

# SNA93 Input-output Tables as an Accounting Framework for TFP-measurement

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## Abstract

The rate of TFP change for an industry can be measured by the difference between the rates of change of the combined output and of the combined input. The rates of change of individual outputs/inputs are weighted together using their value shares. The economy-level measure can be obtained as a weighted average of the industry-level measures, by using the ratios of the values of the output of the individual industries to the value of the final output of the economy as weights (Domar-aggregation). When outputs and intermediate inputs are valued using the same price concept, the final output of the economy consists of separate products with specified prices, and Domar-aggregation in its original form can be used. But in this case the value of primary inputs has to cover, besides the value of capital and labor inputs, also at least part of the net taxes on products. When the outputs are valued at basic prices and the intermediate inputs at purchasers' prices, as required by the theory of production, then at the economy level the difference between these two values does not represent final output valued at any price concept. This makes it impossible to use Domar -aggregation in its original form. Aggregation based on value added is possible. But the value of the economy level output represented by the value added cannot be allocated to different products.

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# 1 Introduction

The prospects of internationally comparable productivity measurement have considerably improved with the publication of the OECD's productivity manual (OECD, 2001). The manual wisely builds, as far as possible, on the SNA93 (ISWGNA, 1993) as an internationally approved system for the description of, among other things, the production processes at the economy and industry levels. There still remain, however, problems in the utilisation of national accounts figures for productivity measurement. In this paper some of these problems are discussed. The reason for writing the paper is my sincere wish to get clarification to these issues in order to be able to calculate, on the basis of national accounts data, productivity measures, that are, as far as possible, internationally comparable and also consistent with the theory of production.

In the industry level TFP-measurement, ideally, all the inputs, primary as well as intermediate, should be treated symmetrically. The industry-level TFP measures should be consistent with the economy-level measure so that it is possible, using some aggregation rule, to obtain the latter from the former ones. For the calculation of these measures a complete set of volumes and prices of the outputs and inputs is required. A necessary prerequisite for this is a complete and consistent set of values of inputs and outputs. This paper is about this complete set of values, especially for outputs and intermediate inputs. The SNA93 offers in its input-output environment various alternatives for this purpose, based either on supply and use tables or on symmetric input-output tables.

The conceptual approach to productivity measurement is in this paper, as well as e.g. in the OECD's (2001) productivity manual, the neoclassical growth accounting framework.<sup>1</sup> This tradition has long roots, with the work of Solow (1957), Jorgenson & Griliches (1967) and Diewert (1976) as important milestones. A complete exposition of the method and its application can be found e.g. in Jorgenson, Gollop & Fraumeni (1987) and Hulten (2001) has written its full (short) biography. The relevant features of this approach, from the point of view of the present paper, are summarised in Section 2. The system of valuation in the SNA93 is described in Section 3. Sections 4-6 deal with the problems relating to the different

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<sup>1</sup> This framework has been chosen since it is the one that is most widely used in TFP measurement. Another possibility would have been the Harrod- type of TFP measures. The set of values needed for the calculation of the latter is however the same as the one for the traditional neoclassical measures. This can be seen e.g. from the empirical part of Cas and Rymes (1991).

options of valuation in the national accounts system and Section 7 tries to answer the question whether the issues discussed in this paper are important.

## 2 Conceptual approach to productivity measurement

The macroeconomic production function of an economy shows the maximum value of output that is possible to achieve with any combination of factors of production:

$$(1) \quad Q = F(X)$$

Here  $X$  is the vector of primary factor supply. The output  $Q$  can be represented alternatively by an index of final output of the economy (deliveries to final demand by domestic industries) or by the economy level value added.

An alternative formulation is to take explicitly into account the fact that output consists of numerous different products. In this case the production function can only be written in the implicit form:

$$(2) \quad F(Y, X, t) = 0$$

Here  $Y$  is the vector of final output.

If the price ratios of inputs and outputs are equal to the corresponding marginal rates of transformation then the rate of TFP-change is:

$$(3) \quad d \ln A = d \ln Q - \sum_k \alpha_k d \ln X_k$$

or alternatively

$$(4) \quad d \ln A = \sum_i \beta_i d \ln Y_i - \sum_k \alpha_k d \ln X_k$$

where  $\beta_i$  and  $\alpha_k$  are the value shares of outputs and inputs.

