Session 2B: Productivity Measurement Under Alternate Assumptions I
Time: Monday, August 6, 2012 PM

Paper Prepared for the 32nd General Conference of
The International Association for Research in Income and Wealth

Boston, USA, August 5-11, 2012

Measures of Productivity Change: Which Outcome Do You Want?

Mark Vancauteren, Erik Veldhuizen and Bert M. Balk

For additional information please contact:

Name: Mark Vancauteren
Affiliation: Statistics Netherlands and Hasselt University

Email Address: Mark.Vancauteren@uhasselt.be

Measures of productivity change: Which outcome do you want?[1]

Mark Vancauteren[a,b], Erik Veldhuizen[a] and Bert M. Balk[c]

[a]Statistics Netherlands

[b]Hasselt University

[c]Rotterdam School of Management, Erasmus University

14 July 2012

Abstract: The measurement of productivity change is usually based on models that make use of strong neoclassical assumptions such as competitive equilibrium, constant returns to scale and perfect foresight. In such a setup, there is no role for profit. While neoclassical assumptions make it easy to interpret the estimates of productivity change, there is enough empirical evidence showing that such assumptions are not adequate for all markets. In this paper we discuss a number of choices that play a role in the construction of multi-factor productivity (MFP) measures.

More specifically, we look at five input-output models for the measurement of productivity change, respectively based on gross output, gross and net value added, and gross and net cash flow, and extend these models with variations in the construction of capital input cost, which in turn lead to differently defined profit concepts. In the net-value-added and net-cash-flow based concepts, the cost of time-series depreciation and taxes are treated as intermediate input cost rather than as components of primary input cost. With respect to the measurement of capital input cost, we pay specific attention to the role of endogenous versus exogenous interest rates, the treatment of unexpected holding gains/losses, the utilization ratio of capital and the stock versus service construction of capital.

From a practical point, it is useful to consider when to use each of these different MFP measures and how these can be interpreted, so that an analyst will be in a better position to properly apply specific productivity measures to actual data. The following findings can be summarized: (i) differences between nonzero-profit and zero-profit based MFP measures are small, (ii) MFP change percentages increase in absolute values when one moves from the gross-output concept to the net-cash-flow concept, and (iii) MFP change varies among sectors; generally, the exclusion of

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[1] Corresponding author: Mark.Vancauteren@uhasselt.be. An earlier version of this paper, also co-authored by Dirk van den Bergen, was presented at the 57[th] Session of the International Statistical Institute, Durban, 16 August, 2009; the Economic Measurement Group workshop, Sydney , 9-11 December 2009; and the Productivity Commission, Canberra, 14 December 2009.

unanticipated revaluations matters very little.

Keywords: Productivity, technological change, profit, profitability, input-output models, capital, interest rate, holding gains/losses.

1. *Introduction*

Productivity change, generally defined as output quantity change relative to input quantity change, is an important tool for analyzing the economic performance of a production unit (be it a firm, an industry, or an economy). If more output is possible from a certain set of inputs or if less input is needed for a certain set of outputs then we say that productivity has increased. So defined, measuring productivity change seems to be a simple task. However, constructing productivity measures from actual production data leads to an entire set of methodological issues that merits further discussion.

The *first* set of issues regards the output and input concepts. There are several types of outputs and inputs. In management discussions, productivity is often interpreted as a partial measure; the most common being labor productivity, measured as output per man-year or hour worked. Labour productivity is a indicative and appropriate measure for capturing the enhanced welfare from growth (e.g., GDP per capita). Similarly "capital productivity", measured as output per unit of capital, is partial measure of productivity that reflects the efficiency with which capital stock is used. To a certain extent such efficiency depends on internal and external financial obligations, strategies in funding its capital needs and managing production capacitites.

On the other hand, the concept of (total- or) multi-factor productivity (MFP), which is used when multiple inputs (that is, capital, labor, energy, materials, and services) are taken into account, is considered to provide a more realistic representation of the entire production process. The most widely used model, the so-called KLEMS-Y model, delivers the gross-output MFP. The KLEMS-Y model relates gross (`physical') output to the following input components: capital (K), labor (L), energy (E), materials (M) and services (S). An alternative and widely known concept of MFP is value-added MFP. The KL-VA model defines output as the difference between gross output and intermediate inputs (EMS) while capital (K) and labor (L) determine the input base. A third alternative model is based on the cash flow MFP with output defined as the difference between gross output, labor (L) and intermediate inputs (EMS) while capital (K) is the sole input.

The *second* set of measurement issues regards market structure assumptions. Often, productivity is measured under neoclassical assumptions of perfect competition and constant returns to scale. This implies, amongst others, that there is no market power and that production units make zero profits. The usefulness of the perfect competition assumption relies on the relative easiness to calculate and interpret estimates of MFP change. For instance, Hulten (2010) points towards a strong neoclassical assumption of treating capital as an homogenous entity in which differing types of investment goods are assumed to be perfect substitites (that is, with same prices and growth). These assumption make it easy to calculate the Solow residual. However, competition is clearly imperfect in many markets. In particular, there is ample empirical evidence that shows that typical neclassical assumptions are not adequate for all markets. Because of this, MFP can also be measured by taking into account non-neoclassical assumptions.

The *third* issue relates to interpreting MFP. The interpretation of MFP is usually addressed as a compositional issue. Under the neoclassical assumptions of perfect competition and constant returns to scale, MFP change is just equal to technological change. This is one of the reasons why macroecononomists often erroneously tend to confuse technological change with MFP. For instance, the Solow (1957) productivity residual indexes technological change, assuming there is an aggregated production function in a frictionless market. However, relaxing these assumptions, MFP change includes factors such as technological change (due to input and output innovation, management skills, etc.), technical efficiency change, scale effects, input- and/or output-mix change (due to higher production capacities, deviations from perfect competition, etc.), and other external factors like the weather.

These additional factors are usually linked to the broad concept of profit and profitability. Profit is defined as the difference between revenue and cost, whereas profitability is defined as the ratio of revenue and cost. Profitability is a financial measure for the success and growth of a commercial business. Businesses may generate a positive change in profitability through productivity gains or by changing output prices relative to input prices. Apart from technical details, this linkage between productivity change, price change and profitability change has been explored in the business literature.

We approach the concept of profit and profitability from the capital input side using National Accounts data. In particular, we construct capital input prices – that provide the basis for the calculation of user cost of capital – without making any neoclassical assumptions. According to the zero-profit constraint, user cost of capital is calculated to ensure that total cost equals revenue. This zero profit constraint is realized by using an endogenous interest rate (rate of return). Balk (2010) however argued that such an endogenous interest rate (internal rate of return) is prone to measurement error and the effect of omitted variables. He provides an approach where the revenue is assumed to be the sum of the cost of the inputs and profit, thus waiving the neo-classical zero profit assumption. The cost of capital input is then based on an exogenous interest rate which in turn is based on external information (for example from financial market data or asset price information). As a result, profit can simply be derived by subtracting the user cost of capital from gross operating surplus minus labor cost of self-employed persons.

With this paper, we contribute to the existing literature in several ways. First, we look at five input-output models for the measurement of productivity change, respectively based on gross output, gross and net value added, and gross and net cash flow, and extend these models with variations in the construction of capital input cost, which in turn lead to differently defined profit concepts. In the net-value-added and net-cash-flow based concepts, the cost of time-series depreciation and taxes are treated as intermediate input cost rather than as components of primary input cost. With respect to the measurement of capital input cost, we pay specific attention to the role of endogenous versus exogenous interest rates, the treatment of unexpected holding gains/losses, the utilization ratio of capital, and the stock versus service construction of capital.

