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SEMINAR ON NEW S&T INDICATORS FOR A KNOWLEDGE-BASED ECONOMY: DEVELOPMENT ISSUES

BOOK OF ABSTRACTS

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SESSION I: NEW INDICATORS FOR A KNOWLEDGE-BASED ECONOMY

ITEM 1: INNOVATION SURVEYS AND INDICATORS

THE SECOND ROUND OF INNOVATION SURVEYS BASED ON THE REVISED "OSLO MANUAL"

by **Geneviève Muzart**, OECD

The need of reliable and systematic data for the design, monitoring and evaluation of policies aimed at promoting technological innovation throughout the economic fabric conducted to the development of innovation surveys. Innovation surveys are an attempt to collect firm level data on input to and output on innovation, comparable across countries and over time. They are based on the "Oslo Manual" methodology.

During the mid-nineties, the "Oslo Manual" was rather extensively revised, and then, the second Community Innovation Survey (CIS 2) was prepared by the European Commission. A second harmonised questionnaire prepared beginning of 1997 by EUROSTAT in co-operation with national Experts and the OECD was proposed as a basis for this second round of innovation surveys. A number of Member countries have carried out a new innovation survey or are doing so. According to national policy needs, these new national innovation surveys may or may not fully follow the Oslo Manual methodology and/or the proposed CIS-2 questionnaire.

This presentation will give a rapid overview of the OECD/EUROSTAT "Oslo Manual" - 1997 edition, and the CIS 2 proposed harmonised questionnaire together with the main characteristics of national innovation surveys carried out, or foreseen, in 1997-1999 in OECD countries.

THE LESSONS OF THE HUNGARIAN PILOT INNOVATION SURVEY AND NEW CHALLENGES

by **Annamaria Inzelt**, Innovation Research Centre, Budapest

The first section of the paper will present the dissemination of OECD methodological knowledge in Hungary since 1993. Then it goes into the details of analytical and methodological lessons of the Hungarian pilot innovation survey and follows up with surveys in manufacturing industry. The third section touches upon the difficulties of surveying innovations in the service sector in a less advanced country. It also discusses the changing importance of indicators in the age of globalisation and knowledge-based economies.

PAEP/SEADE: INNOVATION AND TECHNOLOGY INDICATORS FOR THE STATE OF SÃO PAULO/BRAZIL

by **Luís Henrique Proença Soares** (SEADE), **Ruy de Quadros Carvalho** (UNICAMP), **André Furtado** (UNICAMP), Brazil

This paper presents results of the innovation module of the PAEP/SEADE survey. PAEP – Pesquisa da Atividade Econômica Paulista, which stands for Survey of Economic Activity in the State of São Paulo, is a large survey (semi-census) of firms in the most industrialised Brazilian State (38% of Brazilian industrial GDP). PAEP was carried out by SEADE, the state level agency for statistics production. The first PAEP issue collected data in 1996, on a large number of economic variables, in more than 20.000 firms of all sizes, which belong to various activity sectors. The manufacturing industry sector of the survey (10.000 firms) utilised a questionnaire, which included questions about firm innovation activities. These questions follow the OECD methodology for innovation surveys (Oslo Manual). Moreover, the questionnaire also included questions on the diffusion of Information Technologies: computers and computer networks, programmable automation and telecom technologies. The paper just aims at presenting basic results of this first attempt of an innovation survey in Brazil. It shows the number and share of innovative firms by type of innovation (product – incremental or radical – and process) and how they allocate resources for innovative activities. The paper also explores firm's motives for innovation as well as sources of innovation. It is presented the number and share of firms which carry out R & D activities and this information is crossed with information on whether firms are or are not innovative. Information on the number of employees allocated in R & D activities allow for a classification of sectors of the Brazilian manufacturing industry (ISIC classification) by research intensity. Information on process innovation is complemented by data on utilisation of information technologies. Most tables and analysis of the paper consider firm sizes.

