DOĞRUDAN KAMU AR-GE FONLARININ DEĞERLENDİRİLMESİ

TÜBİTAK BTYPDB

Haziran 2008

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EK-1: KATILIMCI LİSTESİ

Ad, Soyad	**Kurum / Firma**
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Selçuk HARPUT	Metal Teknoloji Platformu
Faruk İNALTEKİN	ODTÜ -Teknopark
Miray KARAKUZU	TÜBİTAK-BTYPDB
Kaan KARAÖZ	TÜBİTAK-TEYDEB
Yasemin KESEBİ	Elektrik ve Elektronik Teknoloji Platformu
Yrd. Doç. Dr. Nazan KIRCI	Gazi Üniversitesi Mühendislik-Mimarlık Fakültesi
Metin KIRKIN	DTM İhracat Genel Müdürlüğü Devlet Yardımları Dairesi
Oğuz ÖZBAY	TÜBİTAK-TEYDEB
Bilgehan ÖZBAYLANLI	DPT Sosyal Sektörler ve Koordinasyon Genel Müdürlüğü
Barhan ÖZCE	STRATAGEM
Recep Tuğrul ÖZDEMİR	TÜBİTAK-UIDB
Özgür Kadir ÖZER	DPT Sosyal Sektörler ve Koordinasyon Genel Müdürlüğü
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Ahmet PEMBEGÜL	TÜBİTAK-TEYDEB
Zeynep SARILAR	MOBİLERA Bilişim ve İletişim Teknolojileri Tic. A.Ş.
Özge SEÇMELER	ALTIPARMAK Pazarlama Koll.Şti.
Alper ŞEKER	TÜBİTAK-TEYDEB
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Sinan TANDOĞAN	TÜBİTAK-TEYDEB
Dr. Adem TUNCER	KOSGEB Başkanlığı /YTÜ TEKMER
Perran VAROL	Hacettepe Üniversitesi
Cengiz YAĞCIOĞLU	ETA Elektronik Tasarım San. ve Tic. A.Ş.
R. Murat YILMAZ	Enerji Teknoloji Platformu
Kaan YÜCEL	KOSGEB Başkanlığı /ODTÜ TEKMER
Selcan ZEREN	TÜBİTAK-BTYPDB

EK-2: KONU İLE İLGİLİ LİTERATÜR

Title: Explaining Innovative Activity in Service Industries: Micro Data Evidence for Switzerland

Author(s): Spyros Arvanitis

Publication: Econ. Innov. New Techn.; 2008; Vol. 17(3); pp: 209-225

Keywords: Innovation; Services

Abstract: In this paper, we analysed empirically the innovative behaviour of firms in the Swiss service sector building on the wide consent in economic literature that demand prospects, type and intensity of competition, market structure, factors governing the production of knowledge (appropriability, technological opportunities), financing conditions as well as firm size are the main determinants of a firm's innovative activity. For the empirical work, we used firm data from nine service industries collected by the Swiss Innovation Survey 1999.We obtained a pattern of explanation of the innovative activity which looked quite plausible across the different types of innovation measures used inputoriented and output-oriented innovation variables); it was also consistent to that found earlier for manufacturing. In general, the empirical model captured rather the characteristics of the basic decision to innovate rather than those of the decision to choose some level of innovative activity.

Title: First and Second Order Additionality and Learning Outcomes in Collaborative R&D Programs

Author(s): Erkko Autio, Sami Kanninen, Robin Gustafsson

Publication: Research Policy; 2008; Vol. 37; pp: 59-76

Keywords: Additionality; Collaborative R&D Programs; Innovation Policy; Learning Externality; Knowledge Spillover

Abstract: In this paper, we distinguish between firm-level learning effects that result from 'first-order' and 'second-order' additionalities in innovation policy interventions. 'First-order' additionalities represent direct firm-level R&D subsidies, whereas 'second-order' additionalities result from knowledge spill-overs, horizontal knowledge exchanges between firms, and from other meso- or community-level effects. Analyzing data from collaborative R&D programs in Finland, we show that enhancing identification with a community of practice among R&D program participants (proxy for second-order additionality) enhances firm-level learning outcomes beyond those resulting from direct R&D subsidy (proxy for first-order additionality). Learning effects facilitated by second-order additionality are not confined to technological learning alone, encompassing also business and market learning. We also show that aspects of program implementation enhance identification with a community of practice, which then mediate the relationship between program implementation and firm-level learning outcomes.

Title: Business R&D and the Interplay of R&D Subsidies and Product Market Uncertainty

Author(s): Dirk Czarnitzki, Andrew A. Toole

Publication: Springer Science+Business Media, LLC. 2007, Rev Ind Organ (2007); Vol. 31; pp: 169–181

Keywords: R&D; Real Options Theory; Uncertainty

Abstract: This paper examines the effect of product market uncertainty and government research and development (R&D) subsidies on firm-level R&D investment. Using a sample of German manufacturing firms, we find that product market uncertainty reduces R&D investment and government R&D subsidies increase R&D investment. Moreover, our results indicate that R&D subsidies mitigate the effect of product market uncertainty on R&D investment. These findings suggest that public policies aimed at increasing business R&D investment can achieve this objective by reducing the degree of uncertainty in the product market.

Title: Do Public Subsidies Complement Business R&D? A Meta-Analysis of the Econometric Evidence

Author(s): José García-Quevedo

Publication: KYKLOS; 2004; Vol. 57(1); pp: 87-102

Keywords: -

Abstract: Analysis of the effects of public financing on private investment in R&D has been the object of numerous applied studies without it having been possible to arrive at a definite conclusion. In this paper the results of a meta-regression of econometric evidence on the relationship between public funding of R&D and private R&D expenditures is presented. After the creation of a data-base including all relevant studies and their results and characteristics, a meta-analysis was carried out to examine whether the characteristics of the applied analysis influence the results and explain the differences in the empirical literature on this subject.

Title: How to Allocate R&D (and Other) Subsidies: An Experimentally Tested Policy Recommendation

Author(s): Thomas Giebe, Tim Grebe, Elmar Wolfstetter

Publication: Research Policy; 2006; Vol. 35; pp: 1261-1272

Keywords: Research; Subsidies; Experimental Economics

Abstract: This paper evaluates the typically applied rules for awarding R&D subsidies.We identify two sources of inefficiency: the selection based on a ranking of individual projects, rather than complete allocations, and the failure to induce competition among applicants in order to extract and use information about the necessary funding. In order to correct these inefficiencies we propose mechanisms that include some form of an auction in which applicants bid for subsidies. Our proposals are tested in a simulation and in controlled lab experiments. The results suggest that adopting our proposals may considerably improve the allocation.

Title: The Effect of R&D Subsidies on Private R&D

Author(s): Holger Görg, Eric Strobl

Publication: Economica; 2007; Vol. 74; pp: 215-234

Keywords: -

Abstract: This paper investigates the relationship between government support for R&D and R&D expenditure financed privately by firms using a comprehensive plant level data set for the manufacturing sector in the Republic of Ireland. We find that for domestic plants small grants serve to increase private R&D spending, while too large a grant may crowd out private financing of R&D. In contrast, evidence for foreign establishments suggests that grant provision causes neither additionality nor crowding out effects of private R&D financing, regardless of the size of the subsidy.

Title: How to Promote R&D-Based Growth? Public Education Expenditure on Scientists and Engineers Versus R&D Subsidies

Author(s): Volker Grossmann

Publication: Journal of Macroeconomics; 2007; Vol. 29; pp: 891-911

Keywords: Earnings Inequality; Endogenous Growth; Public Education; R&D Subsidies; S&E Skills

Abstract: This paper compares the positive and normative implications of two alternative measures to promote R&D-based growth: R&D subsidies to firms and publicly provided education targeted to the development of science and engineering (S&E) skills. The model accounts for the specificity of S&E skills, where individuals with heterogeneous ability choose their type of education. Although intertemporal knowledge spillovers are the only R&D externality, the analysis suggests that R&D subsidies may be detrimental to both productivity growth and welfare. Moreover, they raise earnings inequality. In contrast to R&D subsidies, publicly provided education targeted to S&E skills are found to be unambiguously growth-promoting and neutral with respect to the earnings distribution.

Title: The Impact of Public R&D Expenditure on Business R&D

Author(s): Dominique Guellec, Bruno Van Pottelsberghe de la Potterie

Publication: Econ. Innov. New Techn.; 2003; Vol. 12(3); pp: 225-243

Keywords: Technology Policy; Tax Credit; R&D; Panel Data

Abstract: This paper attempts to quantify the aggregate net effect of government funding on business R&D in 17 OECD Member countries over the past two decades. Grants, procurement, tax incentives and direct performance of research (in public laboratories or universities) are the major policy tools in the field. The major results of the study are the following: Direct government funding of R&D performed by firms has a pozitive effect on business financed R&D (except if the funding is targeted towards defence activities). Tax incentives have an immediate and pozitive effect on business-financed R&D; Direct funding as well as tax incentives are more effective when they are stable over time; firms do not invest in additional R&D if they are uncertain of the durability of the government support; Direct government funding and R&D tax incentives are substitutes: increased intensity of one reduces the effect of the other on business R&D; The stimualting effect of government funding varies with respect to its generosity: it increases up to a certain threshold (about 10% of business R&D) and then decreasees beyond; Defence research performed in public laboratories and universities crowds out private R&D; Civilian public research is neutral for business R&D.

Title: The Financing of Research and Development

Author(s): Bronwyn H. Hall

Publication: Oxford Review of Economic Policy; 2002; Vol. 18(1)

Keywords: -

Abstract: Evidence on the 'funding gap' for R&D is surveyed. The focus is on financial-market reasons for under-investment in R&D that persist even in the absence of externality induced under-investment. The conclusions are that (i) small and new innovative firms experience high costs of capital that are only partly mitigated by the presence of venture capital; (ii) evidence for high costs of R&D capital for large firms is mixed, although these firms do prefer internal funds for financing these investments; (iii) there are limits to venture capital as a solution to the funding gap, especially in countries where public equity markets are not highly developed; and (iv) further study of governmental seed capital and sunsidy programmes using quasi-experimental methods is warranted.

Title: R&D Subsidy and Self-Financed R&D: The Case of Japanese High-Technology Start-Ups

Author(s): Tadahisa Koga

Publication: Small Business Economics; 2005; Vol. 24; pp: 53-62

Keywords: -

Abstract: This paper examines whether public R&D subsidies constitute a substitute or complement for privatefinanced R&D. The empirical analysis is based on a panel data of 223 Japanese high-technology start-ups. Our evidence is consistent with the complement hypothesis, i.e., that publiclyfunded R&D does promote private R&D. The complement effects are stronger for more mature firms. This is because such firms, in the growth phase, might have greater demands for R&D funds.

Title: On the Impacts of R&D Support and on Specialization in The Production of New Knowledge

Author(s): Eero Lehto

Publication: Econ. Innov. New Techn.; 2008; Vol. 17(3); pp: 227-240

Keywords: Trading Innovations; R&D Support; Specialization in the Provision of New Knowledge

Abstract: This study considers situations in which specialized innovators and incumbent manufacturers trade on innovations. Manufacturers also invest in their own R&D, and only if they are unsuccessful do they go to the outside market for innovations. We then consider the impacts of public R&D support and show that the desired direct effect on R&D investments or on the number of new innovators easily crowds out in the form of indirect market repercussions. We also show that an industry's natural growth does not induce manufacturers to specialize in either purely in-house or in purely out-house provision of new knowledge.

Title: Crowding out or Stimulus: The Effect of Public R&D Subsidies on Firm's R&D Expenditure

Author(s): Katrin Hussinger

Publication: *draft version*

Keywords: Innovation, Public Innovation Subsidies, Policy Evaluation, Parametric and Semiparametric Two-Step Selection Models

Abstract: This paper analyzes the effects of public R&D subsidies on innovation expenditure in German manufacturing. The key question is whether public R&D stimulates or simply crowds out private investment. Cross sectional data at the firm level are used to estimate the effect of subsidization. By adopting parametric and semiparametric selection models it turns out that public funding increases firms' R&D expenditure. So the hypothesis of crowding-out effects between public and private R&D funding can be rejected.

Title: How Effective Are Fiscal Incentives for R&D? A Review of the Evidence

Author(s): Bronwyn Hall, John Van Reenen

Publication: Research Policy; 2000; Vol. 29(4-5); pp: 449-469

Keywords: Tax Credits; R&D; International

Abstract: This paper surveys the econometric evidence on the effectiveness of fiscal incentives for R&D. We describe the effects of tax systems in OECD countries on the user cost of R&D — the current position, changes over time and across different firms in different countries. We describe and criticize the methodologies used to evaluate the effect of the tax system on R&D behaviour and the results from different studies. In the current (imperfect) state of knowledge we conclude that a dollar in tax credit for R&D stimulates a dollar of additional R&D.

Title: Do Financial Constraints Hold Back Innovation and Growth? Evidence on the Role of Public Policy

Author(s): Ari Hyytinen, Otto Toivanen

Publication: Research Policy; 2005; Vol. 34(9); pp: 1385-1403

Keywords: Corporate Finance; Financial Constraints; Innovation; Firm Growth; Subsidies

Abstract: This paper provides evidence that capital–market imperfections hold back innovation and growth, and that public policy can complement capital markets. We deliver the evidence by studying the effects of government funding on the behavior of SMEs in Finland. By adapting the methodology recently proposed by Rajan and Zingales [Rajan, R.G., Zingales, L., 1998. Financial dependence and growth. American Economic Review 88, pp. 559–587] to firm-level data, we show that government funding disproportionately helps firms from industries that are dependent on external finance. We demonstrate that the result is economically significant and robust to a variety of tests.

Title: Building Programme Evaluation into the Design of Public Research-Support Programmes

Author(s): Adam B. Jaffe

Publication: Oxford Review of Economic Policy; 2002; Vol. 18(1)

Keywords: -

Abstract: There is wide agreement that the high social rate of return to research and innovation justifies government support for research. There is, however, only limited evidence on the effectiveness of different public research programmes. Reliable measurement of programme effectiveness is hampered by the 'selectivity' problem (public funding goes to proposals judged in advance to be likely to succeed) and the question of 'additivity' (whether public funding increases total spending on research or merely displaces funding from other sources). The selectivity problem can be mitigated by building evaluation into programme design, either by partial randomization of the grant process, or by recording the rankings used in grant evaluation and making this information available to researchers. The additivity question reflects the more fundamental problem that the ultimate objective of these programmes is to have long-term effects that are inherently very difficult to measure and attribute to particular programmes.

Title: R&D and Subsidies at the Firm Level: An Application of Parametric and Semi-Parametric Two-Step Selection Models

Author(s): Katrin Hussinger

Publication: Centre for European Economic Research (ZEW); 2003; Discussion Paper No. 03-63

Keywords: Innovation, Public R&D Subsidies, Policy Evaluation, Parametric and Semiparametric Two-Step Selection Models

Abstract: This paper analyzes the effects of public R&D subsidies on R&D expenditure in the German manufacturing sector. The focus is on the question whether public R&D funding stimulates or crowds out private investment. Cross sectional data at the firm level is used. By apllying parametric and semiparametric selection models, it turns out that public funding increases firms' R&D expenditure. Altough the magnitude of the treatment effect depends on the assumptions imposed by the particular selection model.

Title: The Non-Trivial Choice Between Innovation Indicators

Author(s): Alfred Kleinknecht, Kees Van Montfort, Erik Brouwer

Publication: Economics of Innovation and New Technology; 2002; Vol. 11(2); pp: 109-121

Keywords: R&D; Innovative Output; Total Innovation Expenditure; Patents; Factor Analysis

Abstract: We discuss the strengths and weaknesses of five alternative innovation indicators: R&D, patent applications, total innovation expenditure and shares in sales taken by imitative and by innovative products as they were measured in the 1992 Community Innovation Survey (CIS) in the Netherlands. We conclude that the two most commonly used indicators (R&D and patent applications) have more (and more severe) weaknesses than is often assumed. Moreover, our factor analysis suggests that there is little correlation between the various indicators. This underlines the empirical relevance of various sources of bias of innovation indicators as discussed in this paper.

Title: Do subsidies to Commercial R&D Reduce Market Failures? Micro Econometric Evaluation Studies

Author(s): Tor Jakob Klette, Jarle Møen, Zvi Griliches

Publication: Research Policy; 2000; Vol. 29(4–5); pp: 471-495

Keywords: Additionality; Collaborative R&D Programs; Innovation Policy; Learning Externality; Knowledge Spillover

Abstract: A number of market failures have been associated with R&D investments and significant amounts of public money have been spent on programs to stimulate innovative activities. In this paper, we review some recent micro econometric studies evaluating effects of government-sponsored commercial R&D. We pay particular attention to the conceptual problems involved. Neither the firms receiving support, nor those not applying, constitute random samples. Furthermore, those not receiving support may be affected by the programs due to spillover effects which often are the main justification for R&D subsidies. Constructing a valid control group under these circumstances is challenging, and we relate our discussion to recent advances in econometric methods for evaluation studies based on non-experimental data. We also discuss some analytical questions, beyond these estimation problems, that need to be addressed in order to assess whether R&D support schemes can be justified. For instance, what are the implications of firms' R&D investments being complementary to each other, and to what extent are potential R&D spillovers internalized in the market?

Title: Do R&D Subsidies Stimulate or Displace Private R&D? Evidence from Israel.

Author(s): Saul Lach

Publication: Journal of Industrial Economics; 2002; Vol. 50(4); pp: 369-390

Keywords: Additionality; Collaborative R&D Programs; Innovation Policy; Learning Externality; Knowledge Spillover

Abstract: In evaluating the effect of an R&D subsidy we need to know what the subsidized firm would have spent on R&D had it not received the subsidy. Using the data on Israeli manufacturing firms in the 1990s we find evidence suggesting that the R&D subsidies granted by the Ministry of Industry and Trade greatly stimulated company financed R&D expenditures for small firms but had a negative effect on the R&D of large firms, although not statistically significant. One subsidized New Israeli Shekel (NIS) induces 11 additional NIS of own R&D for the small firms. However, because most subsidies go to the large firms a subsidy of one NIS generates, on average, a statistically insignificant 0.23 additional NIS company financed R&D.

Title: The Nature of Innovation Market Failure and the Design of Public Support for Private Innovation

Author(s): Stephen Martin, John T. Scott

Publication: Research Policy; 2000; Vol. 29; pp: 437-447

Keywords: Innovation; Technological Change; Innovation Policy

Abstract: We relate the sources of innovation market failure to the dominant mode of sectoral innovation and outline mechanisms for public support of innovation that target specific sources of innovation market failure

Title: The Effects of Government–Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program

Author(s): Scott J. Wallsten

Publication: RAND Journal of Economics; 2000; Vol. 31(1); pp: 82-100.

Keywords: -

Abstract: I ask whether government-industry commercial R&D grants increase private R&D. Regressing some measure of innovation on the subsidy can establish a correlation between grants and R&D, but it cannot determine whether grants increase firm R&D or whether firms that do more R&D receive more grants. Using a dataset of firms involved in the Small Business Innovation Research (SBIR) program, I estimate a multi-equation model to test these hypotheses. Firms with more employees and that appear to do more research win more SBIR grants, but the grants do not affect employment. Moreover, I find evidence that the grants crowd out firm-financed R&D spending dollar for dollar.

Title: Additionality of Public R&D Grants in A Transition Economy: The Case of Eastern Germany

Author(s): Czarnitzki D, Licht G

Publication: Economics of Transition; 2006; Vol. 14(1); pp:101-131

Keywords: R&D; Innovation; Subsidies; Evaluation of Public Policy, Market

Abstract: This paper examines the input and output additionality of public R&D subsidies in Western and Eastern Germany. We estimate the impact of public R&D grants on firms' R&D and innovation input. Based on the results of this first step we compare the impact of publicly funded private R&D on innovation output with the output effect of R&D funded out of firms' own pockets. We employ microeconometric evaluation methods using firm-level data derived from the Mannheim Innovation Panel. Our results point towards a large degree of additionality in public R&D grants with regard to innovation input measured as R&D expenditures and innovation expenditures, as well as with regard to innovation output measured by patent applications. Input additionality has been more pronounced in Eastern Germany during the transition period than in Western Germany. However, R&D productivity is still larger for the established Western German innovation system than for Eastern Germany. Hence, a regional redistribution of public R&D subsidies might improve the overall innovation output of the German economy.

Title: Evaluation Methods For Non-Experimental Data

Author(s): Richard Blundell, Monica Costa Dias

Publication: Fiscal Studies; 2000; Vol. 21; pp: 427-68

Keywords: -

Abstract: This paper presents a review of non-experimental methods for the evaluation of social programmes. We consider matching and selection methods and analyse each for cross-section, repeated crosssection and longitudinal data. The methods are assessed drawing on evidence from labour market programmes in the UK and in the US.

Title: Do R&D Subsidies Matter? – Evidence for the German Service Sector

Author(s): Dirk Czarnitzki, Andreas Fier

Publication: Centre for European Economic Research (ZEW); 2001; Discussion Paper No. 01-19

Keywords: Innovation, Public R&D Subsidies, Service Sector, Policy Evaluation

Abstract: In recent times the service sector is often called the driving force of today‘s economies. This paper analyses the innovative activities of German service firms. We investigate whether firms that receive public subsidies for innovation projects engage more in innovative activities than others. Additionally, we test the hypothesis that innovative firms are more likely to get public grants in the future. Empirically, it turns out that public grants raise the firms‘ privately financed innovative activities. The more grants a firm has received in the past, the more it invests in current innovation projects. Furthermore, innovating firms are more likely to have future access to public grants. Additionally, the share of university graduates of firms' total employees is an important factor for future participation in public R&D schemes.

Title: Is Public R&D A Complement or Substitute for Private R&D? A Review of the Econometric Evidence

Author(s): David PA, Hall BH, Toole AA

Publication: Research Policy; 2000; Vol. 29(4-5); pp: 497-529

Keywords: R&D; Fiscal Policy; Government Subsidy; Technology Policy

Abstract: Is public R&D spending complementary and thus "additional" to private R&D spending, or does it substitute for and tend to "crowd out" private R&D? Conflicting answers are given to this question. We survey the body of available econometric evidence accumulated over the past 35 years. A framework for analysis of the problem is developed to help organize and summarize the findings of econometric studies based on time series and cross-section data from various levels of aggregation (laboratory, firm, industry, country). The findings overall are ambivalent and the existing literature as a whole is subject to the criticism, that the nature of the "experiment(s)" that the investigators envisage is not adequately specified. We conclude by offering suggestions for improving future empirical research on this issue.

Title: Barriers to Innovation and Subsidy Effectiveness

Author(s): Gonzalez X, Jaumandreu J, Pazo C

Publication: RAND Journal of Economics; 2005; Vol. 36(4); pp: 930-950

Keywords: Research and Development

Abstract: We explore the effects of subsidies by means of a model of firms' decisions about performing R&D when some government support can be expected. We estimate it with data on about 2,000 performing and nonperforming Spanish manufacturing firms. We compute the subsidies required to induce R&D spending, we detect the firms that would cease to perform R&D without subsidies, and assess the change in the privately financed effort. Results suggest that subsidies stimulate R&D and some firms would stop performing in their absence, but most actual subsidies go to firms that would have performed R&D otherwise. We find no crowding out of private funds.

Title: Are R&D Subsidies A Substitute or A Complement to Privately Funded R&D? Evidence from France Using Propensity Score Methods for Non-Experimental Data

Author(s): Emmanuel Duguet

Publication: Working Paper Université de Paris I – Cahiers de la MSE, EUREQua n°2003(75)

Keywords: Propensity Score, Non-Experimental Data, Policy Evaluation, Research and Development, Subsidies

Abstract: This study examines the effect of research and development subsidies on the private funding of R&D in France. We address this issue from the annual R&D survey over 1985-1997, which provides information about the R&D subsidies given by all the ministries to the firms having at least one full-time person working on R&D. In order to determine whether the supported firms would have invested the same amount of private R&D without the subsidies, we use matching methods. We show that the use of these methods is important because the global evaluations, in this paper, more often give a potential effect among the non-supported firms than a real effect among the supported firms. We first study the probability to get a subsidy. We find that this probability is increasing with size, the debt ratio and the importance of privately funded R&D. In a second step, controlling for the past public support the firms benefited from, we find that, on average, public funds add to private funds, so that there would be no significant crowding out effect.

Title: Evaluating Technology Programs: Tools and Methods

Author(s): Georghiou L, Roessner D

Publication: Research Policy; 2000; Vol. 29(4-5); pp: 657-678

Keywords: Technology Programs; Tools; Methods

Abstract: This article reviews the analytical tools, methods, and designs being used to evaluate public programs intended to stimulate technological advance. The review is organized around broad policy categories rather than particular types of policy intervention, because methods used are rarely chosen independent of context. The categories addressed include publicly-supported research conducted in universities and public sector research organizations; evaluations of linkages, especially those programs seeking to promote academic-industrial and public-private partnerships; and the evaluation of diffusion and industrial extension programs. The internal evaluation procedures of science such as peer review and bibliometrics are not covered, nor are methods used to evaluate projects and individuals ex ante. Among the conclusion is the observation that evaluation work has had less of an impact in the literature than it deserves, in part because much of the most detailed and valuable work is not easily obtainable. A second conclusion is that program evaluations and performance reviews, which have distinctive objectives, measures, and tools, are becoming entangled, with the lines between the two becoming blurred. Finally, new approaches to measuring the payoffs from research that focus on linkages between knowledge producers and users, and on the characteristics of research networks, appear promising as the limitations of the production function and related methods have become apparent.

Title: Econometric Evaluation of Public R&D Policies: Current State of the Art

Author(s): Aerts K, Czarnitzki D, Fier A

Publication: Unpublished Manuscript; KU Leuven; 2006

Title: The Effects of Public R&D Subsidies on Firms' İnnovation Activities: The Case of Eastern Germany

Author(s): Almus M, Czarnitzki D

Publications: Journal of Business and Economic Statistics; 2003; Vol. 21(2); pp: 226-36

Keywords: Public Innovation Subsidies; Non–Parametric Matching

Abstract: This study analyzes the effects of public R&D policy schemes on the innovation activities of firms in Eastern Germany.-The main question in this context is whether public funds stimulate R&D activities or simply crowd out privately financed R&D. Empirically, we investigate the average causal effects of all public R&D schemes in Eastern Germany using a nonparametric matching approach. Compared to the case in which no public financial means are provided, it turns out that firms increase their innovation activities by about four percentage points.

Title: International Journal of Technology Management

Author(s): Ulrich Blum, Falk Kalus

Publication: International Journal of Technology Management; 2003; Vol. 26(2/3/4); pp: 270-276

Keywords: -

Abstract: We propose to auction the financial incentives that public institutions hand out in order to enhance certain aims, for instance such as an increased level of research and development. Obstacles such as the heterogeneity of projects may force the institution benefiting from the funds to reveal the market potential. An auction design is proposed for research and development programmes.

Title: An Empirical Evaluation Of The Effects Of R&D Subsidies

Author(s): Isabel Busom

Publication: Economics of Innovation and New Technology; 2000; Vol. 9; pp: 111-148

Keywords: Technology Policy; R&D; Subsidies; Policy Evaluation

Abstract : R&D subsidies are a common tool of technology policy, but little is known about the effects they have on the behavior of firms. This paper presents evidence on the effects that R&D subsidies have on the R&D effort of recipients, and on the probability that a firm will participate in a program granting R&D subsidies. The empirical model consists of a system of equations: a participation equation; and an R&D effort equation. Endogeneity of public funding is controlled for. Estimates are obtained with a cross-section sample of Spanish firms. The main findings are that: 1) small firms are more likely to obtain a subsidy than large firms, probably reflecting one of the public agency's goals; 2) overall, public funding induces more private effort, but for some firms (30% of participants) full crowding out effects cannot be ruled out, and 3) firm size remains related to effort, whether or not a firm gets public funding.

Title: Classifying Technology Policy from An Evolutionary Perspective

Author(s): Uwe Cantner, Andreas Pyka

Publications: Research Policy; 2001; Vol. 30; pp: 759-775

Keywords: Mission-Oriented Policy; Diffusion-Oriented Policy; Technological Specificity; Market Vicinity

Abstract: For the classification of technology policy in an evolutionary framework the taxonomy of mission- and diffusion-oriented policy design introduced by Ergas [Ergas, H. (1987), The importance of technology policy, in: Dasgupta, P., Stoneman, P. (eds.), Economic Policy and Technological Performance, Cambridge Univ. Press, Cambridge.] is useful. However, Ergas' indirect method of identifying the respective policy style is only able to give a first and rough insight in the technology policy of a specific country. To improve on that, we developed a so-called direct method aiming at a sound characterization of single policy measures and giving a more detailed picture about policy orientation. To demonstrate the basic procedure of the suggested approach, it is applied empirically on the German technology policy of the last 2 decades.

Title: Research and Development in Small and Medium-Sized Enterprises: The Role of Financial Constraints and Public Funding

Author(s): Dirk Czarnitzkin

Publications: Scottish Journal of Political Economy; 2006; Vol. 53(3); pp: 335-357

Keywords: -

Abstract: This paper presents microeconometric evidence on financing constraints for research and development activities in German small- and medium-sized firms (SME). Special attention is paid to the role of public research and development (R&D) subsidies. For this purpose SMEs in West and East Germany are compared because these regions are very different in their supply of public R&D funding. The empirical evidence suggests that West German SMEs are financially constrained in their R&D activities by both internal and external resources. In East Germany, firms are not sensitive to external constraints, possibly due to high public R&D subsidies. The results show that R&D in East Germany is to a large extent driven by public subsidies and that the usual financial market mechanisms are dysfunctional with respect to R&D in this region.

Title: Evaluating R&D Effectiveness: A Study on Chinese Practice and Trend

Author(s): Xu Qingrui, Zheng Gang, Liu Jingjiang, Chen Jin

Publication: -

Keywords: -

Abstract: This article reviews and summarizes the popular theories, methods and tools being used to evaluate the R&D performance in China, as well as their limitations and drawbacks. Based on it, and refer to the practice abroad, some promising approaches and trends are introduced by which to evaluate the R&D performance effectively in the coming Knowledge-based Economy Era.

Title: An International Review of Methods to Measure Relative Effectiveness of Technology Policy Instruments

Author(s): Technopolis: Patries Boekholt, Maureen Lankhuizen, Erik Arnold, John ClarkeJari, Kuusisto, Bas de Laat, Paul Simmonds; School of Public Policy Georgia Institute of Technology: Susan Cozzens, Gordon Kingsley; ACIIC, University of Sydney: Ron Johnston

Publication: *Final Report; 2001*

Keywords: -

Executive summary: Is it possible to compare the relative effectiveness of innovation policy instruments? And if so, can this be supported by solid quantitative data that express the level of effectiveness of each innovation policy instrument? These were the key question that led our study into the use of relative effectiveness measurement in an international perspective. On behalf of the Dutch Ministry of Economic Affairs (EZ) a team led by the Technopolis – Group1, has conducted this study in a set of nine countries2. The study established whether relative effective measurement is a common evaluation practice in these countries. The study serves as an important input for the debate on the use of (relative) effectiveness measurement in the Netherlands. Innovation policy instruments are aimed to have effects on innovation behaviour, on levels of innovation activities, on the economic performance of the companies involved and ultimately the society at large. The aim of assessing relative effectiveness is ultimately to make policy choices where and how to invest public money. In order to make these choices politicians and policy makers need information on the achievements of policy instruments in operation. Instruments that function well in achieving their objectives and offer a good 'value-for-money' can be prolonged, alternatives should be found for instruments which are not effective. Policy evaluation is the commonly used tool to provide this information. Our study explores whether other countries employ evaluation methods that allow them to compare the effectiveness of several instruments. The background why this study has been launched is shortly described in Chapter 1. Chapter 2 deals with the question of appropriateness of selecting instruments on the basis of their relative effectiveness. First the chapter summarises modern innovation theory and current thinking on the role of policy in stimulating innovation. The emphasis is on the role of the innovation system in determining the policy mix. Next it analyses what choices a number of benchmark countries have made with regard to public investment in innovation. These are then compared to the Dutch policy mix to assess whether technology policy in the Netherlands deviates from policies in other countries. Chapter 3 looks at the way evaluation is organised in the benchmark countries. By way of a number of good practice examples, the chapter shows that careful preparation of programmes – including an analysis of the rationale, formulation of well defined objectives and measurable targets, an ex-ante assessment of expected effects – can raise their effectiveness ex-post. Chapters 4 and 5 explicitly deal with the issue of the possibility to measure the relative effectiveness of innovation policy instruments. The experiences of other countries serve as a starting point for the analysis. Chapter 4 looks at the methods that are used to measure effectiveness of single programmes and the problems that are involved in these methods. Chapter 5 presents the findings on how relative effectiveness is actually used in other countries and what lessons the Netherlands can draw from these experiences. Chapter 6 summarises the main conclusions and recommendations of this report.