If constant returns to scale are assumed then the value of the inputs is equal to the value of the output(s):

$$(5) \quad Q = \sum_k w_k X_k \text{ and}$$

$$(6) \quad \sum_i p_i Y_i = \sum_k w_k X_k$$

where  $p_i$  and  $w_k$  are the output and input prices respectively. In an open economy imported inputs in the production of domestic output have to be included in the primary inputs, whenever the output is represented by final output.

Domestic intermediate inputs can be disregarded at the economy-level since they are assumed to cancel out. At the industry-level it is natural to include the (vector of) domestic intermediate inputs ( $M^i$ ) in the production function:

$$(7) \quad Q_i = F(M^i, X^i).$$

Again on the same conditions as at the economy level the industry level rate of TFP growth is:

$$(8) \quad d \ln A_i = d \ln Q_i - \sum_j \alpha_{ji}^M d \ln M_{ji} - \sum_k \alpha_{ki}^X d \ln X_{ki}.$$

And the value of output is equal to the value of inputs:

$$(9) \quad p_i Q_i = \sum_j q_j M_{ji} + \sum_k w_k X_{ki}.$$

Here  $q_j$  is the price paid by the users, when the output of the industry  $j$  is used as an intermediate input.

Assuming that the prices received by the producers of the products used as intermediate inputs are equal to those paid by the users of these products, i.e. that:

$$(10) \quad p_i = q_i \text{ for all } i$$

the relationship between the industry-level productivity measures in equation (8) and the aggregate measure of equation (4) can be expressed by the Domar (1961) aggregation formula:

$$(11) \quad d \ln A = \sum_i \frac{p_i Q_i}{\sum_i p_i Y_i} d \ln A_i.$$

In this case the weight of an industry-level rate of TFP change is equal to the ratio of the value of the industry output to the value of final output of the economy. In this form the aggregation rule has been proven at least by Hulten (1978), Peterson (1979), Wolff (1985) and Aulin-Ahmavaara (1999). The alternative is to replace the value of domestic final output by the value added in the aggregation rule. The value of final output and the value added can however be equal only in a closed economy. The aggregation rule based on value added has been used at least by Jorgenson, Gollop and Fraumeni (1987) as well as by Jorgenson and Stiroh (2000).

Equation (6) suggests that in a closed economy the value added is equal to the value of final output. But summing over industries in equation (9) shows immediately that equation (6)

holds simultaneously with equation (9) only if the conditions in equation (10) are met, i.e. if the prices received by the producers of intermediate inputs are equal to those paid by the users of these same inputs. However, the price ratios are assumed to be equal to the marginal rates of transformation between the inputs and outputs. From the point of view of a producer this means that the value of output should be based on the prices received by the producer and the value of the inputs should be based on the prices paid by the producer. In reality taxes and subsidies on products create a wedge between the prices received by the producer and those paid by the user.

The choice of the price concepts used in the valuation of outputs and intermediate inputs has several consequences to productivity measurement. As is obvious from equation (9) it defines the value of the cost that should be covered by the value of primary inputs. The choice of the price concepts also determines, whether or not it is possible to interpret the output at the economy level to consist of separate products with specified prices and to allocate it to the components of final demand (i.e. consumption, gross fixed capital formation, changes in inventories and exports). Likewise, it determines whether or not it is possible to use Domar-aggregation in its original form. These issues will be addressed in the subsequent sections.

### 3 Valuation of outputs and intermediate inputs in the SNA93

There are three different price concepts in the SNA93. They differ from each other in the treatment of the so-called margins. These margins include trade and transport margins as well as taxes less subsidies on products. *Taxes and subsidies on products* are part of the taxes and subsidies on production. Taxes and subsidies on products are distinguished from the *other taxes and subsidies on production* by the fact that they are payable per unit of some good or service e.g. when it is produced or sold.

*Taxes on products* consist of import and export taxes, value-added type and similar deductible taxes and other taxes on products. *Value added type taxes* are deductible in the sense that producers are entitled to deduct the VAT they have paid on the goods and services purchased by them from the amounts of VAT they have invoiced to their customers. Non-deductible VAT is VAT payable by a purchaser, which is not deductible from his own VAT liability, if any. *Other taxes on products* include e.g. general sales tax; excise duties levied on specific kinds of goods (typically alcoholic beverages, tobacco and fuels); taxes on specific

services (such as communication, transportation, insurance, advertising, restaurants); taxes on financial and capital transactions and profits of fiscal monopolies.

