the review of income and wealth

Review of Income and Wealth
Series 60, Supplement Issue, November 2014
DOI: 10.1111/roiw.12140

THE DUTCH GROWTH ACCOUNTS: MEASURING PRODUCTIVITY WITH NON-ZERO PROFITS

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Statistics Netherlands

Since 2007 Statistics Netherlands has been publishing multifactor productivity statistics at the macro and industry branch level. Updates of these statistics are annually released in StatLine, the online statistical database of Statistics Netherlands. In contrast to most other growth accounting exercises, the official growth accounts of Statistics Netherlands employ an exogenous rate of return to capital to calculate capital services. As a consequence, in the Dutch Growth Accounts output does not necessarily match total production costs. Supplementary to the exogenous model, Statistics Netherlands also publishes growth accounts based on endogenous rates of return. The aim of this paper is to investigate the effects of scaling up capital measurement on input cost shares, contributions to output growth, and productivity, applying both the exogenous and endogenous models. The results show that endogenous rates of return to capital are less applicable in growth accounts in which the coverage of capital is restricted to fixed assets only. The rates of return to capital converge when expanding the capital inputs with additional assets such as land, inventories, and subsoil assets. But this is not necessarily true for the capital contributions to economic growth. Finally, the capitalization of a wider range of intangible assets, beyond the SNA boundaries, has particularly for the 1995–2001 period a significant effect on the Dutch Growth Accounting results, irrespective of using either an exogenous or an endogenous rate of return to capital.

JEL Codes: E01, E22, O40

Keywords: growth accounts, intellectual property products, productivity, profitability, sensitivity analysis

1. INTRODUCTION

Since 2007 Statistics Netherlands has been publishing KLEMS type (Capital, Labor, Energy, Materials, and Services) multifactor productivity statistics at the macro and industry branch level. The Dutch Growth Accounts are directly extending the Dutch National Accounts, much in accordance with the EU KLEMS approach (cf. O'Mahony and Timmer, 2009). Extending the 2008 System of National Accounts (2008 SNA, European Commission *et al.*, 2009) toward a productivity accounting framework is also explained in detail by Jorgenson and Schreyer (2013). Statistics Netherlands has been anticipating the new 2008 SNA guidelines by measuring capital services and capitalizing R&D expenses inside a

Note: We thank participants of the 32nd International Association for Research in Income and Wealth Conference (Boston, August 5–11, 2012) and the 2nd World-KLEMS Conference (Cambridge, August 9–10, 2012), and two anonymous referees for their valuable comments on this paper. The views expressed in this paper are those of the authors and do not necessarily reflect the policies of Statistics Netherlands.

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growth accounting framework. Updates of the Dutch Growth Accounts are released annually in the StatLine database of Statistics Netherlands.

Regarding fixed asset estimations, Statistics Netherlands follows the integrated approach as advocated in the OECD Handbook on Measuring Capital (OECD, 2001, 2009), which implies measuring simultaneously wealth stocks, productive stocks, consumption of fixed capital, and capital services, based on one perpetual inventory method (van den Bergen *et al*., 2009).

In recent years, the non-financial balance sheets were gradually developed at Statistics Netherlands by adding, next to fixed assets, estimates for inventories, mineral and energy reserves and land.

In more recent years, research also focused on measuring intangible assets, or intellectual property products, beyond the SNA boundaries. Eventually this empirical research carried out for the Netherlands was aligned to the Corrado *et al*. (2009) line of work (cf. van Rooijen-Horsten *et al*., 2008).

The challenges and limitations of capital measurement cautiously led us to refer to the growth accounting residual as multifactor productivity (*mfp*), instead of total factor productivity (*tfp*), change. Facing constrained capital coverage also motivated us to apply an exogenous rate of return to capital in the "official" Dutch Growth Accounts as published by Statistics Netherlands. Growth accounts based on endogenous rates of returns are also published, but for analytical reasons only. In both approaches alike, the resource rents of mineral and energy assets are determined endogenously, after having first estimated the capital services of fixed assets on the basis of exogenous rates of return.

A prudent growth accounting approach is also advocated by those authors reviewing the growth accounting residual from a broader perspective, beyond that of disembodied technical change. Balk (2009) introduces an "input–output" index productivity measurement framework, which does not rely on what he calls a range of "neoclassical" assumptions such as the existence of competitive markets and production functions subject to constant returns to scale. The outcome of his approach is a growth accounting residual that deliberately captures, in addition to disembodied technical change, a range of other efficiency related components such as changes in capacity utilization or possible changes in returns to scale.

By using an exogenously determined return to capital, Schreyer (2010) considers four possible reasons why the gross operating surplus in the national accounts does not necessarily equal the remuneration of (observed) capital inputs: business cycle effects, mark-ups, returns to scale, and unobserved capital inputs. In accordance with Balk's recommendations, he proposes an "apparent" *mfp* measure that is simply the ratio between a volume index of outputs and a volume index of observed inputs. Besides technical change, this "true residual" will possibly include contributions of the above mentioned (unobserved) components.

Basu and Fernald (2001) examine the effects of business cycles on productivity change and show that under conditions of imperfect competition, or frictions in product or factor markets, productivity and technology are not equivalent. The long-run average rates of productivity growth, as often used by economists, ignore the non-technological terms, such as utilization levels and reallocation of inputs, in productivity statistics as measured in a real life world subject to business cycles, frictions, and distortions. Therefore, Basu and Fernald follow an approach in which these market imperfections are explicitly addressed in productivity calculations.