Title: A Tool for Measuring the Performance in the R&D Organizations

Author(s): Mario Coccia

Publication: -

Keywords: -

Abstract: -

Title: Methodologies for the Analysis of Research Funding and Expenditure: From Input to Positioning Indicators

Author(s): Benedetto Lepori

Publication: Research Evaluation; 2006; Vol. 15(2); pp: 133-143

Keywords: -

Abstract: This paper discusses the status of indicators concerning research funding and expenditure and proposes some pathways for further developments. First, I discuss in depth the design of the R&D statistics based on the Frascati manual and its limitations concerning analytical categories, data availability and quality. Further I argue that, to answer to specific policy questions concerning the allocation of funds, the development of a new generation of indicators is needed — so-called positioning indicators — focusing on the analysis of financial fluxes between research funders, intermediaries and performers, and I present some recent results of comparative European work in this direction. Finally, I draw some general methodological lessons on the nature of these indicators and on the procedure for their production, discussing key aspects such as reproducibility, quality validation, simplicity, contingency and transparency.

Title: Public/Private Technology Partnerships: Evaluating SBIR-Supported Research

Author(s): David B. Audretsch, Albert N. Link, John T. Scott

Publication: Research Policy; 2002; Vol. 31; pp: 145-158

Keywords: Small Business; Innovation; Public/Private Partnership; R&D; Program Evaluation

Abstract: This paper evaluates public support of private-sector research and development (R&D) through the Department of Defense's (DoD's), Small Business Innovation Research (SBIR) Program. Based on alternative evaluation methods applicable to survey data and case studies, we conclude that there is ample evidence that the DoD's SBIR Program is stimulating R&D as well as efforts to commercialize that would not otherwise have taken place. Further, the evidence shows the SBIR R&D does lead to commercialization, and the net social benefits associated with the program's sponsored research are substantial.

Title: R&D Advancement, Technology Diffusion and Impact on Evaluation of Public R&D

Author(s): Michal C. Moore, Douglas J. Arent, Douglas Norland

Publication: Energy Policy; 2007; Vol. 35; pp: 1464-1473

Keywords: Economic-Benefits Evaluation; Market Penetration; Product Innovations

Abstract: In a 2001 report titled Energy Research at DOE: Was It Worth It? a National Research Council (NRC) committee defined a set of simplifying rules to estimate the net economic benefits from technologies supported by the Department of Energy (DOE). We evaluate the efficacy of the NRC rules compared to published literature on acceleration of technology introduction into markets, technology diffusion, and infrastructure change. We also offer considerations for revisions of the rules that call for the use of technology and sectorspecific data, advanced forecasting techniques, and sensitivity analysis to test the robustness of the methodology.

Title: Why Impact Analysis Should Not Be Used for Research Evaluation and What the Alternatives Are

Author(s): Javier Ekboir

Publication: Agricultural Systems; 2003; Vol. 78; pp: 166-184

Keywords: Complexity; Research Policy; Random Processes

Abstract: Many impact studies relate changes in impact indicators to research investments. This is valid only if an implicit assumption is true: that the link between indicators and investments dominates all other relationships that influence the impact indicators. However, this is only true for minor improvements along stable technological paths. In most cases, other factors, such as policies and markets, influence adoption and, consequently, impact. The problem is compounded because impacts often appear after many years and usually cannot be measured. Since many factors influence adoption, research impacts should be analyzed as part of a complex adaptive system that depends on external forces (e.g., markets), the direct and indirect interactions among agents (e.g., researchers, input suppliers and farmers), and the technology's nature and evolution. The complexity framework has broad consequences for agricultural and research policies. Since impacts result from the actions of the whole network, they cannot generally be attributed to individual agents. In evaluating networks, the relevant parameters to study are the rules for generating, collecting and sharing information, financing procedures, intellectual property-rights regulations and availability of human and financial resources. For individual agents the relevant indicators are their patterns of participation in particular networks, benefits and costs of participation, evaluation criteria, financial arrangements and institutional cultures.

Title: An Ex Ante Evaluation Framework for the Regional Benefits of Publicly Supported R&D Projects

Author(s): Stephen Roper, Nola Hewitt-Dundas, James H. Love

Publication: Research Policy; 2004; Vol. 33, pp:487-509

Keywords: Research and Development; Evaluation; Ex Ante; Regional Policy

Abstract: This paper draws on the knowledge-base implicit in ex post evaluations of publicly funded R&Dand other related conceptual and empirical studies to suggest a framework for the ex ante evaluation of the regional benefits from R&D projects. The framework developed comprises two main elements: an inventory of the global private and social benefits which might result from any R&D project; and, an assessment of the share of these global benefits which might accrue to a host region, taking into account the characteristics of the R&D project and the region's innovation system. The inventory of global benefits separately identifies private and social benefits and distinguishes between increments to public and private knowledge stocks, benefits to R&D productivity and benefits from commercialisation. Potential market and 'pure' knowledge spillovers are also considered separately. The paper concludes with the application of the framework to two illustrative case studies.

Title: Learning from Science and Technology Policy Evaluation

Author(s): Bad Herrenalb, Philip Shapira, Stefan Kuhlmann

Publication: European Workshop, available at **http://www.cherry.gatech.edu/e-value** or **http://www.isi.fhg.de/ti/departm.htm**

Keywords: -

Abstract: -

Title: Substitution Versus Additionality: Econometric Evaluation by Means of Micro-Economic Data of the Efficacy and Efficiency of R&D Subsidies to Firms in the Flemish Region

Author(s): Wim Meeusen, Wim Janssens

Publication: CESIT (Centre for the Economic Study of Innovation and Technology); 2001; Discussion paper No 2001/01
Keywords: -

Abstract: Do government R&D subsidies add to the global amount of private expenditures by private firms, or do they rather come in the place of funds that the firms that benefit from them would have provided themselves anyhow ? This is the central question on which we focus in this paper. We use extensive survey data on Flemish firms as the basis of an econometric exercise for the period 1992-1997. We supplement the results obtained in this way by the outcome of a brief interview with R&D managers at a number of large Flemish firms active on the R&D scene. Section 2 reviews the existing literature on the subject, both theoretical and empirical. In section 3 we discuss the data and the general model that is used. Section 4 contains the results from the econometric analysis, and in section 5 we present the results of the higher mentioned interview. We conclude in section 6.

Title: Qualitative Evaluation Methods As A Means of Enhancing Public-Private Cooperation in Innovation Networks

Author(s): Eric Davoine, Ludger Deitmer

Publication: -

Keywords: -

Abstract: Networks with public and private partners have emerged as a key form of Research & development organization, in an endeavour to increase the speed of product and service development in a highly competitive environment. Such public-private partnerships (ppp) enable the actors to save time, to share costs and to develop market oriented innovations. However, cooperation between actors in such PPP-networks requires new structuring tools in order to bring public and private actors to cooperate, which is a major “macro-sociological” issue. This article examines through a case study in the field of biotechnology how qualitative and participative evaluation methods can help the actors to structure their networks and to build effective partnerships at a micro-level.

Title: The Austrian Science Fund: Ex Post Evaluation and Performance of FWF Funded Research Projects

Author(s): Michael Dinges

Publication: Institute of Technology and Regional Policy; 2005; Intereg Research Report Series, Report No. 42

Keywords: -

Abstract: -

Title: Detecting Behavioural Additionality: An Empirical Study on the Impact of Public R&D Funding on Firms' Cooperative Behaviour in Germany

Author(s): Birgit Aschhoff, Andreas Fier and Heide Löhlein

Publication: Centre for European Economic Research (ZEW); 2006; Discussion Paper No. 06-037

Keywords: Public Funding; Firm Behaviour; Policy Evaluation; R&D Co-operation

Abstract: Subsidising research networks has become a popular instrument in technology policies, driven mainly by expected positive spillovers. In particular, the stimulation of R&D co-operation between scientific institutions and industry is considered as most promising. In the context of policy evaluation we analyse if public R&D funding is suitable for influencing firms' collaborative behaviour in the intended way and where applicable, if a lasting change results. The empirical analysis is based on German CIS data and a supplemental telephone survey. Using a nearest-neighbour matching approach we find that R&D funding is indeed a particularly valuable tool for the linking of science into industry R&D partnerships. However, we also show in a bivariate probit analysis that newly initiated R&D co-operations with science are less likely to be continued after funding has ended compared to already existing co-operations. Therefore, the behavioural change induced by public funding is not necessarily longlived.

Title: The Impact of Public Funds on Private R&D Investment: New Evidence from a Firm Level Innovation Study

Author(s): Hans Lööf, Almas Heshmati

Publication: 2005; MTT Discussion Papers 3

Keywords: R&D Investment; Crowding Out; Public Funding; Matching; Subsidies

Abstract: This paper investigates the effectiveness of a public innovation policy aimed at stimulating private R&D investment. The research will examine whether public funding increases the total spending on research or merely displaces funding from private sources. The emprical analysis is based on the Community Innovation Survey data merged with register data. It is an evaluation of whether firms receiving public funds have on average a higher R&D intensity compared to those not receiving any such support. In oeder to account for possible selectivity bias, and to improve comparability of firms, two different versions of a semi-parametric matching approach are employed. The two matching estimators result in somewhat different results. The Nearest Neighbour estimator is preferred to the Kernel estimator. The results support the hypothesis suggesting that there are additive effects of public R&D financing on private research expenditures, but the only beneficiaries are small firms.

Title: Evaluation of Socio-Economic Impacts of Public R&D: Practices and Experiences in Europe

Author(s): Prof. Dr. Stefan Kuhlmann

Publication: -

Title: Behavioural Additionality Effects of R&D Subsidies: Empirical Evidence from Austria

Author(s): Rahel Falk

Publication: -

Keywords: R&D Subsidies; Management of Technological Innovation and R&D; Government Policy

Abstract: There is a broad empirical literature on directly measurable economic effects of public R&Dpromotion schemes. While some papers focus on gross effects such as increased turnover, enhanced productivity, stronger competitiveness, improved market positions and the like (output additionality), others address the question in how far public R&D-assistance induces companies to spend more own additional resources on R&D than they would have spent anyway (input additionality). "Behavioural Additionality" in turn broadens the traditional additionality concepts by looking at permanent changes in the conduct of a company, possibly mirrored in a more formal institutionalization of innovation and R&D-activities. Based on firm-level data this paper is the first to empirically analyse such (behavioural) additionality aspects of companies that have received subsidies from the Austrian federal R&D-support scheme (FFF). The empirical results widely support the notion that assisted companies have been successful to enhance their innovation capabilities and competence building in general and to make use of new technologies and R&D-procedures elsewhere.

Title: Evaluation of Research and Innovation Policies: A Discussion of Trends With Examples from Germany

Author(s): Stefan Kuhlmann

Publication: International Journal of Technology Management; 2003; Vol. 26(2/3/4); pp: 131-149

Keywords: Self-Referential Evaluation; German Research System; Evaluation of Innovation Programs; Summative and Formative Evaluation.

Abstract: Recent changes in the field of evaluation refer to new demands by politics, economies and society to extend the subject of evaluation processes to cross-sectoral research promotion programmes and research institutions, and new developments within the research of evaluation itself. The paper presents an overview of these trends and consequences for the function and methods of evaluation of research and innovation policies against the background of recent German experiences.

Title: Evaluation of Current Fiscal Incentives for Business R&D in Belgium

Author(s): Prof. Bruno Van Pottelsberghe, Steve Nysten, Esmeralda Megally

Publication: Solvay Busıness School, ULB, June 2003

Keywords: -

Abstract: -

Title: Toward a Standard Benefit-Cost Methodology for Publicly Funded Science and Technology Programs

Author(s): Jeanne Powell

Publication: NISTIR 7319, National Institute of Standards and Technology • Technology Administration • U.S. Department of Commerce

Keywords: Advanced Technology Program; Benefit-Cost Analysis; Discounted Cash Flows; Program Evaluation; Science & Technology Programs; Research & Development; Research Impacts; Prospective Analysis; Retrospective Analysis; Social Return on Investment; Public Return on Investment.

Abstract: The Economic Assessment Office of the Advanced Technology Program (ATP) seeks to develop a standard methodology for undertaking benefitcost studies of science and technology projects for purposes of quantifying federal program impacts. A key objective is to facilitate comparability and aggregation among benefit-cost studies of individual projects. This report discusses similarities and differences among the ATP's benefit-cost studies performed to date. The emphasis is on identifying methodological steps that can be taken to facilitate consistency and comparability across studies and aggregation of results of studies performed at different times. Such aggregation is needed to enable analysis across a portfolio of projects funded by a given program over time. This report draws on ATP's experience in funding risky, industry-led advanced technology projects and in conducting and publishing benefit-cost studies of nearly 30 projects. It helps extend the role of the National Institute of Standards and Technology in international, economics-based standards development by helping create a comprehensive standard benefit-cost methodology for the science and technology community.

Title: A Basic Model for Evaluating R&D Performance: Theory and Application in Italy

Author(s): Mario Coccia

Publication: R&D Management; 2001; Vol. 31(4); pp: 453-464

Keywords: -

Abstract: Nowadays the public R&D laboratories have a fundamental role in countries' development, supporting businesses as they face the technological challenges in the turbulent world scenarios. Measuring the performance of R&D organisations is crucially important to decisions about the level and direction of public funding for research and development. This research considers the public laboratories like systems and develops a mathematical model based on the measurement of R&D activities with k□indices. The score obtained from the research laboratories evaluation (relev) methodology synthesises in single value financial, scientific and technological aspects. It is an indicator, for R&D manager and policy maker, of performance in relation to other research organisations or in a time series. The method is an instrument of strategic planning and can be used for the improvement of individual activities and the overall performance of public R&D bodies.

Title: The Evolution of A Local R&D Strategy: The Experience of A Service in the UK National Health Service (NHS)

Author(s): David Rogers

Publication: R&D Management; 2004; Vol. 34(1)

Keywords: -

Abstract: Increasing concern about the state of health-related research in the UK in the 80s and early 90s, led to an influential parliamentary review. The consequence of this was to strengthen health research through a programme that was fully integrated into the management structure of the NHS. No country had ever attempted such an ambitious approach (Black, 1997). In 1994 a far-reaching review, recommended further, revolutionary changes to the management of R&D in the UK National Health Service (Culyer, 1994). Many of these were implemented in 1997 with the result that every UK health service at regional andlocal level has developed an infrastructure, and management arrangements for R&D activity. In most local areas, hospitals with significant involvement in R&D have been eligible to bid to the UK Department of Health for NHS R&D Support funds. In Nottingham, three Hospital Trusts and a community based service made bids to the Department of Health and received grants to support R&D. This paper focuses on one of the hospital Trusts - the mental health service in Nottingham. Our experience will be of particular interest as the first bid that the mental health service made was spectacularly unsuccessful. The organisation was forced to consider dis-investment in its existing research infrastructure and a potential negative impact on the provision of patient care. This led to a wide-ranging consultation and evaluation of research and research-related activity. A range of approaches and tools were deployed to develop the strategy and to ensure its successful implementation and evolution. The strategy reflected a balanced approach, taking into account historical and organisational research strengths, while recognising the need to build capacity and capability, enhance foresight capability and strengthen the knowledge base. The ability to contribute to, and influence policy and practice has been a key driver of the strategy. The result was a successful bid and the evolution of an R&D strategy that has been flexible in its response to policy changes, changing local circumstances and wider socio-economic trends and technical innovations. Furthermore, R&D performance, measured through outputs, impacts and income, has continually improved and increased.

Title: Evaluation of the Finnish Innovation Support System

Author(s): Luke Georghiou, Keith Smith, Otto Toivanen, Pekka Ylä-Anttila

Publication: Ministry of Trade and Industry Finland Publications 5/2003

Keywords: -

Abstract: -

Title: Macroeconomic RTD Evaluation Methodologies

Author(s): Henri Capron, Michele Cincera, Jaime Rojo

Publication: -

Keywords: -

Abstract: -

Title: Methods for Assessing the Economic Impacts of Government R&D

Author(s): Gregory Tassey

Publication: National Institute of Standards & Technology Program Office, Strategic Planning and Economic Analysis Group, Planning Report 03-1

Keywords: -

Abstract: Analyses of the actual or potential economic impacts of government R&D programs have used a number of distinctly different methodologies, which has led to considerable confusion and controversy. In addition, particular methodologies have been applied with different levels of expertise, resulting in widely divergent impact assessments for similar types of R&D projects. With increased emphasis on government efficiency, the current state of methodology for strategic planning and retrospective impact analyses is unacceptable. NIST has over the past decade conducted 30 retrospective microeconomic impact studies of its infratechnology (laboratory) research programs. Additional microeconomic studies have been conducted of technology focus areas in its Advanced Technology Program (ATP) and of the aggregate impacts of its Manufacturing Extension Partnership (MEP) Program. In addition, NIST has undertaken prospective (strategic planning) economic studies of technology infrastructure needs in a number of divergent and important industries. From these studies have evolved methodologies for conducting microeconomic analyses of government technology research and transfer programs. The major steps in conducting economic impact studies are identifying and qualifying topics for study, designing an analytical framework and data collection plan, conducting the empirical phase of the study, writing a final report and summaries of that report, and disseminating the results to government policy makers, industry stakeholders, and other interested parties. Execution of these steps is not straightforward. No consensus exists with respect to scope and depth of industry coverage, development of an analytical framework (including choice of metrics and impact measures), and design of data collection strategies. Even when an acceptable methodology is chosen and effectively executed, the results are frequently not understood by policy makers. NIST has therefore developed a methodology over the past decade that addresses the technology-based economic activity being studied, is appropriate for the nature of the government program or project responding to an underinvestment phenomenon, and provides an analysis understandable by industry and government stakeholders. Based on the NIST experience, this report describes methodologies appropriate for economic impact assessments of Government R&D programs and gives numerous examples of their application to specific studies. Guidelines for interpretation of both qualitative and quantitative results are provided.

Title: Publicly Funded R&D Collaborations and Patent Outcome in Germany

Author(s): Dirk Czarnitzki and Andreas Fier

Publication: Centre for European Economic Research (ZEW); 2003; Discussion Paper No. 03-24

Keywords: R&D; Public Subsidies; Collaboration; Policy Evaluation

Abstract: The stimulation of co-operations and networks has become very popular in R&D policies in recent years. This study examines the development and the impact of publicly funded R&D consortia in Germany. The paper describes the history of R&D funding in Germany with a focus on the development of measures encouraging collaborative R&D activities among firms and public research institutions. Due to a recent shift of policies to more competitive procedures in awarding public funds for R&D, we investigate empirically the impact of such measures on patenting activity at the firm level. The microeconometric results show that collaborating firms are more likely to patent than others. Within the group of collaborating firms, participants in publicly sponsored R&D consortia exhibit a higher propensity to patent than firms in non-sponsored networks. Especially SMEs seem to benefit from spillovers which makes their application for patents more likely.

Title: Indicators for Comparative Analysis of Public Project Funding: Concepts, Implementation and Evaluation

Author(s): Benedetto Lepori, Peter van den Besselaar, Michael Dinges, Ruth Mampuis, Bianca Potì, Emanuela Reale, Stig Slipersaeter, Jean Theves, Barend van der Meulen

Publication: -

Keywords: -

Abstract: -

Title: Evaluation of the NHS R&D Implementation Methods Programme

Author(s): Steve Hanney, Bryony Soper, Martin Buxton

Publication: Health Economics Research Group (HERG); 2003; Research Report No. 29

Keywords: -

Abstract: -

Title: Evaluating R&D: Obstacles and Opportunities in the Application of Network Analysis to the Evaluation of R&D

Author(s): Juan D Rogers, Barry Bozeman, Ivan Chompalov

Publication: Research Evaluation; 2001; Vol. 10(3); pp: 161-172

Keywords: -

Abstract: A comprehensive review of studies that apply the network approach to investigating the development of S&T identifies obstacles characterizing current network research and impeding the revelation of its potential fruitfulness in research assessment. It is argued that, in order to fulfill its promise, network analysis needs to: reformulate the 'quintessential bureaucratic evaluation question'; examine more closely untidy networks; focus on the content of network links rather than their formal aspects; and develop a concept of 'network effectiveness' in terms of the network's ability to expand the uses of S&T knowledge.

Title: The Regional Level of Implementation of Innovation Policies

Author(s): -

Publication: Proceedings of a Workshop held in Brussels on 23-24 November 2000

Keywords: -

Abstract: -

Title: Evaluating R&D: Indicator-Assisted Evaluation of R&D Programmes: Possibilities, State of the Art and Case Studies

Author(s): Hariolf Grupp

Publication: Research Evaluation; 2000; Vol. 8(2); pp: 87-99

Keywords: -

Abstract: The paper examines the utility of science and technology (S&T) indicators for the evaluation of research and development(R&D)programmes. The main objective is to contribute to improved evaluation by quantitative information not being provided by the supported institutions or persons. Thus, S&T indicators try to establish more objective sets of data and to supplement peer evaluations, but not to replace them. The contribution presents a model for the innovation process and a typology of evaluative indicators. It reviews the methodological problems of the use of indicators for the evaluation of R&D programmes. In the empirical part, three very brief case studies are presented: laser metal working R&D (European Union programme), photovoltaics (German programme) and microsystems engineering (comparing Germany, the USA and Japan).

Title: Public Research: Public Research Funding and Research Policy: A Long-Term Analysis for the Swiss Case

Author(s): Benedetto Lepori

Publication: Science and Public Policy; 2006; Vol. 33(3); pp: 205-216

Keywords: -

Abstract: In this paper, an analysis is proposed of the evolution of public research in Switzerland from World War II to the year 2000. Thanks to the combination of different data sources, we produce a set of indicators for the overall volume of funding, the share of projects funds, and the share of the higher-education sector in the public research sector. Results are then linked to the development of the Swiss research and highereducation policy in the same period, leading to the identification of a major turning point at the end of the 1960s, when today's domination of higher education in the public research sector started.

Title: Spin-Offs, Externalities and the Economic Justification of Public Expenditure on R&D

Author(s): Kim Kaivanto

Publication: Centre for European Economic Research (ZEW); 2004; Discussion Paper No. 03-24

Keywords: Spin-Off; Externality; R&D Investment; Government Support; Technology Policy

Abstract: Frequently, public expenditure on R&D is justified with high-profile spin-off successes stories. Such arguments invariably commit to a particular, though not necessarily explicit sense of spin-off. Notwithstanding spin-off arguments' persuasive success in public discourse, their effectiveness in making the case for economic justification is dependent on the nature of the externalities associated with the spin-offs being reported. This paper develops a mapping of spin-off types onto the domain of externalities, spelling out the consequences, in terms of the strength of support conferred, for the economic justification of public expenditure on R&D.

Title: RTD Evaluation Toolbox

Author(s): -

Publication: Socio - Economic Evaluation of Public RTD Policies (EPUB); June 2002

Keywords: -

Abstract: -

Title: RTD-Evaluation Toolbox Assessing the Socio-Economic Impact of RTD-Policies

Author(s): Gustavo Fahrenkrog, Wolfgang Polt, Jaime Rojo, Alexander Tübke, Klaus Zinöcker

Publication: European Commission; August 2002; IPTS Technical Report Series, EUR 20382 EN

Keywords: -

Abstract: This publication presents results of the project called "Socio- Economic Evaluation of Public RTD policies (EPUB)", which has been awarded financial support by the European Commission under the 5th Framework Programme of the European Community for Research, Technological Development and Demonstration Activities (1998 to 2002), and its specific programme "Improving the Human Research Potential and the Socio-Economic Knowledge Base" ("STRATA- Strategic Analysis of Specific Political Issues"). The authors are solely responsible for this publication, which does not represent the opinion of the Commission. Neither the Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the information contained in this publication.

Title: The Economic Benefits of Publicly Funded Basic Research: A Critical Review

Author(s): Ammon J. Salter, Ben R. Martin

Publication: Research Policy; 2001; Vol. 30; pp: 509-532

Keywords: Economic Benefits; Basic Research; Government Funding

Abstract: This article critically reviews the literature on the economic benefits of publicly funded basic research. In that literature, three main methodological approaches have been adopted — econometric studies, surveys and case studies. Econometric studies are subject to certain methodological limitations but they suggest that the economic benefits are very substantial. These studies have also highlighted the importance of spillovers and the existence of localisation effects in research. From the literature based on surveys and on case studies, it is clear that the benefits from public investment in basic research can take a variety of forms. We classify these into six main categories, reviewing the evidence on the nature and extent of each type. The relative importance of these different forms of benefit apparently varies with scientific field, technology and industrial sector. Consequently, no simple model of the economic benefits from basic research is possible. We reconsider the rationale for government funding of basic research, arguing that the traditional 'market failure' justification needs to be extended to take account of these different forms of benefit from basic research. The article concludes by identifying some of the policy implications that follow from this review.

Title: Impact of Evaluation-Based Funding on the Production of Scientific Knowledge: What To Worry About and How To Find Out

Author(s): Jochen Gläser, Grit Laudel, Sybille Hinze, Linda Butler

Publication: -

Keywords: -

Abstract: -

Title: A Toolkit for Evaluating Public R&D Investment Models, Methods, and Findings from ATP's First Decade

Author(s): Rosalie Ruegg, Irwin Feller

Publication: -

Keywords: Advanced Technology Program; Assessment; Economic Evaluation; Evaluation Methods; Impact Analysis; Logic Models; Public Policy; Public-Private Partnership Program; R&D; Spillovers; Technology

Abstract: Evaluation is an essential component of publicly funded R&D programs, both in support of program management and public policy. The Advanced Technology Program (ATP) has emerged over its first decade as a leader in evaluation, engaging nationally prominent evaluators to apply new and existing methods in building an analytical and empirical basis for ATP's operations and performance. This report draws from a body of 45 studies commissioned by ATP between 1990 and 2000 and analyzes the methods and techniques used and examines the findings of those studies. These studies have increased understanding not only of ATP but also of the dynamics of innovation systems and the relationships between public and private sector funding of R&D. The findings examined are organized around five major themes: firm/industry effects, collaboration effects, spillover effects, interfaces and comparisons with other programs, and measures of overall program performance.

The extensive toolkit of evaluation methods presented in the report illustrates how those methods can be used to answer a variety of stakeholder questions. Methods include survey, descriptive and economic case study, bibliometrics, historical tracing, econometrics, expert judgment, social network analysis, cost index, and a composite performance rating system constructed from indicator metrics. Additionally, the use of analytical and conceptual modeling to explore a program's underlying relationships and process dynamics is considered. The political economy of ATP is discussed, and an evaluation framework and an overview of evaluation best practices are provided.

The report integrates and condenses a large body of related research and thus provides ATP with a convenient reference work, toolkit, and planning guide. For those administrators of other programs, public policy makers, and evaluators, the report also serves as an evaluation toolkit by providing a logical framework for program evaluation, illustrating the use of evaluation methods and techniques, providing an overview of evaluation principles and practices, organizing a body of knowledge on how public-private partnership programs function, and contributing to an understanding of what evaluation is and how it is practiced in the field of R&D.

Title: University Research Evaluation and Funding: An International Comparison

Author(s): Aldo Geuna, Ben R. Martin

Publication: -

Keywords: -

Abstract: Many countries have introduced evaluations of university research, reflecting global demands for greater accountability. This paper compares methods of evaluation used across twelve countries in Europe and the Asia-Pacific region. On the basis of this comparison, and focusing in particular on Britain, we examine the advantages and disadvantages of performance-based funding in comparison with other approaches to funding. Our analysis suggests that, while initial benefits may outweigh the costs, over time such a system seems to produce diminishing returns. This raises important questions about its continued use.

Title: Do Innovation Subsidies Crowd Out Private Investment? Evidence from the German Service Sector

Author(s): Dirk Czarnitzki, Andreas Fier

Publication: Applied Economics Quaterly (Konjunkturpolitik); 2002; Vol. 48(1), pp: 1-25

Keywords: Innovation; Public Innovation Subsidies; Service Sector; Policy Evaluation

Abstract: This paper analyses the impact of public innovation subsidies on private innovation expenditure. In the empirical economic literature there is still no common support for the hypothesis of either a complementary or a substitutive relationship between public funding and private investment. We investigate whether firms of the German service sector increase their innovation effort when participating in public policy schemes. Cross-sectional data at the firm level are used to estimate the effect of subsidisation. Applying a non-parametric matching approach we find evidence that the hypothesis of complete crowding-out effects between public and private funds can be rejected.

Title: Additionality of EU Framework Programmes

Author(s): Terttu Luukkonen

Publication: Research Policy; 2000; Vol. 29(6); pp: 711-724

Keywords: Addinality in Evaluation; EU Framework Programmes; R&D

Abstract: This paper draws attention to problems inherent in the routine application of the concept of additionality in evaluation. It exemplifies these problems by expressing them in a typology based on the perceived additionality of public R&D support and the strategic value of the R&D funded. Some categories are considered to represent successes of public R&D support and others to represent failures. The paper questions such routine assumptions, and uses empirical materials from EU framework programmes, a special case of public R&D programmes, to illustrate the problems. The paper ends by suggesting that the present system of evaluation rewards short-term success, and argues that it would be more beneficial to develop evaluation procedures that stretch over a longer period and are therefore able to pick up emerging areas of important technology supported by public programmes.

Title: The Relationship Between R&D Collaboration, Subsidies And R&D Performance: Empirical Evidence from Finland and Germany

Author(s): Dirk Czarnitzki, Bernd Ebersberger, Andreas Fier

Publication: Journal of Applied Econometrics; 2007; Vol. 22; pp: 1347-1366

Keywords: -

Abstract: This study focuses on the impact of innovation policies and R&D collaboration in Germany and Finland. We consider collaboration and subsidies as heterogeneous treatments, and perform an econometric matching to analyze R&D and patent activity at the firm level. In general, we find that collaboration has positive effects. In Germany, subsidies for individual research do neither exhibit a significant impact on R&D nor on patenting, but the innovative performance could be improved by additional incentives for collaboration. For Finnish companies, public funding is an important source of finance for R&D. Without subsidies, recipients would show less R&D and patenting activity, whilst those firms not receiving subsidies would perform significantly better if they were publicly funded.

Title: A Use-and-Transformation Model for Evaluating Public R&D: Illustrations from Polycystic Ovarian Syndrome (PCOS) Research

Author(s): Elizabeth A. Corley

Publication: Evaluation and Program Planning; 2007; Vol. 30(1); pp: 21-35

Keywords: -

Abstract: Evaluating federally funded research and development (R&D) presents unique challenges to both federal science agencies and evaluators. Often focusing only on outcome evaluative measures (such as productivity or economic value) can shortchange the true value of the federal investment. For example, program directors at the National Science Foundation (NSF) and National Institutes of Health (NIH) talk about the “value added” of the new interdisciplinary science centers that they have funded—and they hope to be able to capture how funding can generate increased capacity for new cutting-edge research in the future. The purpose of this paper is to present a use-and-transformation model for evaluating public R&D, which explicitly focuses on measuring capacity-based metrics for evaluation instead of outcome-based metrics. The theory for the model presented here explicitly uses the concept of a Knowledge Value Collective that was introduced by Bozeman and Rogers [Bozeman, B., & Rogers, J. D. (2002). A churn model of scientific knowledge value: Internet researchers as a knowledge value collective. Research Policy, 31(5), 769–794; Rogers, J. D., & Bozeman, B. (2001). “Knowledge value alliances”: An alternative to the R&D project focus in evaluation. Science Technology & Human Values, 26(1), 23–55].