Second, we focus on interpretation and practicability. While different formulations of profitability can be useful in many applications, it is also important to gain insights into the concept of productivity under the presence of differently defined profits. How can we decide what productivity measures to use? How can we interpret them correctly? What is the role of profits? These insights are critical for the interpretation of different measures so that a productivity analyst will be in a better position to properly apply and extend an array of productivity measures to actual data. We provide numerical evidence using national accounting data from the Netherlands' system of productivity measurement. However, it is to be noted that estimates can also be produced at more detailed levels of aggregation such as firm level data.

The paper is organized as follows. In Section 2 we describe the basic outline of the input-output model approach to productivity and profitability. Section 3 discusses the various profit concepts, starting from national accounting data. In this section, we also discuss the decomposition of the user cost of capital. In Section 4 we introduce the various input-output models that lead to different MFP measures. In Section 5 we provide interpretations of each of the input-output concepts of MFP. Section 6 reports the empirical results, and Section 7 concludes.

2. *The input-output model approach to profitability and productivity change*

In this section, we provide a brief outline on measuring profitability and MFP for a multiple input-output production unit (a firm, industry or total economy). It is assumed that input and output prices are available (observed or imputed). We represent time periods by t and let t = 0, 1. In our empirical application we will compare adjacent years. At the output side we have M items, each with their period t output price vector $p^t \equiv [p_1^t \ldots p_M^t]$ and period t quantity vector $y^t \equiv [y_1^t \ldots y_M^t]$. Similarly, at the input side we have N items, each with their period t input price vector $\mathbf{w}^t \equiv [w_1^t \ldots w_N^t]$ and period t input quantity vector $\mathbf{x}^t \equiv [x_1^t \ldots x_N^t]$.

The unit's revenue R^t, that is the value of its gross output, and total production cost C^t for period t are defined as

$$R^t \equiv \mathbf{p}^t \cdot \mathbf{y}^t \equiv \sum_{m=1}^{M} p_m^t y_m^t$$
$$C^t \equiv \mathbf{w}^t \cdot \mathbf{x}^t \equiv \sum_{n=1}^{N} w_n^t x_n^t. \tag{1}$$

Profit is defined as revenue minus cost, $\Pi^t \equiv R^t - C^t$. Profitability is defined as revenue divided by cost R^t / C^t. Profitability gives, in monetary terms, the quantity of output per unit of input, and is thus a measure of return to aggregate input. The profit margin is defined as $\mu^t \equiv \Pi^t / C^t$, and its link with profitability is given by

$$1 + \mu^t = R^t / C^t. \tag{2}$$

If the profit margin μ^t is zero, then the unit's revenue equals its cost in period *t* and the profit of the unit is zero. If μ^t is positive then the unit is making profit. Note that the difference between between revenue and cost could also be attributed to unobserved inputs. Corrado et al. (2006) discuss the importance of intangible investments (e.g. knowledge and human capital) as additional inputs. Schreyer (2003) and Diewert (1992) note that decreasing returns to scale (or equivalently, increasing costs) may also be due to non-observed inputs.

The profitability change between periods 0 and period 1 is given by

$$\frac{1+\mu^1}{1+\mu^0} = \frac{R^1/C^1}{R^0/C^0} = \frac{R^1/R^0}{C^1/C^0}. \tag{3}$$

Any revenue ratio can be decomposed into a price and a quantity index. The basic requirement is that the price and quantity indices satisfy the Product Test, meaning that the product of the price and quantity indices between periods 0 and 1 is equal to the revenue ratio:

$$\frac{R^1}{R^0} = P_R(1,0)Q_R(1,0) \ , \tag{4}$$

where P_R is an output price index and Q_R is an output quantity index. Similarly, any cost ratio can be decomposed as

$$\frac{C^1}{C^0} = P_C(1,0)Q_C(1,0) \,, \tag{5}$$

Where P_C and Q_C are input price and quantity indices. We refer to Balk (2008) for a discussion on the choice of the functional form of all these indices. In our empirical application we employ Fisher indices.

Using equations (4) and (5), profitability change (3) can be decomposed as

$$\frac{R^1/R^0}{C^1/C^0} = \frac{P_R(1,0)}{P_C(1,0)} \frac{Q_R(1,0)}{Q_C(1,0)} \,. \tag{6}$$

The definition of the primal *MFP* index is then given by

$$MFP(1,0) = \frac{Q_R(1,0)}{Q_C(1,0)} \,, \tag{7}$$

that is, output quantity index divided by (total cost based) input quantity index. Using equation

(6), the MFP index can be written as

$$MFP(1,0) = \frac{R^1 / R^0}{C^1 / C^0} \frac{P_C(1,0)}{P_R(1,0)}. \qquad (8)$$

Thus the MFP index is the quantity component of the profitability ratio and can be interpreted as the factor by which the output quantities on average have changed relative to the factor by which the input quantities on average have changed. If MFP(1,0) > 1(< 1), then output growth is greater (smaller). In equation (8), the input price index divided by the output price index, $P_C(1,0)/P_R(1,0)$, is called the dual MFP index. Equation (8) implies that the primal and the dual MFP index are the same if and only if profitability or the profit margin stays the same. The inverse of the dual MFP is called price recovery.

3. *Defining profit*

We start by introducing the so-called KLEMS-Y model. This model relates gross (‘physical’) output (Y) to the following input components: capital (K), labor (L), energy (E), materials (M) and services (S). Notice that capital means owned capital. Leased capital is part of services. The basic accounting identity of the KLEMS-Y model can be written as

$$R^t = C^t + \prod^t . \qquad (9)$$

The relation with the national accounts definitions is as follows. Gross operating surplus (GOS) is defined as value added (= revenue minus intermediate inputs cost) minus labor cost of employees minus taxes and subsidies. Our Π^t is equal to GOS minus (imputed) labor cost of self-employed persons minus capital input cost. Taxes and subsidies are allocated to the labor and capital components they belong to. Under the neoclassical approach, total cost equals revenue or, in other words, GOS minus the labor cost of self-employed persons equals capital input cost.

The total user cost of capital is determined as

$$C_K^t \equiv \sum_{i=1}^{I} \sum_{j=1}^{J_i} \varphi_{ij}^t k_{ij}^t , \qquad (10)$$

where φ_{ij}^t is the unit user cost of of an asset of type i (i = 1,…,I) and age j $(j = 1,\ldots,J_i)$ used during period t, and k_{ij}^t denotes the corresponding quantity (e.g. number of machines, vehicles). In order to keep our notation simple we abstract here from investments made during period t and used during the remainder of that period. *Ex post* unit user cost φ_{ij}^t consists of four components

$$\varphi_{ij}^t = r^t p_{ij}^t + \delta_{ij}^t + \rho_{ij}^t + \tau_{ij}^t. \qquad (11)$$

The first component, $r^t p_{ij}^t$, is the price (or valuation) of an asset, of a certain age, times an interest rate which is called the *rate of return*. This component can be interpreted as the interest cost that is related to financing the capital that is tied up in the asset. Another interpretation is that it reflects the premium that must be paid to the owner of the asset to prevent its sale at the beginning of the period t. It is thus also called the *price of waiting.* The second component, δ_{ij}^t, is the value change of the asset between the start and the end of the accounting period, as expected at the start of the period. This component may be decomposed into the expected revaluation of an asset of unchanging age (anticipated revaluation) and the price difference of two assets that differ precisely one year in age (Hicksian or cross-section depreciation). We call δ_{ij}^t the anticipated *time-series depreciation*. The third component, ρ_{ij}^t, is the *unexpected price revaluation* of an asset of unchanging age. This price revaluation is calculated as the actual revaluation (as obtained *ex post*) minus the expected revaluation δ_{ij}^t. These unexpected price changes relax the assumption of perfect foresight that is usually included in the neoclassical thought. We will come back to this issue in Section 5.4. The fourth component, τ_{ij}^t, denotes the specific taxes and subsidies levied on the use of an asset of type i and age j during period t. We refer to Balk (2011) for a detailed discussion of all these components.