*Subsidies on products* include import and export subsidies; subsidies payable to resident producers with respect of their outputs as well as the losses of government trading organisations and subsidies to public corporations and quasi-corporations to compensate their losses from productive activities.

The *basic price* is the price received by the producer. It includes all the subsidies on products and excludes all the taxes on products. *The producer's price* again includes all the taxes on products except the value-added type and similar taxes and excludes all the subsidies on products. All the trade and transport margins are excluded from both the basic prices and the producer's price. Basic prices and producers' prices do not normally depend on the way, in which the output is used.

The *purchasers' price* is the price that the purchaser has to pay in order to take the delivery of a unit of a good or service at a time and place required by the purchaser, excluding the deductible part of the value added type or similar taxes. All the taxes on products (non-deductible VAT and similar taxes among others) payable by the purchaser as well as trade and transport margins are included in the purchasers' price and all the subsidies on products excluded from it. Most of the market producers, but not all of them, are able to deduct most of the VAT they have paid for their purchase. All the users do not pay the same trade and transport margins. Accordingly purchasers' prices are different for different groups of users.

There are two industry/product –level representations of the production process in the SNA93, i.e. the supply and use tables and the symmetric input output tables. The supply and use tables are product-by-industry tables and joint production is considered possible. The gross outputs are valued at basic prices and uses, intermediate inputs/uses among others, are value at purchasers' prices. The symmetric I-O tables are in the SNA93 preferably product-by-product tables. Both outputs and inputs should be valued at basic prices.

The value chain of domestic output represented in Table 1 can be thought of as a column of use/ symmetric input-output table or as the production account at the industry or economy level. It should be noted that part of the VAT and similar taxes paid on intermediate inputs are non-deductible, as will be explained in the subsequent sections. At the industry-level the difference between producer's prices and purchasers' prices should in fact include also trade

Table 1. The value chain of domestic output in SNA 93

<b>Intermediate inputs, basic prices</b>	<b>(1)</b>
Other product taxes net of similar subsidies on intermediate inputs	(2)
<b>Intermediate inputs, producers' prices</b>	<b>(3)=(1)+(2)</b>
Non-deductible VAT on intermediate inputs	(4)
<b>Intermediate inputs, purchasers' prices</b>	<b>(5)=(3)+(4)</b>
Compensation of employees	(6)
Other taxes on production net of similar subsidies	(7)
Operating surplus/mixed income	(8)
<b>Value added, basic prices</b>	<b>(9)=(6)+(7)+(8)</b>
<b>Output, basic prices</b>	<b>(10)=(5)+(9)</b>
Other product taxes net of similar subsidies on all uses of output	(11)
<b>Output at producers' prices</b>	<b>(12)=(10)+(11)</b>
Non-deductible VAT on all uses of output	(13)
<b>Output, purchasers' prices</b>	<b>(14)=(12)+(13)</b>

and transport margins. This kind of price concept would, however, probably not make much sense in productivity measurement, as a major part of the output of trade and transport industries would in this case be included in the value of the output of the other industries.

#### 4 Output valued at basic prices and uses at purchasers' prices

In the rest of this paper it is for simplicity of exposition assumed that the economy is closed and that every industry has only one product. Trade and transport margins are treated as inputs from the industries producing these margins and are not included in the purchasers' prices. The following notation will be used:

**S** = column vector of industry output,  $n \times 1$

**U** = matrix of intermediate inputs or uses,  $n \times n$

**C** = column vector of private final consumption expenditure,  $n \times 1$

**G** = column vector of government final consumption,  $n \times 1$

**I** = column vector of gross capital formation, (changes in inventories included)  $n \times 1$

**F** = column vector of final demand/ final output  $n \times 1$ ,

**e** =  $(1,1,\dots,1)'$ ,  $n \times 1$

Provided that the same price concept is used in the valuation of all the variables the following identities hold

$$(12) \quad \mathbf{S} - \mathbf{Ue} = \mathbf{C} + \mathbf{I} + \mathbf{G} = \mathbf{F} .$$

Furthermore let

$\mathbf{T}^V$  = non-deductible value added type and similar taxes

$\mathbf{T}^P$  = other taxes on products net of subsidies on products

Both  $\mathbf{T}^V$  and  $\mathbf{T}^P$  have the same dimensions as the matrix or vector to which they refer. E.g.

