ANNEX 4: MULTI-FACTOR PRODUCTIVITY MEASURES IN OECD COUNTRIES

The multi-factor productivity estimates have been compiled by the OECD for the purpose to provide estimates as comparable and consistent across countries as possible. However, they do not necessarily constitute the best source for analysis that relate to the country only. In the recent years, a growing number of national statistical offices (NSO) experienced to develop and publish MFP calculations. This annex briefly presents official multi-factor productivity time-series’ published and regularly updated by Australia, Canada, the Netherlands, New Zealand, Switzerland and the United States and discusses some of the main differences from those computed by the OECD. First, the national data are often significantly more detailed and also timelier than the international data. Second, labour input measures may have been adjusted by the NSOs (Australia, Canada, United States, etc.) to reflect the composition of the labour force e.g., by age, education and experience whereas the OECD labour input data is a simple aggregate of hours worked. However, adjustment methods for labour composition may differ across countries. These and some other technical differences may lead to differences in reported MFP growth between the national and the international source. As a general rule, the national source is to be preferred over the international source for analyses that relate to country only whereas the international source is often better suited for comparisons between countries.

Australia

The Australian Bureau of Statistics (ABS) has computed and published time series of multi-factor productivity indices for several years. The headline figure, also the one that is most timely available is MFP growth for the market sector, an industry grouping comprising agriculture, forestry and fishing; mining; manufacturing; electricity, gas and water supply; construction; wholesale trade; retail trade; accommodation, cafes and restaurants; transport and storage; communication services; finance and insurance; and the cultural and recreational services industries. These are industries with marketed activities for which there are satisfactory estimates of the growth in the volume of output. In addition, MFP productivity measures are presently being developed for individual industries from the Australian and New Zealand Standard Industrial Classification (ANZSIC).

The ABS derives its estimates of MFP by forming a combined chain volume measure of labour and capital and dividing it into a chain volume measures of the gross value added of the market sector. The elements of capital input are compiled for 14 asset types for the corporate and unincorporated sectors for each of the industries included in the market sector. For each capital there is a volume indicator of the flow of capital services and a rental value to weight the service flow with the service flows of other capital inputs. An aggregate chain volume measure of capital services for the whole market sector is then combined with a measure of hours worked using estimates of capital and labour income weights. For more details see ABS (2000).

The ABS’ MFP measures differ in several aspects from the MFP measures computed by the OECD. First and importantly, national data is based on more detailed source data than the international data. Second, ABS adjusts, on an experimental basis, labour input measures to reflect the composition of the labour force e.g., by age, education and experience. There are thus two MFP series, one based on simple hours worked (akin to the OECD labour input data) and one based on hours worked adjusted for compositional changes. Both series are shown in the graph below. It is apparent that MFP based on unadjusted hours rose more quickly than MFP based on adjusted hours. This reflects the fact that unadjusted hours rose less quickly than adjusted hours which in turn means that the composition of labour input has gradually shifted towards more qualified, more experienced workers. In other words, more of output growth can be attributed to labour input, and therefore, a smaller part remains as the ‘unexplained’ MFP residual.

Thirdly, capital input as computed by ABS is based on a broader scope of capital assets than used by the OECD. In particular, the national data includes agricultural land and inventories, two assets that are absent from the OECD capital computations. Productivity indexes fluctuate according to the business cycle. One way to measure the trend rate of growth of productivity is to calculate the average annual growth rate between growth cycle peaks. Growth cycle peaks for multifactor productivity are identified as local maximum positive deviations of the productivity index from its long-term trend. Growth rates of MFP between cycle peaks are shown in the figure below.

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Multi-factor productivity (value-added based) in the Australian market sector
1985=100 (fiscal years)

Multi-factor productivity (value-added based) in the Australian market sector during growth cycles
Percentage changes at average annual rate between MFP growth cycle peaks (fiscal years)


Sources
• For further reading
  • Australian Bureau of Statistics (2000); Australian National Accounts: Concepts, Sources and Methods, Catalogue No 5216.0, Chapter 27.