Using (10) and (11), the accounting identity (9) can be rewritten as

$$\mathrm{R}^t - \mathbf{w}_{LEMS}^t \cdot \mathbf{x}_{LEMS}^t - \delta^t k_\delta^t - \rho^t k_\rho^t - \tau^t k_\tau^t = r^t \left(\sum_{i=1}^{I} \sum_{j=1}^{J_i} p_{ij}^t k_{ij}^t \right) + \Pi^t , \qquad (12)$$

where $\delta^t k_\delta^t \equiv \sum_{i=1}^{I} \sum_{j=1}^{J_i} \delta_{ij}^t k_{ij}^t$, $\rho^t k_\rho^t \equiv \sum_{i=1}^{I} \sum_{j=1}^{J_i} \rho_{ij}^t k_{ij}^t$, and $\tau^t k_\tau^t \equiv \sum_{i=1}^{I} \sum_{j=1}^{J_i} \tau_{ij}^t k_{ij}^t$. Under neo-classical assumptions $\Pi^t = 0$. Equation (12) can then be thought of as an implicit definition of the rate of return: once the value of the capital stock $\sum_i \sum_j p_{ij}^t k_{ij}^t$ and the other components are empirically determined, we can solve equation (12) for the rate of return r^t. This is then called the *endogenous* rate of return. The alternative is to use an *exogenous* rate of return, derived from past rates of returns, other financial performance measures, or consumer price indices. For instance, Oulton (2007) estimates a rate of return using an ARMA model applied to asset prices derived from financial market data. Profit Π^t then follows from equation (12) and will, in general, be unequal to 0.

The question whether to use an exogenous or endogenous rate of return remains an important issue. In practice, these alternatives are variably employed by official statistical agencies (see Balk 2010 for an overview). Schreyer (2003) and Balk (2011) criticize the endogenous rate of return on the grounds that a rate of return which closes the gap between cost and revenue of a production unit is influenced by unobserved inputs and outputs as well as measurement errors. A second critique is that firms make decisions about investments based on expectations as to the rate of return. Using an endogenous rate of return it is then basically assumed that firms have perfect foresight because the endogenous rate of return can only be determined *ex post*. A third critique is that the endogenous rate of return leads to zero profits. However, there is enough empirical evidence that this consequence is unjustified.

One important issue remains to be considered. If some assets are not actually used in the production process but cost incurring, then these costs are paid out of profits. Put otherwise, some part of profit may be a interpreted as return to these non-production related capital assets. For introducing the capital utilization rate equation (9) is written as

$$\mathrm{R}^t = C_K^t + \mathbf{C}_{LEMS}^t + \Pi^t. \qquad (13)$$

For correcting for variations in capital utilization, let $\theta_K^t \; (0 < \theta_K^t < 1)$ be the cost share of the assets actually used in the production process during period *t*. For simplicity, we assume that a single utilization rate applies to all the type-age asset classes. Then we can rewrite equation (13) as

$$R^t = \theta_K^t C_K^t + (1-\theta_K^t) C_K^t + C_{LEMS}^t + \Pi^t \;. \qquad (14)$$

Adding the cost share of unused capital to profit, equation (14) becomes

$$R^t = \theta_K^t C_K^t + \mathrm{C}_{LEMS}^t + \Pi^{*t}, \qquad (15)$$

where profit is now defined as $\Pi^{*t} = (1-\theta_K^t)C_K^t + \Pi^t$. Put otherwise, in the calculation of the MFP index (7) total cost C^t must be replaced by $\theta_K^t C_K^t + \mathrm{C}_{LEMS}^t$.

Unlike capital, we don't need a utilization rate for labor. The reason is that labor is measured by actual hours worked and not by manyears or persons. Thus, under- or overutilization of persons is reflected in hours of work and corresponding wage rates.

4. *MFP measurement models*

By considering different variants of the output and input concept an array of MFP measurement models can be constructed, with potentially different outcomes. More specifically, we look at five input-output models for the measurement of productivity change, respectively based on gross output, gross and net value added, and gross and net cash flow, and extend these models with variations in the construction of capital input cost, which in turn lead to differently defined profit concepts.

First, as introduced above, the KLEMS-Y model (12) can be written as

$$\sigma^t k_\sigma^t + \delta^t k_\delta^t + \rho^t k_\rho^t + \tau^t k_\tau^t + \mathbf{w}_{LEMS}^t \cdot \mathbf{x}_{LEMS}^t + \Pi^t = \mathbf{p}^t \cdot \mathbf{y}^t, \quad (16)$$

where $\sigma^t k_\sigma^t \equiv r^t \left(\sum_{i=1}^{I} \sum_{j=1}^{J_i} p_{ij}^t k_{ij}^t \right)$ and the other variables are as defined above.

The second model uses value added (VA) as its output concept. Value added is gross output revenue minus the cost of intermediate inputs. The KL-VA model is expressed as

$$\sigma^t k_\sigma^t + \delta^t k_\delta^t + \rho^t k_\rho^t + \tau^t k_\tau^t + w_L^t x_L^t + \Pi^t = \mathbf{p}^t \cdot \mathbf{y}^t - \mathbf{w}_{EMS}^t \cdot \mathbf{x}_{EMS}^t. \quad (17)$$

The third model is a variant of the KL-VA model and uses net value added (NVA) as its output concept. NVA is equal to VA minus the cost of depreciation plus tax. Balk (2010) suggests that these cost components can be regarded as intermediate inputs. The KL-NVA model is defined by

$$\sigma^t k_\sigma^t + w_L^t x_L^t + \Pi^t = \mathbf{p}^t \cdot \mathbf{y}^t - \left(\delta^t k_\delta^t + \rho^t k_\rho^t + \tau^t k_\tau^t + \mathbf{w}_{EMS}^t \cdot \mathbf{x}_{EMS}^t \right). \quad (18)$$

The fourth model uses cash flow (CF) as its output concept. CF is defined as VA minus the costs of labor. Another name for cash flow is "variable profit". The K-CF model is expressed as

$$\sigma^t k_\sigma^t + \delta^t k_\delta^t + \rho^t k_\rho^t + \tau^t k_\tau^t + \Pi^t = \mathbf{p}^t \cdot \mathbf{y}^t - \mathbf{w}_{LEMS}^t \cdot \mathbf{x}_{LEMS}^t. \quad (19)$$

The fifth model is a variant of the K-CF model and uses net cash flow (NCF) as its output concept. NCF is equal to CF minus the cost of depreciation plus tax. The K-NCF model is therefore expressed as,

$$\sigma^t k^t_\sigma + \Pi^t = \mathbf{p}^t \cdot \mathbf{y}^t \text{ - } \left(\delta^t k^t_\delta + \rho^t k^t_\rho + \tau^t k^t_\tau + \mathbf{w}^t_{LEMS} \cdot \mathbf{x}^t_{LEMS}\right). \tag{20}$$

In all these models it is assumed that unexpected asset revaluation, $\rho^t k^t_\rho$, is treated as input cost. However, as will be argued in the next section, if we are interested in 'normal' production then unanticipated revaluations should not be retained in the user cost of capital but must be added to profit. This new profit concept will be denoted by Π^{**t}, where $\Pi^{**t} \equiv \Pi^t + \rho^t k^t_\rho$. Following this argument, five additional input-output models can be defined.