The Dutch Growth Accounts were developed in accordance with the "input–output index approach" or the "apparent" *mfp* calculations as recommended by Balk and Schreyer respectively. This means that *mfp* change is straightforwardly calculated as an output volume change index divided by an input volume change index. As the Dutch Growth Accounts are closely linked to the Dutch national accounts and the economic growth measures for the Netherlands (i.e., the Laspeyres index based volume growth change of GDP), volume changes of inputs and outputs are equally based on Laspeyres volume indexes.

This paper builds on the discussion of using either endogenous or exogenous rates of return to capital, by examining in both models the effects of scaling up capital measurement. As shown by Schreyer (2010), the use of exogenous rates of return to capital leads to a new balancing item in the accounts which he labels as variable M and which in the Dutch Growth Accounts is called "net profits" (Statistics Netherlands, 2008).

(1) $$VA = w_e L_e + GOS.$$

(2) $$GOS = w_s L_s + uK + M.$$

Value added (VA) includes roughly two components, the compensation of employees (w_eL_e), where w_e represents the wage rate and L_e total hours worked, and gross operating surplus (GOS). The latter usually contains an imputed labor income of the self-employed producers (w_sL_s) and the sum of user costs of all observed capital items (uK), where u represents the unit user costs and K the volume of capital services. All remaining unobserved income elements are combined in the new balancing item net profits (M), which is usually positive, but could periodically, particularly in times of economic recession, be negative as well.

Now, ex-post the compensation of capital, or the generated income obtained by capital investors, will by convention equal $GOS - w_sL_s = uK + M$. This simple fact of life clearly heads in the direction of an endogenous rate of return. In contrast, the user cost of capital can also be estimated by way of an ex-ante asset rental price approximation. The latter approach deliberately leaves out all unknown factors as captured by the net profits (M) balancing item. As mentioned, the presence of net profits is a key feature of the Dutch Growth Accounts. Expanding the scope of capital will usually, but not necessarily, lead to a downward adjustment of net profits. However, scaling up capital measurement also has other expected effects on the growth accounts:

- The volume index of capital will change, as growth rates of supplementary stocks will usually differ from those already included in the capital volume growth index.
- Capital cost shares (and index weights) will be adjusted in different ways when using either the exogenous or the endogenous model.

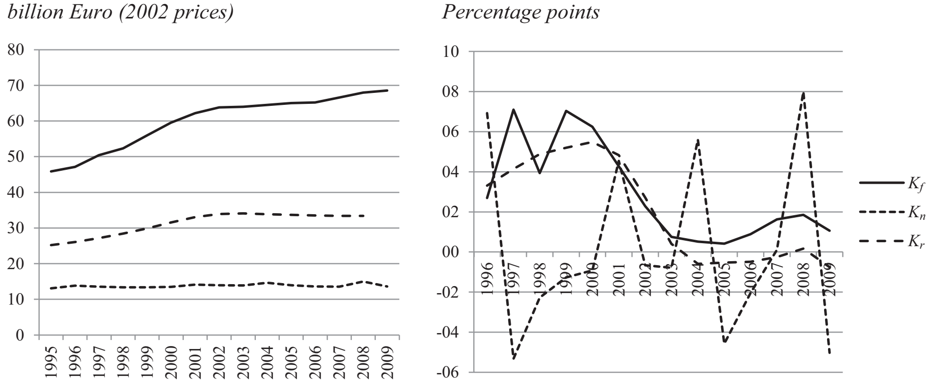

Figure 1. Volume Growth of Capital Services Subdivided by K_f, K_n and K_r in Constant (2002) Euros and in Annual Growth Rates, the Dutch Commercial Sector, 1995–2009

- Obviously, *mfp* changes will be modified (and expectedly be refined).
- Endogenous rates of return to capital will be downwardly adjusted and are generally expected to converge to exogenous rates.

These effects are examined in this paper by introducing in the Dutch Growth Accounts the following capital subsets:

- $K_1 = K_f$
- $K_2 = K_f + K_n$
- $K_3 = K_f + K_n + K_r$

where subscript (*f*) denotes all fixed assets, (*n*) the non-produced assets land and mineral reserves but also inventories, and (*r*) a broader range of intangible assets beyond the SNA asset boundary.

To give a first impression of the order of magnitude of these capital subsets, their size in constant (2002) Euros and their annual growth rates are plotted in Figure 1. These results show a slowdown in growth of K_f and K_r after 2001. Inventories, land, and mineral assets (K_n) do not experience overall growth at all in the examined time period. However, the annual changes in K_n display somewhat erratic movements. One reason is that natural gas extractions are subject to variability in weather conditions. In the Netherlands cold winters will usually lead to higher gas extractions to serve the heating of homes and buildings.

The next section provides a brief overview of the growth accounting framework as developed at Statistics Netherlands. Sections 3 and 4 show the effects of scaling up capital coverage, moving first from K_1 to K_2, and then from K_2 to K_3. Section 5 concludes. Further, Appendix 1 presents a set of tables, showing the growth accounting results at the industry branch level. Appendix 2 provides, in relation to the Dutch Growth Accounts, an overview of methodological papers and references to data sources. The analytical database underlying the calculations in this paper is available upon request.

