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Current Price Identities in Macroeconomic Models:

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Abstract

This paper deals with the problem of maintaining consistency in the book-keeping identities at current prices of disaggregated macroeconomic models such as input-output models, even if the quantity and price relations linking supply and demand in the models contain error terms. Several possible solutions are proposed. Some of them have been implemented in the danish macroeconometric model ADAM used by the treasury, and the experience gained from such current use is reported.

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Key words: input-output, macroeconomic model, identities

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Contents

1. Introduction

This paper deals with the problem of maintaining consistency in the book-keeping identities at current prices of disaggregated macroeconomic models such as input-output models, even if the quantity and price relations linking supply and demand in the models contain error terms. Several possible solutions are proposed. Some of them have been implemented in the danish macroeconometric model ADAM used by the treasury, and the experience gained from such current use is reported.

The problem

Almost every macroeconomic model contains the well-known equilibrium condition linking aggregated supply and demand quantities

$$Y + M = C + I + E$$

In practice, input-output coefficients are used to provide more detail in the determination of supply components, using

$$Y = a_{YC}C + a_{YI}I + a_{YE}E \qquad (1)$$
$$M = a_{MC}C + a_{MI}I + a_{ME}E \qquad (2)$$

where $a_{Yj}+a_{Mj}=1$, $j=C,I,E$ (this restriction on the coefficients ensures that (1) and (2) implies the aggregated condition).

The coefficients a_{ij} can be fixed at a base year value, in which case (1) and (2) will contain an error term (in other years than the base year), or they can be time series of observed coefficients, in which case (1) and (2) are book-keeping identities containing no error term. For the purposes in the main text of this paper the latter interpretation is sufficient.[2]

In a dual way, the same input-output coefficients are used to determine the prices on demand components from the prices on supply components, using

$$p_C = p_Y a_{YC} + p_M a_{MC} + u_C \qquad (3)$$
$$p_I = p_Y a_{YI} + p_M a_{MI} + u_I \qquad (4)$$
$$p_E = p_Y a_{YE} + p_M a_{ME} + u_E \qquad (5)$$

Error terms are included in (3)-(5) since, in practice, such error terms exist even if time series of observed i-o coefficients are used.

[2]The case where (1) and (2) contains error terms is treated in appendix 1.

It is easily verified from (1)-(5) that if the error terms u_C, u_I, u_E were unrestricted (and nonzero), then the value of aggregated supply would be different from the value of aggregated demand, i. e. that $p_Y Y + p_M M \neq p_C C + p_I I + p_E E$. Thus, the most basic current price identity of the model would be broken.

In the observed national accounts statistics the error terms are, of course, restricted in such a way that the current price identities hold. But in model computations non-zero error terms are likely to generate inconsistencies unless the appropriate restrictions are included in the model equations. This is unfortunate because in practical forecasting it is necessary to specify non-zero error terms in the forecast period to avoid jumps in the prices in the first forecast year.

In this paper we will derive the conditions on the error terms that ensure the current price identities of supply and demand. These restrictions are then used to determine a number of the error terms in the model residually. As an alternative, a technical reformulation involving a general adjustment of demand prices is suggested. We will treat only additive error terms in the main text, since the analysis of this case is simpler; the analogous, but technically more complicated case with multiplicative error terms is treated in appendix 2.

The causes of the problem

The standard asssumption in i-o price models such as (3)-(5) is that all supplies from the same source is at the same price. Thus, for example, the same price p_Y is applied to all supplies from domestic production, no matter whether they are used in category *C*, *I* or *E*. If this assumption actually did hold, there would be no room for error terms in (3)-(5), and our problem would not exist. Unfortunately, it is not likely to hold in practice.

Thus in the simplest i-o and CGE model frameworks, where all parameters are calibrated from a single input-output/SAM matrix in a base year, and where all prices are defined to be equal to 1 in this base year, the problem would not be visible at all in the basic data. However, if we would want to introduce price discrimination in such model calculations, so that e.g export prices would be able to move away from home market prices, the problem could easily show up anyway.

In general, *price discrimination* between different users is a main source of error terms in (3)-(5).

In integrated models, in which a combination of input-output tables and economic time series is used, *aggregation problems* is likely to be an even greater cause of error terms in (3)-(5). In such models, the base year of price index calculations is given by the standards of the available national accounts data set, and we will typically have to use equations like (3)-(5) for years where the price indexes are different from 1. In this case the error terms u_C, u_I, u_E are directly computable from the data bank, and they are extremely unlikely to be zero in such years. Typically, this is because the deflation of the national accounts data is carried out at a much more detailed level than the model computations. In Denmark, for example, the deflation of national accounts are carried out at a level of app. 2750 products, while the i-o tables are published at a level of 130 industries only.[3] Thus, e.g., if the domestic supplies to consumption have a different product composition than the supplies to exports, with respect to the deflation level, then the prices for the two supplies are likely to differ, causing error terms in (3) and (5).

