by (7) are likely correct as they stand when the evaluation of the safe investment is adjusted for the risk associated to its financing strategy. Indeed, both formulations contain a germ of truth that can be turned into a rigorous argument when expressed in units of marginal utility along an optimal consumption trajectory. Furthermore, and most importantly, the two rigorous formulations give the same discount rate (as a function of time), thereby resolving the “Weitzman-Gollier puzzle.”

While several generalizations are possible, we focus here on the simplest case, the better to bring across the main points sharply. Our formal argument proceeds as follows. Break up time into a series of discrete periods 0, 1, 2, ..., \( t \), ..., of unit length with corresponding consumptions \( C = (C_0, C_1, ..., C_t, ...) \). We postulate a very general utility function, in the spirit of Irving Fisher, of the form \( V(C) \). We assume that \( V \) is smoothly differentiable, is strictly concave, has positive first derivatives, and satisfies some kind of generalized Inada conditions that will guarantee unique interior solutions. Pure time preference is already built into this general utility function. A special case of \( V(C) \) is the Ramsey-Koopmans form

\[
V(C) = \sum_{t=0}^{\infty} \exp(-\rho t) U(C_t),
\]

where \( \rho > 0 \), \( U'(0) = \infty \) and \( U'(\infty) = 0 \). However, in some ways this special case (9) obscures rather than illuminates the act of seeing through to the core theoretical structure driving the model’s results.

There is just one commodity serving as both consumption and investment. The notion of capital here is intended to be all-inclusive, including human capital, knowledge capital, and so forth. The underlying production function of this “generalized capital” is linear. In

---

4 See Gollier (2009a, 2009b).
state of the world \( i \) it is of the form

\[
K_{t+1} = \exp(r_i)[K_t - C_t],
\]  

(10)

where \( K_t \) is the capital stock at the beginning of period \( t \). The linearity of the production possibilities frontier guarantees that the relevant interest rate in state \( i \) will be \( r_i \) – no matter what is the form of the general Fisherian utility function \( V \).

It is critical in this model to understand the exact timing sequence concerning what information is available at what time, and when decisions are made. The base-case scenario is this. At time 0, the inherited capital stock is given as \( K_0 \) and the state of the world is known. It is assumed that the deterministic problem of maximizing \( V(C) \) subject to (10) has a unique interior bounded solution for all \( i \). Denote the deterministic optimal consumption trajectory in state \( i \) as \( C^*_i = (C^*_0, C^*_1, ..., C^*_t, ...) \). From the linear production possibilities frontier (10), reducing consumption at date 0 by one unit in state \( i \) would result in \( \exp(r_i t) \) extra units available for increased consumption at time \( t \) (without altering the rest of the optimal trajectory). Such a marginal change in the consumption plan should have no effect on intertemporal welfare \( V \). Therefore, the optimal deterministic trajectory in state \( i \) must satisfy the first-order condition

\[
\frac{\partial V(C^*_i)}{\partial C_0} = \frac{\partial V(C^*_i)}{\partial C_t} \exp(r_i t)
\]

(11)

for all \( t \). This condition, which holds in all states \( i = 1, ..., n \), states that investors are indifferent about the financing structure of their projects.

Next suppose that an investment opportunity arises at time \( t = 0^- \), just before the “true” state of the world is revealed at time \( t = 0 \). This safe investment opportunity expends marginal cost \( \delta \) in order to yield a marginal benefit \( \epsilon \) at future time \( t \). Of course the representative agent wishes that the investment decision could be made with the precise information available at time \( t = 0 \), just after the “true” state of the world is revealed and the relevant future marginal product of capital (from time \( t = 0 \) to time \( t = \infty \)) is known with certainty. But the essence of the problem of doing CBA with an uncertain future discount rate is that the investment decision must be made at a time when it is known only that the uncertain future marginal product of capital will be \( r_i \) with probability \( p_i \).

By the envelope theorem and given the optimality condition (11), the possibility to reallocate the costs and benefits of the project over time has no effect on its impact on \( V \), at the margin. This is the key to resolve the puzzle, as we demonstrate it below.