$\mathbf{T}_U^V$  is an  $n \times n$  -matrix. It is worth noticing that  $\mathbf{T}_U^V \neq 0$ .

The price concepts used as the basis of valuation are indicated as follows:

$BP$  = basic price

$PP$  = purchasers' price

For any variable  $X$

$$(13) \quad X^{PP} = X^{BP} + T_X^V + T_X^P .$$

As was mentioned above trade and transport margins are suppressed.

Furthermore

**V** = row vector of value added by industry,  $1 \times n$

**E** = row vector compensation of employees by industry,  $1 \times n$



$\mathbf{O}$  = row vector of operating surplus by industry,  $1 \times n$

$\mathbf{T}^{PN}$  = row vector of other taxes (than those on products) on production net of similar subsidies,  $1 \times n$ .

And

$$(14) \quad \mathbf{V}^{BP} = \mathbf{E} + \mathbf{O} + \mathbf{T}^{PN}.$$

The preferred method valuation of the market output in the SNA93 is at basic prices. Intermediate inputs should be valued at purchasers' prices. This seems to be accordance with the methodology of TFP-measurement.

In the SNA93 environment this would mean that industry level production accounts would be defined as follows:

$$(15) \quad \mathbf{S}^{BP} - \mathbf{e}'\mathbf{U}^{PP} = \mathbf{V}^{BP} = \mathbf{E} + \mathbf{O} + \mathbf{T}^{PN}$$

In productivity measurement the other (than those on products) taxes less subsidies on production ( $\mathbf{T}^{PN}$ ) can be allocated to labour and capital inputs and the labor compensation of the self-employed can separated from the mixed income. If the remaining operating surplus is interpreted to represent capital compensation then the value added at basic prices covers exactly the compensation to the two primary inputs, i.e. labor and capital.

The material balance of the economy would now be the following:

$$(16) \quad \begin{aligned} \mathbf{S}^{BP} - \mathbf{U}^{PP} \mathbf{e} &= \mathbf{S}^{BP} - \mathbf{U}^{BP} \mathbf{e} - \mathbf{T}_U^V \mathbf{e} - \mathbf{T}_U^P \mathbf{e} \\ &= \mathbf{F}^{BP} - \mathbf{T}_U^V \mathbf{e} - \mathbf{T}_U^P \mathbf{e} \end{aligned}$$

or equivalently

$$(16)' \quad \begin{aligned} \mathbf{S}^{BP} - \mathbf{U}^{PP} \mathbf{e} &= \mathbf{S}^{PP} - \mathbf{U}^{PP} \mathbf{e} - \mathbf{T}_S^V - \mathbf{T}_S^P \\ &= \mathbf{F}^{PP} - \mathbf{T}_S^V - \mathbf{T}_S^P \end{aligned}$$

Summing over columns in (15) and over rows in (16) gives:

$$(17) \quad \mathbf{V}^{BP} \mathbf{e} = \mathbf{e}'\mathbf{F}^{BP} - \mathbf{e}'\mathbf{T}_U^V \mathbf{e} - \mathbf{e}'\mathbf{T}_U^P \mathbf{e}$$

or equivalently

$$(17)' \quad \mathbf{V}^{BP} \mathbf{e} = \mathbf{e}'\mathbf{F}^{PP} - \mathbf{e}'\mathbf{T}_S^V - \mathbf{e}'\mathbf{T}_S^P$$

In this case the sum of the rows in the material balance is, in a closed economy, equal to the value added at basic prices at the economy level. The problem is that a row in equations (16) and (16)' does not represent the final use of a product valued at any price concept. The non-deductible value added type and similar taxes ( $\mathbf{T}_U^V \mathbf{e}$ ) as well as the other taxes on products net of similar subsidies ( $\mathbf{T}_U^P \mathbf{e}$ ) deducted from the value of final uses at basic prices ( $\mathbf{F}^{BP}$ ) in (16) are not related to final uses but to intermediate uses. And the non-deductible value added type taxes ( $\mathbf{T}_S^V$ ) and the other net product taxes ( $\mathbf{T}_S^P$ ) deducted in (16)' from final uses at purchasers' prices ( $\mathbf{F}^{PP}$ ) are those paid in any uses of the output. This means that the value added at basic prices at the economy level cannot be thought to consist of the values of separate products.