For a practical example, consider the industry ’construction’ which typically supplies ’building maintenance’ for consumption and ’new buildings’ for investment. The two products are deflated using different prices, at least in the danish national accounts, since maintenance contains almost exclusively labour cost, while the cost of materials contributes much more significantly to the total cost of new buildings. Therefore, the price on the supply from construction to consumption tends to grow faster than the price on the supply from construction to investment. The production price on construction is some weighted average of the two, the weights depending primarily on the level of new building investment (since building maintenance is very stable).

In practice, aggregation problems and price discrimination are both extremely likely to be significant causes of error terms in (3)-(5); however, in models based on time series of national accounts data the aggregation problems will probably be the dominating cause, in particular if the base year of fixed price computations is somewhat back in time, and if the aggregation level is so high that the individual product prices within each aggregate are likely to develop differently.

2. Some solutions

The simple solution to the problem of ensuring the aggregated current price identity is to find the necessary constraint on the error terms and then use this constraint to determine one of the error components residually:

> The value of total supply equals the value of total demand for arbitrary exogenous C, I, E, p_M og p_Y if and only if
>
> $$u_C C + u_I I + u_E E = 0$$
>
> i.e. that the error terms in the demand price equations, weighted with the appropriate quantities, must sum to 0.

Proof: The condition that the value of total supply equals the value of total demand is equivalent to

$$p_Y Y + p_M M = p_C C + p_I I + p_E E \qquad (6)$$

[3]See Thage(1986). We have no wish to pick up the question of commodity vs. industry tables in this context, though; even if the "commodity technology" assumption had been used for the published tables, the deflation would almost certainly still be carried out at a much more detailed commodity level than the "characteristic commodities".

$= (p_Y\, a_{YC}+p_M\, a_{MC}+u_C)C\ +\ (p_Y\, a_{YI}+p_M\, a_{MI}+u_I)I\ +\ (p_Y\, a_{YE}+p_M\, a_{ME}+u_E)E \qquad \Leftrightarrow$

$$u_C C+u_I I+u_E E \quad = 0 \tag{7}$$

using (3), (4), (5), (1) and (2).

Please note that the weighting of the error terms in (7) depends on the quantitiy variables *C*, *I* and *E*. If these variables are exogenous in the model, as they are here, the user could easily, by unawareness, specify the error terms in an inconsistent manner. But even worse, such quantities are usually determined endogenously in a wider model context. In any case, the current price identity (6) can be ensured only if one of the error terms is determined as a function of the other error terms using (7). If, for example, we choose the error term on investment for such a residual determination, we get the equation

$$u_I \ = -(u_C C+u_E E)/I \tag{8}$$

This model - equations (1)-(4), (8) - is termed the *simple residual price model*.

In practice, this type of residual determination has the disadvantage that the whole load of the adjustment is placed on a single demand price, in this case p_I. This could be a problem, in particular if many categories of final demand are specified in the model and, therefore, many different developments must be balanced in this single demand price. The model user could easily, by accident or unawareness, generate a peculiar residual price.

Therefore, it could be a practical alternative to specify a general correction of all demand prices. This is done by enhancing (3)-(5) with a general correction term, *u* (defined to be 0 in the historical data set):

$$p_C \ = \ p_Y\, a_{YC} \ + \ p_M\, a_{MC} \ + \ u_C \ + \ u \tag{9}$$
$$p_I \ = \ p_Y\, a_{YI} \ + \ p_M\, a_{MI} \ + \ u_I \ + \ u \tag{10}$$
$$p_E \ = \ p_Y\, a_{YE} \ + \ p_M\, a_{ME} \ + \ u_E \ + \ u \tag{11}$$

In model computations, the general correction term *u* is then determined using the identity (6) so that

$(u_C+u)C+(u_I+u)I+(u_E+u)E=0 \qquad \Leftrightarrow$

$$u \ = -(u_C C+u_I I+u_E E)/(C+I+E) \tag{12}$$

Now, if the user should specify the exogenous error terms u_C, u_I and u_E in such a way that, without the correction (12), it would lead to a violation of the aggregated value identity (6), then the general correction term *u* would automatically adjust all demand prices in the opposite direction to keep (6) fulfilled. On the other hand, the user has to accept that the final correction of a price, e.g. p_C, could be different from the correction that was originally intended when the value of u_C was set.

This model - equations (1), (2), (9)-(12) - is termed the *simple general price correction model*.