2. The Dutch Growth Accounts

A rather complete review of the Dutch Growth Accounts is provided by van den Bergen *et al*. (2008). The accounts published annually by Statistics

Netherlands include gross output (KLEMS) based, as well as value added (KL) based, *mfp* estimates. This paper mainly addresses the gross output based growth accounts with a focus on capital measurement. The Dutch Growth Accounts are a direct extension of the annually published supply–use tables in current prices and in prices of the previous years. The chain linked Laspeyres volume indexes used to determine the official GDP volume growth estimates for the Netherlands are equally used in the growth accounts to determine the volume growth of output (X) and of all inputs, capital (K), labor (L), and the intermediate consumption items energy, materials, and services. The latter set of inputs is in this paper represented by variable D. For any particular time period the accounting identity, underlying the Dutch Growth Accounts is the following:

$$(3) \qquad \sum_j p_{i,j} X_{i,j} = \sum_j p_{i,j} D_{i,j} + \sum_l w_{i,l} L_{i,l} + \sum_k u_{i,k} K_{i,k} + M_i.$$

For any particular industry branch (i) the sum of outputs equal the sum of costs (i.e., intermediate inputs, labor inputs, and capital inputs) plus the balancing item net profits. Subscript (j) represents the product groups identified in domestic supply ($X_{i,j}$) and the intermediate use ($D_{i,j}$) of goods and services, (l) reflects the labor categories represented in the growth accounts, and (k) the asset categories. As mentioned, M_i is the residual term that shows up when applying an exogenous rate of return to capital.

The main features of the Dutch Growth Accounts can be summarized as follows. First, productivity measurement is restricted to those industries presented in the supply–use tables for which output volumes are truly independently determined from inputs. Together these industries are represented in what is called the "commercial sector," covering the entire economy excluding general government, real estate activities, renting of movables, and private households with employed persons. At the most detailed level, productivity estimates are published according to NACE Rev.2 including 33 different industries. The supply–use tables include at the most detailed level 219 product groups. The intermediate consumption ($D_{i,j}$) includes both domestically produced as well as imported goods and services. Volume changes in product transactions are straightforwardly obtained from the supply–use tables in prices of the previous year.

Labor volumes are measured by hours worked. At this point in time only two labor categories are distinguished, employees and self-employed, that is, $l \in \{e, s\}$. Jorgenson *et al.* (1987) stress the importance of taking the full heterogeneity of labor input into account in productivity calculations. Research at Statistics Netherlands confirms that a further refinement of labor according to quality classes leads to substantially downward adjusted *mfp*-change estimates for the Netherlands in the period 2001–12 (de Bondt *et al.*, 2014). In other words, upgrading of the Dutch labor force cannot be ignored in productivity statistics, so this is beyond doubt an area for future research at Statistics Netherlands. Total labor input in the Dutch growth accounts includes the compensation of employees ($w_e L_e$) and that part of mixed income that can be attributed to the labor input of the self-employed ($w_s L_s$).

The main focus of this paper is on capital measurement. As already indicated, capital (k) represents three subsets of asset categories, $k \in \{f, n, r\}$. The subset of fixed assets (K_f) is according to the 1993 SNA principles. In addition to well-known tangible fixed asset categories such as dwellings, buildings, other structures, machinery, and transport equipment, K_f also includes the following intangible assets mineral exploration, computer software, and entertainment, literary and artistic originals.

Subset K_n expands the fixed assets with inventories and the non-produced assets land and mineral and energy reserves. Inventories include those of raw and semi-manufactured products, final products, as well as wholesale and retail trade related inventories. The estimates of land include agricultural land, land underlying dwellings, and land underlying non-residential buildings. A few categories of land remain currently uncovered, such as recreational land and land underlying construction areas, as representative prices for these types of land cannot be found at present. The mineral assets include a range of rather low-valued assets such as sand, salt, gravel, clay, peat, and limestone while the energy reserves include natural gas and oil. Regarding Dutch mineral and energy reserves, natural gas is by far the most significant asset in terms of resource rents and wealth stocks. Mining of coal has been economically infeasible ever since the 1970s at which point in time the Dutch coal mines were closed.

Subset K_r moves beyond the 1993, and even the 2008, SNA asset boundaries. One of the significant changes between the 1993 and 2008 versions of the SNA is the capitalization of R&D expenditure. However, Corrado *et al.* (2009) put intangible capital measurement, and their contributions to economic growth, in an even broader perspective by taking into consideration, besides R&D and computer software, non-scientific innovations and economic competencies (brand equity, firm specific human capital, and organizational structures). Following their approach for the Netherlands, K_r represents all assets covering innovative property and economic competencies. It should be noted that these experimental estimates are following up on the 2008 SNA research agenda (A4.52, A4.53) which addresses a possible future expansion of fixed capital measurement toward innovation and marketing related assets.

In accordance with the 2008 SNA (cf. ch. 20) and the OECD handbook on Measuring Capital, the balancing item gross operating surplus in the supply–use tables is assigned to the value of assets according to their use in production. These values represent the implicit capital services obtained by producers from non-financial assets. Equation (2) shows that using an exogenous rate of return to capital usually implies that some fraction of gross operating surplus remains unassigned to capital services. However, occasionally, the sum of capital services may also exceed the gross operating surplus.

The determination of capital services in the Dutch Growth Accounts can be explained by using a "standard" user cost of capital formula, as found in the *Measuring Capital* handbook (OECD, 2009, p. 42):

$$u_{i,k,a}^{t} = p_{k,a}^{t}\left(r_{ex}^{t} - i_{k}^{t} + \delta_{i,k,a}\right). \tag{4}$$

In the Dutch Growth Accounts unit user costs of capital are industry (i), asset type (k), vintage (a), and time (t) specific. The first cost component r_{ex}^{t} represents the return to capital, which is exogenously determined as indicated by subscript *ex*. This rate consists of two parts: the first reflects the internal reference rate between banks, which obviously varies over time. The second element is a risk premium reflecting on average the difference between the intra-bank rate and the average return on corporate bonds. This risk premium is set at 1.5 percentage points irrespective of time.