If no taxes or subsidies on products were paid on intermediate uses there would be no problems. But unfortunately this is not the case. And what makes the problem worse is that taxes and subsidies are unevenly distributed to different products. Other taxes (than VAT and similar taxes) on products are, by definition, not deductible and are paid on the output used as intermediate inputs as well as on the output used for other purposes. They consist of excise duties levied on specific kinds of goods (typically alcoholic beverages, tobacco and fuels); taxes on specific services (such as communication, transportation, insurance, advertising, restaurants); taxes on financial and capital transactions and profits of fiscal monopolies. Therefore they are relatively significant for some of the products, while the rest of the products are not affected. Subsidies on products on the other hand are most likely to be related to the output of agriculture. But there can be subsidies on other products, such as transportation as well.

Besides, in countries with a VAT system some of the industries (such as financial, insurance, health and education services) may not be liable to charge VAT on the sales of their output and accordingly cannot deduct the VAT they have paid on their purchases. Therefore some value-added taxes can be paid on any products used as intermediate inputs by these industries.

Purchasers' prices should include the trade and transport margins as well. But they can be treated as outputs of the respective industries<sup>2</sup> and therefore do not cause similar problems as taxes and subsidies on products.

## 5 Outputs and intermediate inputs valued at basic prices

Another possibility would be to value the outputs and intermediate uses using the same price concept. In the symmetric input-output tables the preferred basis of valuation in the SNA93 are the basic prices. In the SNA93 environment this would mean that industry level production accounts would be defined as follows:

$$(18) \quad \begin{aligned} \mathbf{S}^{BP'} - \mathbf{e}'\mathbf{U}^{BP} &= \mathbf{V}^{BP} + \mathbf{e}'\mathbf{T}_U^V + \mathbf{e}'\mathbf{T}_U^P \\ &= \mathbf{E} + \mathbf{O} + \mathbf{T}^{PN} + \mathbf{e}'\mathbf{T}_U^V + \mathbf{e}'\mathbf{T}_U^P \end{aligned}$$

Since taxes less subsidies on products paid on intermediate inputs no more are included in the value the intermediate inputs they have to be included in the value of primary inputs. In equation (18) both the non-deductible value added type taxes ( $\mathbf{e}'\mathbf{T}_U^V$ ) and the other taxes less subsidies on products ( $\mathbf{e}'\mathbf{T}_U^P$ ) are those paid on the intermediate inputs used by an industry and not those relating to the intermediate uses of the output of the industry, as was the case in equation (16).

The net value of taxes less subsidies on products might be relatively small at the economy level but the uneven distribution of both taxes and subsidies creates problems at the industry level. One reason for this is that industries (such as financial, insurance, health and education services) that are not liable to charge VAT on their sales cannot deduct the value added taxes they have to pay on their purchases of intermediate inputs. Besides, e.g. excise duties levied on fuels are most significant in the intermediate uses of electricity production and transportation. Duties levied on alcoholic beverages are important in the case of hotels and restaurants etc. Subsidies are often related to agricultural products and therefore are of significance especially in manufacturing of food products.

The material balance of the economy would now look like the following:

$$(19) \quad \mathbf{S}^{BP} - \mathbf{U}^{BP} \mathbf{e} = \mathbf{F}^{BP}$$

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<sup>2</sup> This is done e.g. by JGF (1987), whose purchasers' prices do not include trade and transport margins.

Summing over the columns in equation (18) and over the rows in equation (19) gives

$$(20) \quad \mathbf{e}'\mathbf{F}^{BP} = \mathbf{E}\mathbf{e} + \mathbf{O}\mathbf{e} + \mathbf{T}^{PN}\mathbf{e} + \mathbf{e}'\mathbf{T}_U^V\mathbf{e} + \mathbf{e}'\mathbf{T}_U^P\mathbf{e}$$

Thus the final output of the economy now does consist of separate products valued at specified prices. But likewise as at the industry level the value of the primary inputs has to cover also the non-deductible value added type of taxes and the other net taxes on products used as intermediate inputs. The valuation of the output at the industry level is in this case correct from the point of view of the producer, but the valuation of the inputs is not. Domar-aggregation in its original form can be used.