Title: New Models for Measuring the R&D Performance and Identifying the Productivity of Public Research Institutes

Author(s): Mario Coccia

Publication: R&D Management; 2004; Vol. 34(3); pp: 267-280

Keywords: -

Abstract: Research evaluation of public institutes is important for measuring the performance of the science sector and improving the cost effectiveness and efficiency of public resource allocation. The purpose of this article is to construct a means of classifying publicly-funded R&D institutions and their performance (high or low). The main findings are two research performance functions, created using discriminant analysis with direct and Wilks methods, which have been successfully applied to 200 public research institutes belonging to the Italian National Research Council. The large number of indicators used within the models creates a macro index that produce, as output, the research performance score. The data analysed is from the 2001 period. The results show that 22.5% of public labs fall into the 'high performance institute' bracket and that they have a site larger than 'low performance institutes'. The models are useful tools for decision making within the research bodies and for reducing X-inefficiency.

Title: How to Regain Funds from Technology Promotion Programs: Results from An Evaluation of the Financial Instruments Used in Public R&D Funding of Incumbent SMEs

Author(s): Rothgang M, Trettin L, Lageman B

Publication: International Journal of Technology Management; 2003; Vol. 26(2-4); pp: 247-269

Keywords: -

Abstract: -

Books

Innovation Policy and Sustainable Development: Can Public Innovation Incentives Make a Difference?

Editor(s): Patries Boekholt

Publication: IWT- laanderen, Brussels (Contributions to a Six Countries Programme Conference); 2002

Learning from Science and Technology Policy Evaluation: Experiences from the United States and Europe

Editor(s): Philip Shapira, Stefan Kuhlmann

Publications: Edward Elgar Publishing; 2003; (ISBN:1840648759)

Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality

Publications: OECD; 2006

R&D Programme Evaluation: Theory and Practice

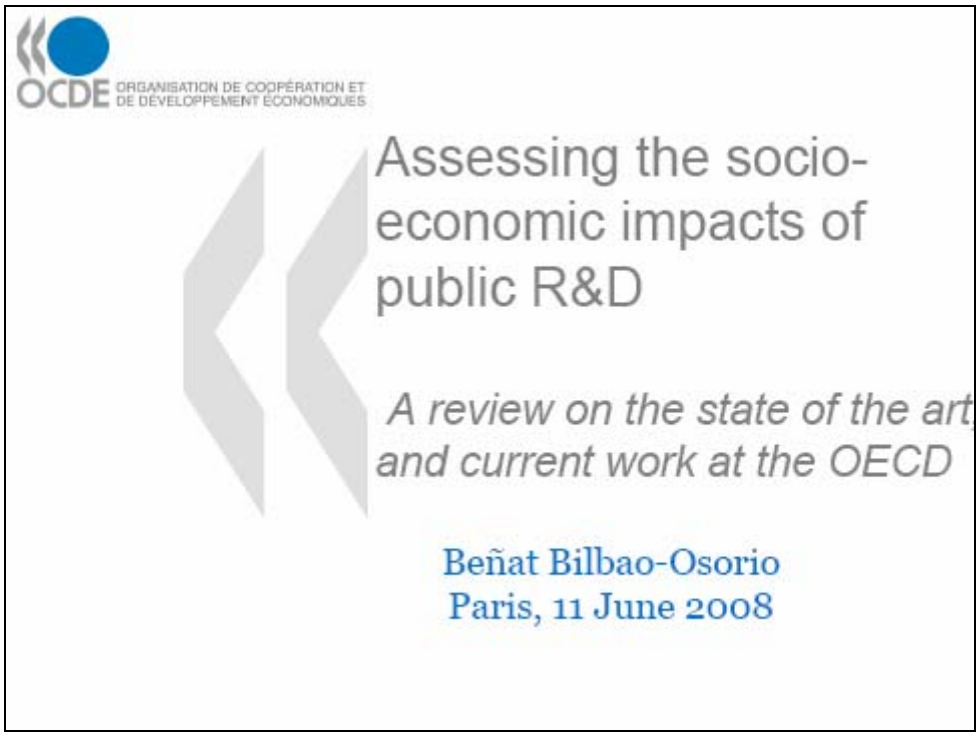
Author(s): Heung Deug Hong, Mark Boden

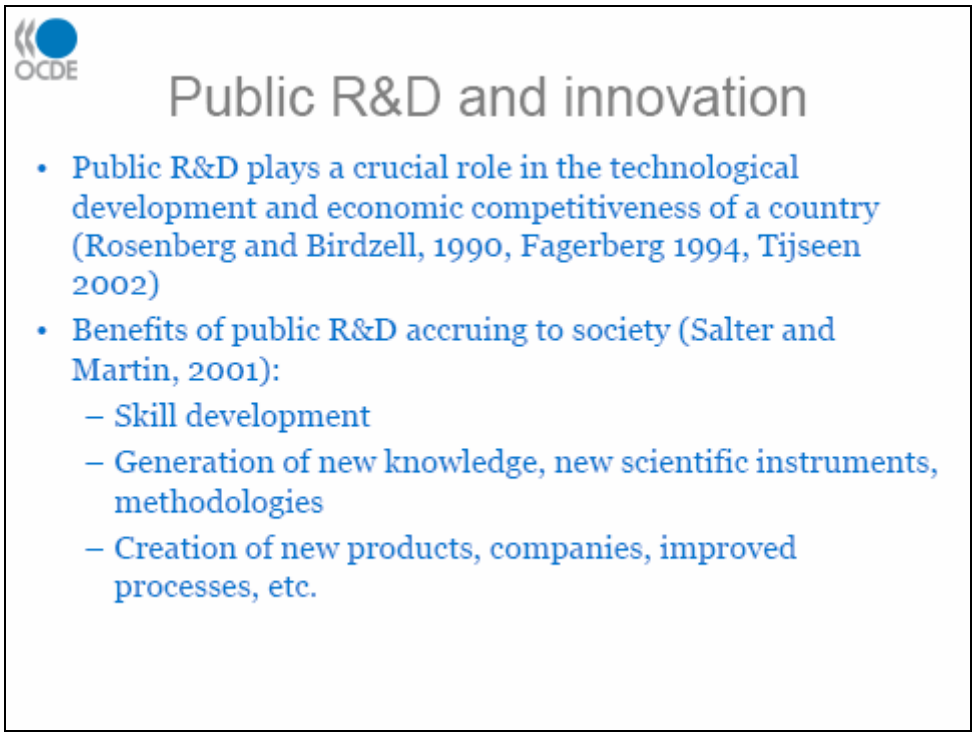
Publications: Ashgate Publishing Ltd.; 2003; (ISBN:0754632075)

EK-3: OECD KAMU AR-GE TOPLANTISI SUNULARI

(Working Party on Technology and Innovation Policy (TIP), Workshop on Assessing the Socio-economic Impacts of Public R&D Investment, 11 June 2008)

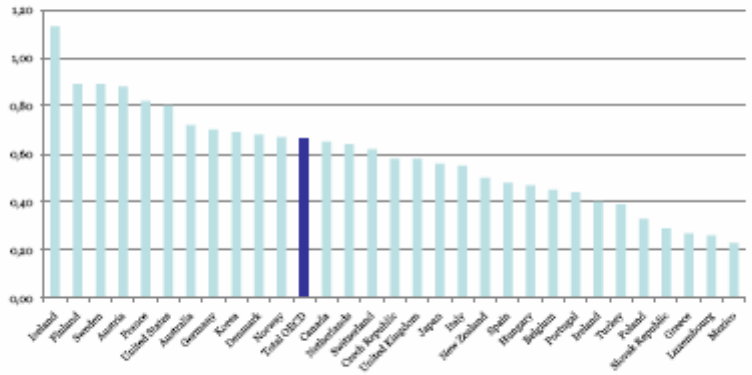
1. **OECD Project on Assessing the Socio-Economic Impacts of Public R&D, Beñat Bilbao-Osorio, OECD, DSTI**





Public R&D in OECD countries (1/3)

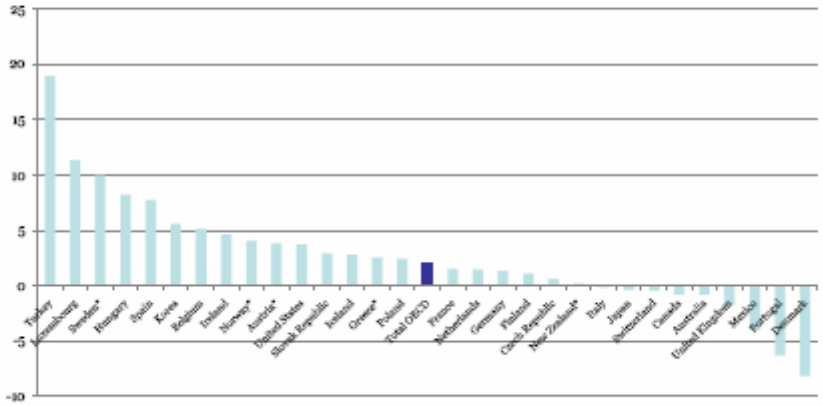
Government-financed GERD as a percentage of GDP(2005)



Source: OECD, MSTI (2008)

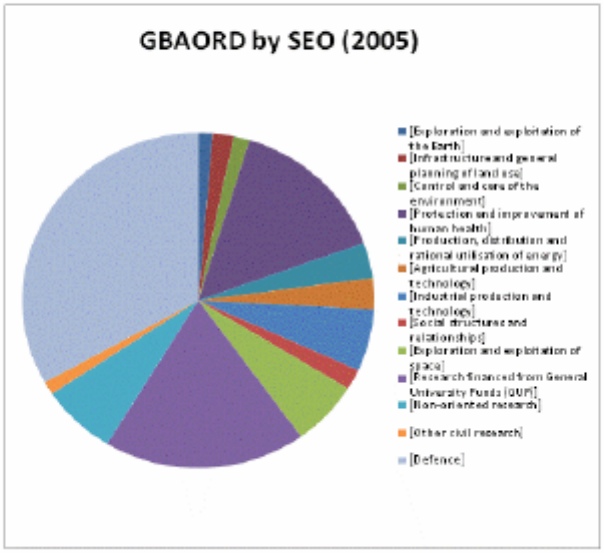
Public R&D in OECD countries (2/3)

Average annual growth rate of GOVERD (2000-2005)



Source: OECD, MSTI (2008)

Public R&D in OECD countries (3/3)



Importance of assessing the impacts of public R&D

- Determine its contribution to public objectives, such as economic growth, health outcomes, energy security
- Justify investments vis-à-vis other alternatives (e.g. education, health, etc)
- Raise awareness in the public and create a better informed society
- Enhance public accountability

Defining "public R&D" impacts

Many definitions of "impacts", depending on:

- The **nature** of the impact: economic, scientific, technological, cultural, societal environmental, etc.
- The **scope** of the impact: systemic, organisational, firm-based
- The **timing** of the impact: estimated, contemporary, ex-post

Challenges assessing public R&D impacts

- **Causality problem**
  What is the relationship between research inputs, outputs, outcomes and impacts? No direct or unidirectional relationship
- **Attribution problem**
  What portion of the benefits should be attributed to initial research and not to other inputs?
- **Internationality problem**
  Role of spillovers
- **Evaluation time scale problem**
  At which time should we measure the impacts?
- **Definition of appropriate indicators**

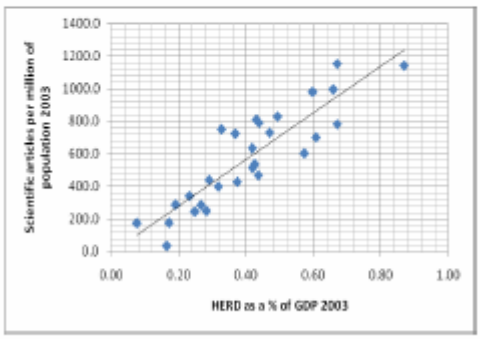
Traditional approaches to measuring "impacts" (1/2)

Traditionally, most work focused on input indicators. Recently, more indicators on research outputs have become available.

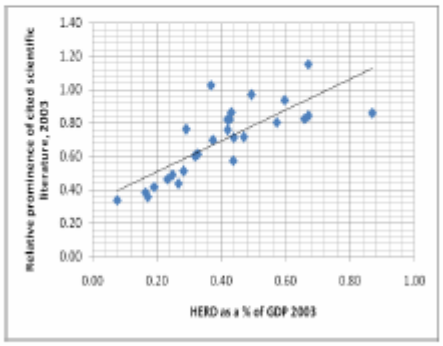
	R&D Inputs					R&D Outputs		
	Total Public R&D (GOVERD + HERD) 2005*	GOVERD 2005* (% of GDP)	HERD 2005* (% GDP)	Basic Research 2005* (%GDP)	Researchers 2004* (per thousand of labour force)	Scientific articles per million population, 2003	Relative prominence of scientific literature, 2003	Share of PCT patents owned by Gov + HE (2002/04)
Iceland	1.28	0.66	0.62	0.53	13	701.8		
Sweden	1.00	0.24	0.76		10.8	1142.8	0.86	0.0
Finland	0.99	0.33	0.66		15.7	997.9	0.83	0.4
Canada	0.90	0.18	0.72		7.3	783.2	0.85	10.3
France	0.79	0.37	0.42	0.52	7.3	516.2	0.76	10.8
Austria	0.77	0.12	0.65	0.39	6.6	604.4	0.80	1.1
Australia	0.76	0.28	0.48	0.42	7.9	791.2	0.71	10.3
Denmark	0.76	0.18	0.58	0.46	9.1	981.6	0.94	3.2
Germany	0.75	0.34	0.41		6.8	536.9	0.82	1.7
Netherlands	0.74	0.24	0.50		4.5	830.6	0.97	1.4
Japan	0.73	0.28	0.45	0.4	10.2	470.3	0.58	4.4
Norway	0.71	0.24	0.47	0.28	8.9	731.4	0.72	0.5
Switzerland	0.70	0.03	0.67	0.84	5.8	1153.5	1.15	2.2
United States	0.68	0.31	0.37	0.48	9.5	725.6	1.03	10.0

Traditional approaches to measuring "impacts" (2/2)

Relationship between R&D in Higher education and Scientific articles



Relationship between R&D in higher education and the relative prominence of cited scientific literature



New Practices assessing Public R&D impacts (1/4)

- Econometric Studies:
  - Microeconometric and macroeconometric analyses of spillovers and social rate of return. Positive effects of (public) R&D on productivity gains
  - Analyse systemic effects in the economy
  - They say little about the innovation process or non-economic impacts of public R&D
- Capitalisation of R&D:
  - (Part of) R&D investment can be capitalised, if an investment to generate future assets
  - "R&D capital" can then be introduced in the production function and estimate its impacts
  - The nature of public R&D generates questions about to what extend it can be capitalised

New Practices assessing Public R&D impacts (2/4)

- General Equilibrium Models type:
  - They can represent in a complex model the relationships established in the economy and estimate (ex-ante) the effect of a change in the model (e.g. increased public R&D) on different parts of the economy
  - The definition of the equation systems and their interrelations rely on a large number of assumptions
- GBAORD:
  - They allow to identify the relationships between input and output indicators classified by specific socio-economic objectives
  - They don't say much about the process on innovation or achievement of goals

New Practices assessing Public R&D impacts (3/4)

- Use of indicators/benchmarking:
  - Easy to compare the evolution and progress on a number of key variables.
  - They fail to explain the process of innovation
- Micro-data analyses:
  - It uses information on enterprises participating in innovation surveys across different countries and it shows the positive role of public R&D (through collaborations between firms and PROs and public funding) on innovation in a series of countries
  - Positive effects are calculated at the micro level and they need to be aggregated in a more meaningful aggregate impacts

New Practices assessing Public R&D impacts (4/4)

- Survey based studies:
  - Through a large survey, identification of individual benefits (added value) on the stakeholders participating in the space programmes
  - This methodology can only be applied to industry focused research and cannot take account of longer term effects
- Case studies:
  - They provide very detailed information about the sources and mechanisms of the impacts
  - The impact analysis tend to be very context specific and difficult to scale up to other experiences

Current work at the OECD (Objective)

- Overall objective

  To improve our understanding of the relationship between public R&D investment and its socio-economic impacts
- Specific objectives:
  - To create a forum of debate between science policy researchers, economists and policy makers
  - To identify national practices dealing with assessing impacts of public R&D investments
  - To highlight particularly promising approaches towards measuring the impacts of public R&D
  - To establish a basis for improved cross-country comparative approaches and methodologies (including the establishment of new data sources and indicators)

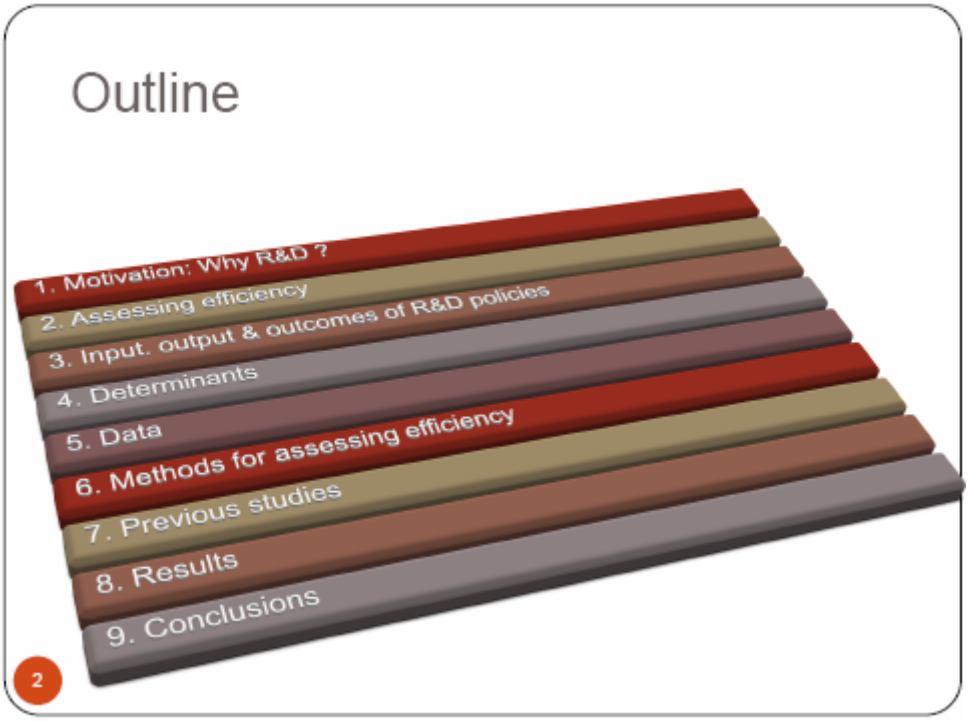
Current work at the OECD (Activities)

1. **Stocktaking of national practices in the field of public R&D impact assessment, organised by objective. The conclusions:**
   - Understanding and measuring the impacts of public R&D is crucial
   - Several challenges avoid a straightforward measurement
   - **The choice of methodology is not universal but context specific**
   - New analytical techniques are being developed
   - All the analytical techniques that intend to capture the full range of impacts of public R&D are still evolving
2. **Expert workshop to take stock and identify new tasks**

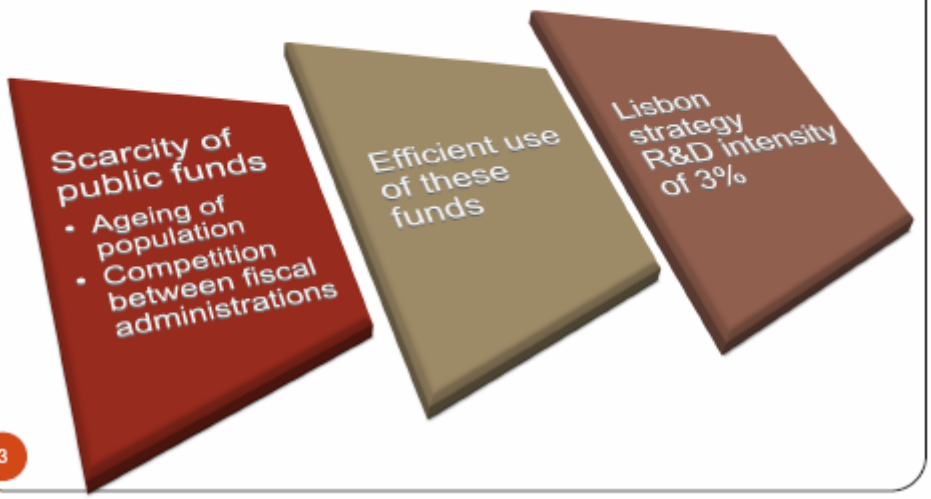
Further work can be continued

- Although progress has been made, still:
  - Methodological frameworks can be improved
  - A common framework to develop and use methodologies has not been agreed to and international collaboration is needed
  - International progress in improving methods and using them across countries could result in enhanced comparability of impacts
  - Impacts that can be observed at the micro level need to be aggregated to more meaningful aggregate impacts

2. Efficiency of Public Spending in Support of R&D Activities: An International Comparison, Michele Cincera, Université Libre de Bruxelles



Why efficiency of public support of R&D?



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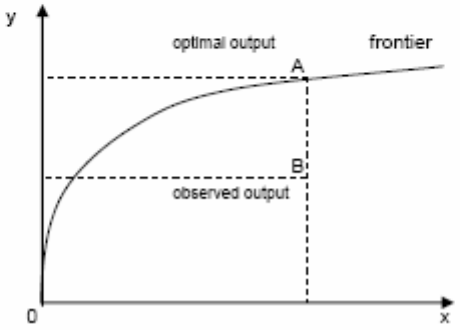
Assessing efficiency (Farrel, 1957)

- Technical efficiency: Maximum amount of output is produced from a given amount of inputs.
- In this case, the entity producing the output is said to be technically efficient and operates on its production frontier.



4

Which input / output / outcomes ?

3 inputs (public support)

- R&D in the business sector financed by governments
- Public R&D (Higher Education and other GOVERD)
- R&D fiscal incentives (tax credits)

1st issue: no variability!

2 outputs (additional R&D)

- R&D spending in the business sector.
- R&D personnel in the business sector.

2nd issue: crowding out effect!

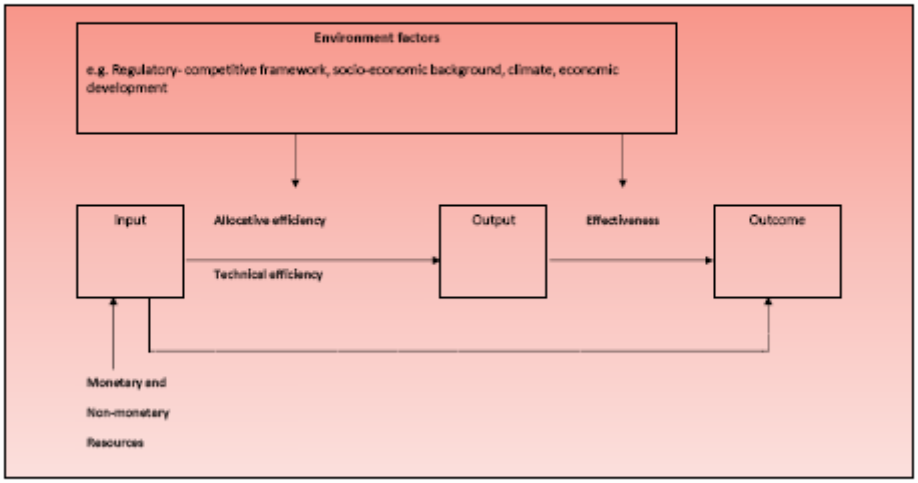
Outcomes

- Innovations
- Economic performance
- Social returns to R&D

3th issue: limit output/outcomes !

5 EFFICIENCY OF PUBLIC SPENDING TO SUPPORT R&D

Concepts of efficiency and effectiveness



6 EFFICIENCY OF PUBLIC SPENDING TO SUPPORT R&D

Which determinants ?

4th issue : exogeneity!

Framework conditions

- Size of Government: Expenditures, Taxes, and Enterprises
- Legal Structure and Security of Property Rights
- Access to Sound Money
- Freedom to Trade Internationally
- Regulation of Credit, Labor, and Business

Factors enhancing the efficiency of private R&D

- Industry-university links
- Basic R&D
- Quality of R&D
- Share of of high-tech sectors
- Share of military R&D

5th issue: no enough obs.!

Factors enhancing the administrative efficiency of R&D policies

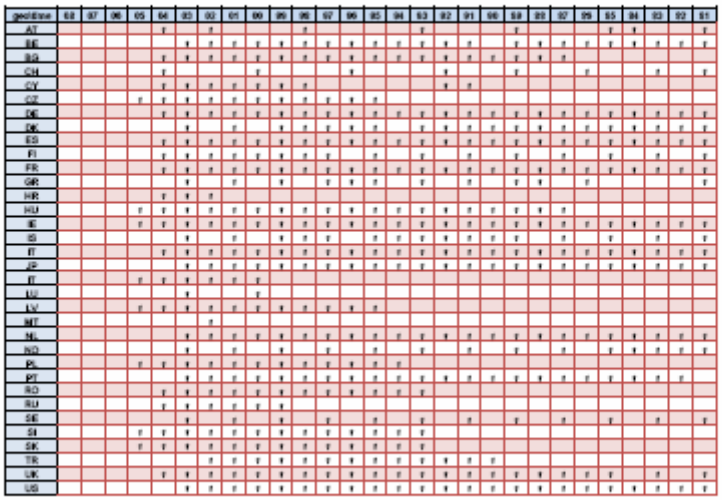
- Control public spending growth more effectively
- Anchor the budget process in a medium-term perspective
- Reduce budget fragmentation and increase transparency

Data : Sources

- OECD (STAN. ANBERD) & EUROSTAT (S&T indicators)
  - Input:
    - Procurement and subsidies (publicly funded R&D performed in the private sector).
    - R&D performed in the public sector.
  - Output:
    - R&D performed in the private sector.
    - R&D personnel in the private sector.
- Warda (2006)
  - Input:
    - R&D Tax credit (B-index, index of fiscal generosity).
- Fraser institute (2006)
  - Environmental variables.

8

Data : Coverage (business R&D, EUROSTAT)



9

Which methods ?

6th issue!

Method	Strengths	Weaknesses
1. Composite performance indicators		
	• Evaluation of public spending in its entirety	• Not suited to assess the efficiency of particular policies e.g. health, education, R&D policies
2. Data Envelopment Analysis (DEA)		
	• Allow one to directly compare the efficiency of countries (ranking) • No need to define the relative importance of the various inputs employed and output produced (due to the absence of weights or prices attached to each outcome) • No need to specify a functional relationship between inputs and outputs • Not subject to simultaneous bias and/or specification errors • Allow to deal with the simultaneous occurrence of multiple inputs and outputs	• Heavy reliance on the accuracy of the data • Difficult to distinguish between output and outcomes • Efficiency scores attributed to inputs while other factors may also contribute • Frontier depends from the set of countries considered (Inefficiences can be underestimated)
3. Stochastic Frontier Estimation (SFE)		
	• Error term with 2 components: conventional error term + term representing deviation from frontier (relative inefficiency) • Allow for hypothesis testing, confidence interval • Allow to explain inefficiency	• Assume functional form for the production function • Assume distributional form of the technical efficiency term • Single output dimension • Frontier depends from the set of countries considered (Inefficiences can be underestimated)

7th issue: outliers!

8th issue: no enough obs !

9th issue: no enough obs !

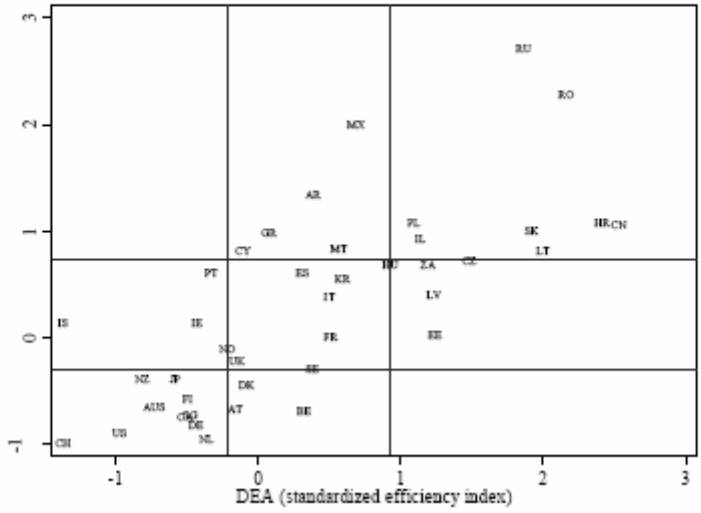
10 EFFICIENCY OF PUBLIC SPENDING TO SUPPORT R&D

Past studies on public R&D efficiency

- No studies at the macro-level based on non-parametric methods !
- Afonso et al. (2006): Several studies using either FDH or DEA find significant inefficiencies of the public sector (health, education) in many countries.
- David et al. (2000): Review of econometric studies on the effects of publicly-financed R&D expenditure in the private sector.
  - At the meso- and macro levels: Complementarity rather than substitution (crowding out) between publicly- and privately-financed R&D-expenditure. Yet, complementarity overestimated due to crowding out effects (higher wages).
  - Studies at the micro or plant level are more mitigated. Studies focusing on US data find evidence of a substitution effect while for non US countries, a complementarity effect seems to predominate.
- Guellec and van Pottelsberghe (2003): Complementarity between public funds to support R&D in the private sector. R&D expenditure performed in the public sector, in particular in the defense sector, appears to crowd out private R&D.

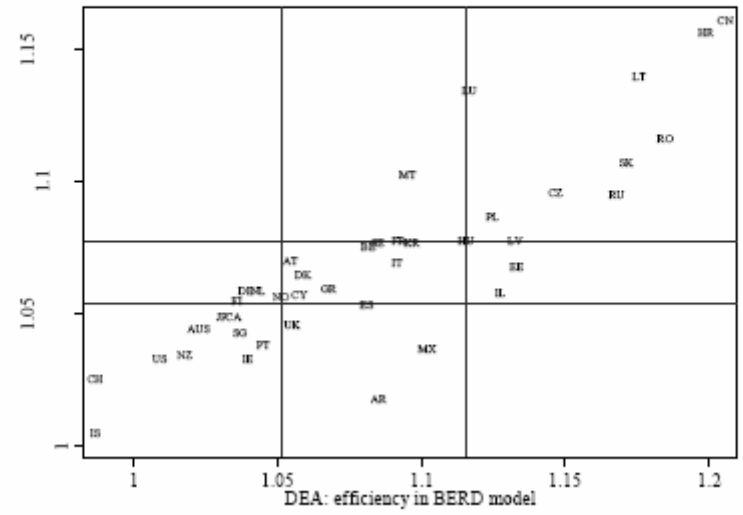
11

Summary of results
Comparison of efficiency scores obtained from SFA vs. DEA



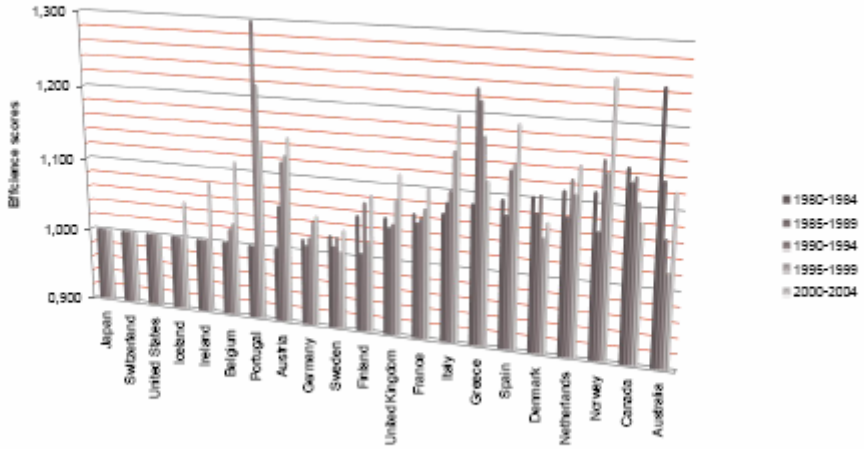
12

Summary of results
Comparison of DEA efficiency scores: R&D expenditures vs. personnel



13

Summary of results
Comparison of DEA efficiency scores: R&D expenditures vs. personnel



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EFFICIENCY OF PUBLIC SPENDING TO SUPPORT R&D

Summary of results
Determinants of efficiency scores
Comparison of SFA and DEA methods

Method /panel Output	SFA/panel R	 P	DEA/panel R	 P
Determinants				
Country groupings				
World regions				
EU15	-	+		+
Rest of Europe	-	-		
High industrialized countries	-	-	-	
Other	-	-		
Internal market and Euroland				
IM		+		
Euro	-			
per capita				
Medium			+	+
High	-	-		
Regulatory conditions				
Size of government	-	-	+	
Legal structure and security of property rights	-		-	
Access to sound money			+	+
Freedom to trade				
Regulation				+

Notes:
R = R&D expenditures; P = R&D personnel; The sign '-' refers to a negative impact of the determinant on inefficiency, i.e. a positive impact on efficiency, and conversely for the sign '+'; Only the signs of the variables that were significant (at the 10% at least) are reported.