The second term in the user cost equation reflects the real holding gains of assets which must be subtracted from the user costs of capital. In practice this component is in particular significant for computers due to rapid and continuing computer price declines. The resulting holding losses are added to the capital user costs of computers. Holding gains lead to a decline in unit user costs.

The third term represents the consumption of fixed capital. Obviously, this component is only relevant for estimating the user costs of fixed assets. For mineral and energy resources, this term is replaced by a depletion element. In the Dutch National Accounts, the perpetual inventory method for measuring capital stocks of fixed assets uses vintage specific depreciation rates. In the past these rates were derived from capital stock statistics obtained from the largest companies which provided information on the age of all tangible fixed assets on their balance sheets. Also, discards of assets (and the age at which they are being discarded) were being reported. The Weibull type of mortality distribution functions derived from this information leads, in combination with postulated age–efficiency profiles, to convex type of age specific depreciation rates, reflecting the periodic value loss of assets due to physical deterioration and normal obsolescence (cf. van den Bergen *et al*., 2009, or box 8 in OECD, 2009).

The volume changes in capital services of fixed asset are derived from changes in the gross productive capital stocks (corrected for efficiency losses), as valued in current and previous years' prices.

The user costs of inventories include only the return to capital component, based on the average inventory size in one year. Commodity price fluctuations, particularly those for energy products, complicate the inclusion of holding gains or losses. Volume changes are derived from the changes in the annual average inventory stocks, as measured in current and previous years' prices.

The user costs of land are measured in a similar way, including only a return to capital. In the period 1995–2009, including holding gains on land would generally lead to negative user costs. Reclassification of (relatively low priced) agricultural land to (high priced) land under dwellings and buildings will be reflected as a volume increase in land use.

The capital services of mineral assets equal their resource rents and these are broadly measured in accordance with guidance found in the Environmental-Economic Accounting Central Framework (United Nations *et al*., 2012) and the OECD Capital Measurement handbook. A detailed methodological description on the valuation of Dutch mineral assets is provided by Veldhuizen *et al.* (2009).

Resource rents (RR_r) are estimated following a residual method based on information about the output and operating costs for the extraction industry (cf. figure 13 in OECD, 2009).

$$\sum_r RR_r = GOS - u_{f,ex} K_{f,ex} \tag{5}$$

Subscript r indicates the possible presence of several natural resources (oil and gas) being extracted under one mining operation. It is important that the scope of the variables reflected in equation (5) is strictly limited to extraction activities. Output, production costs, and gross operating surplus from secondary, non-mining, activities must be excluded in order to obtain purely the resource rents. Together with the user costs of fixed assets ($u_{f,ex}K_{f,es}$), mineral exploration and evaluation costs are deducted in the derivation of resource rents. It is important to stress that the residual calculation of resource rents requires using an exogenous rate of return to the fixed assets used in these mining operations. In other words, the estimation of resource rents requires a hybrid exogenous/endogenous user cost approach. As a result net profits will not be measured for the mining industry.

As extraction costs cannot be assigned to individual resources, resource rents for gas and oil are divided according to their corresponding commodity values. To avoid substantive price fluctuations, unit resource rents follow a three-year moving average. The volume changes of capital services obtained from mineral and energy assets strictly follow variations in extraction levels.

Adding K_r practically involves two adjustments in the supply–use tables. First, investments in innovative property and economic competencies on own account must be added to gross output. Under the 1993 SNA rules, this output remains basically unrecorded. Second, purchased items, headed under innovative property and economic competencies, must be reclassified from intermediate consumption to gross fixed capital formation. This capitalization of current expenses merely reflects a shift in recording from the production to the capital account, and as such, a time shift of costs. In the growth accounts, the recording of outlays on these new subsets of intangible assets in terms of investment and revolving capital services should foresee in a better link of inputs and outputs of production with respect to timing. Both types of adjustments lead to an upward correction of the gross operating surplus. All intangible assets headed under K_r are treated as fixed capital and thus, following equation (4), related capital services include all three user cost components: a return to capital, holding gains, and consumption of fixed capital.

Finally, the taxes minus subsidies on production, which are attributed to capital, are recorded as a separate entry without any attempt to assign them to capital services of specific asset categories. In other words, these taxes do not enter the user cost formula (4). The recording of these taxes in current and previous years' prices is directly obtained from the supply–use tables.

For any particular industry, the Laspeyres capital volume index used in the Dutch Growth Accounts is as follows:

$$\dot{K}^t = \frac{\sum_k \sum_a u_{k,a}^{t-1} K_{k,a}^t + T_{t-1}^t}{\sum_k \sum_a u_{k,a}^{t-1} K_{k,a}^{t-1} + T_{t-1}^{t-1}}. \tag{6}$$

TABLE 1
Main Effects of Capital Extension, from K_1 to K_2, on the Dutch Growth Accounts, the Dutch Commercial Sector, 1995–2009

	K_1 Exogenous	K_1 Endogenous	K_2 Exogenous	K_2 Endogenous
			%	
Mfp-growth*	0.76	0.78	0.81	0.77
Contributions of capital to growth*	0.44	0.54	0.43	0.55
Total capital cost shares	0.12–0.18	0.22–0.24	0.16–0.21	0.22–0.24
Returns to capital	2.4–4.8	9.3–17.3	2.4–4.8	6.1–10.0
Net profit shares to output	6–12	0	2–9	0

*Annual averages, geometric means.