TECHNOLOGICAL INNOVATION SURVEYS IN SIX PROVINCES OF CHINA AND MAIN RESULTS

by **Zhang Jing** and **Xu Yongchang**
National Research Center for Science and Technology for Development, People's Republic of China

This paper presents and discusses the main results of surveys of product and process innovation activity and outputs in enterprises of six provinces (Beijing, Shanghai, Jiangsu, Liaoning, Guangdong and Heilongjiang provinces) between 1993 and 1995. A major focus of this paper is on the characteristics of innovation activity and level of innovation in different enterprises with different ownership and size during the period of China's transitional economy. A number of other matters are also dealt with, such as innovation expenditure and related outputs in large and medium firms as key measurable quantities relating to technological innovation capabilities, the scale of innovativeness, and government support on technological innovation, etc. Also, there is a discussion on the new look at the results from the surveys.

INNOVATION SURVEYS IN AUSTRALIA

by **Bill Pattinson,** ABS, Australia

Australia has conducted a second innovation survey of Manufacturing businesses. The 1996-97 survey was based on the guidelines of the 1997 Oslo manual. As well as the standard questions (as used in the CIS) a number of new areas of questioning have been tried. The paper has two main parts which present the results of the 1996-97 survey and some findings related to the new areas of questioning.

The first part of the paper compares the results from the latest survey with those from the previous survey (1993-94). The main results are presented and some explanation of the differences in the results of the two surveys are also given. Overall the rate of technological innovation in Australia has shown a decline between the two surveys. This decline was largely due to the decline in the rate of technological innovation in the very small businesses.

The second part of the paper presents the results of some of the new areas of questioning that are not part of a standard Innovation survey. These areas of questioning deal with: the measurement of the impacts of innovation using qualitative and quantitative measures; information on abandoned innovations; frequency of innovation, particularly looking at innovation activity in each year of the 3 year reference period; the measurement of non-technological innovation; and, the use of innovation surveys as an alternative for collecting advanced manufacturing technology data.

The topics covered in the second part of the paper highlight some issues and alternatives to the existing Oslo guidelines. Most countries have now conducted two surveys in the Manufacturing sector and a number of countries are or have attempted surveys in the Services sector. The experiences of all countries, especially those that have tried alternative questions, should be shared and used to complement the current guidelines.

MEASURING INNOVATIVE CAPABILITIES OF FIRMS.

by **Pierre Mohnen**, UQAM, Canada and **Dominique Guellec**, OECD

Innovation surveys offer a mix of qualitative and quantitative data. The purpose of this presentation is twofold. First to assess ways of calculating aggregate, country or industry level, indicators based on qualitative data. Second, to calculate innovation indicators based on the some of the quantitative data contained in the Community Innovation Surveys and to discuss their relevance and drawbacks.. The data used are those of the first Community Innovation Survey, for a range of European countries.

ITEM 2: MEASURING S&T OUTPUTS

PATENT-BASED INDICATORS

by **Dominique Guellec and Bruno Van Pottelsberghe,** OECD

Patent-based indicators are among the most often used indicators of inventive output. They are quite readily available, simple, cost effective, and the connection between patents and inventions is straightforward. They are however subject to some drawbacks, such as high heterogeneity and country biases. Hence the necessity to improve methods used for their calculation. This contribution focuses on patents applied to or granted by the European Patents Office (EPO); various methods for counting these patents are compared and their respective advantages and drawbacks are assessed. These indicators are also compared with other patents based indicators, such as patents granted in the US, and patents applied to or granted by national offices. OECD as well as many APEC countries are included in the analysis.

SYSTEMIC OVERVIEW INDICATORS — LESSONS FROM TRACKING PATENT AND BIBLIOMETRIC OUTPUTS, AND R&D INPUTS, ALL ON A COMPARABLE BASIS

by **Kevin Bryant and Luciano Lombardo**, Department of Industry, Science and Resources, Australia

A development from our on-going work in monitoring the Australian national system of innovation has been the investigation of a new broad-brush technique for rapid comparison of a range of existing science, technology and innovation indicators across several countries. A number of interesting perceptions have emerged from this work, and we consider that we have achieved a useful means of charting and comparing science and technology inputs, innovative activity, and knowledge production — a means that complements more commonly used indicator approaches. The approach we have developed appears to be particularly useful in situations where *change* over a period is unusually rapid. Therefore, our methods have special relevance to those economies that are making particular efforts to improve their standing in science and technology.