Summary of results
Impact of administrative, institutional and business determinants on DEA efficiency scores - Panel data TOBIT regression

Dependent Variable: DEA unpredicted efficiency scores based on ln(BERD)				*N obs.*	*Log-Like-lihood*	*LR test*	
Administrative and institutional R&D enhancing factors							
More effective control of public spending growth	-0.005	(0.045)		31	4.8	T	
Anchoring the budget process in a medium-term perspective	0.016	(0.035)				T	
Reduced budget fragmentation and increased transparency	-0.013	(0.018)				T	
Share of enterprises receiving public funding for innovation	-0.002	(0.004)		46	6.4	3.1	**
Business R&D enhancing factors							
Summary Innovation Index()	-0.404	(0.199)	**	31	-1.98	T	
Public procurement advertised in the Official Journal as a % of	0.024	(0.008)	***	43	58.3	22.6	***
Public procurement advertised in the Official Journal as a % of total public procurement	0.005	(0.001)	***	42	57.8	31.5	***
Industry-university links (business funded R&D performed in other sector than the business one)	-0.001	(0.001)		113	38.4	48	***
Basic R&D performed in the private sector in % of total business R&D	0.016	(0.013)		46	-4.2	11.1	***
Share in % of researchers, scientists & engineers in the private sector as a % of total active population	-0.126	(0.117)		50	13.8	7.1	***
Share in % of researchers, scientists & engineers in the total business R&D personnel	-0.001	(0.003)		50	13.2	8.5	***
Share of Public Credit Appropriation in the defence sector	0.001	(0.001)		84	49.5	45.7	***
Strength of the IPR system							
Full sample	0.030	(0.006)	***	65	34.4	19.2	***
EU15 and most industrialized countries	-0.037	(0.005)	***	41	47.2	24.8	***
New EU Member States and rest of the World	0.132	(0.033)	***	23	8.71	3.62	**
Share in % of high-tech sectors in total manufacturing value added	-0.008	(0.004)	*	35	15.3	T	

Notes:
*Annual dummies included; standard errors in parentheses for generalized Tobit pooled regression; *** (**, *) denote a significance level of 1% (5%, 10%).*

Are results suitable to draw conclusions ?

DEA and SFA results are not always comparable due to:

- different assumptions underlying the estimations (which cannot be tested)
- data limitations (# of obs., particularly for SFA)
- potential endogeneity of determinants

Macroeconomic country data may not necessarily be sufficient to judge about inefficiencies without a detailed case-by-case study

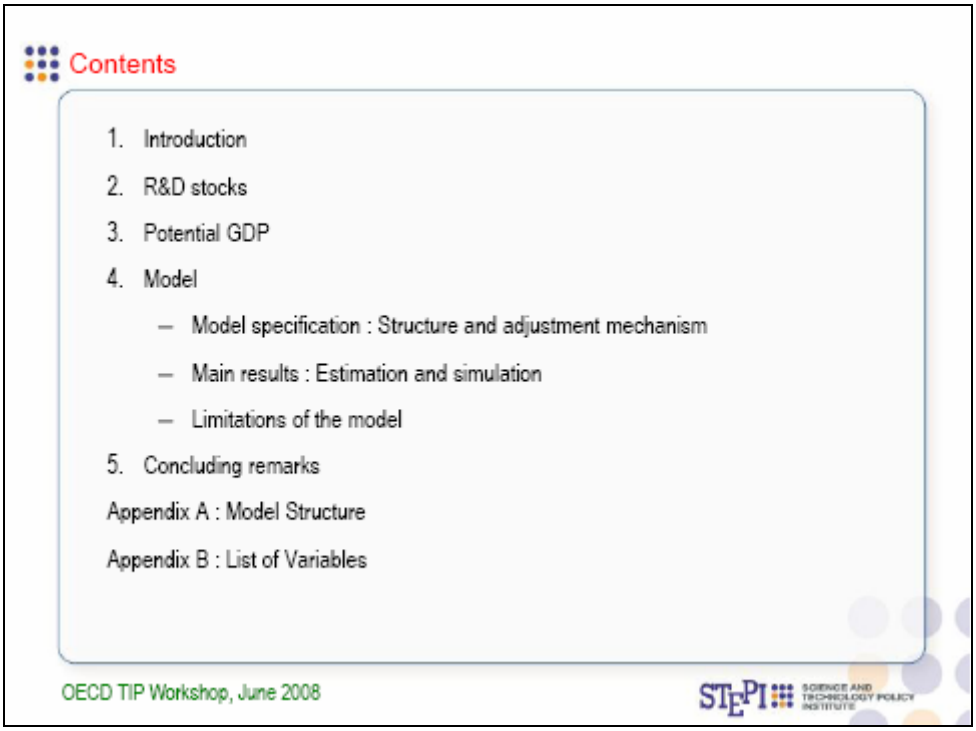
But:

- Rankings of countries, i.e. three groups, in terms of efficiency levels are more or less similar across methods
- Importance of a well functioning system for securing intellectual property
- Top performing countries, Japan, Switzerland and the United States actually rely on very different public R&D strategies
- No unique public strategy that determines high efficiency levels

Thank you for your attention !

Questions

3. Long-Run Behaviour of R&D Investment and Economic Growth: A Macro-Econometric Model, Taeyoung Shin, Science and Technology Policy Institute - Korea, Vice-President



Introduction

- Motivation
  - To show relationship between R&D activity and major macro-economic variables. Most studies investigate a single production function only.
  - To provide a reference for the discussion about sustainability of Korean economy in transition from resourced-based growth strategy to innovation-based growth strategy.
- We established a macro-econometric model including R&D sector.
  - A simultaneous equation system : small model (49 equations and identities).
  - Recalculation of the national accounts was necessary to avoid double counting.
- After estimation of the model, we carried out a simulation analysis for alternative policy measures, such as R&D investment, construction investment, investment fund for SMEs, and unemployment fund.
  - To Measure direct and indirect effect of R&D on the major economic variables.
  - To make a comparison of effects of alternative policy instruments.

R&D Stock : Data and national accounting

- Data
  - From the national accounting, we have

$$GDP = C + I + G + (X - M) + RD$$

  - R&D investment consists of private R&D (RD_P) and public R&D (RD_G). It also consists of consumption expenditure and purchase of R&D capital. The consumption expenditure includes private and government expenditures. The R&D capital is divided into equipments (RD^Q) and buildings (RD^H)
  - That is,

$$RD = RD_P + RD_G$$

$$RD = RD^C + RD^K$$

$$RD^C = RD_P^C + RD_G$$

$$RD^K = RD^Q + RD^H$$

P ≡ private
G ≡ government
C ≡ consumption expenditure
K ≡ R&D capital
Q ≡ equipments
H ≡ buildings

R&D Stock : Data and national accounting

- Then, we recalculate the national accounts and separate out the R&D sector of the national economy.

$$GDP = \left(C - RD_P^C\right) + \left(I - RD^K\right) + RD + \left(G - RD_G\right) + \left(X - M\right)$$

- Therefore, we can divide the national economy into R&D sector and non-R&D sector from the above equation.
- Note that R_G is not broken down into consumption expenditure and R&D capital purchase. It is taken account as consumption expenditure.

R&D Stock : Estimation

☐ Assumptions

- R&D lags
  - Private R&D : 2 years
  - Public R&D : 3 years
- Rate of knowledge obsolescence : 0.125 (8 years)

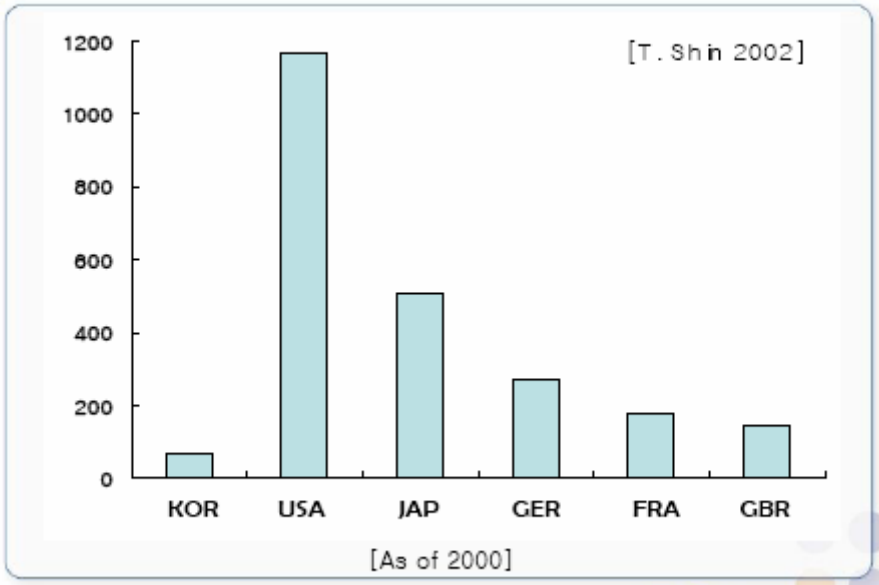
$$RDSK_t = RD_{t-l} + (1-\delta)RDSK_{t-1},$$

$$l = 2 \text{ for public R\&D}; l = 3 \text{ for private R\&D}$$

$$RDSK_0 = \sum_{i=0}^{\infty} RD_{t_0-i}(1-\delta)^i \Rightarrow RDSK_0 = RD_{t_0}\left[\frac{1+g}{g+\delta}\right]$$

$g \equiv$ growth rate of R&D stock
$\delta \equiv$ rate of knowledge obsolescence

R&D Stock : An international comparison



Potential GDP : Production function

☐ Production function

$$Y_t = A(R_t) f(K_t, L_t)$$

$$\Rightarrow \log Y_t = \beta_0 + \beta_1 \log K_t + (1-\beta_1)\log L_t + \beta_2 \log RDSK_t + \varepsilon_t$$

Y≡GDP
K≡capital stock
L≡labor
RDSK≡R&D stock

$$\log Y_t = -5.852 + 0.3043 \log K_t + (1-0.3043)\log L_t + 0.2097 \log RDSK_t$$
$$(-24.98)\ (4.829) \qquad\qquad (5.678)$$

$$R^2 = 0.997, \quad D.W. = 0.409$$

Potential GDP : Natural rate of unemployment

- Natural rate of unemployment : rate of unemployment without accelerating inflation
  - The price equation was estimated as follows.

$$\dot{P}_t = 10.803 - 4.242U_t - 0.053\dot{U}_t + 0.300\dot{P}_{M_t}$$
$$(2.663)(-3.415)\quad(-0.667)\quad(3.045)$$

U≡rate of unemployment
P_M≡import prices
LF≡labor force

  - Then, the natural rate of unemployment is

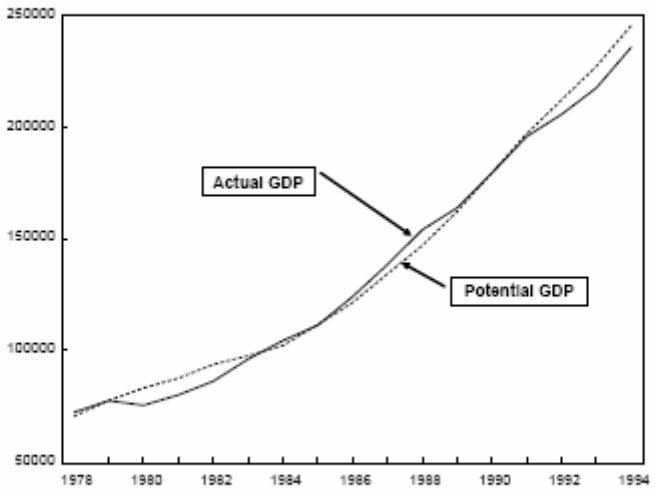
$$U^N = 2.547\ (=10.803/4.242)$$

- The number of the employed at the natural rate of unemployment will be

$$L^N = (LF - L_{RD}) - (U^N \times LF/100)$$

- The potential GDP can obtained plugging L^N into the production function.

Potential GDP and real GDP



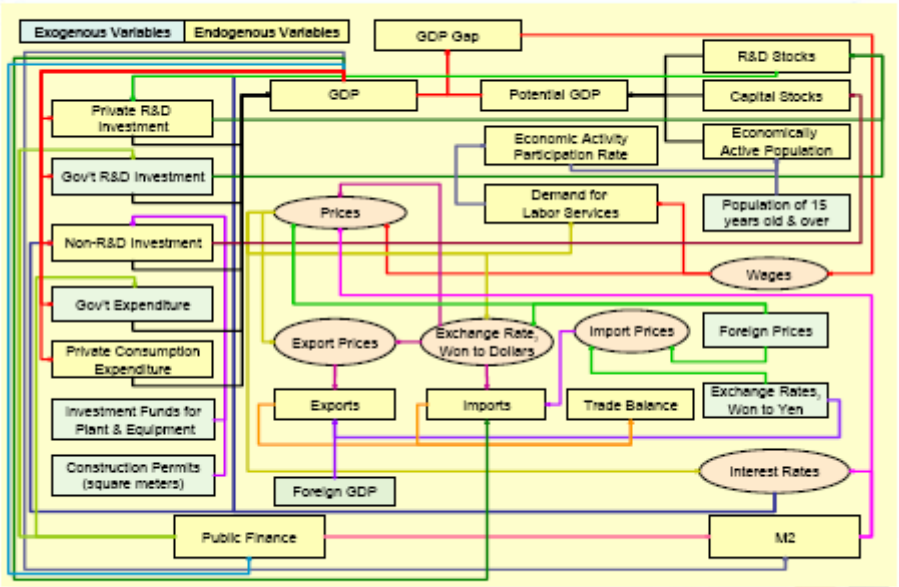
Model : Structure

- The model includes 6 sectors and exogenous variables
  - Demand side and prices
  - Supply side
  - Wage and employment
  - Foreign trade
  - Monetary sector
  - Public finance.
- The model consists of 27 behavioral equations and 22 identities.

Model : Adjustment mechanism

- The model is established in the way that the interaction of real GDP and potential GDP (GDP gap) makes self-adjustment of the economy toward an equilibrium.
  - If there is a change in GDP gap by a shock, the economy will leave an equilibrium and starts to adjust; and to move toward a new equilibrium. The shock is conveyed through the price variables to other sectors.
- For example, if government increases R&D spending,
  - Firstly, real GDP↑ → GDP gap (excess demand) ↑ → wage ↑ → price ↑ ⋯ → ⋯ new equilibrium.
  - Secondly, in time R&D stocks ↑ → potential GDP↑ → GDP gap↓ → wage↓ ⋯ → ⋯ new equilibrium.
  - This can be shown in the flow chart below.

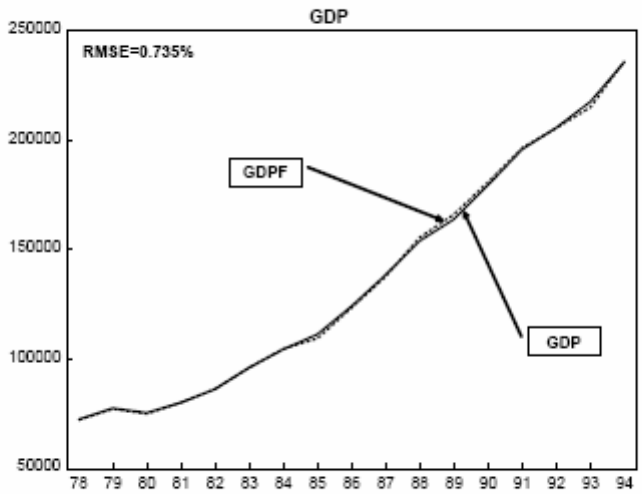
Model : Flow chart



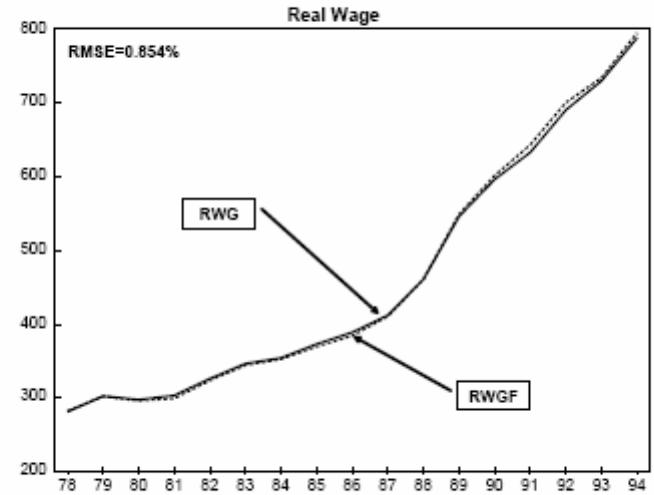
Model : Goodness of fit

Variables	RMSE (%)	Variables	RMSE (%)
DEMAND SIDE AND PRICES	2.086	FOREIGN TRADE	2.31
GDP	0.735	*EXCB*: commodity exports	2.734
CPVRD: private consumption of non-R&D Sector	0.504	*IMCB*: commodity imports	0.979
KHRD: construction investment of non-R&D sector	1.383	*EXSNB*: non-factor income from abroad	5.16
KIQRD: plant/equipment investment of non-R&D sector	3.538	*IMSNB*: non-factor income to abroad	3.523
RDIFV: private R&D investment	4.865	*PX*: export price index	1.342
PGDP: GDP deflator	2.102	*PM* import price index	1.45
CPI: consumer price index	1.498	*ER*: exchange rates	0.981
WPI: producer's price index	2.061		
		MONETARY SECTOR	2.816
SUPPLY SIDE	0.483	*RM2*: real M2	1.305
PTGDP: potential GDP	0.483	*RCB*: yields of corporate bonds	4.327
WAGES AND EMPLOYMENT	1.596	PUBLIC FINANCE	3.189
LFPR: participation rate in economic activities	0.558	*TXR*: tax revenues	3.714
EMPD: number of the employed in non-R&D sector	0.704	*CGE*: expenditures of central government	2.663
RDMN: number of researchers	1.859		
RWG: monthly real wage of workers in MFG.	0.854	TOTAL	2.133
RDWG: annual R&D personnel expenses per researcher	4.003		

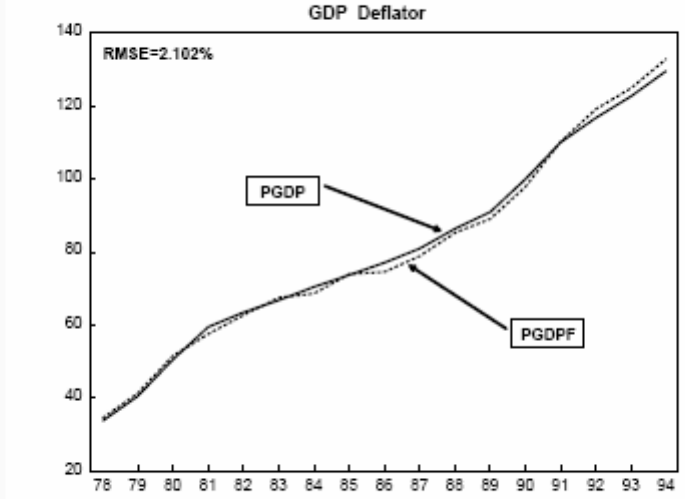
Goodness of Fit : GDP



Goodness of Fit : Real wage



Goodness of Fit : GDP deflator

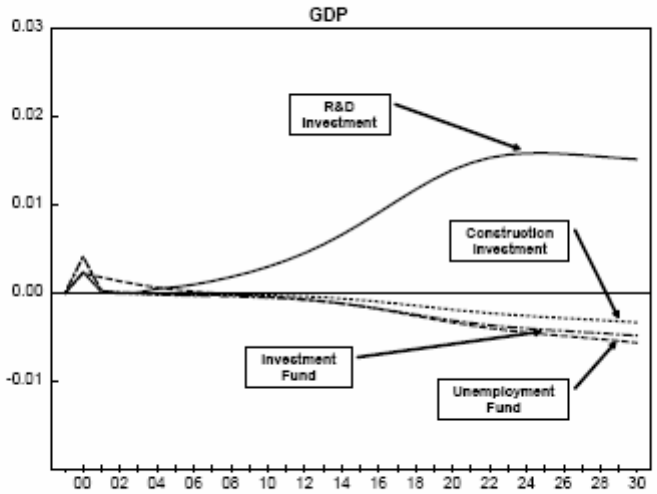


Simulation results

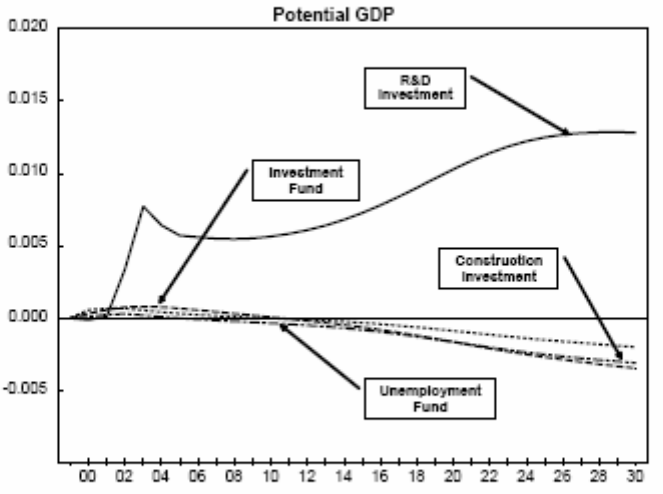
After	GDP (%)				Unemployment Rate (% point)			
	R&D investment	Construction investment	Investment fund	Unemployment fund	R&D investment	Construction investment	Investment fund	Unemployment fund
One year	0.250	0.420	0.230	0.420	-0.052	-0.044	-0.025	-0.048
5 years	0.060	-0.010	0.070	-0.010	0.029	0.004	-0.004	0.005
10 years	0.240	-0.020	-0.020	-0.040	-0.037	0.003	0.006	0.008
15 years	0.670	-0.060	-0.110	-0.110	-0.085	0.005	0.012	0.013
20 years	1.300	-0.160	-0.290	-0.270	-0.130	0.014	0.026	0.025
25 years	1.590	-0.250	-0.440	-0.400	-0.136	0.021	0.037	0.033
30 years	1.540	-0.310	-0.540	-0.460	-0.104	0.022	0.037	0.032

Note : Numbers are cumulative effects when the government increases the spending of one trillion KRW by deficit financing.

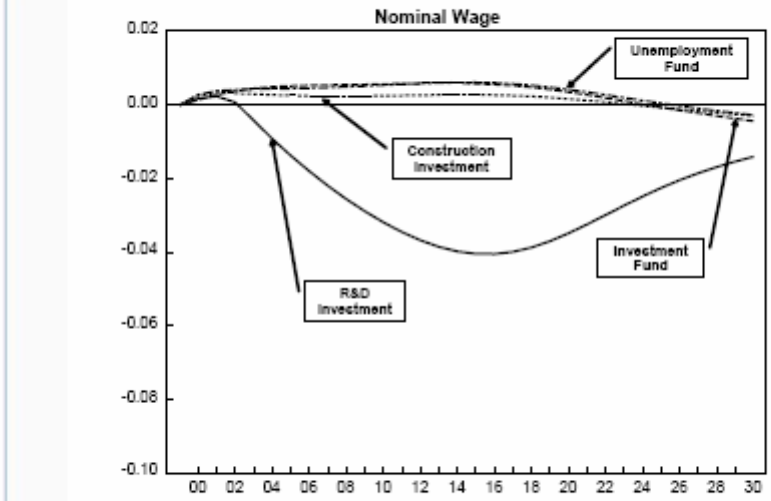
Simulation Results : GDP



Simulation Results : Potential GDP



Simulation Results : Nominal wage



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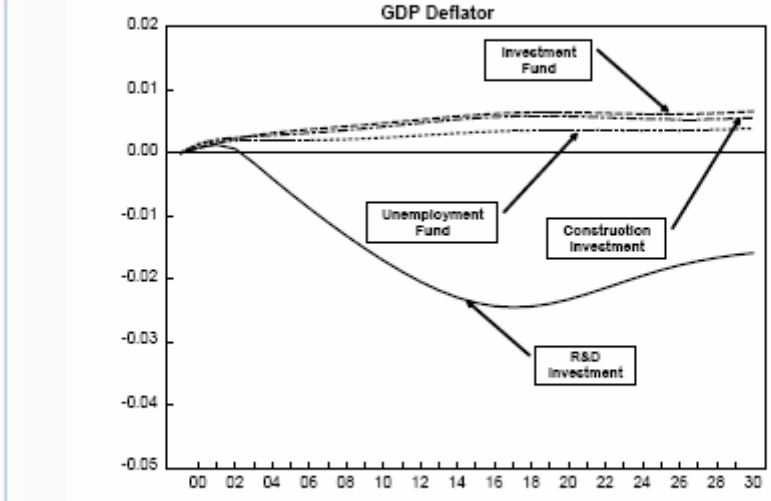
Simulation : GDP deflator



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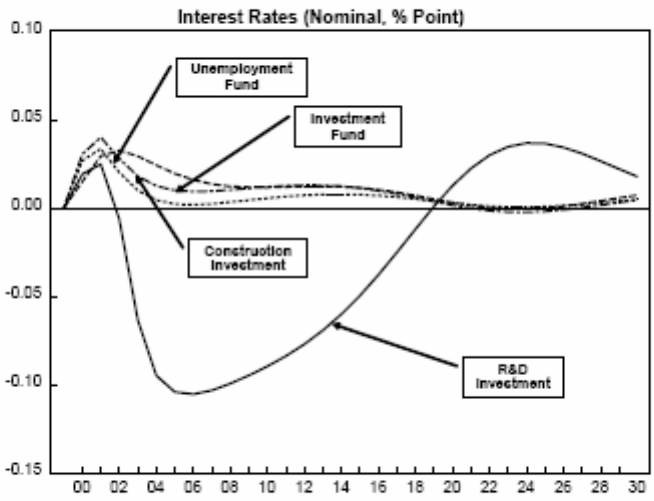
Simulation Results : Nominal interest rate



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Simulation Results : Rate of unemployment

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Limitation of Model

- In estimating R&D stocks, some assumptions were required
  - Lag structure
  - Rate of knowledge obsolescence
- Data
  - Sample size : sample period 1975~1994
  - R&D data
- Other econometric considerations
  - Data stability : Unit root and cointegration

Concluding Remarks

- The macro-econometric model is a useful scheme to show how R&D activity is related to the national economy.
  - Real variables
  - Price variables
- The simulation results show that
  - Public spending on R&D might have a permanent effect on real variables, with stabilizing price variables.
  - Public spending on other policy alternatives exhibit only short-run effect on real variables, with having positive effect on prices in the long run.
- The government policy might need to focus more on R&D in the long run for the sustainable economic growth.
  - Switching growth strategy from resourced-based to Innovation-based growth.
  - Increasing R&D investment is important—particularly stimulating private R&D by the policy instrument.