Canada
Statistics Canada has computed and published time series of multi-factor productivity indices for a number of years. The headline figure, also the one that is most timely available is MFP growth for the business sector. In addition, MFP productivity measures are published for many 2-digit and 3-digit industries from the North American Industry Classification System (NAICS).

Multi-factor productivity (value-added based) in the Canadian business sector, 1981=100

MFP indices are computed as the ratio between value-added and combined labour and capital input, i.e., they constitute value-added based MFP measures. Statistics Canada’s MFP measures differ in several aspects from the MFP measures computed by the OECD. First and importantly, the national data is significantly more detailed and also more time than the international data. Second, labour input measures have been adjusted by Statistics Canada to reflect the composition of the labour force e.g., by age, education and experience whereas the OECD labour input data is a simple aggregate of hours worked. Thirdly, capital input as computed by Statistics Canada is based on a broader scope of capital.
assets than used by the OECD. In particular, the national data includes land and inventories, two assets that are absent from the OECD capital computations.

Productivity measures at the industry level are derived from a set of industry accounts. Under this approach, a variety of productivity series at the industry level are constructed using alternative measures of output along with their corresponding inputs. Industry data on outputs and inputs permit the construction of bottom-up MFP measures for major sectors as a weighted average of industry productivity growth rates. More detailed information on the methodology underlying Statistics Canada’s productivity series can be found in the series description Productivity Measures and Related Variables (CANSIM Record No 1402) and in Baldwin and Harchaoui (2005).

Multifactor productivity (value-added based) in Canada, 2-digit and selected 3-digit NAICS industries, 1995-2004
Percentage change, annual rate

Source: Statistics Canada, CANSIM Table 383-0022

Sources
- Statistics Canada, CANSIM Database, Tables 383-0021 to 383-0022. Available at: http://www.statcan.ca

Netherlands

In 2007, Statistics Netherlands published a first set of MFP estimates at the industry branch and macro levels for the Netherlands for the period 1995-2006. The basic methodology behind these MFP estimates closely follows the methods presented in international documents such as the OECD Productivity Manual. In some specific aspects, however, the MFP measures from Statistics Netherlands differ from MFP measures computed by the OECD.

The official MFP measures, the gross-output based MFP (defined as a quantity index of gross output divided by a quantity index of combined KLEMS input) and the value-added based MFP (measured as a quantity index of combined labour and capital input), are computed and then compared with calculations using alternative assumptions with regard to the volume index formula, the user cost of capital, and the labour income of self-employed (self-employed are assumed to have the same income per hour or per year as employees).
It follows that international comparisons between the national MFP results for Netherlands and OECD’s MFP data for other countries have to be made with the necessary caution. In particular, Statistics Netherlands do not adopt the behavioural and structural assumptions of the neo-classical production framework, i.e. constant scale of returns and perfect competition and choose an axiomatic approach for the calculation of aggregate quantity or volume change of inputs and outputs. As a result, MFP change cannot be interpreted as exclusively the result of technological change but may also be due to scale effects, efficiency improvements, R&D investments that lead to monopolistic behaviours on the part of producer, and other factors. More detailed information on the methodology underlying Statistics Netherlands productivity measures can be found in the method description in Balk et al. (2007).

The headline figure is MFP growth for the commercial sector, in practice defined as the whole economy except general government, defence, subsidized education, real estate activities, renting of movables, and private households with employed persons. This is an important difference on the scope with OECD MFP statistics.

**Contribution of multifactor productivity to value-added volume changes in Netherlands, commercial sector, 1995=100**

Productivity statistics at the industry level are performed at two different levels of aggregation: 36 industries, 9 industries. Under this approach, a variety of productivity series are constructed using alternative measures of output along with their corresponding inputs. Industry data on outputs and inputs permit the construction of bottom-up MFP value-added based measures for major sectors as a weighted average of industry productivity growth rates.