As mentioned, the taxes are a separate entry in the capital volume index. Variable T_{t-1}^{t} in equation (6) denotes capital related taxes on production in the current year (t), but expressed in previous year's ($t-1$) tax rates.

3. Introducing Inventories, Land, and Mineral and Energy Reserves in the Dutch Growth Accounts

This section presents the extension of capital measurement in the Dutch Growth accounts by introducing, in addition to fixed assets, inventories, land, and mineral and energy reserves. The subset K_2 represents the coverage of capital as found in the regularly published Dutch Growth Accounts. A number of key outcomes are summarized in Table 1.

A first, rather striking, result is the apparent "robustness" of the average *mfp* measures in terms of selecting one out of four growth accounting set-ups. Moving either from K_1 to K_2, or from an exogenous to an endogenous rate of return to capital, does not seem to affect the average annual *mfp* growth rates very much. A similar picture emerges when looking at the contributions of capital to output growth. Moving from one model to another may lead to changes of roughly a tenth of a percentage point, but not more. With an exception of the mining and quarrying industry, similar outcomes are found when examining these model choices at the industry branch level. One may almost conclude that completing the coverage of capital in addition to fixed assets is not quite worth the effort.

But this would indeed be a hasty conclusion. It appears that the effects of a model choice are examined in a period of time in which the Netherlands experienced a real estate bubble that came to a burst by the end of 2008. In the national accounts, the effects of rising real estate prices are reflected in the price of land, and this leads for land to increasing user costs, which surpass the user cost increases of other asset categories. In addition, this time period is characterized by rapidly increasing energy prices. These cost effects appear to have had a significant effect on the capital contributions to economic growth, and thus on *mfp* change. This effect could be isolated as follows, using the exogenous model:

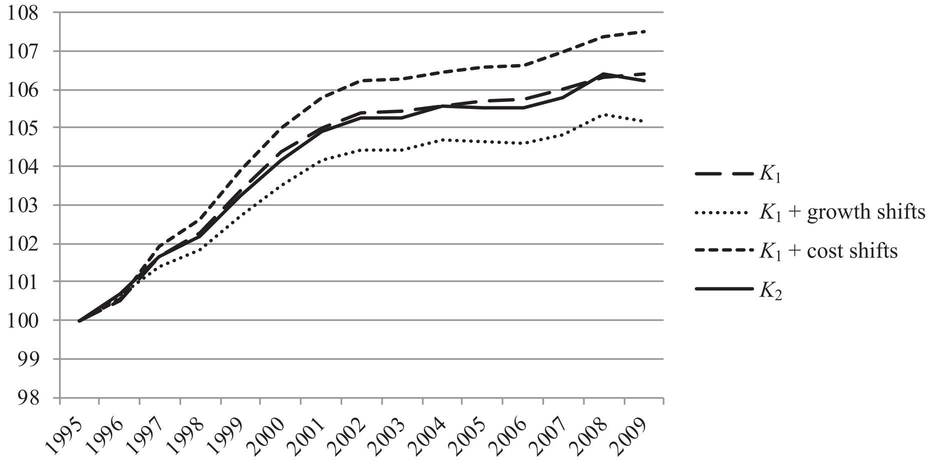

Figure 2. Contributions of Capital to Economic Growth, Separating Growth Shift and Cost Shift Effects when Moving from K_1 to K_2 in the Exogenous Model, the Dutch Commercial Sector, 1995–2009

$$\dot{u}'_{ex,2}\dot{K}_{ex,2} - \dot{u}'_{ex,1}\dot{K}_{ex,1} = \dot{u}'_{ex,1}\Delta\dot{K}_{ex} + \Delta\dot{u}'_{ex}\dot{K}_{ex,2}, \text{ or,}$$
$$= \dot{u}'_{ex,2}\Delta\dot{K}_{ex} + \Delta\dot{u}'_{ex}\dot{K}_{ex,1}$$

where $\dot{u}'$ represents for the commercial sector, or a particular industry branch, the annual change in capital user costs as shares of total input costs (intermediate consumption, labor costs, and user costs of capital), and $\dot{K}$ indicates the annual rate of overall change in capital stock measured in volume terms. Subscript *ex* indicates the use of an exogenous rate of return to capital in the capital user costs and in the capital volume indexes, while subscripts 1, 2 indicate the use of either K_1 or K_2 in the overall capital stock volume index. Further, $\Delta\dot{K}_{ex} = \dot{K}_{ex,2} - \dot{K}_{ex,1}$ and $\Delta\dot{u}'_{ex} = \dot{u}'_{ex,2} - \dot{u}'_{ex,1}$. Taking the average of these two "closed" decomposition forms one obtains:

$$(7) \qquad \dot{u}'_{ex,2}\dot{K}_{ex,2} - \dot{u}'_{ex,1}\dot{K}_{ex,1} = 0.5\Delta\dot{u}'_{ex}\left(\dot{K}_{ex,1} + \dot{K}_{ex,2}\right) + 0.5\left(\dot{u}'_{ex,1} + \dot{u}'_{ex,2}\right)\Delta\dot{K}_{ex}.$$

In other words, in the exogenous model scaling up capital measurement from K_1 to K_2 embodies two effects:

- Changes in shares of capital costs relative to total production costs, $= 0.5\Delta\dot{u}'_{ex}\left(\dot{K}_{ex,1} + \dot{K}_{ex,2}\right)$.
- Changes in the average growth paths of capital stocks, $= 0.5\left(\dot{u}'_{ex,1} + \dot{u}'_{ex,2}\right)\Delta\dot{K}_{ex}$.