Appendix A : Model structure

Demand side and prices

	Dependent Variables	Independent Variables: Demand/ Prices	Supply Side	Wage/ Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	CPVRD	GDP CPVRD					TXR	
	KHRD	GDP						BCP
	KIQRD	GDP INFR PGDP	KSQRD			RCB		
	RDPV	GDP INFR	RDSTK			RCB		RDPB
	PGDP	PGDP		WGE	ER	M2		PM
	CPI	PGDP CPI						
	WPI	PGDP WPI			ER			PM
	INFR	PGDP						
Identities	GDP	CRD EX KIRD IM RDI SDI						
	CRD	CPVRD CPBRD						
	KIRD	KIHRD KINV KIQRD						
	RDI	RDPV RDPB						
	EX	EXC EXSW						
	EXC				EXCB			
	EXSW				EXSWB			
	IM	IMC IMSW						
	IMSW				IMCB			

Appendix A : Model structure

Supply side

	Dependent Variables	Independent Variables: Demand/ Prices	Supply side	Wage/ Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	PTGDP		KSKRD RDSTK	EMPDW				MORIB YDAYB
	EMPW			LF RDMN				URSTR
Identities	KSTRD		KSHRD KSQRD					
	KSHRD	KIHRD	KSHRD					
	KSQRD	KIQRD	KSQRD					
	RDSTK		RDKPV RDKPB					
	RDKPV	RDPV	RDKPV					
	RDKPB	RDPB	RDKPB					

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Appendix A : Model structure

Wage and employment

	Dependent Variables	Independent Variables: Demand/ Prices	Supply Side	Wage/ Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	*LFPR*	*GDP*	*PTGDP*	*EMPL* *LFPR*				*POP15*
	EMPD	*CPI* *GDP*		*WGE* *EMPD*				
	RDMN	*RDI*		*RDWG* *WGE* *RDMN*				
	WGE	*PGDP* *GDP*	*PTGDP*	*WGE*				
	RDWG	*RDI*		*RDWG*				
Identities	*UR*			*EMPL* *LF*				
	LF			*LFPR*				*POP15*
	EMPL			*EMPD* *RDMN*				

Appendix A : Model structure – Monetary sector/Public finance

Monetary sector

	Dependent Variables	Independent Variables: Demand/ Prices	Supply Side	Wage/ Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	*M2*	*PGDP* *GDP* *INFR*				*RCB* *M2*	*CGE* *CGR*	
	RCB	*INFR*				*M2* *RCB*		

Public finance

	Dependent Variables	Independent Variables: Demand/ Prices	Supply Side	Wage/ Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	*TXR*	*GDP* *PGDP*						
	CGE	*GDP* *PGDP*					*CGE*	
Identities	*GBB*						*CGR* *CGE*	
	CGR						*TAXR*	*RGE* *RGO*

Appendix A : Model structure – Foreign trade

Foreign trade

Dependent Variables		Independent Variables						
		Demand Prices	Supply Side	Wage Employment	Foreign Trade	Monetary Sector	Public Finance	Exogenous Variables
Behavioral Equations	EXCB				FX			IMW YEN
	IMCB	GDP			FM ER IMCB			
	EXSNB				EXCB			
	IMSNB				IMCB IMSNB			
	FX	WPI			ER FX FM			
	FM							PMO YEN
	ER	WPI			EXCB IMCB EXSNB IMSNB			PWW YEN
	NCB				NTB NSNB NNTRB			
Identities	NTB				EXCB IMCB			
	NSNB				EXSNB IMSNB			EXSFB IMSFB

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Appendix B : List of variables

1. **Endogenous Variables**

CGE	Expenditures of Central Government (Billion won at current prices)
CGR	Revenues of Central Government (Billion won at current prices)
CPI	Consumer Price Index (1990=100)
CRD	Gross Consumption Expenditures in Non-R&D Sector (N/A, billion won at constant prices)
CPVRD	Private Consumption Expenditures in Non-R&D Sector (N/A, billion won at constant prices)
DPI	Disposable Income (N/A, billion won at constant prices)
EMPD	Number of the Employed in Non-R&D Sector (Thousand persons)
EMPDN	Number of the Employed at the Natural Rate of Unemployment (Thousand persons)
EMPL	Number of the Employed (Thousand persons)
ER	Exchange Rates (won/US dollar)
EX	Exports of Goods and Services (N/A, billion won at constant prices)
EXC	Commodity Exports (N/A, billion won at constant prices)
EXCB	Commodity Exports (BOP, million dollars at constant prices)
EXSN	Non-Factor Income from Abroad (N/A, billion won at constant prices)
EXSNB	Non-Factor Income from Abroad (BOP, million dollars at constant prices)
GBB	Government Deficits (Billion won at current prices)
GDP	Gross Domestic Product (N/A, billion won at constant prices)
IM	Imports of Goods and Services (N/A, billion won at constant prices)
IMC	Commodity Import (N/A, billion won at constant prices)
IMCB	Commodity Import (BOP, million dollars at constant prices)
IMSN	Non-Factor Income to Abroad (N/A, billion won at constant prices)
IMSNB	Non-Factor Income to Abroad (BOP, million dollars at constant prices)

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Appendix B : List of variables

INFR	Rate of Inflation (%)
KIHRD	Construction Investment in Non-R&D Sector (N/A, billion won at constant prices)
KIRD	Gross Fixed Capital Formation in Non-R&D Sector (N/A, billion won at constant prices)
KIQRD	Plant/Equipment Investment in Non-R&D Sector (N/A, billion won at constant prices)
KSQRD	Capital Stocks in Plant and Equipment (Non-R&D) (Billion won at constant prices)
KSHRD	Capital Stocks in Construction (Non-R&D) (Billion won at constant prices)
KSTRD	Capital Stocks in Non-R&D Sector (Billion won at constant prices)
LF	Economically Active Population (Thousand persons)
LFPR	Participation Rate in Economic Activities (%)
M2	Money Supply (End of year, billion won)
NSNB	Invisible Balance (BOP, million dollars at constant prices)
NTB	Trade Balance (BOP, million dollars at constant prices)
PGDP	GDP Deflator (1990=100)
PM	Import Price Index (Commodities, in dollars, 1990=100)
PTGDP	Potential GDP (Billion won at constant prices)
PX	Export Price Index (Commodities, in dollars, 1990=100)
RCB	Yields of Corporate Bonds (Average, %)
RDI	R&D Investment (Billion won at constant prices)
RDIPV	Private R&D Investment (N/A, billion won at constant prices)
RDKPB	Public R&D Stocks (Billion won at constant prices)
RDKPV	Private R&D Stocks (Billion won at constant prices)
RDMN	Number of researchers (Thousand persons)
RDSTK	R&D Stocks (Billion won at constant prices)

Appendix B : List of variables

RWG	Monthly Wage of Workers in Mining and Manufacturing (thousand won at constant prices)
RDWG	Annual R&D Personnel Expenses per Researcher (million won at current prices)
TXR	Tax Revenues (Billion won at current prices)
UR	Rate of Unemployment (%)
URSTR	Natural Rate of Unemployment (%)
WGE	Monthly Wage of Worker in Mining and Manufacturing (Thousand won at current prices)
WPI	Producer's Price Index (1990=100)

2. Exogenous Variables

BCP	Construction Permits (10 thousands square meters)
CPBRD	Government Expenditures in Non-R&D Sector (N/A, billion won at constant prices)
EXSFB	Factor Income from Abroad (BOP, million dollars at constant prices)
IMSFB	Factor Income to Abroad (BOP, million dollars at constant prices)
IMW	Imports of OECD (Billion dollars at constant prices)
KINV	Inventories (N/A, billion won at constant prices)
LDBC	Commercial Banks' Investment Fund for Plants and Equipments (End of year, billion won)
MORI	Manufacturing Operation Ratio Index (1990=100)
MORIB	Average Manufacturing Operation Ratio Index (1990=100)
NNTRB	Transfer Balance (BOP, million dollars at constant prices)
PMO	Prices of Crude Petroleum (in dollars, 1990=100)
POP15	Population above 15 (Thousand persons)
PWW	GDP Deflator of OECD (1990=100)

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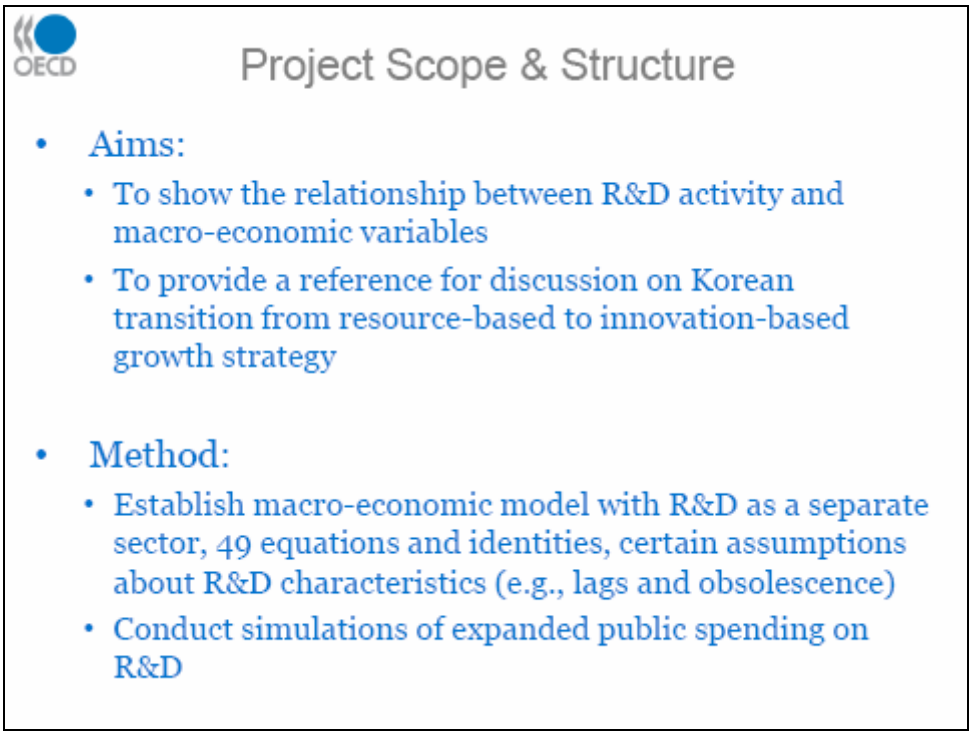
Appendix B : List of variables

RDIPB	Public R&D Investment (N/A, billion won at constant prices)
RGE	Net Revenue of Government Owned Corporate (Billion won at current prices)
RGO	Other Government Revenues (Billion won at current prices)
SDI	Statistical Discrepancies (N/A, billion won at constant prices)
YDAY	Annual Workdays in Mining and Manufacturing (12monthly workdays, days)
YDAYB	Average Annual Workdays in Mining and Manufacturing (days)
YEN	Yen per US Dollar (Yen/Dollar)
Dij	Dummy, ij=1, for year ij; otherwise=0
DDijst	Dummy, ij-st=1 for year ij-st; otherwise=0

4. Comment on "Long Run Behavior of R&D Investment and Economic Growth", Douglas Lippoldt, OECD, Structural Policy Division Directorate for Science, Technology and Industry



Strengths…

- Relatively clear and simple approach
- Delivers insights into basic relationships among the macro variables of interest
- Provides indications of possible impacts of adjustment in policy levers

Refining present report…

- Would be helpful to have a more detailed specification of the **caveats**
  - R&D returns may not be smooth or linear (in fact often lumpy)
  - Disruptive technologies may also impact rates of obsolescence
  - Provides indications of associations, but does not explain process
- Would be helpful to have indication of **sensitivity** (e.g., how important are assumptions such as rate of obsolescence?)

Possibilities for further development…

- Clarify impact of globalisation on R&D
  - Korean firms may conduct or own R&D abroad
  - Fruits of R&D can be intangible, easily scaled and leveraged, may be tradable
  - R&D systems not contained by national boundaries

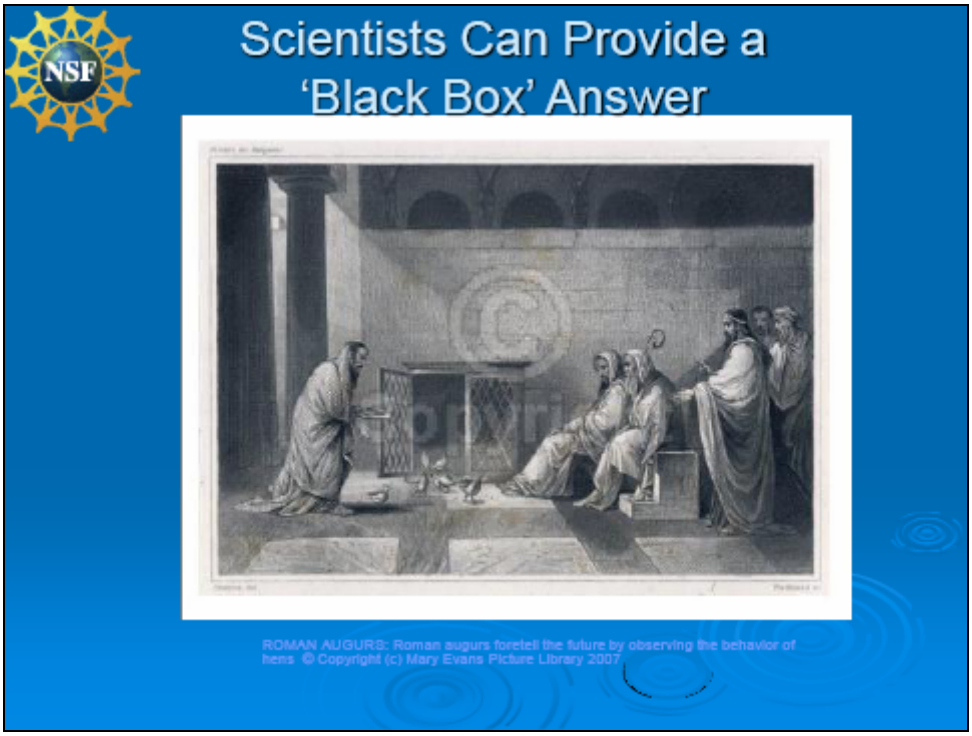
Possibilities for further development…

- May be able to refine: assess R&D variation performance by sector (e.g. lags & obsolescence; perhaps nest in model)
- Assess variation over time (e.g. due to change in non-tech innov or user-driven innovation)
- Conclusions: public spending may have relatively positive long-term effects; perhaps also nuance between public & private R&D


OECD
Thank you for your attention.

5. Impact Assessment at the National Science Foundation, Julia Lane, National Science Foundation. Director, Office of Science and Innovation Policy, United States


aci activities address administration agencies basic believe bills
budget capacity change competitiveness
concern congress consensus continuing doubling
economic nded fact
federa fyi generation
impact im nt issues
marburge policy
arch
private product
science
resources share sustained term university year
"Neal, how much did you say we need to spend on nanotechnology?"
Graphic Source: 2006 Presentation by Neal Lane on the Future of U.S. Science and Technology
Tag Cloud Source: Generated from 2007 Presentation by John Marburger on Science Policy and Budget Issues

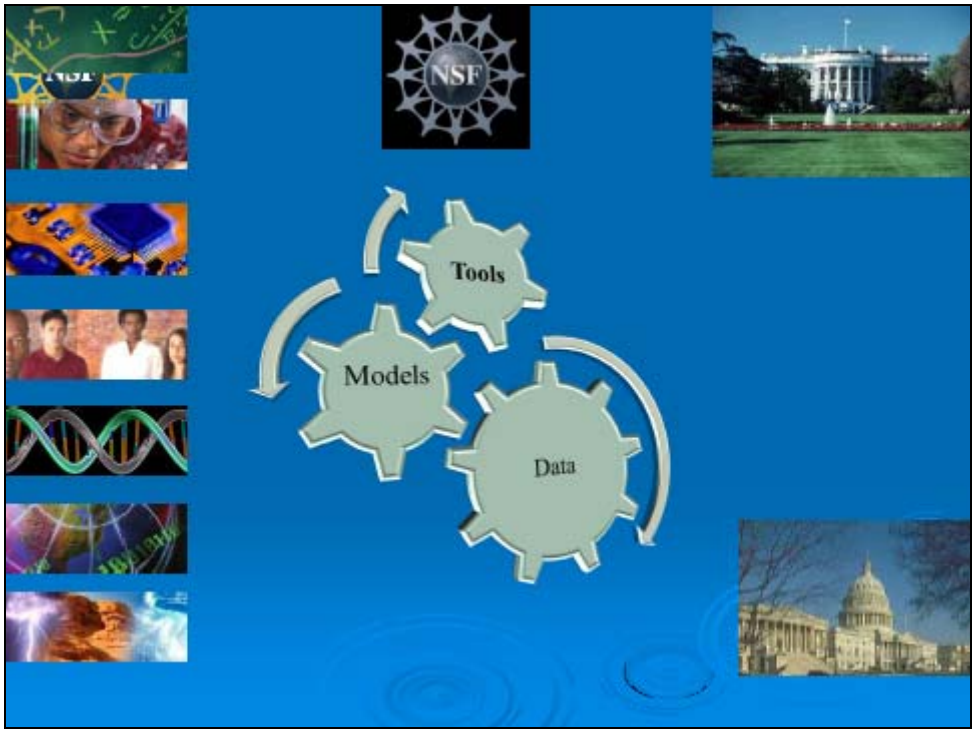

NSF
Scientists Can Provide a
'Black Box' Answer
ROMAN AUGURS: Roman augurs foretell the future by observing the behavior of hens © Copyright (c) Mary Evans Picture Library 2007

Or…
We Can Use Science

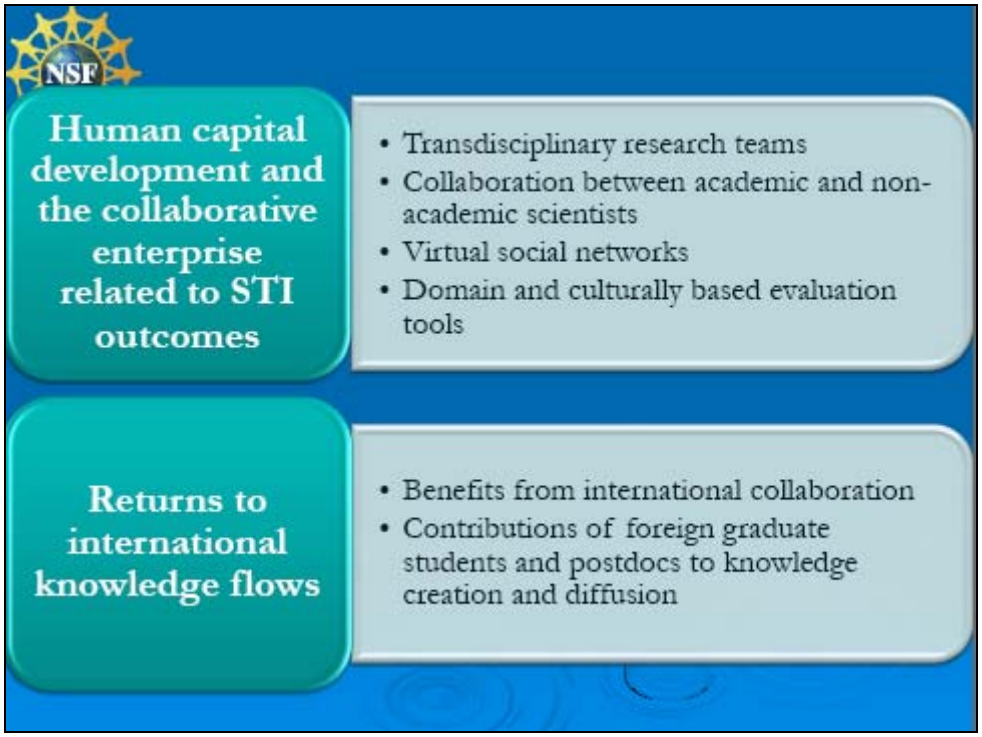
Innovation and Policy are
Fundamentally
Human and Social Activities

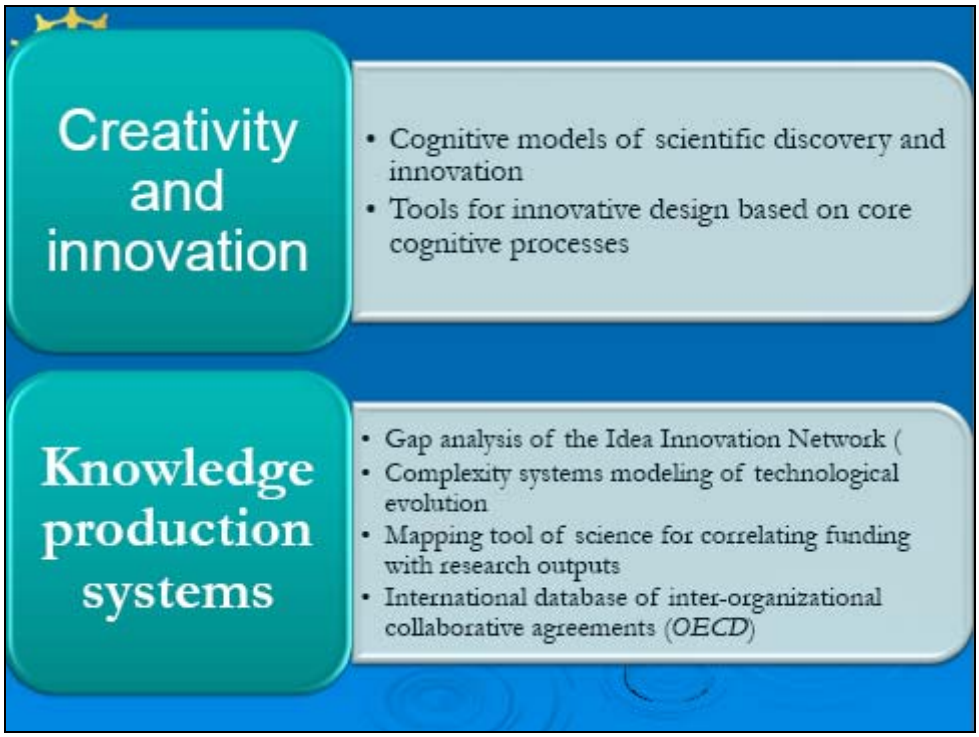
An Ecosystem of Innovation

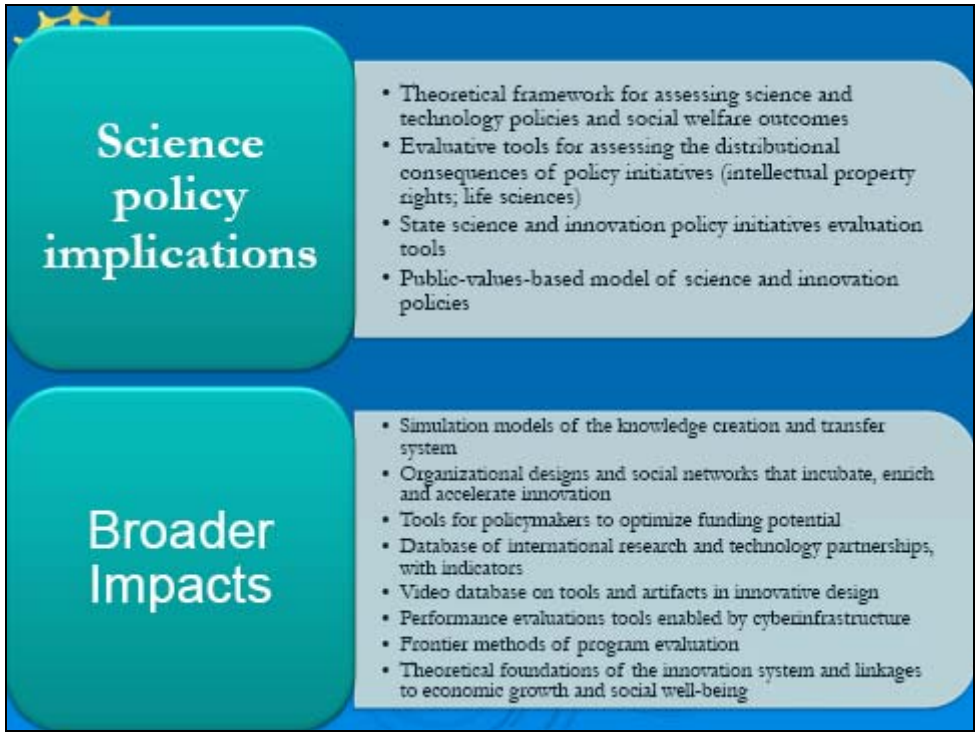

SciSIP Goals
Understanding
develop usable knowledge and theories
Measurement
improve and expand science metrics, datasets and analytical models and tools
Community of Practice
cultivate a community of practice focusing on SciSIP across the academy, the public sector and industry

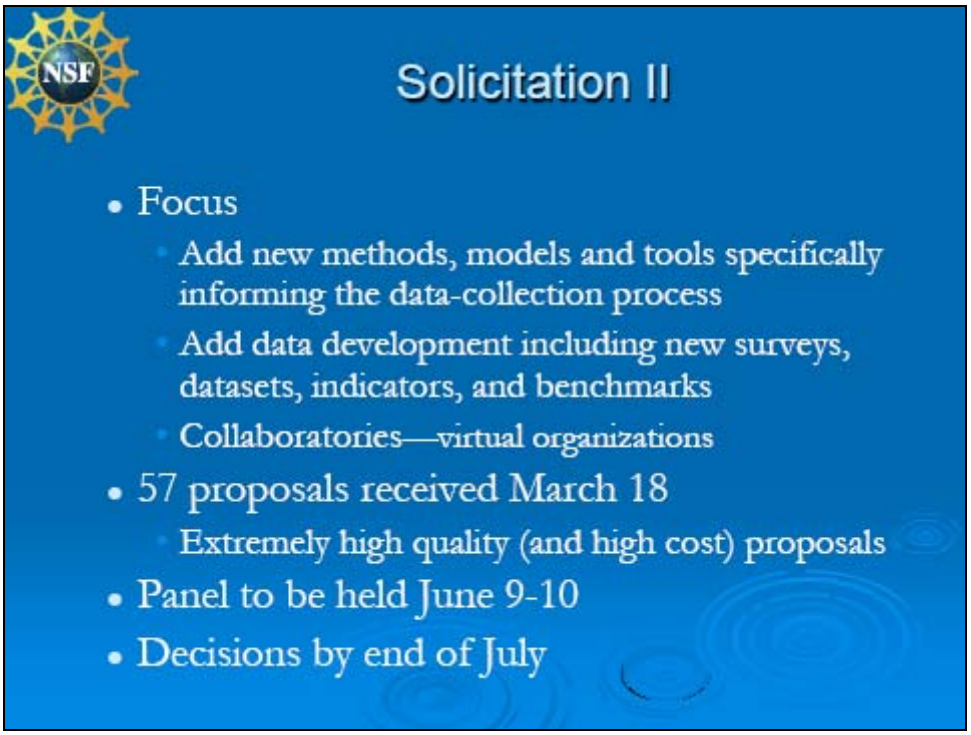

Tools
Models
Data


Investigator Initiated Research
Solicitations
Workshops


Human capital development and the collaborative enterprise related to STI outcomes
Transdisciplinary research teams
Collaboration between academic and non-academic scientists
Virtual social networks
Domain and culturally based evaluation tools
Returns to international knowledge flows
Benefits from international collaboration
Contributions of foreign graduate students and postdocs to knowledge creation and diffusion


Creativity and innovation
• Cognitive models of scientific discovery and innovation
• Tools for innovative design based on core cognitive processes
Knowledge production systems
• Gap analysis of the Idea Innovation Network (
• Complexity systems modeling of technological evolution
• Mapping tool of science for correlating funding with research outputs
• International database of inter-organizational collaborative agreements (OECD)


Science policy implications
• Theoretical framework for assessing science and technology policies and social welfare outcomes
• Evaluative tools for assessing the distributional consequences of policy initiatives (intellectual property rights; life sciences)
• State science and innovation policy initiatives evaluation tools
• Public-values-based model of science and innovation policies
Broader Impacts
• Simulation models of the knowledge creation and transfer system
• Organizational designs and social networks that incubate, enrich and accelerate innovation
• Tools for policymakers to optimize funding potential
• Database of international research and technology partnerships, with indicators
• Video database on tools and artifacts in innovative design
• Performance evaluations tools enabled by cyberinfrastructure
• Frontier methods of program evaluation
• Theoretical foundations of the innovation system and linkages to economic growth and social well-being

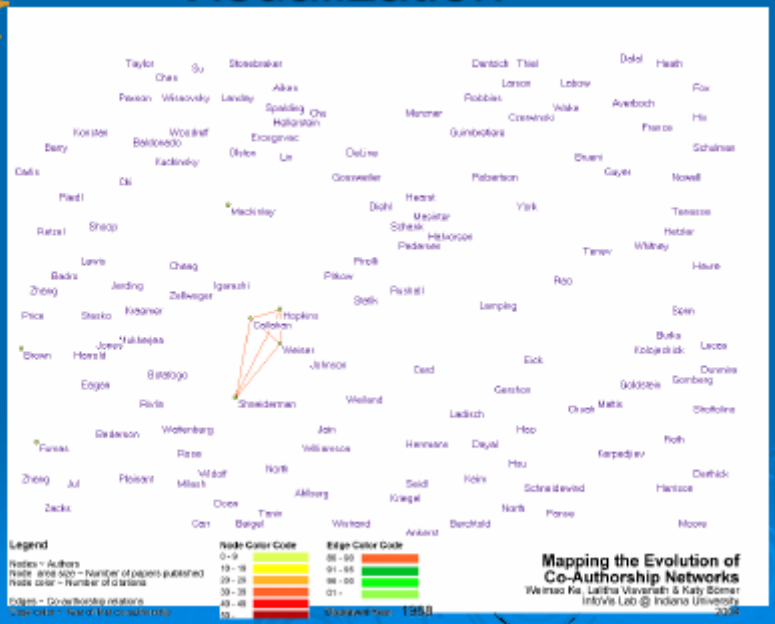

Solicitation II
• Focus
◦ Add new methods, models and tools specifically informing the data-collection process
◦ Add data development including new surveys, datasets, indicators, and benchmarks
◦ Collaboratories—virtual organizations
• 57 proposals received March 18
◦ Extremely high quality (and high cost) proposals
• Panel to be held June 9-10
• Decisions by end of July


Workshops
Advancing the Scientific Study of Discovery - Innovation Partnerships
Joint with SBE/IOS, ENGR, CISE and MPS
TBD
Describing the Elephant: Studying Innovation and Change in Organizations
Joint with Kauffman Foundation and SBE/IO
TBD
A Deeper Look At The Visualization Of Scientific Discovery In The NSF Context
Joint with SBE/SRS, OCI, CISE, MPS
Sept 11-12 2008

Data on Organizations

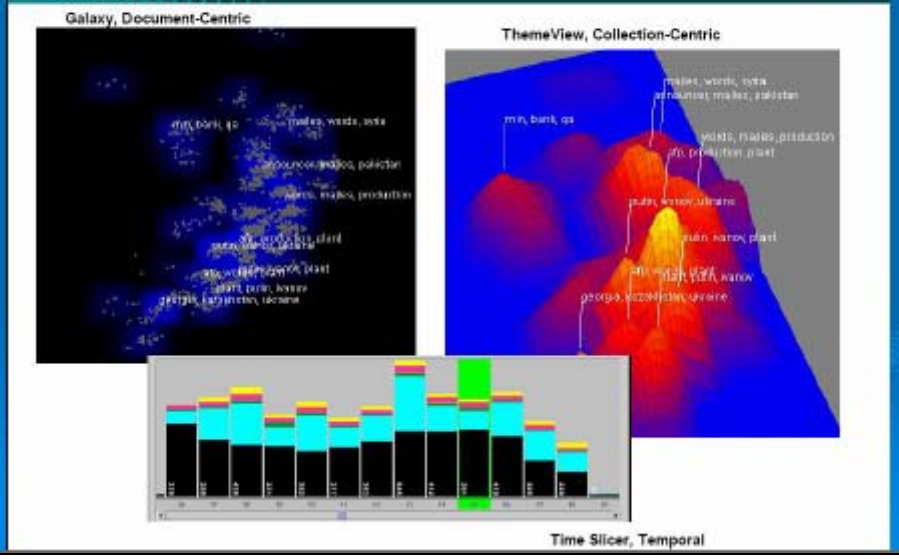
- Researcher Driven
  - Data infrastructure
  - Web 2.0 approach
  - Virtual Collaboratory
- New approaches to collecting data
  - Survey
  - Administrative
  - Webscraping
  - Etc…
- Confidentiality
- Collaboration with businesses

Visualization



Visual Analytics

Analytics with Multiple Abstractions Over Time



Solicitation III

- Will be posted October 2008
- Deadline January 2009
- Awards May 2009

SciSIP Milestones

- **Longer term:**
  - An evidence-based understanding of the impacts of the S&E enterprise
  - A capacity to better nourish and harness the capabilities of the national STEM workforce
  - The development of a Community of Practice

The NSF Science & Engineering Enterprise Statistical Data Collections

SciSIP funded Redesigns and New Surveys


National Science Foundation
NSF
Business Research & Development Survey (BRDS)
• BRDS redesign.
- Financial measures of domestic and global R&D activity
- R&D employment detail
- R&D management, strategy, and technical focus
- Intellectual property and technology transfer activities
21


National Science Foundation
NSF
Academic Research & Development Survey
• Survey redesign will.
- Provide more detailed sources of funds including industry support by field
- Reflect multi- and interdisciplinary R&D, new fields
- Explore feasibility of obtaining data on R&D personnel
- Examine potential means of tracking technology transfer activities
- Improve international comparability (e.g., collection of non-S&E R&D data)
22

National Science Foundation

Other SRS R&D Surveys

- Two surveys of federal government funding of R&D
- New State Government R&D Survey.
  - Data collections for 2006 & 2007 & periodic in the future
- Research Facilities Survey in academic and biomedical facilities (with NIH)
- Nonprofit R&D Survey; early planning stage
  - 2 types of R&D data – performers & funded
  - Characteristics of nonprofits conducting R&D
  - Characteristics of R&D conducted
  - Exploration of intellectual property IP
  - Exploration of Innovation

23

National Science Foundation

Research & Development: Other Activities

- R&D Satellite Account—joint work with Bureau of Economic Analysis (BEA).
- R&D investment accounted for about 4 ½% of real GDP growth from 1959-1995 and for 6 ½% from 1995-2002
- Linking NSF's Business R&D data with BEA data on foreign direct investment
- U.S. firms' international R&D activities
- Foreign firms' R&D activity in U.S. by state and industry

24

National Science Foundation

Innovation: U.S. Surveys

- Innovation is not the same as R&D
- SRS surveys collect no innovation-specific data
- Planning to obtain data on innovation activities of firms with fewer than 5 employees
- Exploring addition of periodic innovation modules to redesigned Business R&D Survey

25

National Science Foundation

Human Resources

- Addition of field of bachelor's degree to American Community Survey (ACS) which is part of the U.S. Census

- Will provide timely annual estimates of S&E workforce and immigrant scientists & engineers (now dependent on decennial Census data for best estimates)

26

Human Resources

- SRS Postdoc Data Project to increase quality and quantity of information on postdocs/early career scientists & engineers
- Ongoing work with OECD, UNESCO, and the EU to improve quality and international comparability of data on education, workforce, and mobility – continual incremental improvements
- Exploration of data and ongoing work on S&E jobs outsourcing, off-shoring
- Collecting information on recipients of S&E doctorates from U.S. institutions residing outside the U.S.