**Contribution of multifactor productivity to value-added volume changes in Netherlands, 2-digit and selected 3-digit NACE industries, 1995-2005**

*Average annual growth rate*
Statistics Netherlands will expand the system of productivity statistics, including quality changes in labour; including capital services of R&D and ICT; and constructing complete balance sheets for non-financial assets with the extension of the coverage of assets to inventories and non-produced assets such as land and subsoil assets.

**Sources**

**New Zealand**

In 2006, Statistics New Zealand released, for the first time, an official time series of multi-factor productivity growth. This first dataset relates to the ‘measured sector’, consisting of industries for which estimates of inputs and outputs are independently derived in constant prices. Excluded are those industries – mainly government non-market industries whose services, such as administration, health and education, are provided free or at nominal charges – whose real value-added is measured in the national accounts largely using input methods, such as numbers of employees. Using an input series to estimate the change in outputs implicitly assumes nil productivity growth and to include these industries in the ‘measured sector’ would lead to a bias in the productivity series. Also excluded are a number of private sector market industries that similarly use some form of input measure to estimate real output, for example the residential and commercial property industries whose output is measured by the growth in property assets.

Labour input is measured as the total number of hours paid, the number of ordinary and overtime hours for which an employee is paid. It excludes unpaid overtime but may include some hours that are not actually worked, such as paid leave and statutory holidays. While Statistics New Zealand states a conceptual preference of a measure of hours worked over hours paid, it has greater confidence in the quality of its hours paid data which are also available for longer time series. These data considerations led to the choice of hours paid over hours worked. A full description of data sources and methodology can be found in Statistics New Zealand (2006).

Statistics New Zealand follows standard methodology and derives its estimates of MFP by subtracting a volume growth measure of labour and capital inputs from a volume growth measure of output, constant price gross value added.

The elements of capital input are compiled at a level of 24 types of assets, and 22 industries. This is more detailed and broader in scope than the OECD’s own estimates of capital services (which exclude, for example, residential buildings). In the national series for New Zealand, for each type of asset in every industry there is a volume indicator of the flow of capital services and a rental value to weight the service flow with the service flows of other capital inputs. An aggregate chain volume measure of capital services for the whole economy is then combined with a measure of hours worked using estimates of capital and labour income weights.

The basic methodology behind the New Zealand MFP estimates closely follows the methods presented in international documents such as the OECD Productivity Manual. In some specific aspects, however, the national measures differ from MFP measures computed by the OECD (scope of capital assets, sector coverage). It follows that the OECD’s estimates of New Zealand’s MFP growth cannot be directly compared with the national estimates published by Statistics New Zealand.

**Sources**
- Statistics New Zealand (2006); *Productivity Statistics: Sources and Methods*; available at http://www2.stats.govt.nz
Switzerland

In 2006, the Swiss Federal Statistical Office published a first set of MFP estimates for Switzerland. This first dataset relates to the total economy and comprises thus the private and the public sector. This differs from other national MFP measures (e.g., Canada, Australia or the United States) but is similar to the OECD MFP statistics.

Labour input measures also correspond to the simple unadjusted series of hours worked that are used by the OECD. This reflects a constraint on data availability that does not presently permit the Swiss Federal Statistical Office to adjust hours worked for compositional change although the desirability of such an adjustment is clearly recognised by the Statistical Office.

The Swiss Federal Statistical Office follows standard methodology and derives its estimates of MFP by deducting, from the volume measure of GDP a weighted volume growth measure of labour and capital inputs. The elements of capital input are compiled at a level of 16 types of assets. For each type of asset there is a volume indicator of the flow of capital services and a rental value to weight the service flow with the service flows of other capital inputs. An aggregate chain volume measure of capital services for the whole economy is then combined with a measure of hours worked using estimates of capital and labour income weights.