The investment project raises the expected utility of the representative agent if and only
Using the optimality condition (11), this can be rewritten in two equivalent ways. The "Weitzman approach" consists in eliminating \( \partial V(C^*_i)/\partial C_t \) from the above inequality. It yields

\[
\varepsilon \sum_{i=1}^n q^W_i \exp(-r_it) \geq \delta \quad \text{with} \quad q^W_i = \frac{p_i \frac{\partial V(C^*_i)}{\partial C_0}}{\sum_{i=1}^n p_i \frac{\partial V(C^*_i)}{\partial C_0}}.
\]  

This is equivalent to discount the future flow \( \varepsilon \) at a rate \( R^W_*(t) \) defined as follows:

\[
R^W_*(t) = -\frac{1}{t} \ln \left( \sum_{i=1}^n q^W_i \exp(-r_it) \right).
\]  

Alternatively, the "Gollier approach" consists in eliminating \( \partial V(C^*_i)/\partial C_0 \) from (12) by using condition (11). It yields

\[
\varepsilon \geq \delta \sum_{i=1}^n q^G_i(t) \exp(r_it) \quad \text{with} \quad q^G_i(t) = \frac{p_i \frac{\partial V(C^*_i)}{\partial C_t}}{\sum_{i=1}^n p_i \frac{\partial V(C^*_i)}{\partial C_t}}.
\]  

This is equivalent to discount the future flow \( \varepsilon \) at a rate \( R^G_*(t) \) equaling

\[
R^G_*(t) = \frac{1}{t} \ln \left( \sum_{i=1}^n q^G_i(t) \exp(r_it) \right).
\]  

Observe the close links between the definition of \((R^W_*(t), R^G_*(t))\) in (14) and (16) and the definition of \((R^W(t), R^G(t))\) in (2) and (7). They are equal up to a risk adjustment of probabilities. Weitzman converts all cash flows into consumption at time 0 and adjusts state-contingent net present values with units of marginal utility at time 0. Gollier converts all cash flows into consumption at time \( t \) and adjusts net future values with units of marginal utility at time \( t \). These risk adjustments are crucial because, although the properties of \( R^W(t) \) and \( R^G(t) \) are very heterogeneous, it is very easy to check from the optimality condition (11) that

\[
R^W_*(t) = R^G_*(t)
\]

for all \( t \)!! This means that the adjustment of the valuation for risk resolves the "Weitzman-Gollier puzzle". Let \( R_*(t) \) denote this efficiently risk-adjusted discount rate.

It remains to explore the properties of this common risk-adjusted discount rate. Using
the easier formulation $R_* = R^W_*$, it is not difficult to show that

$$R_*(0) = \sum q^W_i r_i, \quad \frac{dR_*(t)}{dt} < 0, \quad R_*(\infty) = \min\{r_i\},$$

(17)

so that qualitatively the properties of the efficient discount rate $R_*(t)$ resemble closely those of $R^W(t)$ recommended by Weitzman, with the only quantitative difference being the substitution of “Weitzman-adjusted probabilities” $\{q^W_i\}$ for the unadjusted probabilities $\{p_i\}$. It is good to provide an intuition to the result that the term structure of the socially efficient discount rate be decreasing. In this model in which shocks on capital productivity are permanent, risk on consumption growth are also permanent, as seen from equation (11). This implies that risks are magnified by time, compared to the more standard Brownian motion in which it is known that the term structure of discount rate is flat. What are the consequences of this magnification of long term risk on the discount rate for long maturities? Intuitively, future risk should induce prudent consumers to sacrifice more for this future. This is the Keynesian notion of precautionary saving. This is translated into using a smaller discount rate.

Let us illustrate this result by considering the special case of the Ramsey-Koopmans specification (9) for $V$. Let us in particular consider the case of the logarithmic utility function $U(C) = \ln C$. In that case, one can rewrite the optimality condition (11) as $C_{it} = C_{i0} \exp(r_i - \rho)t$. Rewriting the intertemporal budget constraint (10) as $K_0 = \Sigma_t C_{it} \exp(-r_t t)$ and eliminating $C_{it}$ yields that

$$C_{i0} = K_0 (1 - \exp(-\rho))$$

for all $i = 1, ..., n$. Observe that the initial consumption is risk free in this special case. As is well-known, consumption is not affected by a change in the interest rate in the logarithmic case. It implies that one is neutral to the small risk affecting the net present value of the project at date 0, which implies in turn that the Weitzman rule $R^W(t)$ given in equation (2) is correct in that case. This can be seen by observing in (13) that $q^W_i = p_i$ for all $i$, so that $R^W_*(t) = R_*(t) = R^W(t)$! In this case, Weitzman’s rule was qualitatively and quantitatively correct.