An additional model can be defined which is closely related to the net output approach concept of value-added (NVA) and cash flow (CF). Instead of treating expected time-series depreciation, unexpected revaluation, and tax as intermediate input, these capital input cost components can also be added to profit. This leads to $\Pi^{****t} \equiv \Pi^t + \delta^t k^t_\delta + \rho^t k^t_\rho + \tau^t k^t_\tau$. The accounting relation (16) then becomes

$$r^t\left(\sum_{i=1}^{I} \sum_{j=1}^{J_i} p^t_{ij} k^t_{ij}\right) + \mathbf{w}^t_{LEMS} \cdot \mathbf{x}^t_{LEMS} + \Pi^{****t} = \mathbf{p}^t \cdot \mathbf{y}^t, \tag{21}$$

where $\sum_i \sum_j p^t_{ij} k^t_{ij}$ measures the net capital stock. The KL-VA and K-CF variants follow naturally.

Setting in equation (21) $\Pi^{****t} = 0$ leads to an endogenous rate of return, which may be called the Solow-Kuznets rate. This rate reflect common practice where the rate of return of capital is calculated as cash flow divided by a measure of net capital stock. In the business literature the Solow-Kuznets rate is known as return-on-assets (ROA). Adding this model to our analysis allows us to verify whether or not there is numerical difference between an MFP index using a capital input quantity index based on the *service* concept or the *stock* concept. Since there is not much empirical material available, this could be interesting.

Summarizing, we consider five input-output models: KLEMS-Y, KL-VA, KL-NVA, K-CF, K-NCF. Also, we consider five profit concepts (note that the notation slightly differs from Balk 2010):

- Revenue minus total cost: $\Pi^t = R^t - C^t_{KLEMS}$.
- Revenue minus total cost plus cost of unutilized capital : $\Pi^{*t} = \Pi^t + (1-\theta^t_K)C^t_K$.
- Revenue minus total cost plus value of unexpected asset revaluations: $\Pi^{**t} = \Pi^t + \rho^t k^t_\rho$.
- Revenue minus total cost plus cost of unutilized capital plus value of unexpected asset revaluations of utilized capital: $\Pi^{***t} = \Pi^t + (1-\theta^t_K)C^t_K + \theta^t_K \rho^t k^t_\rho$.
- Revenue minus total cost plus value of expected time-series depreciation, unexpected revaluation, and tax: $\Pi^{****t} = \Pi^t + \delta^t k^t_\delta + \rho^t k^t_\rho + \tau^t k^t_\tau$.

Profit can be set unequal to 0 (with an exogenous interest rate) or equal to 0 (leading to an endogenous interest rate). Note that, for instance, setting $\Pi^{**t} = 0$ implies that $\Pi^t = -\rho^t k^t_\rho$, which is not necessarily equal to 0. All in all we consider 46 models, schematically:

Profit concept	Π		Π^*		Π^{**}		Π^{***}		Π^{****}	
Model	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$
KLEMS-Y										
KL-VA										
KL-NVA									-	-
K-CF										
K-NCF									-	-

5. *Economic interpretations of different MFP concepts*

The MFP measure is generically defined by equation (7). By considering different variants of the output and input concept, as explained in the previous section, an array of *MFP* models can be constructed, each with different outcomes. Before we turn to some empirical results, it is worthwile to put some emphasis on the economic interpretation of the gross output, value-added and cash flow measure that emerge from the literature. Here we also take a look at the role of profit.

5.1. Gross-output and value-added MFP

Value-added and gross output define economic quantities differently. Gross output is the value of output of the production process while value added is the difference between the value of output and the value of intermediate inputs. Intermediate inputs like materials, energy, services, etc. are very important for many of the manufacturing industries. If the production unit is an entire economy, value-added and Gross Domestic Product (GDP) are sometimes interchangeable. GDP is the sum of value-added in various economic activities which is equal to all incomes earned by the production of goods and services.

Gross output and value added MFP have also different uses. The advantage of the gross output MFP growth is that it includes the effect of efficient or inefficient use of intermediate inputs as a source of industry growth. In this sense, this measure provides a more complete picture of the production process. On the other hand, the value-added MFP corresponds to the income that is generated by capital and labor. Value-added MFP may be considered as an important contributor to income that flows into society. OECD (2001) interprets this measure as an industry's capacity to translate technological change into income (from production) and final demand.

As shown by Balk (2009a), if profit equals 0 then value-added lnMFP is equal to gross-output lnMFP times the ratio of (mean) revenue to (mean) value-added. This ratio is called the Domar factor. It describes the difference between gross-output based MFP and value-added based MFP through the importance of intermediate inputs. In case of industries where intermediate inputs are important, which Domar refers to as the 'thinness' of an industry, the two measures will deviate.

An interesting implication about the role of intermediate inputs is in the context of outsourcing. An important reason why outsourcing occurs is to save on labour costs and other inputs. Conceptually, outsourcing means that intermediate inputs (EMS) are substituted for labor (L) and/or capital inputs (K). The gross output MFP measure would hardly be affected since this transfer takes place in the denominator.

The value-added concept of MFP is easily comparable across industries because it does not depend on the scale of operations. This is particularly true for industries where differences in the magnitude of gross output MFP are caused by differences in the value of intermediate inputs. For instance, the footwear industry and the machinery industry have large differences between gross output but they are the result of differences in the intermediate inputs used. In such situations, value-added based measures should be used. In addition, the value-added approach to MFP is preferred for analyzing the relationship between individual and aggregate measures of productivity change (see OECD, 2001; Balk, 2009b).

5.2. Cash flow based MFP

In the cash-flow concept of MFP, output is defined as revenue minus the cost of non-capital inputs (LEMS), while owned capital (K) is the sole input factor. Cash flow (also called gross profit, or gross return to capital) can therefore be considered as the return to capital input. When it comes to understanding what the cash flow based MFP really measures, it is important to bear in mind that the monetary value of output not only captures returns on assets but also profit Π^t. The notion that the value of a firm depends on its cash flow is well recognized in the finance and accounting literature. Firms need to raise and invest capital in assets. A firm's cash flow is the return of the capital that is generated from these investments. In fact, a firm is positive valued if these returns exceed the costs of capital because it indicates the extent to which a firm may be able to repay its financial obligations as well as its strategies in funding its capital needs. Indeed, a large empirical body (e.g., Lamont, 1997; Fazarri et al. 1998; Bushman et al. 2011) find evidence that cash flow variables can improve the explanatory power of investment models.

If there is no owned capital (that is, a firm chooses to lease all capital assets rather than buy them) then cash flows is equal to profit. In this case, the cash flow concept of MFP does not make sense. On the other hand, capital deepening firms that rely on substantial financial resources rely more on the availability of internal cash flows.

Linked to the cash flow concept of MFP, profit asumptions may certainly matter. In line with the zero-profit assumption, neoclassical models assume that capital markets are perfect (that is, exhibit perfect foresight) and that investment adjusts immediately to the desired stock of capital (Hall and Jorgenson, 1967); In contrast, the non-zero profit assumption suggest that informational asymmetries in capital markets are important investment and cash flow determinants which may also affect the cash flow concept of MFP. Indeed, the recent financial crisis has shown us how information assymmetries may impact the allocation of capital and investment opportunities.

5.3. Gross versus net output

In each of the above mentioned input-output models of MFP we can distinguish between a gross and net output concept. In the net output concept, the cost of time-series depreciation $(\delta^t k_\delta^t)$, unexpected price revaluation $(\rho^t k_\rho^t)$, and tax $(\tau^t k_\tau^t)$ are treated as intermediate input cost. The remaining cost of capital is the waiting cost $(\sigma^t k_\sigma^t)$. Of course, for the KLEMS-Y model the two concepts are identical.

By definition, a comparison of gross- and net-based MFP indices allows for an analysis of changing the capital composition. In the net output approach, the importance of capital deepening is greatly reduced. For instance, Diewert (2008) found that the net approach increased Canadian business sector MFP growth by about 0.12 percent points per year in the period 1961-2006, representing a 10% increase in the average rate of MFP growth.