Interdisciplinary, Multidisciplinary, and Emerging Fields

- Activities include:
  - Updating taxonomy for fields of science (e.g., exploring bibliometric methods) for education, research, and jobs
  - Identifying emerging fields through survey responses to open-ended questions
  - Collecting information about interdisciplinary/ collaborative nature of S&E jobs.

Cyberinfrastructure

- Lack of uniform definitions and agreed – upon measures; multiple definitions as technologies evolve
  - SRS continues to track pertinent developments
  - Academic Research Facilities Survey as primary vehicle
    - Currently collects data on:
      - Computing and networking
      - Infrastructure
      - Measures of cyberinfrastructure activities (constrained by the data available to survey respondents)
    - Beginning to pick up information relevant to Cyber databases such as computing storage & bricks & mortar necessary to support the cyberinfrastructure
    - Sharing of computing resources

Thank you!

Comments and questions invited.

For more information please contact:

Julia Lane
jlane@nsf.gov

6. Impact Assessment in the National Institute of Advanced Industrial Science and Technology- AIST, Mitsutaka Matsumoto, National Institute of Advanced Industrial Science and Technology, Japan

AIST

Assessing the impacts of public R&D in National Institute of Advanced Industrial Science and Technology (AIST)

Mitsutaka MATSUMOTO, Ph.D.
Research and Innovation Promotion Office,
National Institute of Advanced Industrial Science and Technology (AIST), Japan

OECD workshop on "Assessing the socio-economic impacts of public R&D investment"
11 June 2008, at OECD, Paris

AIST

Presentation Outline

1. Outline of AIST
2. A modeling framework to estimate the market creation economic impacts of AIST R&D

AIST

1. Outline of AIST

AIST

Missions of AIST

Under our fundamental philosophy "To Realize a Sustainable Society", we have set the following four goals in order to produce the seeds of innovative technologies (which could involve a level of risk) and promote the effective realization of our research findings as products, in accordance with the national policy for economy and industries.

Contribution to a sustainable society

AIST strategically engages in research and development to provide a high-quality, safe, and sound life where people can coexist with nature.

Contribution to industrial competitiveness

AIST transforms the structure of Japanese industries and strengthens the industrial competitiveness through innovations in industrial technology by enhancement of its function as the innovation hub.

Contribution to local industrial development

AIST engages in world level research and development using local technological resources. It also helps the local industrial technology by strengthening the cooperation among local industries, academia, and governments.

Contribution to industrial technology policies

AIST identifies research and development issues to be undertaken by the Japanese government, by understanding and analyzing the environment of the industrial technology, and then proposes policies about mid- and long-term industrial technology strategies.

AIST

Mission Areas of AIST

3 AIST missions are stated by the government

- Research and development in science and technology
- Geological survey and provision of geo-information
- Development of metrology standards

AIST

Research Fields and Staffs

Number of Employees
(As of April 1, 2007)

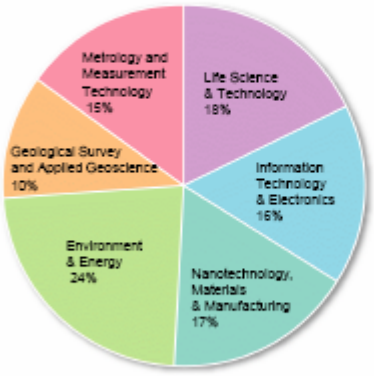
Researchers	2,487
Administrative staff	704
Total number of employees	**3,191**

(Excluding 12 executives)

Number of Visiting Researchers at AIST

Postdoctoral researchers	600
From private companies	950
From universities	2,000
From corporation etc	900
From overseas	850

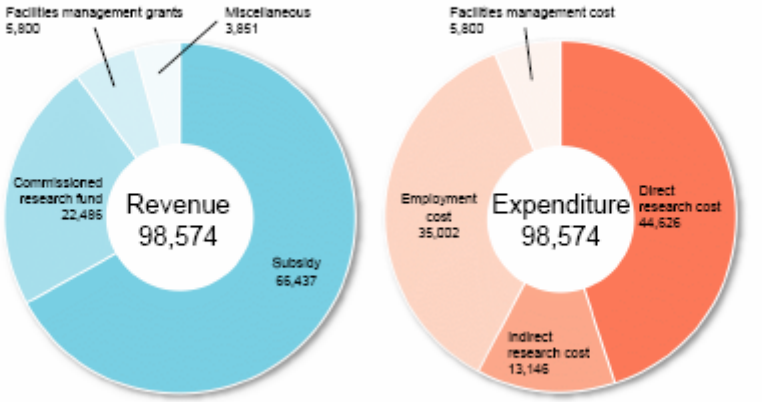
(NOTE : Each figure is estimate of visiting researchers accepted during FY 2006.)



Composition of Research Staff by Research Field

AIST

Budget



(FY 2006,
Unit : Million yen (=10 thousand US$))

AIST

AIST R&D output

Activities Involving Intellectual Property

Domestic Patents	Applications	1,185
	Registered	375
Foreign Patents (no. of countries)	Applications	193
	Registered	158
Utilization (Domestic + Foreign)	License Agreements	640
	Royalties	446 million JPY

(FY 2006)

Research Papers, Publications and Presentations

Papers	6,654
Presentations	12,108
Books and Reports	775
Publications on Earth Sciences	74
Publications on Measurement Technology Standardization for Measurement	207

(FY 2005)

Public Relations

Number of Press Releases	108
Number of Reports on AIST Activities in Mass Media	
Newspapers	1,849
TV / Radio	120
Total	1,969
Number of Tours and Visitation Arrangements	4,233

(FY 2005)

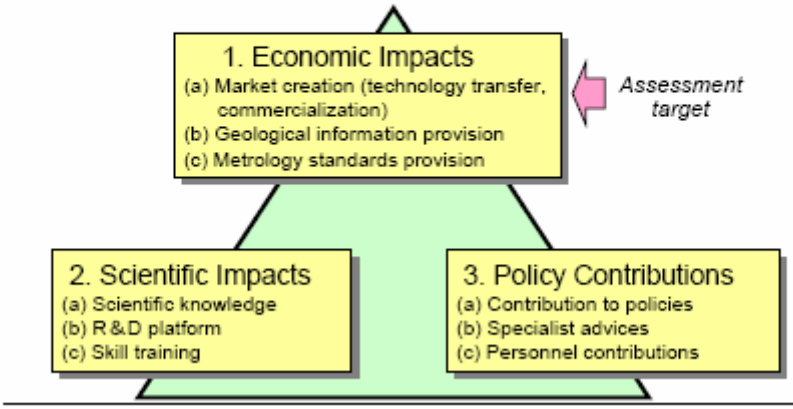
AIST

2. A modeling framework to estimate the market creation economic impacts of AIST R&D

AIST

Assessment Scope (1)

- We classified socio-economic impacts of AIST R&D to 3 categories.
- Our studies are currently targeted at the economic impacts.



AIST

Assessment Scope (2)

- We classified the economic impacts to 3 categories.
- Of the categories, our studies are currently targeted at the market creation economic impacts (positive contribution).

Assessment target

Economic impacts

Market creation contribution
(Positive Contribution)

Economic effects of creating new markets of products or services originating from new technologies.

Risk offset contribution
(Negative Contribution)

Economic effects of evincing some technologies or methods are unsuccessful. Such works prevent others from wasting time and resources. Public R&D institutes have a role of undertaking high-risk research which are not undertaken by private companies.

Loss aversion (Avoidance)

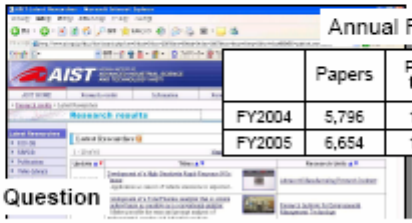
Effects of avoiding social losses by providing disaster prevention information, environmental monitoring information, etc. Effects of saving costs in other organizations' by providing metrology standards, etc.

AIST

Approach

Developing a modeling framework to estimate the market creation economic impacts of AIST R&D

- Bottom-up approach
- Estimating the market creation economic impacts of annual AIST R&D outputs
  - Measuring the impacts by the market scale (not by consumer surplus, etc.)
  - Not considering/multiplying the contribution ratio of AIST



Annual R&D outputs

	Papers	Presen-tations	Domestic patent applications	. . . .
FY2004	5,796	10,622	1,569	
FY2005	6,654	12,108	1,378	

Research Question

- How to estimate the market creation economic impacts of annual AIST R&D output?

AIST

Case Study (1): Market creation from AIST R&D output

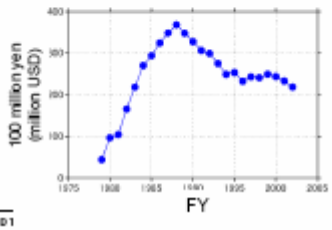
Poly-acrylo-nitril (PAN) based Carbon Fiber

Carbon reinforced plastics are hard and light. They are widely used for golf club shafts, fishing rods, aerospace base, and recently, passenger aircraft and automobiles.

Innovation process

- R&D Output
  1959: Patent application by an AIST researcher
- Technology Transfer
  1965-82: Technical assistance to 28 companies
- Commercialization
  1970-: Patent licensed TORAY Co.
  commercialized golf shafts.
- Market scales
  Peak at 40 billion yen (0.4 billion USD) in 1988.
  20-25 billion yen in 1990s. Might re-increase with applications to aircraft and autos.

Global market scale of PAN carbon fiber



AIST

Case Study (2): Market creation from AIST R&D output

Hypotensive (blood pressure lowering) functional food

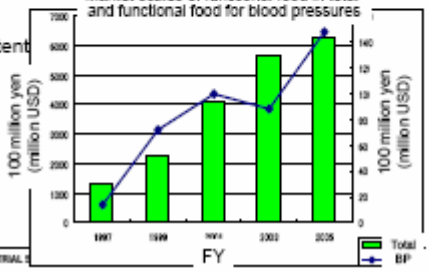
Markets of functional food such as immune recruiting food, cholesterol-lowering food are growing. AIST undertook research for hypotensive functional food.

Cow milk casein based hypotensive peptide

Innovation process

- R&D Output
  1981: Patent application by an AIST researcher
- Technology Transfer
  1986-89: Collaborative research and patent applications with a company
- Commercialization
  1997: Collaborating company began to sell products.
- Market scales
  15 billion yen in 2005 (600 billion yen for functional food total). Still growing.

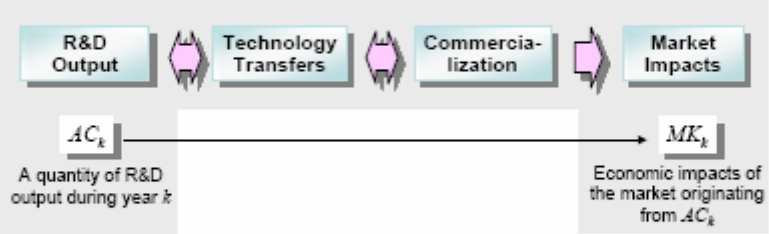
Market scales of functional food in total and functional food for blood pressures



AIST

Modeling Framework

- A typical process of R&D outputs' creating market impacts

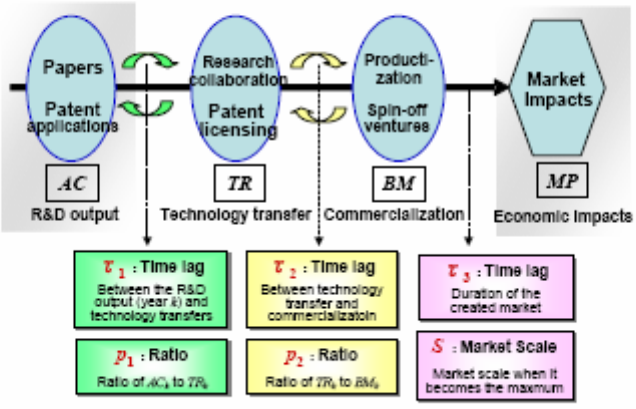


- What are the market creation economic impacts (MK_k) of annual AIST R&D output (AC_k) ?

AIST

Modeling Framework

- 6 parameters in the model



AIST

Modeling Framework

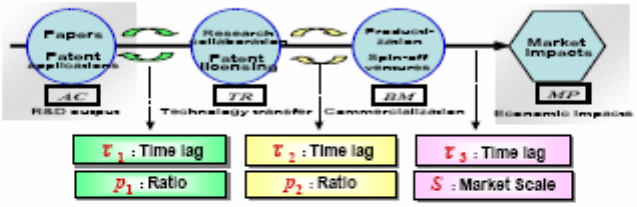
- **Parameters of the case studies**
  - Time lags and market scales of the 2 cases

	Time lags		Market scale	
	Years for R&D output → technology transfer	Years for technology transfer → Commercialization	Years for Commercialization → Market scale peak	Market scale in peak
PAN Carbon Fiber	6 years 1959: Patent application 1965-62: Technology assistance	5 years 1970: Commercialization	18 years 1988: Peak (might re-increase)	40 billion yen (400 million USD)
Hypotensive functional food	6 years 1981: Patent application 1987: Joint patent application	10 years 1997: Product selling	Over 8 years Not yet reaching the peak	Currently 15 billion yen (150 million USD)

- **Presently undertaking and accumulating case studies**

AIST

Model Formulation



An example definition of the parameters

- p_1 : Coefficient $(0 \le p_1 \le 1)$
- τ_1 : A distribution function of time t. The integration is 1: $\int_0^\infty \tau_1(t)dt = 1$
- p_2 : Coefficient $(0 \le p_2 \le 1)$
- τ_2 : A distribution function of time t. The integration is 1: $\int_0^\infty \tau_2(t)dt = 1$
- $f(\tau_3, S)$: A time function of average market scale from the commercialized year

AIST

Model Formulation

- AC_k : A quantity of AIST R&D output during year k
- $TR_k(t)$: A quantity of technology transfers of AC_k during year $k+t$

$$TR_k(t) = p_1 \cdot AC_k \cdot \tau_1(t)$$

- $BM_k(t)$: A quantity of commercialization of AC_k during year $k+t$

$$BM_k(t) = AC_k \cdot p_1 \cdot p_2 \cdot \int_0^t \tau_1(\theta) \cdot \tau_2(t-\theta) d\theta$$

- $MP_k(t)$: Market creation economic impacts of AC_k during year $k+t$

$$MP_k(t) = AC_k \cdot p_1 \cdot p_2 \cdot \int_0^t \left(\int_0^w \tau_1(\theta) \cdot \tau_2(w-\theta) d\theta \right) \cdot f(t-w) dw$$

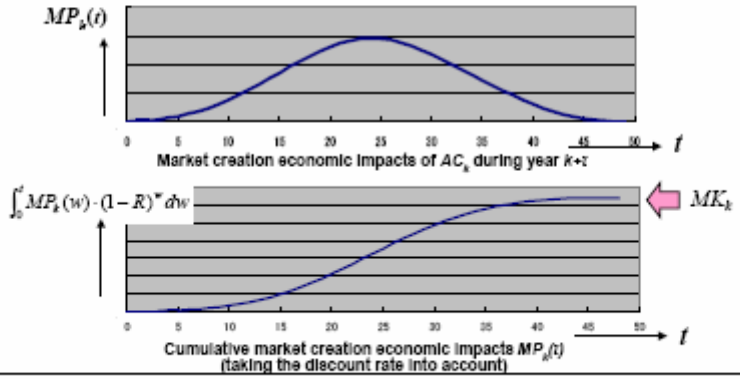
- MP_k : Total market creation economic impacts of AC_k
  (defining the discount rate R)

$$MP_k = AC_k \cdot p_1 \cdot p_2 \cdot \int_0^\infty \left(\int_0^t \left(\int_0^w \tau_1(\theta) \cdot \tau_2(w-\theta) d\theta \right) \cdot f(t-w) dw \right) \cdot (1-R)^t dt$$

AIST

Model Formulation

- By setting the parameters and functions,
  market creation economic impacts are estimated.
- Illustration of the model application



AIST

Future Work

- Currently quantifying the parameters and functions
  - Accumulating and analyzing case study data
- Refining the model
  - Reflecting research field attributes
    (e.g. technology transfer ratio (p_1) differs in different research field)
  - Reflecting interdependencies among the parameters
    (e.g. faster commercialization ($\tau_1 + \tau_2$) increases the market scale (S))
  - Reflecting the contribution ratio of AIST

AIST

Summary

AIST outline

- AIST is one of the largest public R&D institute in Japan
- The research field covers: "Life Sciences & Technology", "Information Technology & Electronics", "Nanotechnology, Materials & Manufacturing", "Environment & Energy" and "Geological Survey & Applied Geoscience" and "Metrology & Measurement Technology".

Modeling framework

- The model is a bottom-up one and is targeting at assessing the market creation economic impacts of R&D outputs
- The model formulates market creation impact processes with 4 processes (R&D output, technology transfer, commercialization, and market impacts), and consists of 6 parameters (3 time lag parameters, 2 ratios, and market scale)
- Future work includes refining the model and quantifying the parameters by accumulating case study data

7. Effects of Swedish Traffic Safety Research 1971-2004, Peter Stern, VINNOVA

Effects of Swedish Traffic Safety Research 1971-2004

Peter Stern, Ph D
VINNOVA

OECD, Paris, June 11 2008

About VINNOVA

Mission: to promote sustainable growth by financing RTD and developing effective innovation systems in the fields of technology, transport and working life

Annual budget: Around 195 million euros

Number of employees: Around 180 persons

Instruments: R&D prgms, Centres of Excellence, institutes, SME schemes, international cooperation and others

Number of programmes running : Around 50

International cooperation

Need for impact analyses

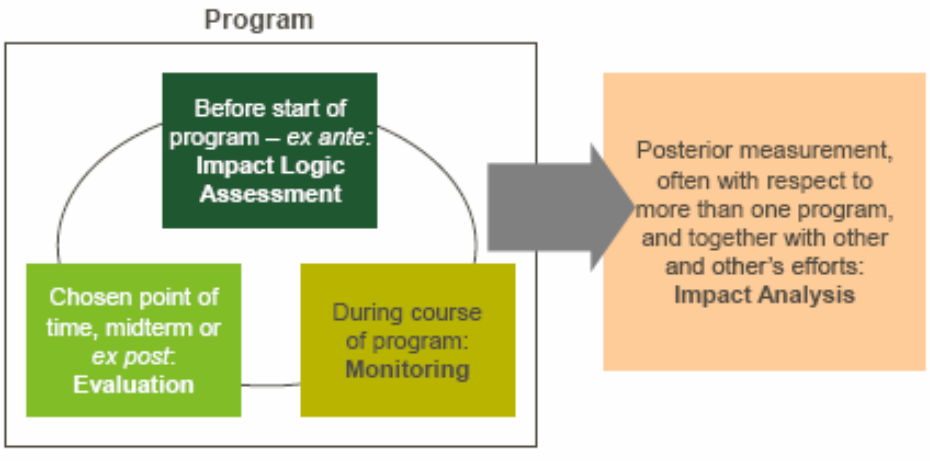
Policy makers need relevant information to underpin decision making

Often long delay before full effects of research are visible
Most ex post evaluations concluded shortly after end of programme

Consequence: Full effects of funded research not analysed

Ministry of Industry tells VINNOVA to perform impact analyses:
"to describe impacts that have resulted from VINNOVAs R&D-funding. Also comment on importance of used instruments for achieved impacts."

Impact analysis – The context



VINNOVA's impact analyses

4 pilot studies in 2001

6 impact analyses concluded

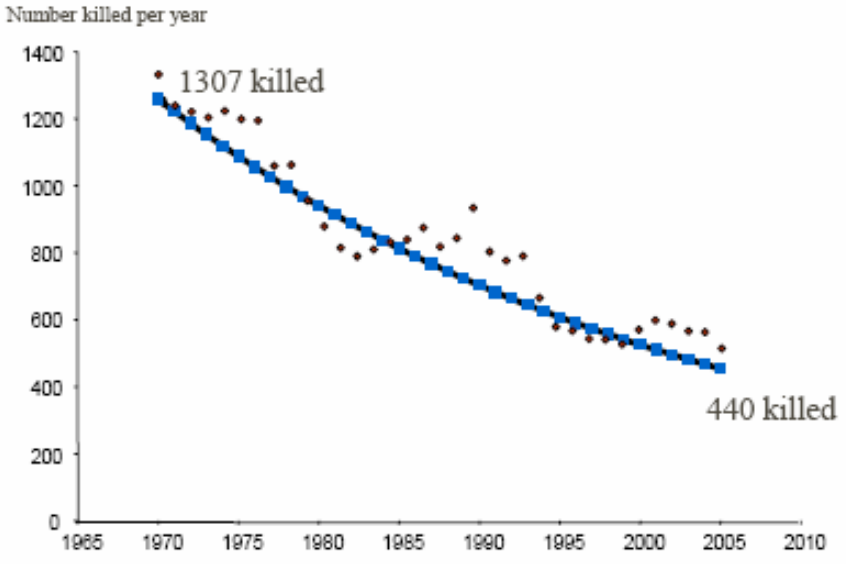
- Competence centre programme 1995 – 2003 — 8 years of perspective
- Impacts of neck injuries research 1985 – 2003 — 18 years
- User oriented ICT research 1982 – 1997 — 15 years
- Traffic safety research 1971 – 2004 — 33 years
- Role of R&D for Swedish mobile phone development 1975 - 2000 — 25 years
- Seed financing programmes 1992 – 2002 — 10 years

2 ongoing studies

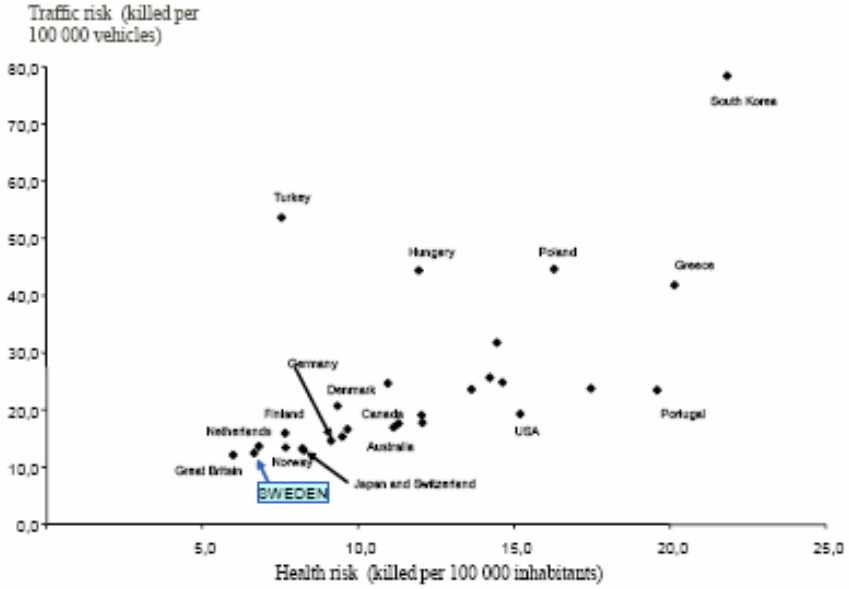
- Impact from research in life sciences
- Research and innovation in Industrial Sector Programs

Number of killed in traffic 1970 – 2004

Note. Traffic volume increased from 37 to 77 billion vehicle kilometres in same period (208 %).



Sweden successful as regards traffic safety



Traffic accident costs in 2005

Degree of injury	Number in 2005	Costs per injury (M €)	Costs to society (M €)
Killed	440	1,90	840
Severe injuries	4 400	0,35	1 520
Injuries	44 000	0,02	840
Total			3 200

Note 1 – costs according to SIKA 2005
Note 2 – statistics re. number of injured is incomplete. For each killed, 10 are assumed to be severely injured and 100 to be injured.

Why impact analysis?

Concern for position of behavioural sciences research

Intuitive belief that funded research was successful, need to understand if this was true and in which ways it was successful

How analysis was implemented

Initially unclear how to arrange a successful analysis
Exploratory interviews
Advisory group – particularly informed individuals
Early conclusion – focus on people (not e.g. money or projects)

Overview of all Swedish research 1949 – 2005

Selected evaluator team
Field competence: Norwegian Institute of Transport Economics (TÖI)
Synthesis of 1600 research articles on traffic safety measures,
incl. to what degree measures were based on research

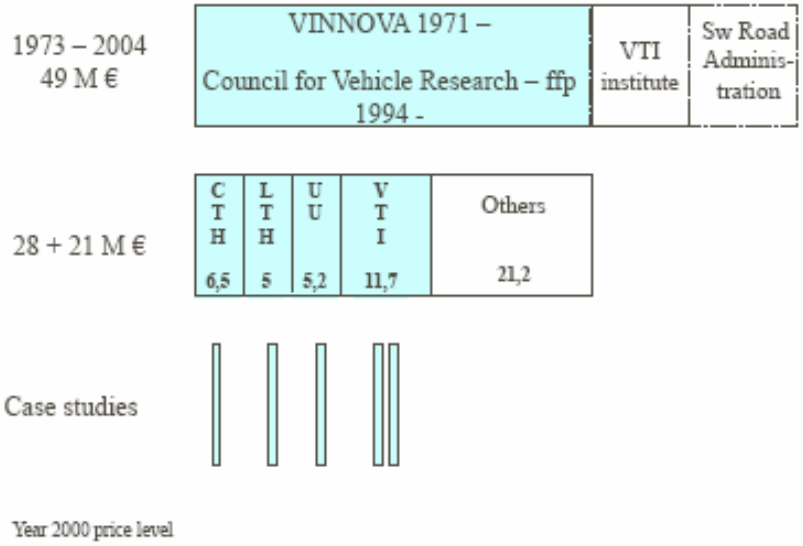
Evaluation competence: Professor Arild Hervik, University of Molde

Step by step approach – 3 successive contracts
Important inputs from advisory group

Four dominating research environments

- Department of Applied Road Safety, Chalmers Institute of Technology
  - Safety systems for vehicles such as whiplash injuries, air bags, safety belts
  - 6,5 M €, 34 projects
- Department of technology and society, Lund Institute for Technology
  - Research on traffic environment in urban areas
  - 5,0 M €, 62 projects
- Department of Psychology, University of Uppsala
  - Research on human behaviour in traffic
  - 5,2 M €, 54 projects
- Swedish National Road and Transport Research Institute (VTI)
  - Technologies for roads and vehicles, tests, traffic economy, driver training etc
  - 11,7 M €, 105 projects

Impact analysis on three levels



Year 2000 price level

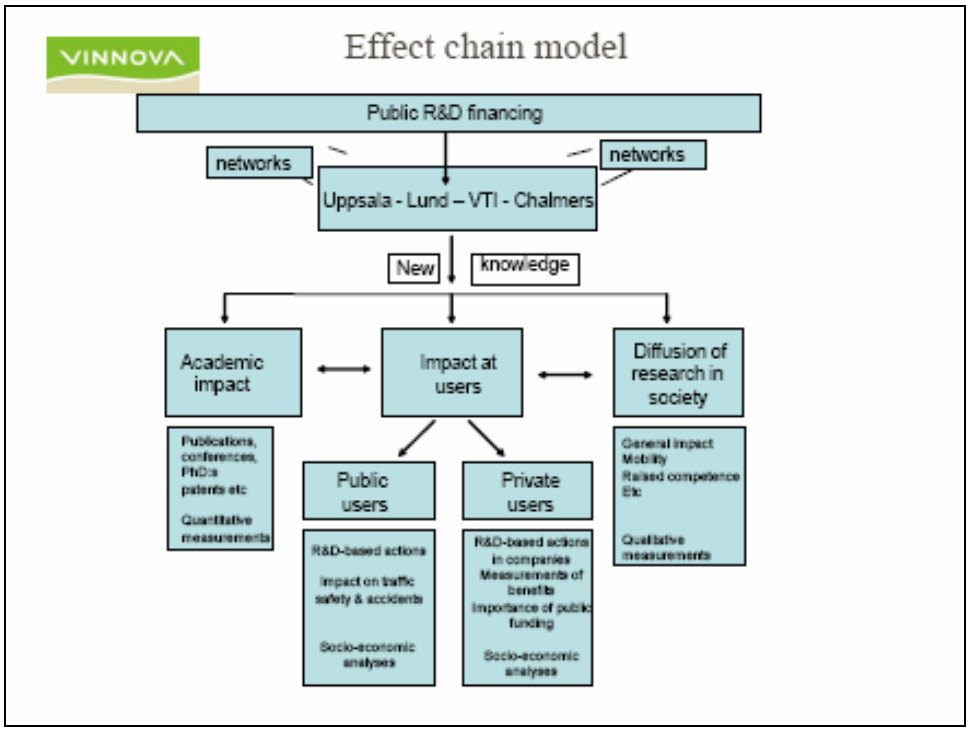
Summary – impacts of traffic safety research

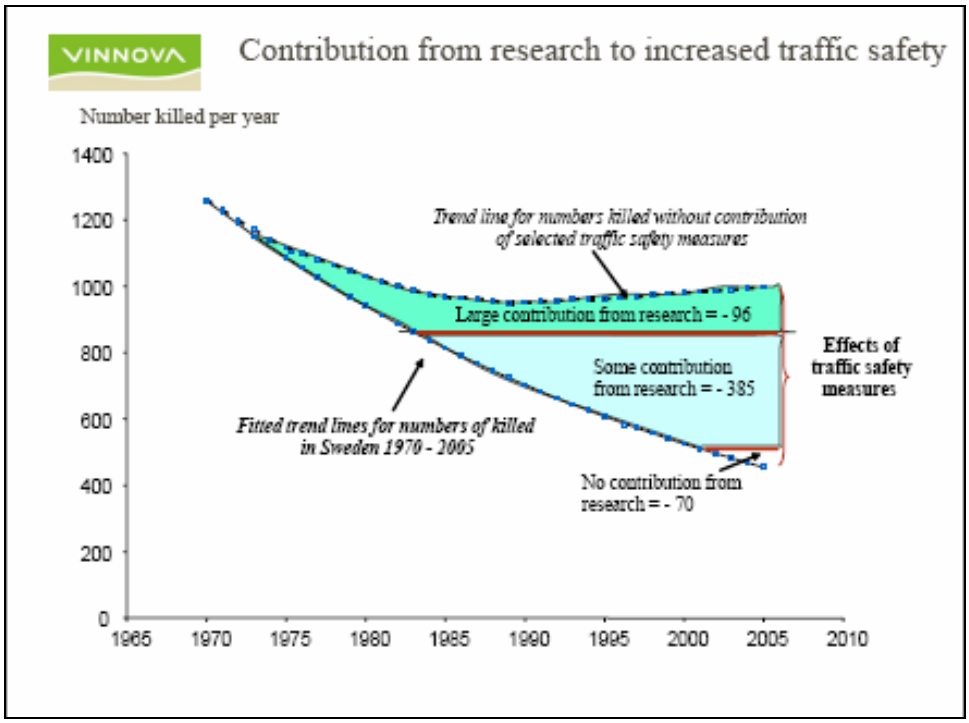
VINNOVA and Council for Vehicle Research have contributed to:

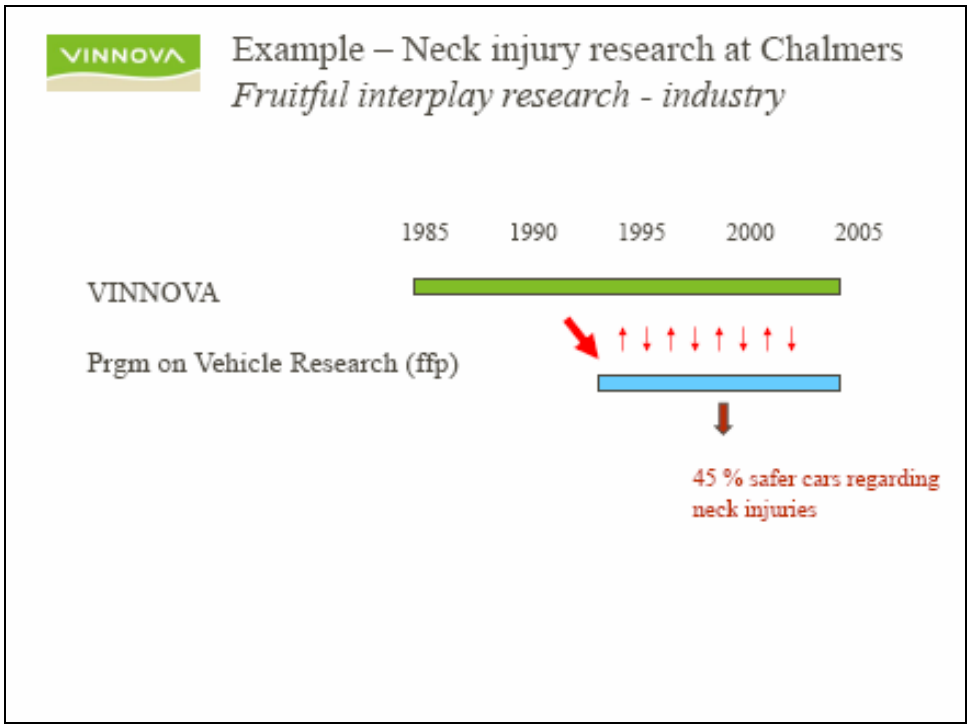
- 481 lives saved annually – at a value of 920 M € --
  and many traffic related injuries prevented (at an even higher value – appr x2)
- Swedish automotive industry has developed a considerable number of safety related products, of importance to the industry's competitiveness
- Swedish research holds a high academic level in an international perspective
- Sweden has established university departments that trains qualified personnel in all domains of the traffic safety area – a Good Research Circle
- Effects on society's way of thinking, in Sweden and in Europe

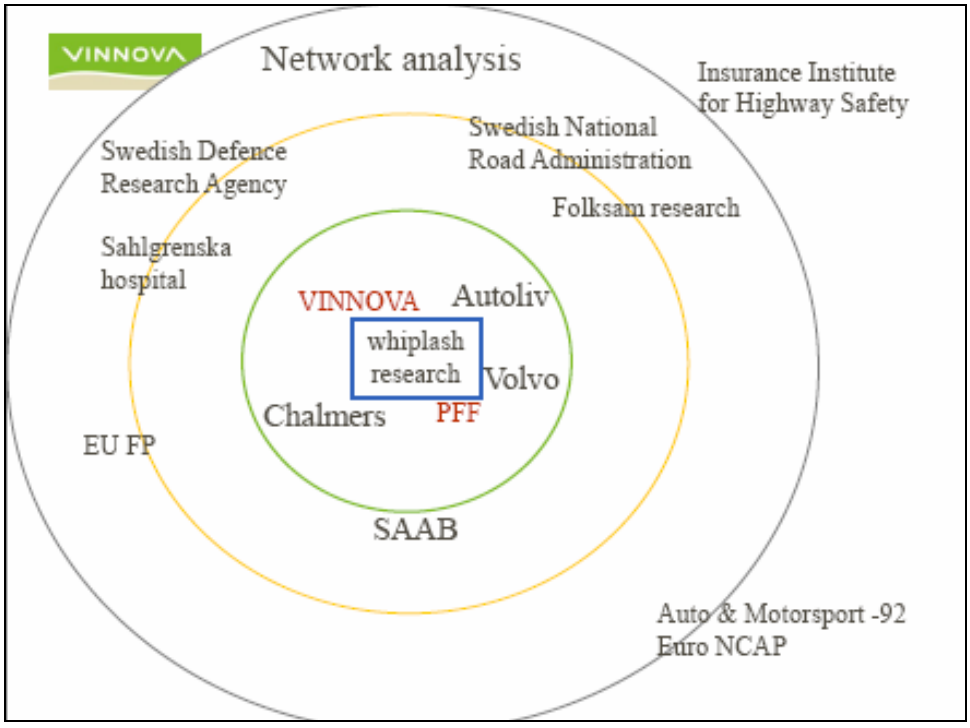
VINNOVAs and ffp:s financing crucial
Swedish Road Administration important in applying safety measures

Upstream approach


VINNOVA
Effect chain model
Public R&D financing
networks
networks
Uppsala - Lund – VTI - Chalmers
New
knowledge
Academic impact
Impact at users
Diffusion of research in society
Publications, conferences, PhDs patents etc
Quantitative measurements
Public users
Private users
General impact
Mobility
Raised competence
Etc
Qualitative measurements
R&D-based actions
Impact on traffic safety & accidents
Socio-economic analyses
R&D-based actions in companies
Measurements of benefits
Importance of public funding
Socio-economic analyses


VINNOVA
Contribution from research to increased traffic safety
Number killed per year
1400
1200
1000
800
600
400
200
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Trend line for numbers killed without contribution of selected traffic safety measures
Large contribution from research = - 96
Some contribution from research = - 385
No contribution from research = - 70
Fitted trend lines for numbers of killed in Sweden 1970 - 2005
Effects of traffic safety measures


VINNOVA
Example – Neck injury research at Chalmers
Fruitful interplay research - industry
1985
1990
1995
2000
2005
VINNOVA
Prgm on Vehicle Research (ffp)
45 % safer cars regarding neck injuries


VINNOVA
Network analysis
Insurance Institute for Highway Safety
Swedish National Road Administration
Swedish Defence Research Agency
Folksam research
Sahlgrenska hospital
VINNOVA
Autoliv
whiplash research
Volvo
Chalmers
PFF
EU FP
SAAB
Auto & Motorsport -92
Euro NCAP

About whiplash injuries

Causes 65% of all disabling road traffic injuries

- 2000 p disabled annually
- 200 p early retreats annually, incl. younger persons

Injuring mechanisms still not fully understood

Occurs at low speed – e.g. peak hour accidents

Solution –> find better vehicles – not a road environment issue

Worrying increase in number of injuries

Chalmers test equipment and applications - simple products based on advanced understanding

Chalmers BioRID test model

Autoliv/Volvo - WHIPS active whiplash protection

Autolivs YSAB – system for cars already in use

SAAB SAHR-system

Impact - neck injury research

Socio-economic impact	Impact on business	Impact on research
Volvo & SAAB cars 1998 - 165 M € Sweden (1800 M € USA) Autoliv YSAB System 165 M € Autoliv crash curtains 175 M €	Increased sales due to improved safety SAAB, VOLVO Autoliv Crash curtain >1100 M € (90 % exports)	World class research

Volvo SAAB 50% safer
Crash curtain 45%

Impact on safety standards

Centres of excellence
Ford and GM

Centre of excellence
GM

Conclusions

- Basic research initiated by an important societal need
- Multi-discipline research
- Mutual dialogue university research – industrial development
- Cluster within automotive industry marked by openness
- Condition for establishing research at Autoliv
- VINNOVA's grants crucial

Impact of analysis as such (as we understand it)

Policy level
Ministry of Industry - improved understanding of what VINNOVA produces - also in other areas than traffic safety

Strategic value - national consensus on traffic safety research. Consensus that behavioural sciences research is important for entire system of traffic safety research.

Industry
They refer to the analysis. Important for location of GM and Fords safety research in Sweden.

Research
Instrumental for establishing SAFER research centre in Gothenburg
Feedback to researchers – their work has been important

Reflection on VINNOVA's impact analyses

They have been possible to do and they have been extremely useful

Most important – they give a broader and more nuanced picture of impacts that follow from VINNOVAs RTDI funding

Results have been positively received and easy to communicate at policy level

Analyses have been motivated by specific forward looking needs

Demands for competence (field, evaluation) higher than normal
-> limits which analyses may be possible to perform successfully

We have not seen academic research that focuses on full effects of R&D

We welcome information on similar analyses elsewhere

Reflection (cont.)

Have we chosen too simple success stories?
E.g. analysis on User oriented ICT research 1984 – 2005 have met difficulties measuring socio-economic impact (work life research difficult to measure)

Complements *ex post* evaluations – often concluded before impact is visible

Key factor to communicate results in a way that policy makers can understand

Reflection (cont.)

Should impact analyses regard particularly important issues?
E.g. ICT 1980 - 2005, biotechnology 1980 - 2005?

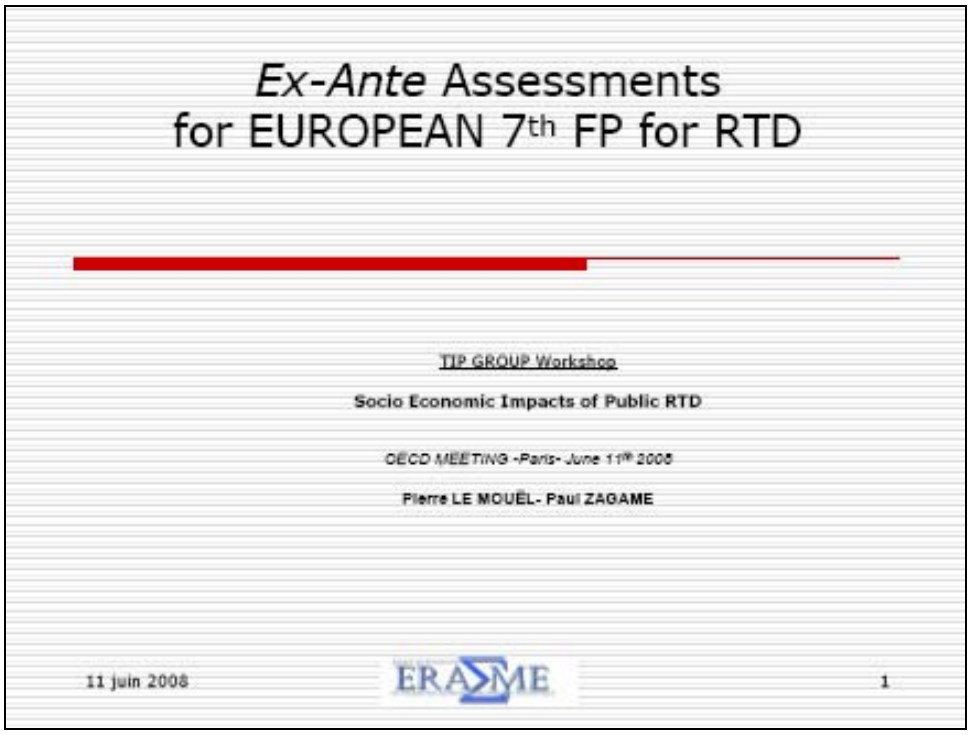
Or should we focus on mechanisms, instruments, how instruments complement each other?

How large studies are possible to manage?

Our impact analyses have been time consuming and fairly costly
They depend on availability of expertise – that policy makers will respect

Are they done elsewhere?

8. The EU FP7. Ex-ante Impact Assessment, Professor Paul Zagamé, Université de Paris 1, Phanteón-Sorbonne



I. Methodological and Theoretical Aspects

I.1 What can we learn from new growth theories ?

I.2 The Technical Progress in NEMESIS

I.1 What can we learn from the new growth theories? 1/2

- We can act on long term growth
- R&D Policies are important
- Complete description of endogenous technical progress grounded on microeconomics

I.1 What can we learn from the new growth theories? 2/2

- Possibilities of non decreasing returns
- Knowledge externalities
  - Social returns of research are greater than private returns
  - Spontaneous research level is insufficient: needs for R&D subsidies.

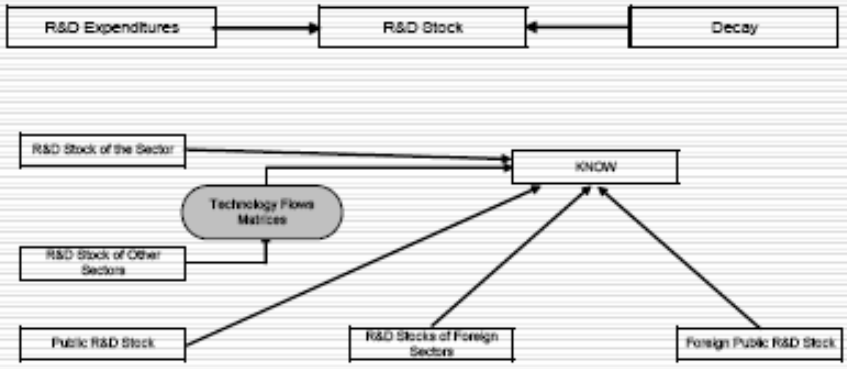
I.1 What can we learn from the new growth theories?

- Two types of innovations
  - Process
  - Product (quality)
- Endogenous technical progress
  - Learning
  - R&D
- Knowledge externalities (Knowledge Spillovers)
  - Inter-sectoral
  - Inter-national

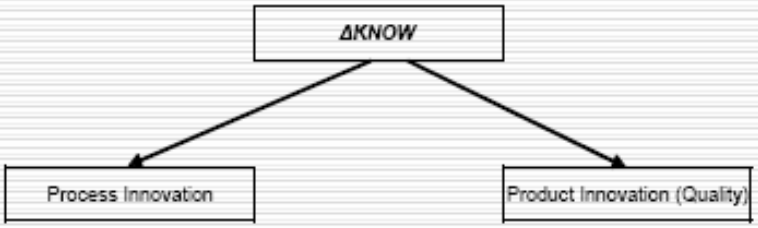
I.2 The technical progress in NEMESIS

- From R&D to knowledge stock
- From knowledge to innovations
- From innovation to economic performances

I.2 The technical progress in NEMESIS From R&D to knowledge stock

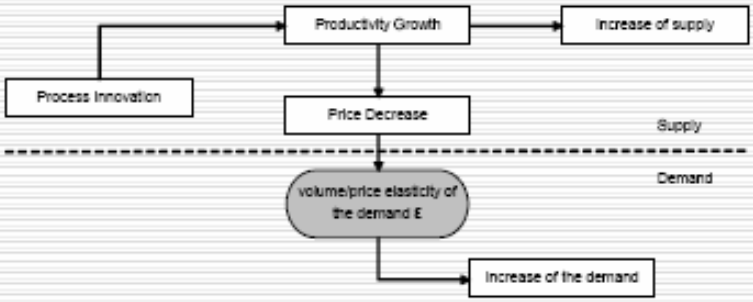


I.2 The technical progress in NEMESIS
From knowledge to Innovation…



I.2 The technical progress in NEMESIS
From innovations to economic performances…

- Process innovation:



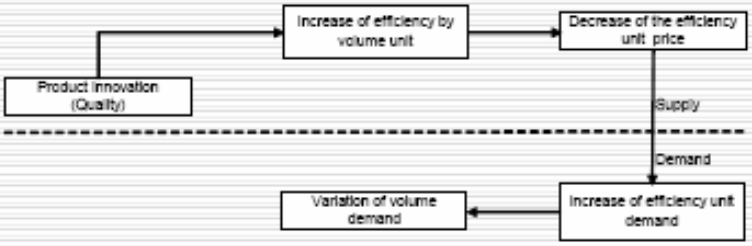
I.2 The technical progress in NEMESIS
From innovations to economic performances…

- Process innovation :
  - Increase of the demand greater than the supply increase if $\varepsilon>1$
  - But in time series $\varepsilon<1$

    → Thus, absorption following a productivity shock is not sufficient for maintaining factors use

I.2 The technical progress in NEMESIS
From innovations to economic performances…

- Product Innovation:



I.2 The technical progress in NEMESIS 7/9

From innovations to economic performances

- Product innovations:
  - For a production increase, the increase of the demand for the new efficiency must be greater than the increase of efficiency due to the innovation, that is generally the case.
  - Moreover, product innovations makes more than compensate the decrease of factor employment due to process innovations

I.2 The technical progress in NEMESIS

Technical progress equations

- Process innovations

$$\frac{\Delta TFP}{TFP} = a\frac{\Delta KNOW}{KNOW}$$

- Quality (product) innovations

$$\frac{\Delta QUAL}{QUAL} = a'\frac{\Delta KNOW}{KNOW}$$

I.2 The technical progress in NEMESIS
Technical progress equations

- Economic performance

$$\frac{\Delta Y}{Y} = \varepsilon \frac{\Delta TFP}{TFP} + \varepsilon' \frac{\Delta QUAL}{QUAL}$$

Production increase

Demand increase due to process innovations

Demand increase due to quality innovations

$$\frac{\Delta Y}{Y} = (\varepsilon a + \varepsilon' a') \frac{\Delta KNOW}{KNOW} \rightarrow \boxed{\frac{\Delta Y}{Y} = \beta \frac{\Delta KNOW}{KNOW}}$$

I.2 The technical progress in NEMESIS
Technical progress equations

- Econometric studies

$$Y = A \cdot (SRD)^{\alpha} F(K, L)$$

$$\frac{\Delta Y}{Y} = \alpha \frac{\Delta SRD}{SRD}$$

  - a similar role than β

I.2 The technical progress in NEMESIS

- Value of σ in the literature (Mohnen [90], Griliches [92], Nadiri [93], Cameron [98], Guellec et alli [92] van Pottelsberghe de La Potterie [2001], Bagnoli [2001])
  - Between 0.05 et 0.20
  - Knowledge elasticity variables with technological achievement of the sector: more important in R&D intensive sectors (equi-returns).

II. General conditions for exercise

- II.1-Main mechanisms involved
- II.2-Crowding in effects
- II.3-Economic performance
- II.4-Allocation of funding
- II.5-Evolution of F.P.
- II.6-All the scenarios.

II-General conditions for exercise

- II.1-Main mechanisms involved
  - Subsidies from M.S and European F.P. increases RTD expenses (crowding effects)
  - RTD increases Knowledge variable and then :
    - Productivity
    - Quality
  - Increases competitiveness, external, internal demand and then economic performances : GDP, employment, exports.

II-General conditions for exercise

- II.2 Crowding-in effects 1/3
  - David, Hall, Toole (2000)
  - Duguet (2002)
  - Guellec and van Pottelsberg (2003)
    - Crowding-in depends on the rate of subsidies
    - 1 → 1.7 – 2

II-General conditions for exercise

- II.2-Crowding-in effects 2/3
- Positive leverage
  - Private RTD
    - 1 for Member States Funding 1 → 2
    - 1.1 for F.P.: 1 → 2.1
    - 1.4 for performance allocation and networks effects (best practice) : 1>2.4

II-General conditions for exercise

- II.2-Crowding-in effects 3/3
- Negative leverage: Diminution of 1€ FP
  - Reversibility
    - -2.1 € without national compensation,
    - -2.1 + 0.5*2 = -1.1€ with a 50% compensation
  - Irreversibility
    - -1€

II-General conditions for exercise

II.3-Economic performance β

$Y=A(KNOW)^{\beta} F(K,L...)$

- β increases with RTD efforts
  - Ref. Scen. 1: β identical for F.P and M.S funding

    (β from 0.075 to 0.124)
  - Ref Scen.2: β higher for F.P funding (from 0.0075 to 0.13) than for MS funding (from 0.075 to 0.10)

II-General conditions for exercise

- II.4-Allocation of European funding 1/2
  - Member states
    - FP6 structure
    - Grand-fathering: Proportional to RTD expenses
    - Performance:
      - Public research: Publications
      - Private research: Patents

II-General conditions for exercise

- II.4-Allocation of European funding 2/2
  - Inside Nations
    - 60% private research except for performance
    - 40% public research
  - Sectors in Nations
    - Grand fathering

II-General conditions for exercise

- II.5-Evolution of F.P. Funding (annual rate of growth)

	FP7 2007-2010	After
BAU	3.87%	3.87%
Generally	doubling	3.87%
Voluntarist	doubling	7.74%
Renationalisation	3.87%	3.87%
Discontinuation	0%	0%

III-Results

- III.1- Grand fathering
- III.2- Performance
- III.3- Voluntary
- III.4- Renationalisation
- III.5- Discontinuation
- III.6- Costs of non F.P

III-Results

- III.1-Grand fathering results 1/2
  - Crowding in: 1.1
  - β : identical
  - Allocation: proportional to RTD efforts
  - Evolution of FP: doubling for FP7 and 3.7% after

III-Results

III.1-Grand-fathering Results 2/2

Europe	2010	2015	2020	2025	2030
GDP	0.08	0.16	0.25	0.35	0.45
Quality Adjusted GDP	0.15	0.32	0.41	0.58	0.69
Extra-European Exports	0.00	0.15	0.31	0.47	0.64
Extra-European Imports	0.08	-0.02	-0.11	-0.21	-0.27
Total Investment	0.10	0.13	0.17	0.22	0.29
Households Final Consumption	0.11	0.20	0.30	0.41	0.52
Factors Productivity	0.05	0.05	0.10	0.10	0.15
R&D Intensity*	0.036	0.04	0.046	0.052	0.059
Products Quality	0.10	0.20	0.20	0.30	0.30
Employment in Research**	31	37	44	50	59
Total Employment**	115	155	220	305	428

In % deviation from baseline scenario, except* (in % of GDP) and** (in thousands)

III-Results

III.2-Performance results 1/2

- Crowding-in 1,4
- β identical
- Allocation proportional to:
  - Publications (public)
  - Patents (private)
- Evolution of FP doubling for FP7 and 3,7% after

III-Results

- III.3-Voluntarist results 1/2
  - Crowding-in 1,1
  - β identical
  - Allocation proportional
  - Evolution of FP: Doubling R&D intensity of FP from 0.06% to 0.23% in 2030

III-Results

- III.3- Voluntarist results 2/2

Europe	2010	2015	2020	2025	2030
GDP	0.08	0.19	0.34	0.58	0.92
Quality Adjusted GDP	0.16	0.34	0.65	1.04	1.62
Extra-European Exports	0.00	0.16	0.42	0.87	1.56
Extra-European Imports	0.08	-0.01	-0.15	-0.44	-0.84
Total Investment	0.10	0.17	0.26	0.40	0.60
Households Final Consumption	0.11	0.22	0.38	0.61	0.92
Factors Productivity	0.05	0.05	0.15	0.20	0.35
R&D Intensity*	0.04	0.067	0.104	0.157	0.228
Products Quality	0.10	0.20	0.40	0.60	0.89
Employment in Research**	34	60	95	145	214
Total Employment**	120	203	336	550	905

In % deviation from baseline scenario, except* (in % of GDP) and** (in thousands)

III-Results

- III.4-Renationalisation results 1/2
  - Crowding-in 1,1 for FP and 1 for MSF
  - β_{FP} = 0.13 (end)
  - β_{MSF} = 0.10 (end)
  - Allocation: FP6
  - FP efforts: 3.87% for FP7 and after
  - MS efforts : Enough for giving the same global subsidies as in doubling FP7

III-Results

- III.4-Renationalisation results 2/2

Europe	2010	2015	2020	2025	2030
GDP	0.06	0.10	0.15	0.21	0.27
Quality Adjusted GDP	0.06	0.18	0.15	0.29	0.35
Extra-European Exports	-0.04	-0.03	0.00	0.04	0.07
Extra-European Imports	0.10	0.14	0.15	0.18	0.21
Total Investment	0.10	0.15	0.20	0.25	0.32
Households Final Consumption	0.08	0.14	0.22	0.30	0.39
R&D Intensity*	0.037	0.04	0.046	0.051	0.058
Products Quality	0	0.1	0.0	0.1	0.1
Employment in Research**	18	21	25	29	34
Total Employment**	121	173	238	320	428

In % deviation from baseline scenario, except* (in % of GDP) and** (in thousands)

III-Results

- III.5-Discontinuation results 1/2
  - Crowding-in -1,1 → -2,1
  - β identical
  - Allocation grand-fathering
  - FP efforts null during FP7 and after
  - MS efforts as in the Baseline scenario, no compensation

III-Results

- III.5- Discontinuation results 2/2

Europe	2010	2015	2020	2025	2030
GDP	-0.17	-0.34	-0.51	-0.68	-0.84
Quality Adjusted GDP	-0.32	-0.57	-0.82	-1.07	-1.31
Extra-European Exports	-0.31	-0.76	-1.18	-1.58	-1.92
Extra-European Imports	0.17	0.52	0.87	1.18	1.43
Total Investment	-0.12	-0.16	-0.22	-0.30	-0.40
Households Final Consumption	-0.13	-0.26	-0.39	-0.53	-0.66
Factors Productivity	-0.05	-0.15	-0.20	-0.25	-0.30
R&D Intensity*	-0.062	-0.066	-0.073	-0.08	-0.089
Products Quality	-0.20	-0.30	-0.40	-0.50	-0.60
Employment in Research**	-52	-59	-67	-77	-87
Total Employment**	-143	-292	-446	-627	-839

In % deviation from baseline scenario, except* (in % of GDP) and** (in thousands)

III-Results

- III.6-Costs of non FP results 1/2

→ Voluntarist –Discontinuation

III-Results

- III.6-Costs of non FP results 2/2

Europe	2010	2015	2020	2025	2030
GDP	0.25	0.52	0.85	1.26	1.76
Quality Adjusted GDP	0.48	0.91	1.47	2.11	2.93
Extra-European Exports	0.31	0.92	1.60	2.45	3.49
Extra-European Imports	-0.09	-0.53	-1.02	-1.62	-2.26
Total Investment	0.22	0.33	0.48	0.69	1.01
Households Final Consumption	0.24	0.48	0.78	1.14	1.59
Factors Productivity	0.10	0.20	0.35	0.45	0.65
R&D Intensity*	0.102	0.133	0.177	0.237	0.317
Products Quality	0.30	0.50	0.80	1.09	1.49
Employment in Research**	86	119	163	222	301
Total Employment**	263	495	782	1 177	1 743

In % deviation from baseline scenario, except* (in % of GDP) and** (in thousands)

IV-Conclusion 1/5

- Spontaneous level of RTD efforts is far from the optimum in European countries. Public subsidies can be a way of increasing RTD
- The success of such policies depends on « crowding effects »
  - The crowding-in is more important for European Fundings: 1.1 versus 1
    Networks effects
    Best practice transfers
  - Allocation of funding performance-based increases the crowding-in

IV-Conclusion 2/5

- In some cases the β elasticity of economic performances is more important for European funding (best practice transfers and Networks effects)

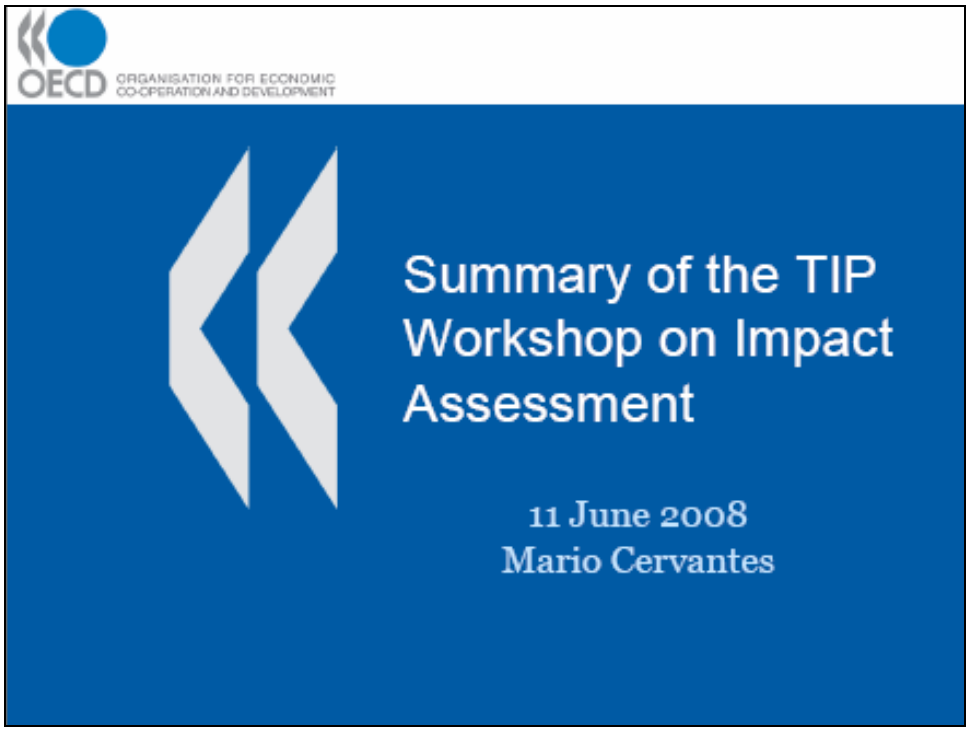
IV-Conclusion 4/5

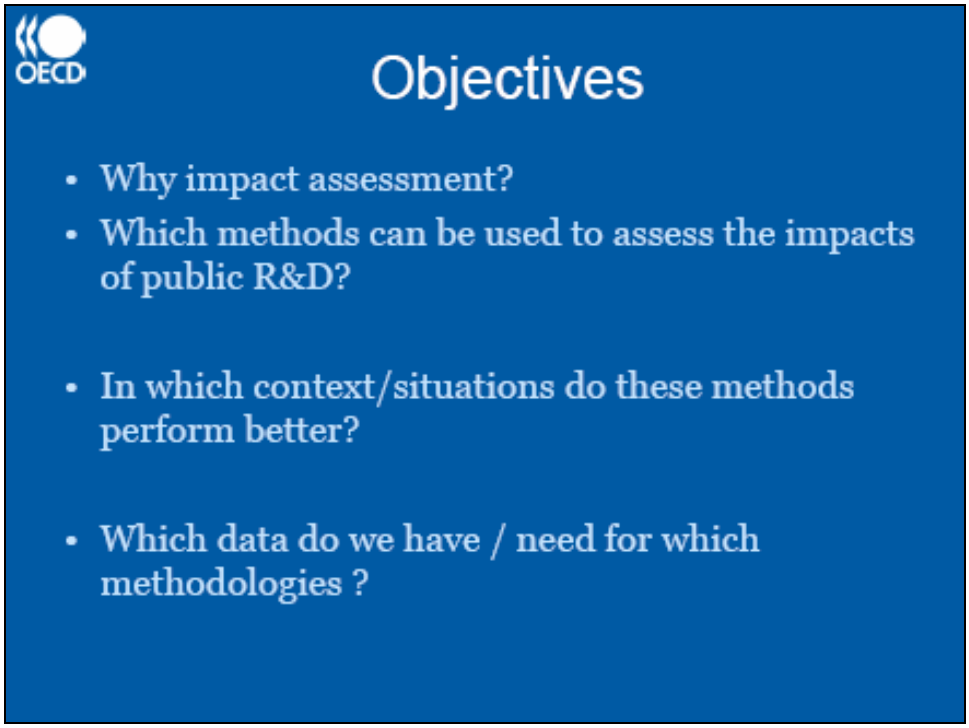
- There is no perfect substitution between FP funding and MS funding
- Necessity to think to an application of the « subsidiarity principle »
- Great performance in terms of multiplier effects of FP expenses
  - Crowding-in
  - Innovation and supply effects in 2030 of an FP voluntary Program :
    - 1.76% GDP
    - 1,7 M employment

IV-Conclusion 5/5

- Deepening :
  - DEMETER
  - WIOD

9. New Initiatives on Public R&D Investment in the US, Julia Lane, National Science Foundation. Director, Office of Science and Innovation Policy, United States





Impact Assessment: state of the art

- 1) To assess the contribution of public R&D to achieving public objectives
- 2) Measuring impacts is neither straightforward nor easy task
- 3) Importance of defining impacts (nature, scope, timing)
- 4) New practices emerging
- 5) Choice of methodology not universal but context specific

Efficiency of public support to Biz R&D

-Difference in efficiency of public R&D support across countries

– There are determining factors (Framework conditions, IPRs, etc)

– Use of different methods: composite, performance indicators, and DEA

– Result: Complimentarily between public and private R&D

– Policy Implication: Not necessarily more public support to biz. R&D but change at margins

– Model relies on input oriented methodology, but the methodology could be broadened

Macro-econometric model to assess impact of R&D on economic growth

- Capitalisation of (private and public) R&D investment
- Finds that public R&D investment is one of the main sources of longer term economic growth relative to other types of public intervention
- Potential caveats: assumptions for depreciation, interest rates
- Need to expand, include global R&D flows

Impact assessment at NSF

- An approach rather than a methodology. Programme to develop data and methodology
- Linking bodies of knowledge to assess interdisciplinary processes
- Focus on organisations and networks
- Bottom up and data intensive
- BUT need to consider system effects and the changing role of innovation (rise of services)
- Results expected in 3 years

Ex-post modelling and case study analysis

- Impact analysis in reverse , from product/invention to research funding
- Longer-time horizons required
- Problems of selection bias (assessing successful innovations only?)
- Attribution problems (internal vs. external research)

Social effect modelling

- Upstream approach, impact on society then impact on companies then impact on research then importance of funding!
- Interviews, advisory group, etc
- Impact analysis is time consuming and costly , and depend on expertise
- Need for competence of evaluators (specific field and evaluation), look outside your own your country!
- Communicating results in a way that policy makers can understand is key
- Attribution remains a challenge

Quantitative model for ex ante impact assessment

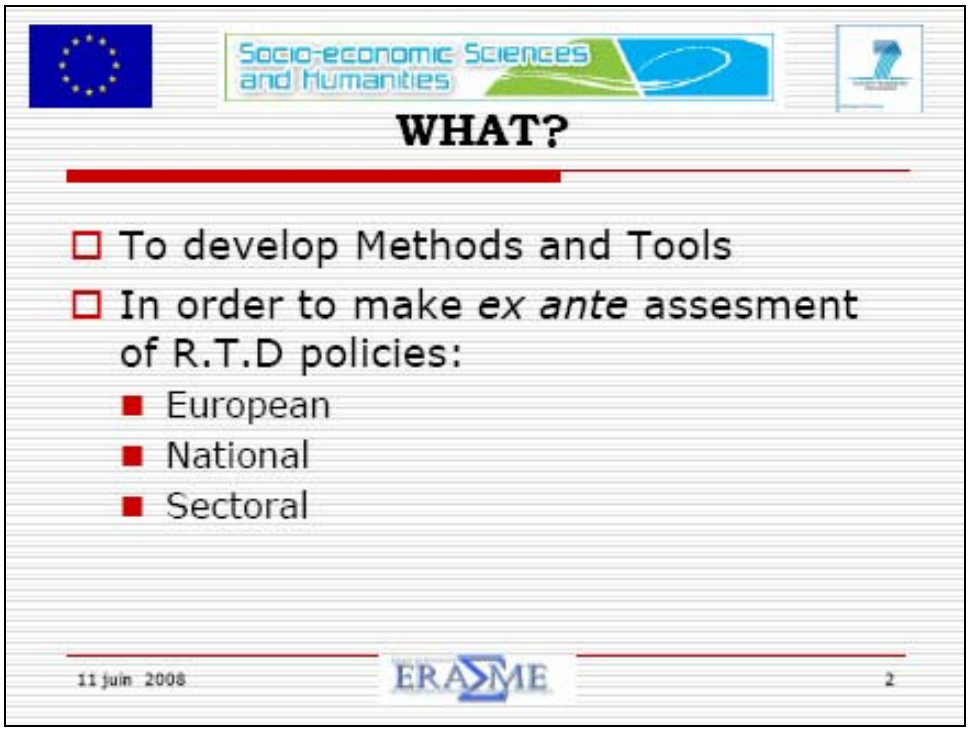
- Ex ante effects of FP 7 on competitiveness, growth and employment
- Take into account new growth theories
- Hypothesis driven [crowding in depends on network effects, allocation decisions, RTD spending and (positive)spill-overs]
- Scenarios of FP 7 funding tested; positive leverage effects but differ on employment and GDP
- Limitations of model: very large # variables and assumptions, focus on subsidies, time-frame contingent

Policy round-table : Options to go forward?