Our approach derives from the observation that the most commonly used science and technology indicators involve a ratio — but are often interpreted as if they consisted only of a numerator and as if the denominator could be ignored. Business sector expenditure on R&D (BERD) as a percentage of gross domestic product (GDP) is an example. Where BERD/GDP has been low relative to other countries, an increase is generally judged as a success. However, in the current difficult economic circumstances being experienced by some countries, it would be mathematically possible for BERD to decrease significantly, but for BERD/GDP still to increase if GDP falls at a faster rate than BERD. This has happened in the past for some countries.

Following through on these considerations, we have experimented in constructing indicators using denominators other than GDP. In particular, we have investigated families of indicators where the denominator — for R&D expenditure considered on a sectoral basis, for patents, for numbers of publications, and for citation counts — represents an aggregate for 19 OECD countries. This approach permits R&D inputs to be compared directly with corresponding “outputs”.

Using these aggregate denominators for time series presented on logarithmic scales means that rapidly developing economies can be readily contrasted with those in a relatively “steady state” — and that broad anomalies can be identified. In addition, some surprising perceptions of a more general kind emerge. For example, while higher education R&D expenditure (HERD) statistics are known to be broadly less reliable than is desirable, we conclude that overall they are of better quality than some have supposed. Moreover, clear evidence emerges that expenditure on R&D in government agencies (GOVERD) is substantially similar in kind to HERD. Thus, in our view, R&D policy issues for these two sectors should mostly be considered in conjunction.

ITEM 3: HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY

HUMAN RESOURCES DEVOTED TO SCIENCE AND TECHNOLOGY IN AUSTRALIA

by **Bill Pattinson,** ABS, Australia

Australia conducts a 5 yearly census of its population, the most recent being in respect of 1996. In this population census, data are collected about the characteristics of all people living in Australia, including their occupation and their qualifications. Thus it is possible to use this source of information to identify those persons who belong to the stock of human resources devoted to science and technology (HRST).

The ABS has recently undertaken this analysis for the 1991 and 1996 population censuses and is in the process of publishing the results. It is intended to release this publication before the OECD Conference being held in Australia.

In this paper (and in the publication) ABS looks at the stock of HRST for 1996 and shows how this has changed over the previous 5 years. The paper provides international comparisons to the extent possible.

The paper looks at a disaggregation of the Australian results into the stock of HRST occupations and HRST qualifications and the subset (core) in common and the distribution of HRST by age and gender. The paper then proceeds to examine the unemployment and participation rates of people in HRST in 1996 and their income and shows how different these are compared to other members of Australian society.

DEVELOPMENT OF MOBILITY INDICATORS

by **Mikael Akerblom,** Statistics Finland

Indicators on mobility of human resources are an important complement to traditional R&D statistics in measuring knowledge flows describing linkages in the innovation system. The Nordic countries have register data, from which very detailed data about the mobility of persons can be extracted. A first pilot study has been made to use these data 'Formal Competencies in the Innovation Systems of the Nordic Countries (available from http://www.sol.no/step/). A more extensive Nordic study will most probably start within the next few months. The possibilities in other countries to produce mobility indicators are being studied. The first step in this direction is the 'Inventory of National Efforts in OECD Countries to Quantify Science and Technology' made for the OECD by Mikael Rosengren, Statistics Sweden. This study investigated the policy needs for mobility indicators and identified possible data sources and special studies, which could be used to produce indicators. The next step will be to study these sources and special studies in detail to see if at least some roughly comparable indicators can be actually calculated.