The general view in the literature is that both concepts of output are reasonable measures (e.g., Hulten, 2010). There are also some compelling arguments against the net approach. Hulten (2010) argues that the interpretation of a net-based MFP is implausible given that technological change and R&D are related to an output measure that does not include depreciation. In addition, data may also be a problem. While prices and quantities of gross output concepts are widely available, net prices and quantities are more difficult to measure.

5.4 Unexpected holding gains/losses

When the perfect foresight assumption is relaxed, the inclusion of unexpected holding gains/losses ($\rho^t k_\rho^t$) captures the notion of uncertainty in the value of capital stocks. Unexpected holding gains or losses can be the result from unanticipated price shocks (e.g., oil prices), unexpected changes in demand of existing assets, sudden technological improvements, physical damage, etc. This means that the estimated value of the capital stock is changed as a result of revised expectations between a beginning and an ending period.

However, there are different views on whether or not to include unexpected holding gains and losses in income. These views rather pertain to finding a proper definition of income. If unexpected holding gains/losses are directly linked to the financial position and profits of a firm, then unanticipated holding gains/losses should be included as an input of the production process. On the other hand, if unexpected holding gains/losses are not directly linked to the production unit (e.g., holding gains from speculative trading activities of a non-financial firm; price changes resulting from changing tastes in the demand for financial assets unconnected with the production proces), then these gains/losses may still be relevant for the overall income of the firm.

The notion that income should include all capital gains/losses refers to the Haig-Simons income concept (originated by Simons (1938) and Haig (1957)). On the other hand, the view that only expected capital gains/losses should be included in income is in line with the Hicks income measure. For the purpose of this paper, we will not elaborate the discussion on whether or not unexpected holding gains/losses should be included. Rather, we approach this question from a statistical point of view by investigating the consequences of including or excluding unexpected holding gains/losses for each of the proposed MFP measures.

5.5. Capital utilization

The rate of capital utilization takes into account that capital services are not fully proportion to the capital stock. Indeed, how much capital is needed depends on the intensity of the use of capital and its variability may be explained by business cycles, changes in (aggregate) demand or even management practices (Hulten, 2010).

In case the adjustment of capital services by their effective utilization is not accounted for, this will lead to an incorrect MFP measure. The main reason is that the cyclical behavior of the true inputs is more pronounced than measured inputs. Because variations in inputs are assumed to be the major source for variations in MFP (e.g. Solow, 1957), the pro-cyclicality of MFP may be spurious (Basu and Fernald, 2002). Coremberg (2008) shows the pro-cyclical bias in (Argentinean) MFP if unadjusted capital services are used: in particular, MFP would be overestimated at the beginning of a positive business cycle and underestimated in the recessive stages. This bias is due to the fact that the contribution of unadjusted capital to (GDP) growth is underestimated during expansion and overestimated in contraction. Similarly, Field (2003) notes that the productive capital from equipment tends to be higher because of its annual depreciation rates. Therefore the contribution of capital stock, as opposed to capital services, will understate the capital input growth if the share of equipment is rising.

There is a general consensus that capital stock needs to be adjusted by its effective utilization; however, there seems to be discussion on how to implement these adjustments. The most effective way of making the capital adjustment is to use an explicit capital utilization ratio that can be extracted from data. However, Hulten (2010) criticizes this approach because it does not take into account adjustments of corresponding capital prices. In case data is not available on the utilization of capital, there are a number of alternative proxy indicators that capture the adjustment in capital. For instance, data on hours worked, employment rates, energy consumption and output gaps are the most common ones (Coremberg, 2008). However, all these variables present some questionable problems.

6. *Empirical results*

Our empirical results are based on input and output data for the major Netherlands' manufacturing and service industries over the years 1995-2008. Data come from Statistics Netherlands (CBS)' website www.statline.cbs.nl/statweb. Components of capital input cost are available upon request. For mining and quarrying capital excludes subsoil assets. We consider 9 industries and the commercial sector, defined as the sum of all the industries for which independent measures of input and output quantity change are available. The interest rate that plays a role in the calculation of the user cost of capital is set equal to the inter-bank interest rate plus 1.5%. It appears that over the period 1995-2008 our interest rate varies between 4.5% and 7.5%. We refer to Van den Bergen *et al*. (2007) for a detailed discussion of all the computational aspects. Capital utilization ratios are available from the Dutch Business Cycle survey that is compiled by Statistics Netherlands in cooperation with the Dutch Chamber of Commerce.

We begin by plotting the annual profit margins for the period 1995-2008 in Figures 1 and 2.

[Figure 1]

[Figure 2]

In general, all sectors exhibit positive profit margins with the exception of the agriculture, forestry and fishing. In this sector we find that, on the basis of more detailed data, the increasingly negative profit margins after 2001 are the result of decreasing output prices and increasing input prices. Electricity, gas and water supply exhibits a stark upward trend after 2001. The profit margin increased from 3% to about 20% in 2008. It must be noted that in 2001 the Netherlands' energy market has been liberalized, which may explain this profitability behavior. We also note that the profit margin of the financial and business activities sector decreased between 2005 and 2008. A more detailed data analysis confirms that this decrease must be attributed to the banking and insurance industry. For these industries, however, industry accounts may not fully reflect their true profitability, since important parts of profit, like stockholding profits, are not included in the accounts. In summary, we clearly find that profits and, hence, non-neoclassical behavior, are important for each of the sectors during the time period considered here.

It is obvious that the profit margins as calculated depend on the magnitude of the exogenous rate of return. By way of sensitivity analysis, we have calculated at which level the rate of return must be set in order to get zero profits. One of the results is that for the commercial sector after year 2000 the exogenous interest rate must be increased with 5.7 to 8.2 percentage points to obtain zero profits.

We now address the effect of the various models on the MFP measures. In Table 1 one finds average annual MFP growth rates for all the models considered. This table is restricted to Manufacturing because this is the only sector for which capital utilization rates (per subsector) are available. One key observation is that the MFP change percentages, on average, increase when one moves from the gross-output to the cash-flow based measuree. On average, the annual MFP growth percentages were 0.74 , 5.87 and 9.12 respectively for the KLEMS-Y, K-CF and K-NCF models.

[Table 1]

In the rows below of Table 1, it shows average absolute differences between the MFP growth rates for each model relative to the $\Pi \neq 0$ (baseline) models. For instance, the average absolute difference between growth rates according to the KLEMS-Y $\Pi \neq 0$ model and the KLEMS-Y

$\Pi = 0$ model is .07 percentage point. Or, adjusting profit for unutilized capital and unexpected asset revaluations leads to MFP percentages that differ by .09-1.56 percentage point from the baseline percentages.

Table 2 exhibits more detailed results. The first three columns refer to the baseline models. The last three colums provide differences between the mean MFP growth rates for the $\Pi \neq 0$ and the (baseline) MFP growth rates for the $\Pi = 0$ models. We note that for Agriculture, forestry and fishing it was not possible to calculate net cash flow based MFP for all the years. In 2003, 2005 and 2006, either the Laspeyres output index or the Paasche output index became negative, due to which the Fisher output index could not be constructed. In this industry, the net cash flow is very small, sometimes even negative. Since the net cash flow is calculated as the sum of both positive and negative entries, the net cash flow in constant prices may have a different sign then the net cash flow in current prices, causing a negative Laspeyres or Paasche output index.