The magnitude of each of these two effects, as estimated for the 1995–2009 period, is shown in Figure 2. For the whole economy when moving from K_1 to K_2 natural gas extraction and land appears to be dominating the capital expansion in terms of user costs. Overall the individual annual growth rates of land stocks, and gas extractions, are below those of fixed assets. This means that including these natural resources leads to lower contributions of capital to economic growth, and thus to upward adjustment in *mfp* changes. However, the rising energy and real estate prices in the 1995–2009 period clearly had a reverse, *mfp* diminishing, effect. In

TABLE 2

Overview of Effects on Cost Shares and Growth Rates when Moving from K_1 to K_2 in the Endogenous Model, the Dutch Commercial Sector, 1995–2009

	K_1	K_2
	%	
Total capital cost shares	0.22–0.24	0.22–0.24
Cost shares K_f	0.22–0.24	0.16–0.20
Cost shares K_n		0.04–0.06
Average annual capital growth rate	2.4	2.4
Average annual growth rate K_f	2.4	2.7
Average annual growth rate K_n		0.9

1995 natural gas extraction and land use contributed, respectively, less than 8 percent and 5 percent to all user costs of capital. In 2009 these shares were almost 17 percent and 9 percent. On average, both effects appear to phase out each other, resulting in surprisingly similar *mfp* estimates.

These results do not represent a generally expected outcome. Perhaps, an expected outcome is that mineral extraction and land use will usually show growth rates which are below those of the total productive capital stock of fixed assets. In periods of moderate energy and real estate (or land) price increases, this volume effect may surpass price effects, leading overall to a downward adjustment of *mfp* changes when moving from K_1 to K_2.

A decomposition of capital's contributions to growth in weight changes and growth effects is less easily conducted on the basis of an endogenous model. Table 2 shows that in the growth accounting model using endogenous rates of return, the total capital cost shares (u'_{en}), will remain unchanged when moving from $K_{en,1}$ to $K_{en,2}$. However, in this model a re-weighting will occur within the capital volume index, as the return to capital is reallocated over the pre-existing (K_f), and the newly introduced, subsets of asset categories (K_n). When moving from $K_{en,1}$ to $K_{en,2}$, K_f will receive smaller weights in favor of K_n, and this cost shift effect is also indicated in Table 2. It should be noted that the cost shares of K_n increase over time as a result of rising energy and real estate prices.

Perhaps an unexpected effect is the upward adjustment of the average growth rate of K_f by 0.3 percentage points. The redistribution of capital returns affects the weights of individual fixed asset categories as represented by the $\dot{K}_f$ volume index. Overall, this effect reflects a negative correlation between an asset's size in terms of wealth stocks and its average growth rate in volume terms. When moving from K_1 to K_2, large but relatively slow growing assets like infrastructure obtain smaller weights at the benefit of small but rapidly depreciated, and fast growing assets such as computers. It should be noted that the user costs of computers include in addition substantive holding losses. In other words, computers increasingly dominate $\dot{K}_f$ when expanding capital measurement from K_1 to K_2.

Another observation is that, contrary to the exogenous model as used in the Dutch Growth Accounts, endogenous rates of return to capital are industry specific. This somewhat complicates analyzing the effects of capital expansion as the imputed asset rental prices for one particular asset category may differ between industries. An important exception is of course the mining industry where a combined endogenous and exogenous approach is followed.

The magnitude of net profits (M) in the exogenous model (almost 43 billion Euros in 2009 based on K_2) indicates that the total value of capital services differs substantially between the two models. Obviously, moving from K_1 to K_2 leads to a convergence of exogenous and endogenous rates of return to capital. But even then, differences in the size of total capital services remain significant between the exogenous (86 billion Euros) and the endogenous model (129 billion Euros).

A few observations could be made when examining the results at industry branch level. Over the whole 1995–2009 period, the returns to capital in "agriculture, forestry, and fishing" are quite low. Endogenous rates are below the exogenously determined ones, indicating structural negative net profits. For 2009, adding land results in doubling the value of capital services and thus a further fall in net profits. In the Netherlands, agriculture is a rather heterogeneous industry branch including, besides the more traditional farming activities, rather high-tech and capital intensive greenhouse based horticulture. Using the K_2 based exogenous model, annual productivity gains are on average 0.62 percent, which is just below those of the commercial sector as a whole (0.79 percent). Overall, these results may indicate measurement complexities regarding a representative imputed labor income of the self-employed agricultural workers (currently this income may be overstated) or the precise demarcation of the productive and consumptive use of capital goods or consumer durables (e.g., land, motor vehicles). So this is clearly an issue for further research.

Measuring *mfp* change in the mining and quarrying industry based on fixed capital only is quite troublesome. In the Netherlands, mining is characterized by substantive (fixed) capital deepening. Without considering movements in resource extractions, mining faces unrealistic *mfp* declines. However, it should be stressed that in the observed 1995–2009 period, besides productivity gains, mining profits are also fed by favorable energy price developments relative to input prices. The K_n expansion leads to a total sum of capital services that is almost five times higher (reference year 2009, using the exogenous model), which stresses the significance of resource rents in the production costs of the mining industry.

"Trade, hotels, restaurants, and repair" is a third industry branch where the introduction of K_n, inventories in particular, leads to a substantial rise, of 22 percent in 1995 and of 34 percent in 2009, in the sum of capital services. However, overall capital shares in total production costs are relatively small (on average just above 10 percent) and the volume growth rates of inventories appear to be comparable to those of K_1. Surprisingly, in the endogenous model adding inventories leads to a substantially higher capital growth index which again reflects the reallocation effects of capital returns, from relatively slow growing, to faster growing, asset stocks, particularly in those industries obtaining relatively large net profits.