ITEM 4: GLOBALISATION OF SCIENCE AND TECHNOLOGY

INTERNATIONAL S&T MOBILITY AND THE GLOBALISATION OF SCIENCE

by **Jennifer Sue Bond,** NSF, USA

This paper will discuss the importance of measuring human resources in science and technology in the national and international context and will argue that international mobility flows are one of the key indicators of the globalisation of science. Patterns of foreign student training in the United States at the doctoral and postdoctoral levels will be presented as well as immigration flows of scientists and engineers. Data on international co-authorship of scientific papers will be presented as further evidence of the globalisation of science and as one of the effects of international mobility.

GLOBALISATION OF TECHNOLOGY

by **Thomas Hatzichronoglou,** OECD

Along with the liberalisation of trade and investment, technology -- and more particularly information and communication technology -- is a major driving force behind the increased globalisation of economic activity. At the same time, globalisation of the economy has facilitated the diffusion and internationalisation of technology.

There are a number of indicators which take into account the globalisation of technology but in the framework of the OECD, their systematic development covers four areas: trade of high technology products (including trade of intermediary goods,) trade of patents, licenses, know-how, etc (all elements included in the technological balance of payments), the decentralisation and relocation of R&D laboratories by multinational firms and the filing of patents by firms across various markets. This presentation will be limited to indicators regarding the first three areas. The indicators of the first two are the oldest but in the framework of globalisation it was necessary to take into account some rather neglected phenomena such as technology diffusion across intermediary goods or various qualitative aspects of trade (notably high-tech-products) as well as the very important role multinational firms play in the patents and licensing trade. On the other hand, the third family of indicators concerning decentralisation and relocation of R&D activities and/or laboratories by multinational firms is very new and requires special surveys, the results of which will be presented.

ITEM 5: PUBLIC SUPPORT TO INDUSTRIAL R&D

IMPROVING MEASURES OF THE LEVEL AND STRUCTURE OF GOVERNMENT SUPPORT FOR INDUSTRIAL TECHNOLOGY

by **Alison Young,** Consultant, Paris.

Governments fund a wide range of activities which directly or indirectly encourage the development and application of industrial technology in their respective countries. Current R&D statistics give only an incomplete picture of these activities. A new framework has been established and tested as part of a recent OECD study examining best S&T policy practices for technology, productivity and job creation. The presentation will draw the lessons of the pilot data compilation exercise and describe the work to develop new indicators, notably for fiscal incentives for science and technology.

SESSION II: DEVELOPING S&T STATISTICAL SYSTEMS IN NON-OECD COUNTRIES

NATIONAL PRESENTATIONS

SCIENCE AND TECHNOLOGY STATISTICS- SYSTEM, METHODOLOGY, ISSUES AND PROBLEMS-INDIAN CONTEXT

by **Dr. Laxman Prasad and Rakesh Chetal**, NSTMIS, India

The need for science statistics in India has grown over the last twenty five years or so. The system of data collection through suitably designed questionnaires has been devised together with a computer package for analysis. Policy makers, particularly those concerned with planning, implementation and management of science, felt the need for comprehensive information not only on the use of input resources which comprise mainly financial and human resources deployed and infrastructure available to science and technology but also the output of such activities measured in terms of increased productivity, increased economic growth, new products/processes developed, their large scale diffusion, patent filed and impact on society. Such information could be useful for undertaking cost benefit analysis and other economic studies as well as for efficient programming, planning and budgeting. It will also help to compare the national efforts with that of other countries.

The Department of Science and Technology by virtue of its responsibility in S&T policies, their implementation and R&D funding, has been carrying out the studies relating to national resources devoted to S&T activities at regular intervals since 1971.

The present paper will deal with S&T system and S&T statistical system in India. The collection of data for S&T statistics and problems faced will also be dealt with in detail. The paper will also deal with the present status of information and analysis on various parameters, in particular, the following:

- Aggregate and sectoral distribution of R&D expenditure
- S&T manpower sectorally
- R&D expenditure by objectives in tune with UNESCO classification
- R&D expenditure in various fields of science
- Patent data
- Number of research papers published yearwise
- Technology Development

Despite the problems encountered and issues raised in the exercise of building up science statistics, the coverage and reliability of data on R&D has increased over the years. India's science statistics are fairly timely and there is every possibility that the time gap will be further reduced in the future. It will not be out of place to state that India is one of the few developing countries engaged in collecting S&T statistics and publishing reports regularly.