4 Concluding Remarks

We will not bother to go through all of the many caveats that should attach to the results of this paper. Nor shall we discuss possible extensions to more complicated and realistic
situations.

The bottom-line message that we wish for readers to take away from this paper is the following. When future discount rates are uncertain but have a permanent component, then the “effective” discount rate must decline over time toward its lowest possible value. Empirically, this important feature can have significant ramifications for climate-change CBA – by weighting the distant future much more heavily than is done by standard exponential discounting at a constant rate.5

References


CESifo Working Paper Series
for full list see www.cesifo-group.org/wp
(address: Poschingerstr. 5, 81679 Munich, Germany, office@cesifo.de)

2801 Evžen Kočenda and Jan Hanousek, State Ownership and Control in the Czech Republic, September 2009

2802 Michael Stimmelmayr, Wage Inequality in Germany: Disentangling Demand and Supply Effects, September 2009

2803 Biswa N. Bhattacharyay, Towards a Macroprudential Surveillance and Remedial Policy Formulation System for Monitoring Financial Crisis, September 2009

2804 Margarita Katsimi, Sarantis Kalyvitis and Thomas Moutos, “Unwarranted” Wage Changes and the Return on Capital, September 2009

2805 Christian Lessmann and Gunther Markwardt, Aid, Growth and Devolution, September 2009

2806 Bas Jacobs and Dirk Schindler, On the Desirability of Taxing Capital Income to Reduce Moral Hazard in Social Insurance, September 2009

2807 Hans Gersbach and Noemi Hummel, Climate Policy and Development, September 2009

2808 David E. Wildasin, Fiscal Competition for Imperfectly-Mobile Labor and Capital: A Comparative Dynamic Analysis, September 2009


2811 Slobodan Djajić and Michael S. Michael, Temporary Migration Policies and Welfare of the Host and Source Countries: A Game-Theoretic Approach, October 2009

2812 Devis Geron, Social Security Incidence under Uncertainty Assessing Italian Reforms, October 2009

2813 Max-Stephan Schulze and Nikolaus Wolf, Economic Nationalism and Economic Integration: The Austro-Hungarian Empire in the Late Nineteenth Century, October 2009

2814 Emilia Simeonova, Out of Sight, Out of Mind? The Impact of Natural Disasters on Pregnancy Outcomes, October 2009

2815 Dan Kovenock and Brian Roberson, Non-Partisan ‘Get-Out-the-Vote’ Efforts and Policy Outcomes, October 2009
2816 Sascha O. Becker, Erik Hornung and Ludger Woessmann, Catch Me If You Can: Education and Catch-up in the Industrial Revolution, October 2009

2817 Horst Raff and Nicolas Schmitt, Imports, Pass-Through, and the Structure of Retail Markets, October 2009

2818 Paul De Grauwe and Daniel Gros, A New Two-Pillar Strategy for the ECB, October 2009

2819 Guglielmo Maria Caporale, Thouraya Hadj Amor and Christophe Rault, International Financial Integration and Real Exchange Rate Long-Run Dynamics in Emerging Countries: Some Panel Evidence, October 2009

2820 Saša Žiković and Randall K. Filer, Hybrid Historical Simulation VaR and ES: Performance in Developed and Emerging Markets, October 2009

2821 Panu Poutvaara and Andreas Wagener, The Political Economy of Conscription, October 2009

2822 Steinar Holden and Åsa Rosén, Discrimination and Employment Protection, October 2009

2823 David G. Mayes, Banking Crisis Resolution Policy – Lessons from Recent Experience – Which elements are needed for robust and efficient crisis resolution?, October 2009

2824 Christoph A. Schaltegger, Frank Somogyi and Jan-Egbert Sturm, Tax Competition and Income Sorting: Evidence from the Zurich Metropolitan Area, October 2009


2826 Hartmut Egger and Udo Kreickemeier, Worker-Specific Effects of Globalisation, October 2009

2827 Alexander Fink and Thomas Stratmann, Institutionalized Bailouts and Fiscal Policy: The Consequences of Soft Budget Constraints, October 2009

2828 Wolfgang Ochel and Anja Rohwer, Reduction of Employment Protection in Europe: A Comparative Fuzzy-Set Analysis, October 2009