One may conclude that in the exogenous growth accounting model the capital expansion is accounted for in a rather transparent way, particularly because the pre-existing capital index $\dot{K}_1$ remains unaltered. The endogenous model does not have this property, due to the redistribution of capital returns when adding new asset categories, which makes it less easy to detect the effects of capital expansion in this particular growth accounting framework.

4. Introducing Intangible Assets Beyond the 1993 (and 2008) SNA Boundaries

Unfortunately, estimates at the industry branch level of the supplementary intangible assets "innovative property" and "organizational structures" are restricted to the period 1996–2007. For the commercial sector, a provisional estimate is also available for 2008. In Section 2 it was explained that the introduction of these intangible assets in the accounts leads to an upward adjustment of output and a downward adjustment of intermediate consumption. The resulting increase in gross operating surplus represents approximately the capital services of these newly introduced capital items. Using an exogenous model, the adjustments in the growth accounting identity can be summarized as follows:

$$M_{K_3} = I_r - u_r K_r + M_{K_2} \tag{8}$$

where $M_{K_{2,3}}$ denotes the net profits in the K_2 and K_3 based growth accounts, respectively, I_r gross fixed capital formation in the supplementary intangible assets, and $u_r K_r$ the related capital services.

The adjustments in net profits are for three years reflected in Table 3. Adjustments in gross fixed capital formation and capital services are of a similar order of magnitude which leads overall to relatively small adjustments in net profits. The table shows that the capitalization of purchased assets, previously recorded as intermediate consumption, is relatively small compared to own account investment. It should be mentioned that these adjustments in intermediate consumption are provisional as research in intangible assets put new light on the underlying data sources. In particular, the recording of R&D expenditure will be modified substantially in the cause of the upcoming 2008 SNA revision. It should be noted that intangible (and tangible) investment reached a peak in 2001 followed by a gradual declining trend in more recent years. This development is in line with other investments which also show less prosperous developments in the period following 2001.

TABLE 3

Adjustments in Net Profits when Moving from K_2 to K_3 in the Exogenous Model, the Dutch Commercial Sector, 1995–2008

	1995	*2001*	2008	1995	2001	2008
	million Euros			*As percentage of output (based on K_3)*		
M_{K_2}	7,233	30,202	42,069	2.2	6.2	6.4
Gross fixed capital formation (I_r)	21,119	33,595	38,074	6.3	6.8	5.8
On own account	18,404	28,182	32,318	5.5	5.7	4.9
Purchased	2,715	5,413	5,756	0.8	1.1	0.9
Capital services ($u_r K_r$) (–)	–21,988	–31,902	–41,430	–6.6	–6.5	–6.3
M_{K_3}	6,364	31,895	38,713	1.9	6.5	5.8

TABLE 4

Main Effects of Capital Extension, from K_2 to K_3, on the Dutch Growth Accounts, the Dutch Commercial Sector, 1995–2008

	K_2 Exogenous	K_2 Endogenous	K_3 Exogenous	K_3 Endogenous
			%	
Output growth*	3.13	3.13	3.04	3.04
Contributions to growth				
Intermediate Consumption*	1.04	0.98	0.95	0.90
Labour*	0.60	0.56	0.56	0.53
Capital*	0.48	0.60	0.60	0.72
Mfp*	1.02	0.99	0.93	0.90
Total capital cost shares	16–21	22–24	22–26	28–29
Returns to capital	2.4–4.8	6.1–10.0	2.4–4.8	4.9–7.2
Net profit shares to output	2–9	0	2–9	0

*Annual averages, geometric means.

The exogenous model shows a declining trend in total capital costs shares. These findings are in line with the declining investments–GDP shares observed for the Netherlands (Centraal Planbureau, 2014) over a longer period of time. This effect is partly a price effect, resulting from relatively high investment price deflators, particularly those of computers, respective to GDP price developments.

Table 4 shows that the exogenous and endogenous rates of return to capital further converge when moving from K_2 to K_3. The downward adjustments in the endogenous rates of return clearly result from the upward adjustments in capital stocks after intangible asset capitalization.

Otherwise the overall effects of introducing the supplementary intangible assets in the Dutch Growth Accounts are perhaps somewhat disappointing, particularly when comparing these results with the findings of Corrado *et al.* (2009), cf. Table 4. However, it should be emphasized that their results are not entirely comparable to those presented in Table 4, as K_r only covers the intangibles that remain presently unrecorded in the standard national accounts. This means, for example, that computer software is already included in K_2.

However, splitting the results into two time intervals, 1996–2001 versus 2001–08, as shown in Table 5, reveals a different picture. The 1995–2001 period, occasionally identified as the dot.com bubble, shows a much greater capital deepening than observed in the subsequent 2001–08 period. This effect becomes even stronger when taking K_r into measurement. The results suggest that new information technology applications and intangible capital investments are, at least to some extent, complementary. The results also indicate that the productivity gains were particularly obtained in the period following the burst of the dot.com bubble.

Van Rooijen-Horsten *et al.* (2008) compare more closely the results for the Netherlands with those of Corrado *et al.* for the U.S., but come nevertheless to similar conclusions. Contrary to findings for the U.S., in the Netherlands capitalizing intangibles hardly leads to a downward adjustment of *mfp*.