DEVELOPMENT OF SCIENCE AND TECHNOLOGY INDICATORS IN INDONESIA

by **Siti Meiningsih**, Indonesian Institute of Sciences, Jakarta

Progress in various disciplines of science within the last few decades has documented major breakthroughs in which the distances between the science and its output has been significantly reduced. Application of various science-driven technologies, such as computer-science, biotechnology has reoriented our approach in data processing and analysis.

In Indonesia, the indicators for S&T was first issued in 1993, covering four categories: input, output, feedback and processing indicators. Input indicators involve manpower and budget allocated for S&T program whereas output indicators cover any added value to the manpower capability, company, industries or R&D. An assessment of input and output indicators is relatively easy and hence these issues predominantly the first document of S&T indicators in Indonesia. Indicators are used in company or industry by processing measurement of industrial technology indicators. Feedback indicators involve the public appreciation of the technology produced. This is the most difficult to be assessed and yet still need an appropriate method of assessment of science and technology activity in industries, socio-economic status of Indonesia.

With regard to the concept of S&T activity developed by OECD and UNESCO, there are four groups of sectors in the S&T or Research and Development (R&D) in Indonesia: Government, Business Enterprises, Universities and Non-profit Organisations. Application of S&T in the national development program can be grouped into three categories; R&D, Scientific and Technological Services (STS) and Scientific & Technological Education and Training (STET). The R&D activity plays two key roles in the application and development of science and technology whereas the other two activities are only supportive.

One major problem of research in Indonesia, in general, is the lack of facilities in bridging the research output to the marketplace. The Integrated Competitive Research Program (RUT) is one S&T policy instrument to address the R&D problems in Indonesia. The presentation for S&T indicators seminar should be concentrated on R&D activities:

R&D activities cover:

1. Production Technique
2. Experimental Development (Technology)
3. Applied Research
4. Basic Research
5. Institutional Development

Types of Research:

1. Integrated Research Program
2. Co-operative Research Program
3. Top Down Research Program
4. Selected Research Program
5. In-house Research

Nine Expected Promising Scientific Fields:

1. Biotechnology
2. Medical Technology
3. Agriculture Technology
4. Engineering
5. Material Science
6. Chemistry and Process
7. Energy Technology
8. Microelectronics and Informatics
9. Environment

NEW S&T INITIATIVES, INDICATORS AND SURVEYS IN SOUTH AFRICA

by **J. Webb**, Department of Arts, Culture, Science and Technology and **W. Blankley**, Foundation for Research Development

The Department of Arts, Culture, Science and Technology White Paper on Science & Technology *Preparing for the 21st Century* of September 1996 laid the framework for a National System of Innovation (NSI) in South Africa. The need for the NSI created a demand for new sources and types of information and indicators on the science and technology system. Several new initiatives and surveys have been introduced to obtain such information, including the National Framework for Innovation Indicators, a National Research and Technology Audit, a National Research and Technology Foresight Project, a revised Survey for R&D Resources, a survey of Innovation in South Africa’s Manufacturing Industry, a review of Government-Funded Science, Engineering and Technology Institutions and the development of Key Performance Indicators for the Science Councils. An overview of these initiatives and the types of new information and indicators they are producing in support of the NSI are presented.

ESTABLISHING MONITORING AND EVALUATION PROCEDURES FOR S&T PROGRAMS, PLANS AND PROJECTS

by **Paulo Cesar G. Egler**, Ministry of Science and Technology, Brazil

One of the main lacks of the Brazilian management process for policies, programmes, plans and projects (PPPPs) in science and technology - S&T - is the absence of effective monitoring and evaluation procedures. This lack was considered so relevant, that the current version of the *Programa de Apoio ao Desenvolvimento Científico e Tecnológico - PADCT III* (Program for Supporting the Scientific and Technological Development), a programme supported by a loan with the World Bank, has included the monitoring and evaluation activities as one of the areas to be developed.