- Interagency work at NSF , data development
- DEMETER
  - develop methods and tools for ex ante assessment of EU, National and sectoral policies
  - link RTD and Human K
- NESTI (ongoing) work on measurement
  - Analysis of GBOARD
  - Tax incentives
  - Foreign funding of R&D


OECD
Policy round-table : Options to go forward?
• NESTI (new initiatives)
– Commercialising R&D
– Measuring R&D and impact in public and semi-public organisations
– Innovation indicators
– Flows of knowledge from publicly funded research organisations

10. Methodological work envisaged by the DEMETER project, Professor Paul Zagamé, Université de Paris 1, Phanteón-Sorbonne




Socio-economic Sciences and Humanities
WHAT?
European R.T.D Policies
Lisbon related strategies
F.P. for R.T.D
Synthesis of the different actions cost of the Non Europe of Research
11 juin 2008
ERASME
3


Socio-economic Sciences and Humanities
WHAT?
National Policies and National Action Plans (NAP) for R.T.D and their Evolution
Assessment for the Coherence and synergies between actions at the National levels and at the European one
Over all impact assessment
11 juin 2008
ERASME
4


Socio-economic Sciences and Humanities
WHAT?
Sectoral Policies:
European
National
11 juin 2008
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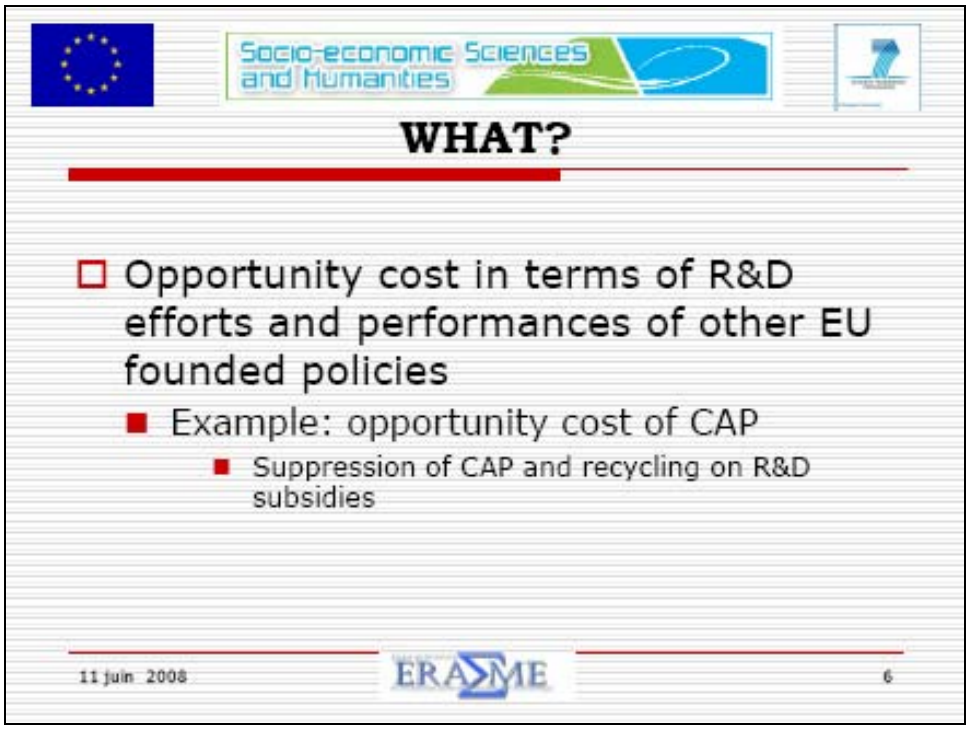
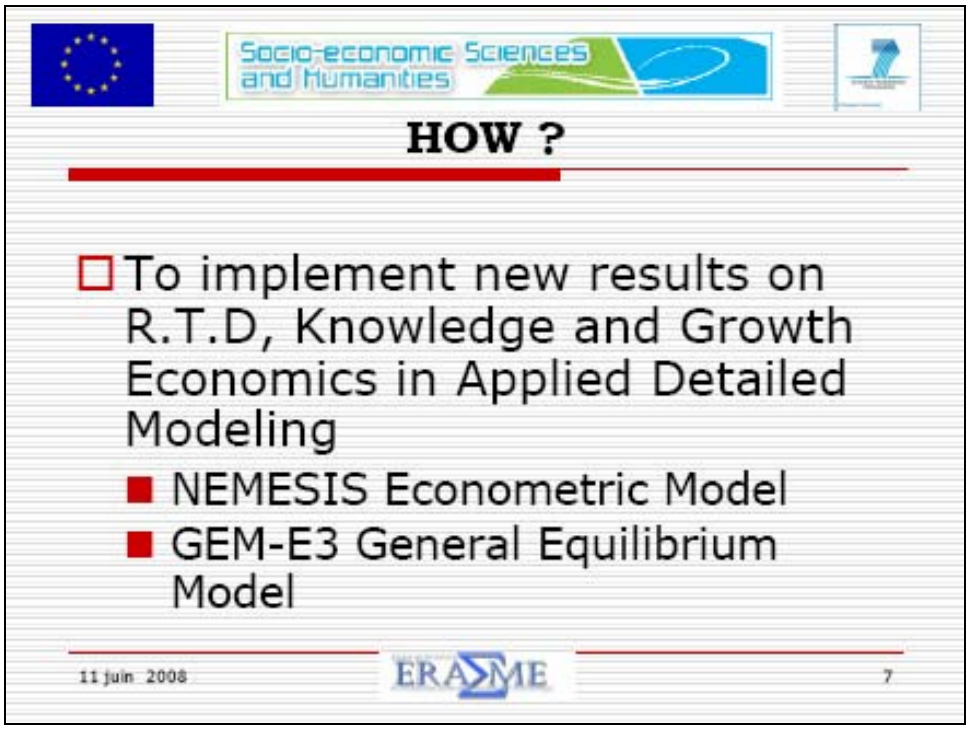
5


Socio-economic Sciences and Humanities
WHAT?
Opportunity cost in terms of R&D efforts and performances of other EU founded policies
Example: opportunity cost of CAP
Suppression of CAP and recycling on R&D subsidies
11 juin 2008
ERASME
6


Socio-economic Sciences and Humanities
HOW ?
To implement new results on R.T.D, Knowledge and Growth Economics in Applied Detailed Modeling
NEMESIS Econometric Model
GEM-E3 General Equilibrium Model
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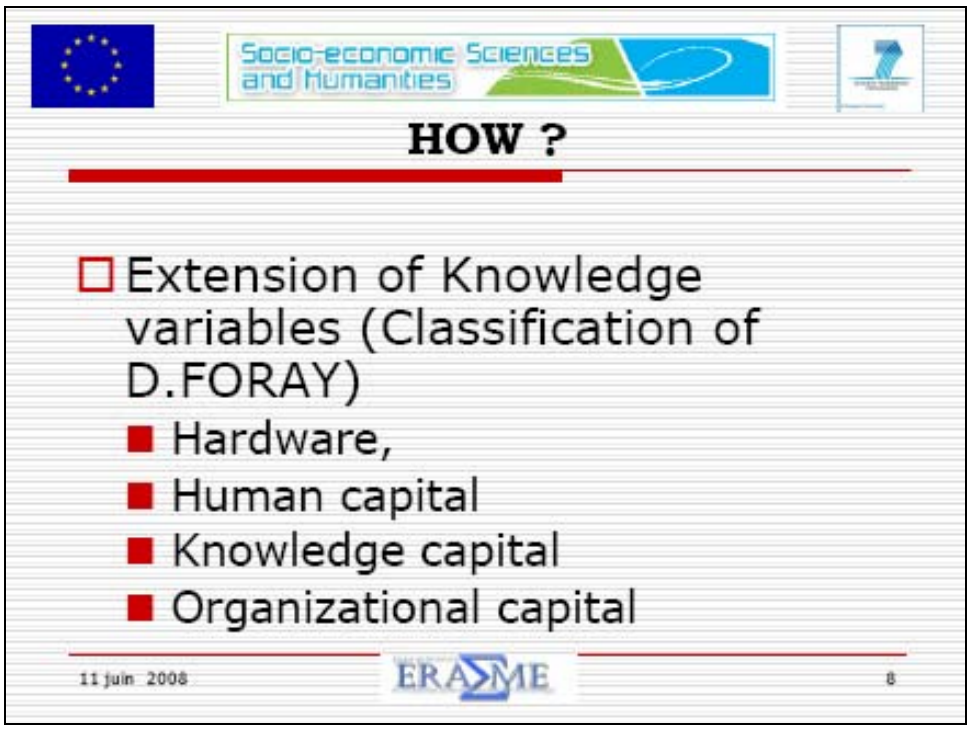
Socio-economic Sciences and Humanities
HOW ?
Extension of Knowledge variables (Classification of D.FORAY)
Hardware,
Human capital
Knowledge capital
Organizational capital
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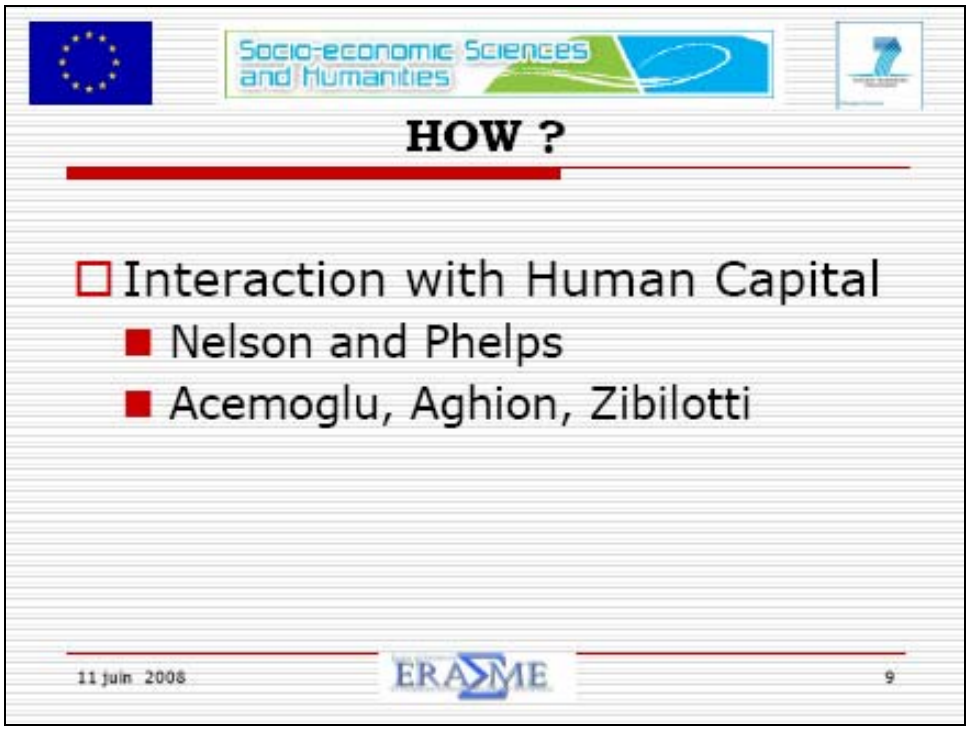
Socio-economic Sciences and Humanities
HOW ?
Interaction with Human Capital
Nelson and Phelps
Acemoglu, Aghion, Zibilotti
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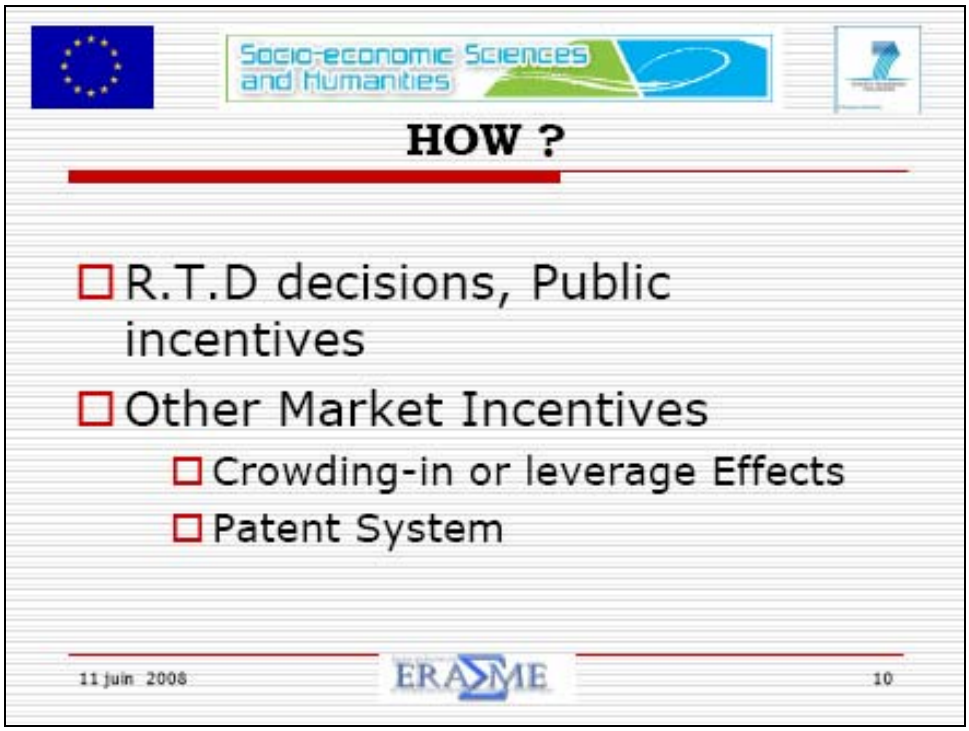
Socio-economic Sciences and Humanities
HOW ?
R.T.D decisions, Public incentives
Other Market Incentives
Crowding-in or leverage Effects
Patent System
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ERASME
10

HOW ?

- Externalities
- New Data Basis coherent with EU-KLEMS

WHO ?

- ERASME (France): Fougeyrollas, Gaffard, Le Mouël, Zagamé
- UNU-MERIT (Netherlands): Soete
- ICCS-NTUA (Greece): Kapros, Kouvaritakis
- FPB (Belgium): Bossier, Keugels
- K.U. Leuven (Belgium): Van Regemorte
- EPFL (Switzerland): Foray

11. Work on Indicators For Improving Public R&D Impact Assessments, Fred Gault, Statistics Canada/Alessandra Colecchia, OECD, DSTI

Indicators for improving public R&D impact assessments

Fred Gault
Chair of NESTI

Existing Measures

- Analysis of 30 years of GBAORD (Government Budget Appropriations or Outlays for R&D)
  - DSTI/EAS/NESTI(2008)25
- Tax incentives and other incentives
  - DSTI/EAS/NESTI(2008)27
  - Contributions, grants and contracts
  - Size distribution of R&D performers
- Foreign funding for R&D
  - Policy implications

New Initiatives

- Commercializing R&D
  - Higher Education, Government & Business
  - NESTI Room Document
- Measuring R&D and its impacts in public and semi-public organizations
  - Questionnaire (NESTI) to guide case studies (RIHR)
  - DSTI/EAS/STP/NESTI(2008)30

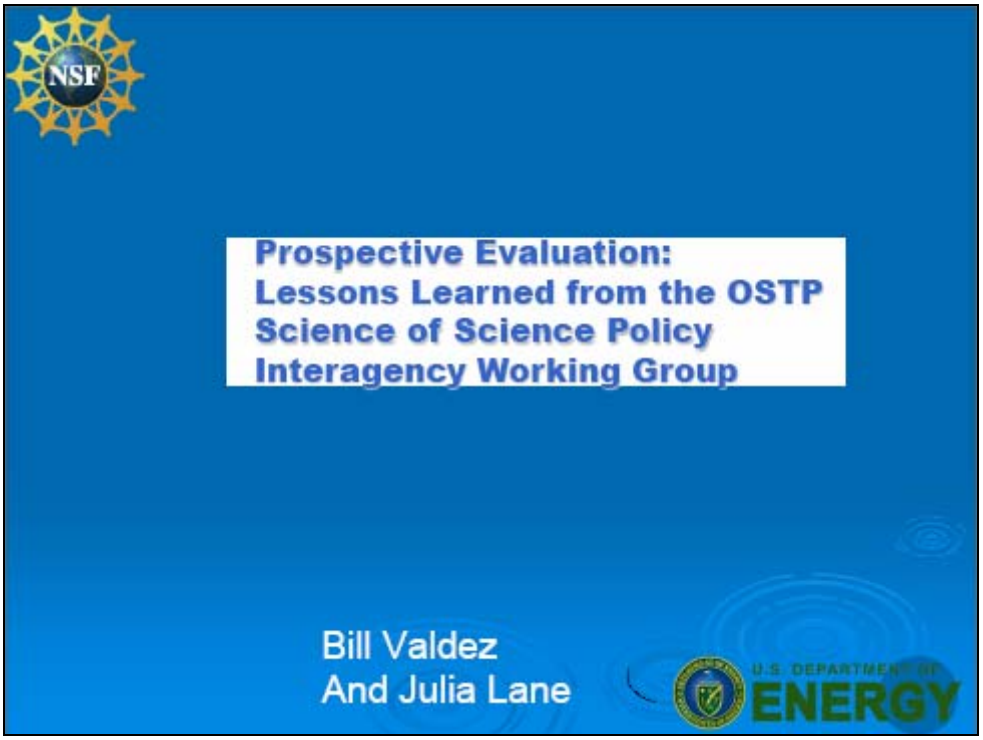
Other Projects

- Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs OECD(2007)
  - Ch 7 Towards understanding the impacts of science, technology and innovation activities
  - Ch 11 University research in an 'innovation economy'
  - Ch 13 A framework to measure the impact of investments in health research

Other Projects

- Flow of knowledge from publically funded research organizations using innovation surveys
  - Frances.Anderson@statcan.ca

12. Main conclusions on methodologies for Impact Assessment, Mario Cervantes and Beñat Bilbao-Osorio, DSTI, OECD



What we have learned

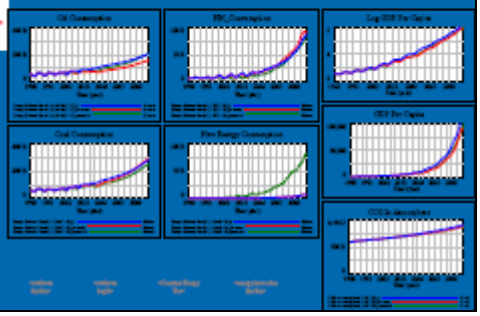
- There is very little capacity within the Federal government to conduct science policy analysis and evaluation. This is caused by both resource constraints (total Federal investment in this area is less than $20 million/year) and an absence of a defined set of effective practices.
- Perhaps the greatest barrier to effective analysis is the absence of reliable data.
- The scientific community is skeptical about the use of new decision support tools, but is open to a discussion, particularly one that centers on decision support tools that are scientifically rigorous and transparent.
- There is great confusion about the problem set being tackled, primarily because there is great confusion about the definition and use of key terms (i.e., innovation, discovery, basic research, mission-driven research, etc.).
- There is no agreed upon model of national innovation. This means that there is no agreement about what makes one system more innovative than another.
- **Because of the above, reports like the "Gathering Storm" the provide seriously flawed analyses and misguided advice to science policy decision makers.**

Qualitative Methods – Gold Standard

Qualitative methods (peer review, expert judgment, logic models, strategic planning, case studies, committee of visitors, etc.) remain the gold standard for policy makers who use decision support tools when making R&D l policy deci

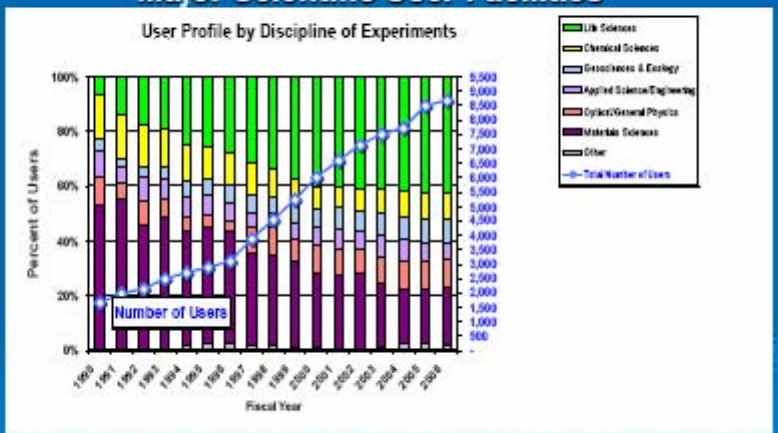
2. Best Tools Need Expert Scientists

The best emerging quantitative decision support tools (risk analysis, dynamic modeling, network analysis, datamining, etc.) rely heavily upon expert judgment and advice from the scientific community to be successful.



3. Progress in process metrics

Major Scientific User Facilities

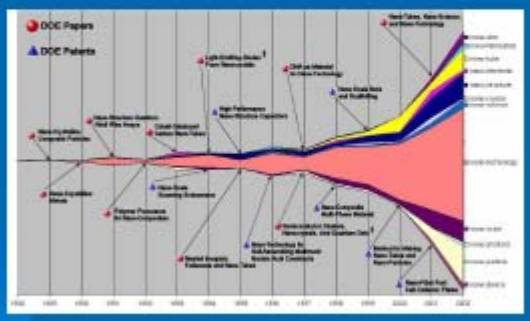


Considerable progress has been made on process metrics for science program management, but outcome/impact measures are still in their infancy.

4. Traditional tools are flawed

Lawrence Berkeley Lab's
Core Nano Network, 2000-2004

Emergence of the Term "Nano" in Open Literature‡ Showing Representative DOE Papers and Patents

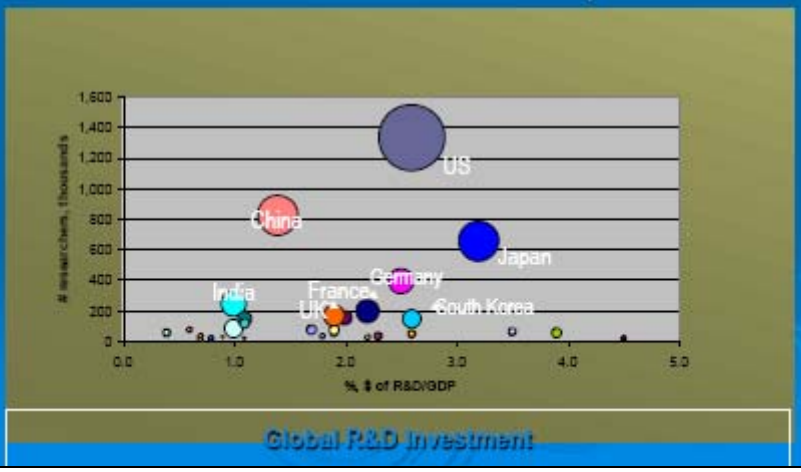


The traditional tools of R&D evaluation (bibliometrics, innovation indices, patent analysis, econometric modeling, etc.) are seriously flawed and promote seriously flawed analyses.

•Terms with at least 10 occurrences in at least one year. Width of color band indicates relative number of occurrences
‡ Papers identified by the Institute for Scientific Information as among the Top 25 Highly Cited Papers in Nanotechnology.

5. Limited government capacity for analysis

There is very little capacity within the Federal government to conduct science policy analysis and evaluation. This is caused by both resource constraints (total U.S. Federal investment in this area is less than $20 million/year) and an absence of a defined set of effective practices.



6. Absence of Reliable Data

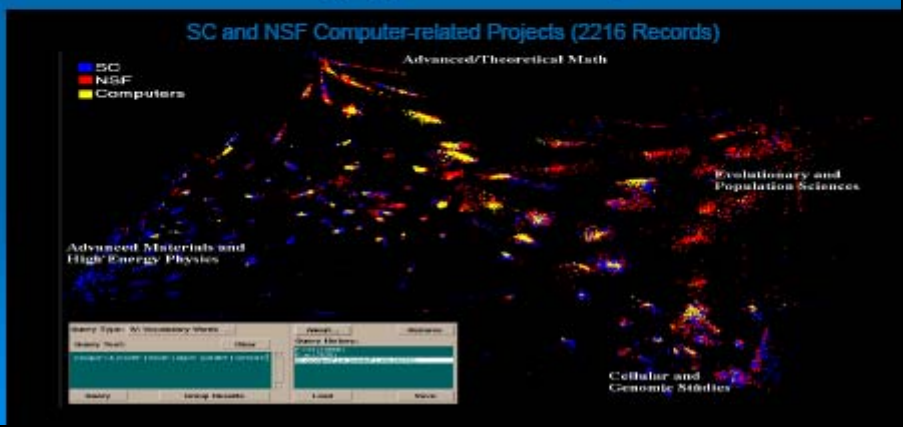
Complexity is Daunting

- U.S. Economy is $13.9 Trillion, w/50 States & 3,066 counties
- Federal Budget is $2.9 Trillion
- U.S. Federal R&D Investment - $136.9 Billion
- General Science Budget - $8.3 Billion
- $28.4 Billion to 1,227 colleges and universities for S&E
- 5.9 Million High Tech Workers
- 11 Million Scientists, Engineers and Technicians
- 4,807,000 scientists and engineers in US (2001)
- R&D data is typically found in journals, conference, workshops, pre-print servers, and scientific databases

Sources: OMB FY09 Budget Request
American Association of Counties – U.S. counties
CIA World Factbook (2006)
NSF SRS – budget (2007), academic funding (2005)
AeA, *Cyberstate\$ 2008: A Complete State-by-State Overview of the High-Technology Industry* (2008)
http://www.dpeaflcio.org/programs/analyses/2002_sci_eng.htm, Dept for Professional Employees

7. Open to new rigorous tools

The scientific community is skeptical about the use of new decision support tools, but is open to a discussion, particularly one that centers on decision support tools that are scientifically rigorous and transparent.



8. Confusion over key terms

A new generation of innovation metrics opens opportunities to apply new analytic tools to assess policy and strategic choices.

- **Growth Accounting**—economists will be able to better estimate the nation's productivity performance in terms of contributing factors and outputs.
- **Knowledge Economy**—composite knowledge indicators will improve investment decisions for R&D, education and capital resources.
- **Financial Reporting**—financial reports could provide a balanced scorecard of physical as well as intangible assets.
- **Valuation of Innovations**—business executives and financial markets could better value R&D activity and related intangibles, estimate financial results, improve long term stock market valuations and predict outcomes.
- **System Dynamics**—expanding the range of "real-time" innovation metrics would help build more robust systems dynamics models and policy simulations. .
- **General Purpose Technology (GPT)** — improved analysis of the strategic contribution of GPT's which set the stage for incremental innovation and have the inherent potential for pervasive application in a wide variety of industries.
- **Tech-led Regional Development and Clusters**—shift the emphasis from strengthening inputs to the innovation infrastructures toward improving the efficiency, rate and output of innovation.

9. No model of innovation

Figure 1. National Innovation Ecosystem

There is no agreed upon model of national innovation. This means that there is no agreement about what makes one system more innovative than another.

Highly performing innovation systems should have the following attributes:

- *Competition for Resources*
  - (Money, Ideas, People, Facilities)
- *An open market place for ideas*
  - (Patents, Papers, Copyrights, IP)
- *Resources sufficient for system growth*
  - (People, Equipment, Money, Land, Energy)
- *Checks & Balances*
  - (Transparency, Multiple Funding Sources, External Review)

An absence of any of these will seriously impair the effectiveness & efficiency of any innovation system.

10. Misinformation and Advice

Because of the above, reports like the "Gathering Storm" cam provide flawed analyses and misguided advice to science policy decision makers.

- Existing "Innovation Indexes" suffer from a host of problems, primarily a lack of context, causality, and comparability.