At the economy level the producer however is at the same time the user. Therefore it is hard to say whether the final output should be valued at basic prices that are relevant from the point of view of the producer or at the purchasers' prices that are relevant from the point of view of the users.

## 6 Outputs and intermediate inputs valued at purchasers' / producers' prices

Although purchasers' prices are not recommended as a basis of valuation of output in the SNA93, its GDP at market prices in fact is the difference between output valued at purchasers' prices and intermediate inputs valued at purchasers' prices. The industry level production accounts can, in principle, in this case, be defined as follows:

$$(21) \quad \begin{aligned} \mathbf{S}^{PP'} - \mathbf{e}'\mathbf{U}^{PP} &= \mathbf{V}^{BP} + \mathbf{T}_S^{V'} + \mathbf{T}_S^{P'} \\ &= \mathbf{E} + \mathbf{O} + \mathbf{T}^{PN} + \mathbf{T}_S^{V'} + \mathbf{T}_S^{P'} \end{aligned}$$

Again it is not possible to think the value primary inputs to consist solely of the compensations on capital and labor. For an industry this means that the value of all the net taxes on products paid on the output of the industry in all its uses ( $\mathbf{T}_S^{V'}$  and  $\mathbf{T}_S^{P'}$ ) has to be covered by the value of the primary inputs. In the case represented by equation (18) it was the net taxes on products paid on the intermediate inputs used by the industry that had to be covered. Again, some of the industries are affected more than the rest of them. The value added type taxes are naturally paid mainly on the output of industries producing consumer goods and services. Other taxes on products are likely to be significant e.g. in the case of

manufacturing of beverage and tobacco products, manufacturing of petroleum products and insurance services. Subsidies on products are of importance e.g. in the case of agriculture and transportation. At the industry-level purchasers' prices should include the trade and transport margins as well. But they can be treated as outputs of the respective industries and therefore do not cause similar problems as taxes and subsidies on products.<sup>3</sup>

When both inputs and outputs are valued at purchasers' prices the material balance is the following:

$$(22) \quad \mathbf{S}^{PP} - \mathbf{U}^{PP} \mathbf{e} = \mathbf{F}^{PP}$$

Again summing over columns in (21) and the rows in (22) gives:

$$(23) \quad \mathbf{e}' \mathbf{F}^{PP} = \mathbf{E} \mathbf{e} + \mathbf{O} \mathbf{e} + \mathbf{T}^{PN} \mathbf{e} + \mathbf{T}_s^{V'} \mathbf{e} + \mathbf{T}_s^{P'} \mathbf{e}$$

Thus the final output at the economy level does consist of separate products valued at specified prices, this time valued from the users' point of view. Domar-aggregation in its original form can be used both in the case of purchasers' prices and in the case of producers' prices. The problem in the case of purchasers' prices is that the prices are different depending on the use, since value-added type taxes are not, in most cases, paid on capital formation and exports.

If both outputs and intermediate inputs were valued at producers prices, e.g. in the symmetric input-output tables, non-deductible VAT on all uses of the output of an industry in equation (21) should be replaced by non-deductible VAT on the intermediate inputs used by the industry in equation (18). The final output would consist of products valued at specified prices. The problem with the producers' prices is that they reflect neither the prices received by the producers' nor those paid by the users.

Yet another alternative is to value outputs at producers' prices and intermediate inputs at purchasers' prices. In this case there would be no term representing non-deductible VAT in equation (21). Since the basis of valuation of output would be different from that of intermediate uses, the final output would not consist of products valued at specifies prices, although this time this problem would be much smaller than in the case discussed in section 4.

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<sup>3</sup> This price concept obviously would, at the industry level, resemble the price concept of the GPO in the U.S. national accounts (see Yuskavage, 1996). Taxes on products should however in this price system be allocated to the industries that have produced the product on which the taxes are paid (e.g. gasoline) and not to the industry that collects the taxes (e.g. wholesale trade) as seems to be the case in the U.S. GPO.

A special case is Canada's valuation of output at modified basic prices and intermediate inputs at purchasers' prices (see Lal, 1999). The modified basic price does not include subsidies on products. In terms of equation (21) this would mean that there would be no term representing non-deductible VAT and that the term representing other net taxes on products should be replaced by a (negative) term representing subsidies on products. According to Lal (1999) this is not a major problem "as subsidisation is quite small in Canada". However, since subsidies are often, concentrated on the outputs of a few industries, such as agriculture and transportation, they might pose a problem in the case of these industries, if not in Canada in any case in other countries. And of course the final output does would not in this case consist of separate products valued at specified prices.