Additionally, conscious of this problem, the Ministry of Science and Technology established, since 1996, a Secretariat with the objective of implementing both the collection, storage and dissemination of S&T global statistics and indicators, and the co-ordination of the monitoring and evaluation activities for the S&T PPPPs in the context of the federal government.
The aim of this paper is to portray the main activities being carried out by the Ministry of Science and Technology in the domain of the monitoring and evaluation procedures and practices, with the purpose not only of making present the activities already done or in course, but, and principally, of discussing possible co-operation in this subject with other countries.

THE CURRENT STATUS OF BRAZILIAN S&T INDICATORS AND THEIR COMPATIBILITY WITH OECD STANDARDS

by **Edson Kenji Kondo**, National Council for Scientific and Technological Development, Brazil

This paper explains the evolution of S&T indicators in Brazil in the last four years, period in which the author had the privilege of participating in the initiative led by the Ministry of Science and Technology through its Secretariat for Monitoring and Evaluation. Both, the quality and the quantity of indicators evolved significantly in this period. The first Brazilian publication on National S&T Indicators was published in 1996, with 16 tables, 3 containing S&T data, and none about R&D data. Today, the third publication contains 75 tables, of which 29 are R&D input data, 24 are S&T input data, and 19 are R&D/S&T output data. In terms of comparability with OECD data, Brazil changed from literally none, three years ago, to about 50 today. The definitions used comply with the main methodological manuals produced by OECD, but the construction of indicators had to be based upon indirect data produced by many organisations in Brazil, re-estimating them when needed to make the data as closely comparable with those of OECD countries. Many challenges still lie ahead for Brazil, particularly regarding the new institutional arrangements that has been shaping, and which has the important task of consolidating the production of indicators in Brazil at a new level of reliability.

OECD INTERNATIONALLY COMPARABLE DATABASES ON S&T: MONITORING PROCEDURES WITH MEMBER AND NON-MEMBER COUNTRIES

by **Geneviève Muzart and Laudeline Auriol**, OECD

This paper reviews all procedures related to the maintenance and development of OECD S&T databases: methodological work conducted in the framework of the OECD Group of National Experts on Science and Technology Indicators (NESTI), publication of methodological manuals and guidelines; data collection via the international OECD survey on resources devoted to research and development; quality control; description of databases; and use of data. Special attention is given to R&D data. More specific work related to non-member countries is also described at length and some thoughts are given on the possibility of including non-OECD APEC countries in OECD S&T databases on non members.

S&T INDICATORS IN INDUSTRIALISING ASIAN ECONOMIES -- WHICH WAY FORWARD?

by **Sam Garrett-Jones,** Centre for Research Policy, University of Wollongong, Australia

The 1990s have seen an increasing demand for quantitative measures of scientific and technological performance among industrialising Asian economies. Based on experience in particular with Malaysia, Indonesia and the ASEAN group, the paper first considers the state of development of S&T indicators systems in the region and the scope of indicators in use. What is driving the development of indicators and how are they being used? Second, it examines the different requirements for indicators in the industrialising countries. This is expressed, for example, in the balance between indicators of research on the one hand, and indicators of other innovative activity, technological capability, technology acquisition and skills on the other. To what extent are industrialising countries able to "leap-frog" the OECD members in applying indicators of technological innovation and knowledge transfer? Third, the paper considers the implications of these trends for regional and other international collaboration in S&T indicators.

THE MEXICAN S&T INDICATORS SYSTEM

by **Adrian Jimenez**, Mexican National Council for Science and Technology

The presentation focuses on the Mexican experience in adapting its S&T statistical system to OECD standards. After a brief description of the evolution of Mexican S&T indicators system, the main problems encountered in this adaptation process are discussed and the way they were solved are highlighted. The 1998 R&D survey is presented with emphasis on the steps taken to improve upon the quality of information collected in previous surveys. In addition, the presentation includes an overview of the design of the first Mexican innovation survey and a report on its main result.