The basic methodology behind the Swiss MFP estimates closely follows the methods presented in international documents such as the OECD Productivity Manual. In some specific aspects, however, the Swiss MFP measures differ from MFP measures computed by the OECD. The national data is based on more detailed source data than the six-way asset classification used by the OECD. There is also important difference in the scope of capital measures. In particular, the estimates by the Swiss Federal Statistical Office include residential assets which are excluded from the OECD data. It follows that international comparisons between the national MFP results for Switzerland and OECD’s MFP data for other countries have to be made with the necessary caution.

Sources
• Swiss Federal Statistical Office http://www.bfs.admin.ch
• For further reading
Multi-factor productivity (value-added based) in Switzerland 1991=100

In percentage points

Source: Swiss Federal Statistical Office

The United States Bureau of Labor Statistics has computed and published time series of multi-factor productivity indices for a number of years. The headline figure, also the one most time available are MFP growth for the business and the non-farm business sector. In addition, MFP productivity measures are published for 18 3-digit SIC manufacturing industries and 86 4-digit SIC manufacturing industries, railroad transportation, and air transportation and the utility and gas industry.

Availability of the U.S. BLS productivity measures for major sectors and sub-sectors of the economy

<table>
<thead>
<tr>
<th>Productivity measure</th>
<th>Input(s)</th>
<th>Index available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour productivity¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>Labour</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Non-farm business</td>
<td>Labour</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Non-financial corporations</td>
<td>Manufacturing, total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Durable</td>
<td></td>
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<tr>
<td></td>
<td>Non-Durable</td>
<td></td>
</tr>
<tr>
<td>Multi-factor productivity²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private business</td>
<td>Labour, capital</td>
<td>Annually</td>
</tr>
<tr>
<td>Private non-farm business</td>
<td>Labour, capital</td>
<td>Annually</td>
</tr>
<tr>
<td>KLEMS Multi-factor productivity</td>
<td>Manufacturing and 2</td>
<td>Labour, capital, energy, materials, services</td>
</tr>
<tr>
<td></td>
<td>2-digit SIC industries and services</td>
<td>Annually</td>
</tr>
</tbody>
</table>

¹Includes government enterprises; multi-factor productivity measures exclude such enterprises
Business sector indices of MFP are computed as the ratio between value-added and combined labour and capital input, *i.e.*, as value-added based MFP measures.

**Major sectors and manufacturing industries of the economy in the United States**

<table>
<thead>
<tr>
<th>Multi-factor productivity (value-added based) in the business sector 1987=100</th>
<th>KLEMS multi-factor productivity in manufacturing, 1987=100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987 1989 1991 1993 1995 1997 1999 2001 2003 2005</td>
<td>1987 1989 1991 1993 1995 1997 1999 2001 2003 2005</td>
</tr>
<tr>
<td><strong>Private business sector</strong></td>
<td><strong>Manufacturing industries</strong></td>
</tr>
<tr>
<td><strong>Private non-farm business sector</strong></td>
<td></td>
</tr>
</tbody>
</table>


Industry-level multifactor productivity measures are constructed by dividing an index of output by an index of combined inputs. Combined inputs are a weighted average of employee hours, capital services (land, structures, equipment and inventories), and intermediate purchases (materials, energy, and purchased services).

**KLEMS multi-factor productivity in the US, 3-digit SIC manufacturing industries, 1987-2005**

Percentage change, annual rate

The indexes of output and of combined inputs are Törnqvist indexes, developed for each industry by computing a weighted average of the growth rates of the various outputs or inputs between two periods, with weights based on relative cost shares. The weight for each item equals its average value share in the two periods. Thus, industry-level MFP measures follow a KLEMS-type approach which is different from the value-added based approach for the total business sector. For a more complete discussion of the Törnqvist methodology see "Industry Productivity Measures," Chapter 11 of the BLS Handbook of Methods.

BLS MFP measures differ in several aspects from the MFP measures computed by the OECD. First and importantly, the national data is significantly more detailed and also more time than the international data. Second, labour input measures have been adjusted by BLS to reflect the composition of the labour force e.g., by age, education and experience whereas the OECD labour input data is a simple aggregate of hours worked.

**Sources**
- For further reading