## 7 Is all this important?

The existence of taxes and subsidies on products causes problems in productivity accounting, no matter which price concepts are used in the valuation of outputs and intermediate inputs. If outputs were valued at basic prices and intermediate inputs at purchasers' prices, then it would be impossible to think the output at the economy level to consist of separate products valued at specified prices and to allocate it to the components of final output. In this case the problem is caused by the taxes and subsidies on products paid on intermediate uses of the products. These taxes can be either non-deductible value added type of taxes or other taxes on products. This problem is demonstrated in section 4, equations (16), (16)', (17) and (17)'. At the economy level this does not seem a big problem. E.g. in Finland in 1995 all the taxes less subsidies on products in intermediate uses were about 3 per cent of the total value of intermediate uses. But for some groups of products taxes and subsidies paid on their intermediate uses are really significant. For instance in the case of the agricultural products the percentage of subsidies was around 20. The percentage of other than value added taxes was around 35 in the intermediate uses of petroleum products and above 15 in the intermediate uses of insurance services. This shows that the problem is of empirical significance.

If both the outputs and the intermediate inputs were valued at basic prices, the economy level final output would consist of separate products with specified prices. However the value of primary inputs should include the value of taxes less subsidies on products payable on

intermediate inputs. This is demonstrated in section 5, equation (18) for industry level and equation (20) for national level. This, again, needn't be a big problem at the level of the total economy, but for some of the industries it is of importance. For instance in manufacturing of food products subsidies on products used as intermediate inputs in this industry mounted to about 40 per cent of the value added of the industry at basic prices. In manufacture of refined petroleum products etc. taxes paid on products used as intermediate inputs in this industry made more than 20 per cent of its value added at basic prices. In hotels and restaurants the corresponding figure was over 10 per cent and in transportation, financial intermediation and insurance as well as in electricity, gas and water supply just below 10 per cent etc.

In case both outputs and intermediate inputs were valued at purchasers' prices then the value of the primary inputs should include the taxes less subsidies payable on any uses of the outputs (equation (21) for industry level and equation (23) for national level). This is significant already at the economy level. E.g. in Finland in 1995 the net value of taxes less subsidies on products was around 15 per cent of the total value added at basic prices. In case outputs were valued at producers' prices only other than the value added type net taxes on products should be included. Even these mounted to more than 5 per cent of the total value added and are of course very unevenly distributed between the industries.

## 8 Concluding remarks

In order to have a consistent set of productivity measures the industry level and the economy level outputs obviously have to be valued using the same price concept. Likewise the intermediate inputs both at the economy level and at industry level have to be valued using the same price concept. The price concepts used in the valuation of the outputs on the one hand and of the inputs on the other may be different. Even if the intermediate inputs do not explicitly appear in the economy level productivity measurement, it is not possible to define the value of the economy level output without assuming something about the basis of the valuation of the intermediate inputs.

The existence of taxes and subsidies on products has to be taken into account when the basis of valuation is decided. The choice of the price concepts has an effect on the residual value that has to be covered by the value of the primary inputs both at the industry level and at the economy level. The residual value may, depending on the price concepts, have to cover,

besides the value added at basic prices, either the net taxes on products used as intermediate inputs or all the net taxes on products relating to all uses of the output of the industry/economy. In the former case the value of these net taxes can be substantial at the industry –level even if it not necessarily at the economy level. In the latter case their value is significant already at the economy level and even more so for some of the industries.

The choice of the price concepts used in the valuation of output and intermediate uses also determines whether the valuation of final uses can be thought to consist of separate products with specified prices as the basis of valuation. It is obvious that this is possible only in the case that outputs and intermediate inputs are valued using the same price concept. The only case that exactly meets this requirement is the valuation of both intermediate inputs and outputs at basic/producers' prices. The valuation of intermediate inputs purchasers' prices and outputs at producers' prices comes close. In case of valuation of both outputs and inputs at purchasers' prices it has to be taken into account that they can be different in different uses.

These problems are not due to the SNA93 system of valuation, which only duly reflects the complexities of the real world.



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