[Table 2]

The main results are the following. First, we note that MFP change varies among sectors. The sectors with high MFP growth rates are trade, hotels, restaurants and repair, and transport, storage and communication. Second, we find that the majority of sectors exhibit higher MFP growth in the period 2002-2008 than in 1996-2001. The sectors with, notably, high MFP growth, confirmed by each of the input-output concepts, in the latter period are electricity, gas and water supply, financial and business activities, and construction. Sectors that experienced MFP decline are mining and quarrying, and care and other service activities. Note that MFP change retains its sign across all the input-output models. Third, one sees that MFP index numbers are very sensitive to the underlying definitions of the input and output concepts. The MFP change percentages increase in absolute value when one moves from the gross-output concept to the net-cash-flow concept. For instance, over the period 1996-2008 the commercial sector gross-output based MFP growth was 0.94% while the net-cash-flow based growth was 7.42%. Differences between the two sub-periods are much larger for the cash-flow based than for the gross-output and value-added based MFP growth percentages. For example, the cash-flow-based MFP change of the sector financial and business activities increased from -3.49% over 1996-2001 to 6.57% over

2002-2008. Particularly in the sectors construction, and financial and business activities such differences are large. These differences can be explained by the fact that the input base for the cash-flow-based MFP is very much smaller than the input base for the gross output and value-added MFP**.** Fourth, we generally find that differences between the MFP percentage changes from endogenous and exogenous models also become more pronounced when one moves from the gross-output-based to the cash-flow based MFP. Especially in the financial and business activities sector the differences between endogenous and exogenous MFP growth rates are notable. For example, for the cash-flow based MFP growth the rate based on the endogenous interest rate was 2.1 percentage points lower than the rate based on the exogenous interest rate. We find no apparent and conclusive differences between endogenous and exogenous interest rates based MFP growth rates.

How sensitive are the industry-level MFP growth rates to the in- or exclusion of unexpected capital gains/losses? Compare Table 3, based on Π^{**}, to Table 2, based on Π. In the NCF case the differences are substantial in Agriculture, forestry and fishing. In addition, over the period 2002-2008, excluding unexpected revaluations from profit implied lowering net-cash flow based MFP growth for the commercial sector with 1.3 percentage point (from 9.50 to 8.20).

[Table 3]

Finally, in Figure 3 the profitability decomposition shown by equation (6) is presented. We see the cumulative effect of the annual changes in profitability, MFP, and price recovery, with 1995 = 100, according to the KLEMS-Y $\Pi \neq 0$ model. Overall, we observe that MFP and profitability increased significantly over the period under consideration; price recovery on the other hand, shows a strong decreasing trend since 2002. These results suggest that the benefits of MFP growth have not only been given to producers but also to consumers via falling output prices.

[Figure 3]

7. *Conclusion*

By considering different input-output concepts, profit definitions and rates of return, it is evident that a unique measure of MFP growth does not really exist and choices have to be made. The recent economic reality shows us that the neoclassical assumption of zero profit may be too restrictive so that some models could be eliminated; still, a wide array of possibilities still exist.

The aim of this paper has been to provide more insight into MFP measures that can be derived from an accounting framework. More specifically, we have looked at five input-output models for the measurement of productivity change, respectively based on gross output, gross and net value added, and gross and net cash flow, and extended these models with variations in the construction of capital input cost, which in turn lead to differently defined profit concepts. In the net-value-added and net-cash-flow based concepts, time-series depreciation and tax are treated as intermediate input cost components rather than as components of primary input cost. With respect to the measurement of capital input cost, we pay specific attention to the role of endogenous and exogenous interest rates, the treatment of unexpected holding gains/losses, and the utilization ratio of capital. In addition, we looked at the stock versus service concept construction of capital; for the first, only the waiting cost component is retained while the remaining capital input cost components (time series depreciation, revaluation, tax) are added to profit.

While for each of these MFP measures different behavioral assumptions can be justified, we also provided some discussion on the usefulness and how these measures can be interpreted. The choice of internal versus external rate of returns can be evaluated on the basis of economic reality. On the other hand, each of various input-output concepts of MFP growth has a different interpretation and the choice of measurement depends on the purpose of the analysis. For instance, the gross output measure relates to the productivity of production related inputs and outputs, the value-added measure relates to an income concept and cash flows look at the productivity of capital.

Also central to the analysis of this paper is a comparison of the 46 MFP growth measures on actual Netherlands' data. Most important is the availability of detailed national accounts data. Especially the capital data need to be accurate and detailed in order to make useful inferences on the importance of profit (non-neoclassical assumptions). The application to nine sectors of manufacturing and services for the period 1995-2008 showed that

- Differences between nonzero-profit and zero-profit based MFP measures are small as far as average growth rates are concerned. The direction of the differences is variable.
- The MFP change percentages increase in absolute value when one moves from the gross-output concept to the net-cash-flow concept.
- MFP change varies among sectors. Generally, the exclusion of unanticipated revaluations matters very little.
- MFP and profitability increased significantly over the period under consideration; price recovery showed a strong decreasing trend.

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RESULTS

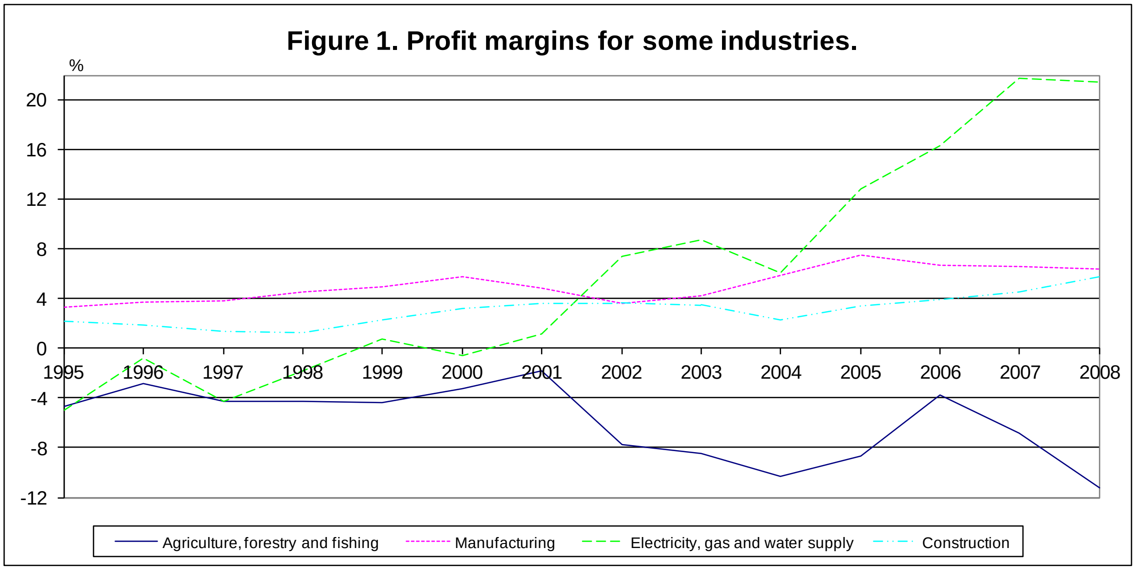
Figure 1. Profit margins for some industries.
%
20
16
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8
4
0
-4
-8
-12
1995
1996
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Agriculture, forestry and fishing
Manufacturing
Electricity, gas and water supply
Construction