2829 Rainald Borck and Martin Wimbersky, Political Economics of Higher Education Finance, October 2009


2831 Klaus Wälde, Production Technologies in Stochastic Continuous Time Models, October 2009
2832 Biswa Bhattacharyay, Dennis Dlugosch, Benedikt Kolb, Kajal Lahiri, Irshat Mukhametov and Gernot Nerb, Early Warning System for Economic and Financial Risks in Kazakhstan, October 2009

2833 Jean-Claude Trichet, The ECB’s Enhanced Credit Support, October 2009

2834 Hans Gersbach, Campaigns, Political Mobility, and Communication, October 2009

2835 Ansgar Belke, Gunther Schnabl and Holger Zemanek, Real Convergence, Capital Flows, and Competitiveness in Central and Eastern Europe, October 2009

2836 Bruno S. Frey, Simon Luechinger and Alois Stutzer, The Life Satisfaction Approach to Environmental Valuation, October 2009

2837 Christoph Böhringer and Knut Einar Rosendahl, Green Serves the Dirtiest: On the Interaction between Black and Green Quotas, October 2009

2838 Katarina Keller, Panu Poutvaara and Andreas Wagener, Does Military Draft Discourage Enrollment in Higher Education? Evidence from OECD Countries, October 2009

2839 Giovanni Cespa and Xavier Vives, Dynamic Trading and Asset Prices: Keynes vs. Hayek, October 2009

2840 Jan Boone and Jan C. van Ours, Why is there a Spike in the Job Finding Rate at Benefit Exhaustion?, October 2009

2841 Andreas Knabe, Steffen Rätzel and Stephan L. Thomsen, Right-Wing Extremism and the Well-Being of Immigrants, October 2009

2842 Andrea Weber and Christine Zulehner, Competition and Gender Prejudice: Are Discriminatory Employers Doomed to Fail?, November 2009

2843 Hadi Salehi Esfahani, Kamiar Mohaddes and M. Hashem Pesaran, Oil Exports and the Iranian Economy, November 2009


2845 Guglielmo Maria Caporale, Burcu Erdogan and Vladimir Kuzin, Testing for Convergence in Stock Markets: A Non-Linear Factor Approach, November 2009

2846 Michèle Belot and Jan Fidrmuc, Anthropometry of Love – Height and Gender Asymmetries in Interethnic Marriages, November 2009

2847 Volker Nitsch and Nikolaus Wolf, Tear Down this Wall: On the Persistence of Borders in Trade, November 2009

2848 Jan K. Brueckner and Stef Proost, Carve-Outs Under Airline Antitrust Immunity, November 2009

2850 Scott Alan Carson, The Relationship between Stature and Insolation: Evidence from Soldiers and Prisoners, November 2009

2851 Horst Raff and Joachim Wagner, Intra-Industry Adjustment to Import Competition: Theory and Application to the German Clothing Industry, November 2009

2852 Erkki Koskela, Impacts of Labor Taxation with Perfectly and Imperfectly Competitive Labor Markets under Flexible Outsourcing, November 2009

2853 Cletus C. Coughlin and Dennis Novy, Is the International Border Effect Larger than the Domestic Border Effect? Evidence from U.S. Trade, November 2009

2854 Johannes Becker and Clemens Fuest, Source versus Residence Based Taxation with International Mergers and Acquisitions, November 2009

2855 Andreas Hoffmann and Gunther Schnabl, A Vicious Cycle of Manias, Crashes and Asymmetric Policy Responses – An Overinvestment View, November 2009

2856 Xavier Vives, Strategic Supply Function Competition with Private Information, November 2009

2857 M. Hashem Pesaran and Paolo Zaffaroni, Optimality and Diversifiability of Mean Variance and Arbitrage Pricing Portfolios, November 2009

2858 Davide Sala, Philipp J.H. Schröder and Erdal Yalcin, Market Access through Bound Tariffs, November 2009

2859 Ben J. Heijdra and Pim Heijnen, Environmental Policy and the Macroeconomy under Shallow-Lake Dynamics, November 2009

2860 Enrico Spolaore, National Borders, Conflict and Peace, November 2009

2861 Nina Czernich, Oliver Falck, Tobias Kretschmer and Ludger Woessmann, Broadband Infrastructure and Economic Growth, December 2009

2862 Evžen Kočenda and Martin Vojtech, Default Predictors and Credit Scoring Models for Retail Banking, December 2009

2863 Christian Gollier and Martin L. Weitzman, How Should the Distant Future be Discounted when Discount Rates are Uncertain?, December 2009