The results for the Netherlands indicate that the capital indexes $\dot{K}_{ex,2}$, $\dot{K}_{en,2}$, $\dot{K}_{ex,3}$ and $\dot{K}_{en,3}$ all move in a close range of each other: in the 1995–2008 period

TABLE 5
Main Effects of Capital Extension, from K_2 to K_3, Split into Two Time Intervals, 1996–2001 versus 2001–08, Based on the Exogenous Model, the Dutch Commercial Sector

	K_2		K_3	
	1996–2001	2001–2008	1996–2001	2001–2008
		%		
Output growth	4.33	2.12	4.32	1.96
Contributions to growth				
Intermediate Consumption	1.68	0.51	1.49	0.49
Labour	1.09	0.18	1.02	0.17
Capital	0.80	0.20	1.07	0.21
Mfp	0.77	1.24	0.74	1.10

Annual averages, geometric means.

the average annual growth rates of each of these capital stocks range from 2.5 to 2.7 percentage points. Certainly this does not mean that intangible capital plays an insignificant role in the Dutch economy. When looking at the commercial sector, van Rooijen-Horsten *et al.* show that in more recent years tangible and intangible investments in current prices reach similar levels. Intangible capital plays a significant role in most industry branches represented in the commercial sector, with the exception of "agriculture, forestry and fishing," "mining and quarrying," and "electricity, gas, and water supply." In particular the financial and business services sector relies heavily on intangible capital, particularly economic competencies. In this industry branch, moving from K_2 to K_3 entails in the more recent years a doubling of capital services.

5. Conclusions

In this paper we investigated the effects of scaling up capital measurement in the Dutch Growth Accounts, examining the 1996–2009 time period and applying both exogenous and endogenous rates of return to capital. Generally, one may conclude that *mfp* estimates are not very sensitive to using either endogenous or exogenous rates. However, analyzing the effects of expanding capital measurement is somewhat easier in an exogenous growth model, as the effects of adjusted growth rates and costs shares can be quantified in a rather transparent way. In the endogenous model the reallocation of capital returns may lead to unexpected weighting effects of pre-existing assets in the capital growth index. At the availability of fixed assets only, we recommend using an exogenous rate of return to capital, particularly because such *mfp* estimates will usually be partial, resulting in overestimated capital returns and capital cost shares when applying an endogenous model.

At first impression, scaling up capital measurement from K_1 to K_2 does not lead to a very different picture when looking at the growth accounts of the Dutch Commercial sector as a whole. However, a decomposition of cost shift and growth shift effects shows that the capital services of land and mineral reserves have below average growth rates. Yet, rapidly growing land and energy prices, relative to overall asset price developments, lead to rising contributions to growth which fully compensate for these dampening growth effects when adding this new subset of assets in the overall capital services volume index.

For specific industry branches such as mining and trading, *mfp* estimates are rather meaningless without taking into consideration either mineral assets or inventories.

The contributions to growth of intangible assets (beyond the SNA scope) become predominantly apparent when examining separately the time intervals 1996–2001 versus 2001–08. The results show that the introduction of these intangible assets further amplifies the relatively strong capital deepening characterizing the 1996–2001 dot.com bubble period. For the more recent years, estimates for the Netherlands show that in current value terms intangible investment has reached similar levels as tangible investment.

The following recommendations for further research could be made. We persist in our preference for using an exogenous rate of return to capital in the "official" Dutch Growth Accounts. The balancing item "net profits" reflects, as indicated by Schreyer (2010), a wider range of unmeasured factors. However, the calculations of endogenous rates of return are helpful in assessing exogenous rates, particularly the branch specific (risk) premiums. This is clearly an area for future research.

The net profits (or endogenous returns to capital) provide an indication of the quality of the capital estimates, and of the national accounts and growth accounts more broadly. For example, the structural negative net profits encountered in the "agriculture, forestry, and fishing" industry indicate that a refinement is needed in the assessment of productive capital stocks (land and fixed assets). Some assets may partly be used for consumptive purposes which should be eliminated from the capital services estimates.

Due to missing representative land prices, at present a small number of minor land categories, such as land underlying construction and recreational land, remain uncovered in the Dutch balance sheets. This is another area for future research.

Following 2008 SNA and the European System of Accounts 2010 (Eurostat, 2013) guidance, Statistics Netherlands investigated the possible estimation of additional assets such as "valuables," "contracts, leases, and licenses," and "purchased goodwill and marketing assets" (cf. Cheung *et al.*, 2013). However, this research is not expected to lead on short notice to further extensions of the Dutch balance sheets.

In the Netherlands, research in intangible assets had a temporary character, covering estimates for the period 1995–2008 only. Nevertheless, one prolonged result is the measurement of R&D investment which will become part of the Dutch National Accounts after the ESA 2010 revision (publication is scheduled in the summer of 2014). The broadening of fixed assets in the direction of innovation and marketing is on the 2008 SNA research agenda, so this may trigger further research in the coming years.

Last but not least, the contributions to economic growth of labor quality shifts represent at present an important omission in the Dutch Growth Accounts. It is expected that this omission will be overcome in the new set-up of the Dutch Growth Accounts, in response to the national accounts revision in 2014.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix 1: Overview of Tables

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Table A.2: Growth accounts by industry, based on the K_1—endogenous model, average annual changes, The Netherlands, 1995–2009
Table A.3: Growth accounts by industry, based on the K_2—exogenous model, average annual changes, The Netherlands, 1995–2009
Table A.4: Growth accounts by industry, based on the K_2—endogenous model, average annual changes, The Netherlands, 1995–2009
Table A.5: Growth accounts by industry, based on the K_3—exogenous model, average annual changes, The Netherlands, 1995–2007
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