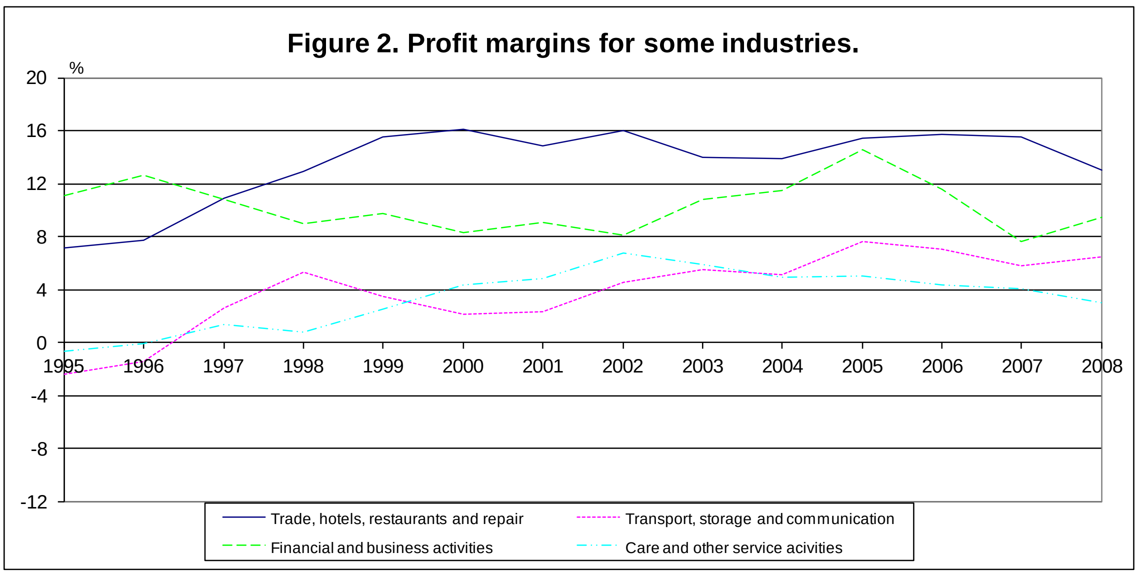
Figure 2. Profit margins for some industries.
%
20
16
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1995
1996
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2000
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2002
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2004
2005
2006
2007
2008
Trade, hotels, restaurants and repair
Transport, storage and communication
Financial and business activities
Care and other service acivities

Table 1. MFP in manufacturing industry 1996/2008

Model	Π		Π^{*}		Π^{**}		Π^{***}		Π^{****}	
	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$
KLEMS-Y	0.74	0.76	0.77	0.78	0.77	0.79	0.79	0.81	0.83	0.84
KL-VA	2.43	2.27	2.57	2.44	2.56	2.38	2.69	2.53	3.05	2.76
KL-NVA	2.82	2.56	2.89	2.68	2.89	2.69	2.93	2.80	-	-
K-CF	5.87	6.12	6.10	6.35	6.20	6.34	6.44	6.57	7.70	7.02
K-NCF	9.12	8.89	9.36	9.12	8.84	9.27	9.93	9.50	-	-

Absolute average annual differences between model Pi-1 exogenous and rest

Model	Π		Π^{*}		Π^{**}		Π^{***}		Π^{****}	
	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$	$\neq 0$	$= 0$
KLEMS-Y		0.07	0.08	0.07	0.03	0.07	0.09	0.08	0.15	0.13
KL-VA		0.17	0.24	0.32	0.13	0.13	0.31	0.33	0.63	0.41
KL-NVA		0.26	0.14	0.24	0.09	0.17	0.18	0.24	-	-
K-CF		0.39	0.97	1.07	0.33	0.56	1.00	1.20	2.31	1.51
K-NCF		0.33	1.00	1.02	0.46	0.52	1.56	1.15	-	-

Table 2. MFP change using different models.

	Exogenous model			Differences with endogenous model		
	1996/2001	2002/2008	1996/2008	1996/2001	2002/2008	1996/2008
	%			*percentage point*		
Gross output based MFP						
Agriculture, forestry and fishing	-0.45	0.92	0.29	0.02	-0.09	-0.04
Mining and quarrying	-2.29	-1.15	-1.68	-1.05	-1.45	-1.27
Manufacturing	0.71	0.77	0.74	-0.02	-0.01	-0.01
Electricity, gas and water supply	0.27	1.28	0.81	0.00	-0.23	-0.12
Construction	-0.35	0.32	0.01	0.03	-0.01	0.01
Trade, hotels, restaurants and repair	1.50	1.53	1.51	-0.12	-0.05	-0.08
Transport, storage and communication	1.77	1.76	1.76	0.08	-0.14	-0.04
Financial and business activities [1]	-0.18	1.16	0.54	0.04	-0.37	-0.18
Care and other service activities[2]	-0.25	0.03	-0.10	-0.04	0.06	0.01
Commercial sector	0.67	1.18	0.94	0.07	-0.14	-0.04
Value added based MFP						
Agriculture, forestry and fishing	-0.93	1.78	0.52	0.03	-0.30	-0.14
Mining and quarrying	-1.71	0.47	-0.54	-0.11	0.14	0.02
Manufacturing	2.29	2.56	2.43	0.11	0.21	0.16
Electricity, gas and water supply	0.77	3.94	2.46	-0.04	-0.19	-0.12
Construction	-0.76	0.74	0.05	0.08	0.04	0.06
Trade, hotels, restaurants and repair	2.84	2.67	2.75	0.09	-0.01	0.04
Transport, storage and communication	3.43	3.51	3.47	0.21	-0.19	-0.01
Financial and business activities [1]	-0.16	1.66	0.81	0.16	-0.54	-0.21
Care and other service activities[2]	-0.36	0.04	-0.14	-0.04	0.09	0.03
Commercial sector	1.07	1.76	1.44	0.18	-0.15	0.00
Net value added based MFP						
Agriculture, forestry and fishing	-1.00	2.29	0.76	0.06	-0.59	-0.29
Mining and quarrying	-1.25	0.99	-0.05	0.43	0.62	0.53
Manufacturing	2.64	2.97	2.82	0.21	0.30	0.26
Electricity, gas and water supply	0.66	4.95	2.95	-0.11	-0.18	-0.15
Construction	-0.78	0.78	0.06	0.10	0.05	0.08
Trade, hotels, restaurants and repair	3.25	2.99	3.11	0.21	0.05	0.12
Transport, storage and communication	4.23	4.36	4.30	0.31	-0.19	0.04
Financial and business activities [1]	-0.03	1.85	0.97	0.32	-0.55	-0.14
Care and other service activities[2]	-0.39	0.05	-0.15	-0.04	0.09	0.03
Commercial sector	1.28	2.06	1.70	0.20	-0.10	0.04
Cashflow based MFP						
Agriculture, forestry and fishing	-3.12	8.53	2.99	-0.04	0.64	0.31
Mining and quarrying	-2.37	-0.06	-1.13	-0.63	-0.41	-0.51
Manufacturing	5.46	6.22	5.87	-0.55	0.01	-0.25
Electricity, gas and water supply	1.23	5.38	3.44	0.04	-0.13	-0.05
Construction	-6.32	4.14	-0.83	-0.74	-0.35	-0.54
Trade, hotels, restaurants and repair	7.52	7.02	7.25	-1.58	-0.87	-1.19
Transport, storage and communication	8.29	7.88	8.07	0.27	-0.69	-0.25
Financial and business activities [1]	-3.49	6.57	1.81	-2.05	-2.23	-2.14
Care and other service activities[2]	-2.05	0.18	-0.86	-0.31	0.32	0.03
Commercial sector	2.52	5.09	3.89	-0.51	-0.76	-0.64
Net cashflow based MFP						
Agriculture, forestry and fishing	-1.04			0.00		
Mining and quarrying	-1.83	0.39	-0.64	0.01	0.00	0.00
Manufacturing	8.48	9.67	9.12	-0.03	0.46	0.23
Electricity, gas and water supply	1.00	7.33	4.36	0.00	-0.24	-0.13
Construction	-9.18	6.55	-1.02	0.01	-0.04	-0.02
Trade, hotels, restaurants and repair	13.11	10.50	11.70	-0.25	-0.20	-0.22
Transport, storage and communication	15.58	14.15	14.80	0.97	-1.02	-0.11
Financial and business activities [1]	-0.41	13.82	7.02	1.72	0.64	1.18
Care and other service activities[2]	-3.57	0.32	-1.49	-0.23	0.53	0.17
Commercial sector	5.06	9.50	7.42	0.59	1.05	0.83

[1] excluding real estate services and renting of movables
[2] excluding private households with employed persons

Table 3. MFP change using different models.

	Exogenous model without holding gains			Differences with endogenous model		
	1996/2001	2002/2008	1996/2008	1996/2001	2002/2008	1996/2008
	%			*percentage point*		
Gross output based MFP						
Agriculture, forestry and fishing	-0.36	0.91	0.32	0.11	-0.10	0.00
Mining and quarrying	-2.37	-1.17	-1.73	-1.13	-1.48	-1.32
Manufacturing	0.76	0.79	0.77	0.03	0.01	0.02
Electricity, gas and water supply	0.33	1.32	0.87	0.07	-0.19	-0.07
Construction	-0.30	0.33	0.04	0.07	0.00	0.03
Trade, hotels, restaurants and repair	1.57	1.55	1.56	-0.04	-0.02	-0.03
Transport, storage and communication	1.82	1.77	1.79	0.13	-0.12	-0.01
Financial and business activities [1]	0.02	1.22	0.67	0.24	-0.31	-0.06
Care and other service activities [2]	-0.19	0.05	-0.06	0.03	0.08	0.06
Commercial sector	0.78	1.21	1.01	0.18	-0.11	0.02
Value added based MFP						
Agriculture, forestry and fishing	-0.74	1.76	0.59	0.22	-0.32	-0.07
Mining and quarrying	-1.72	0.44	-0.56	-0.12	0.11	0.00
Manufacturing	2.48	2.63	2.56	0.30	0.28	0.29
Electricity, gas and water supply	0.98	4.09	2.64	0.16	-0.03	0.06
Construction	-0.65	0.76	0.11	0.19	0.07	0.12
Trade, hotels, restaurants and repair	2.99	2.71	2.84	0.24	0.03	0.13
Transport, storage and communication	3.55	3.54	3.54	0.33	-0.17	0.06
Financial and business activities [1]	0.14	1.75	1.00	0.46	-0.45	-0.02
Care and other service activities [2]	-0.26	0.08	-0.08	0.06	0.12	0.09
Commercial sector	1.24	1.81	1.55	0.35	-0.10	0.11
Net value added based MFP						
Agriculture, forestry and fishing	-0.81	2.25	0.82	0.24	-0.64	-0.22
Mining and quarrying	-1.31	0.98	-0.08	0.36	0.61	0.50
Manufacturing	2.78	2.99	2.89	0.34	0.32	0.33
Electricity, gas and water supply	0.98	4.97	3.11	0.21	-0.16	0.01
Construction	-0.67	0.81	0.12	0.22	0.08	0.14
Trade, hotels, restaurants and repair	3.37	3.02	3.18	0.33	0.08	0.20
Transport, storage and communication	4.30	4.39	4.35	0.38	-0.17	0.09
Financial and business activities [1]	0.25	1.93	1.15	0.60	-0.47	0.03
Care and other service activities [2]	-0.28	0.09	-0.08	0.07	0.14	0.10
Commercial sector	1.43	2.04	1.76	0.35	-0.12	0.10
Cashflow based MFP						
Agriculture, forestry and fishing	-2.71	8.59	3.22	0.37	0.70	0.54
Mining and quarrying	-2.41	-0.07	-1.16	-0.66	-0.42	-0.53
Manufacturing	6.00	6.38	6.20	0.00	0.16	0.09
Electricity, gas and water supply	1.47	5.56	3.65	0.28	0.05	0.16
Construction	-5.46	4.36	-0.29	0.12	-0.14	-0.01
Trade, hotels, restaurants and repair	8.38	7.26	7.77	-0.73	-0.63	-0.68
Transport, storage and communication	8.54	7.95	8.22	0.53	-0.62	-0.09
Financial and business activities [1]	-1.79	7.27	2.99	-0.35	-1.53	-0.96
Care and other service activities [2]	-1.47	0.43	-0.45	0.28	0.57	0.43
Commercial sector	3.19	5.32	4.33	0.16	-0.54	-0.21
Net cashflow based MFP						
Agriculture, forestry and fishing	-9.58			-8.54		
Mining and quarrying	-1.90	0.38	-0.68	-0.06	-0.01	-0.04
Manufacturing	8.43	9.19	8.84	-0.08	-0.02	-0.05
Electricity, gas and water supply	1.46	7.22	4.52	0.46	-0.35	0.04
Construction	-7.39	6.96	0.08	1.81	0.37	1.09
Trade, hotels, restaurants and repair	13.33	10.60	11.85	-0.03	-0.09	-0.07
Transport, storage and communication	14.91	14.18	14.52	0.30	-0.99	-0.39
Financial and business activities [1]	0.93	14.29	7.92	3.06	1.11	2.08
Care and other service activities [2]	-2.51	0.71	-0.79	0.83	0.92	0.88
Commercial sector	5.61	8.20	6.99	1.14	-0.25	0.40

[1] excluding real estate services and renting of movables
[2] excluding private households with employed persons

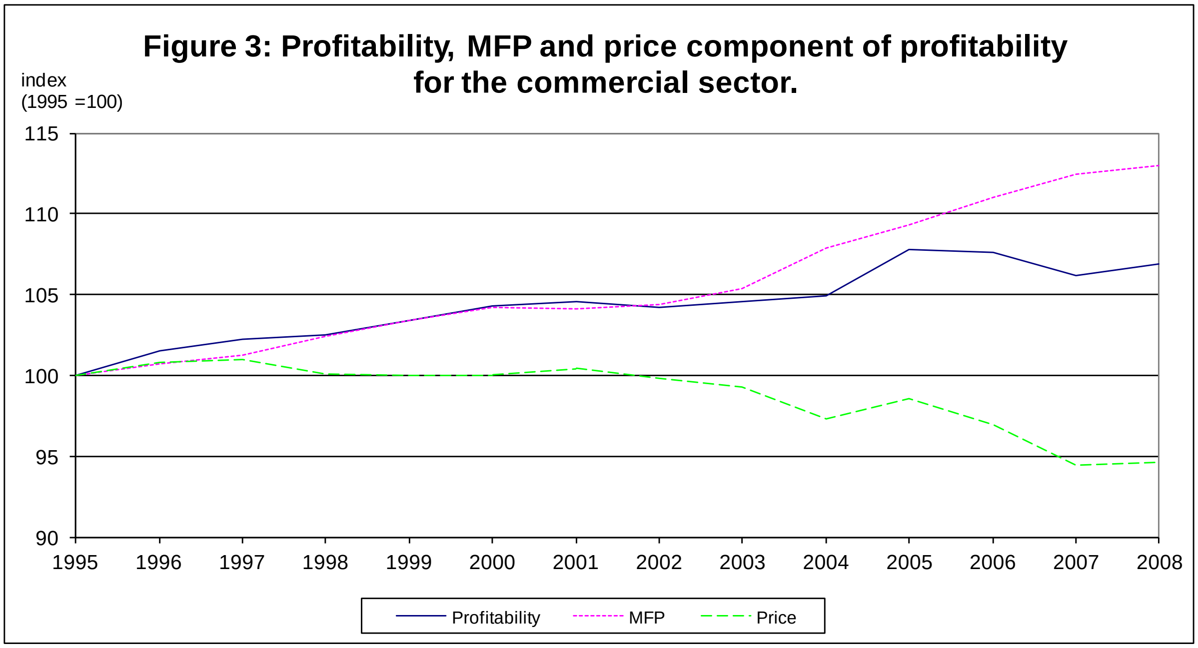

Figure 3: Profitability, MFP and price component of profitability
for the commercial sector.
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(1995 =100)
115
110
105
100
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1995
1996
1997
1998
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2000
2001
2002
2003
2004
2005
2006
2007
2008
Profitability
MFP
Price