More sophisticated corrections of demand prices

It should be noted that, though both the residual and the general price corrections ensures the aggregated identity (6), neither of them is sufficient to guarantee the current price identities for the individual components *Y* and *M* in the model. A closer look at this question requires, however, a more general, i-o type formulation of the model.

Therefore, we reformulate the model (1)-(4) as follows

$$Y = C_Y + I_Y + E_Y \quad (13)$$
$$M = C_M + I_M + E_M \quad (14)$$

where C_Y, C_M, I_Y, I_M, E_Y, E_M are the individual cells of the i-o quantity matrix, determined by the equations

$$C_i = a_{iC}\, C \qquad i=Y,\ M \quad (15)$$
$$I_i = a_{iI}\, I \qquad i=Y,\ M \quad (16)$$
$$E_i = a_{iE}\, E \qquad i=Y,\ M \quad (17)$$

Equations (13)-(17) are, of course, equivalent to (1) and (2).

Likewise, the price equations are reformulated to determine the price of the individual i-o cells, as

$$p_{Yj} = p_Y + u_{Yj} \qquad j=C,\ I,\ E \quad (18)$$
$$p_{Mj} = p_M + u_{Mj} \qquad j=C,\ I,\ E \quad (19)$$

which means that the final demand price equations become identities given by

$$p_C = (p_{YC}C_Y + p_{MC}C_M)/C = p_Y\, a_{YC} + p_M\, a_{MC} + a_{YC}u_{YC} + a_{MC}u_{MC} \quad (20)$$
$$p_I = (p_{YI}\, I_Y + p_{MI}\, I_M)/I = p_Y\, a_{YI} + p_M\, a_{MI} + a_{YI}\, u_{YI} + a_{MI}\, u_{MI} \quad (21)$$
$$p_E = (p_{YE}E_Y + p_{ME}E_M)/E = p_Y\, a_{YE} + p_M\, a_{ME} + a_{YE}u_{YE} + a_{ME}u_{ME} \quad (22)$$

using (15)-(19). The only new feature in this price determination is that the error term u_j in each of equations (3)-(5) is replaced by two "cell-specific" error terms using the relation

$u_j \ = a_{Yj}\, u_{Yj} \ + a_{Mj}\, u_{Mj}$ j=C, I, E (23)

Such "cell-specific" error terms are necessary to ensure that the value of supply is equal to the value of demand for each supply component *Y* and *M*. In the case of *Y* we get that

$$p_Y\, Y \quad = p_{YC}C_Y \ + p_{YI}\, I_Y \ + p_{YE}\, E_Y \tag{24}$$
$$= (p_Y + u_{YC})\ C_Y \ + (p_Y + u_{YI})I_Y \ + (p_Y + u_{YE})E_Y \quad \Leftrightarrow$$

$$u_{YC}C_Y \ + u_{YI}\, I_Y \ + u_{YE}\, E_Y \ = 0 \tag{25}$$

using (18) and (13). This condition is completely analogous to the condition for aggregated consistency, (7), but here it involves only the domestic supplies from *Y*. Of course, a similar condition is required for the imported supplies from *M*.

In general, there will be a condition like (25) for every supply component in the model, which will enable us to determine residually one of the "cell-specific" price error terms of the corresponding row of the i-o table.

This model - (13)-(22), (25) - is termed the *full residual price model*.

Once again we can avoid the residual determination of a "cell-specific" demand price by specifying a general row correction of the prices from each supply component, in analogy with (9)-(11). This means that (18) and (19) is replaced by

$p_{Yj} \ = p_Y + u_{Yj} \ + u_Y$ j=C, I, E (26)
$p_{Mj} \ = p_M \ + u_{Mj} \ + u_M$ j=C, I, E (27)

and that the general correction of the "cell-specific" prices in each row can be found in analogy with (12) as

$$u_Y \ = -(u_{YC}C_Y + u_{YI}\, I_Y + u_{YE}\, E_Y)/Y \tag{28}$$
$$u_M \ = -(u_{MC}C_M + u_{MI}\, I_M + u_{ME}\, E_M)/M \tag{29}$$

This model - (13)-(17), (20)-(22), (26)-(29) - is termed the *full general price correction model*.

Another possibility: Correction of supply prices

The solutions discussed so far have taken the supply prices as given and, therefore, suppressed the effects on aggregated prices from changes in the composition of demand. Such a suppression has the advantage that the economic properties of any determination of supply prices in a wider model context are unchanged, such as e.g. homogeneity with respect to total cost.

On the other hand, in some situations it could be desirable to allow the effects from a change in demand composition to change aggregated supply prices. This would, of course, require that the error terms of demand price equations had a clear interpretation as caused by price discrimination, rather than by unspecified aggregation problems with no clear interpretation. The best example is probably that the we could want to model export prices differently from the home market prices. If competition is harder on the export market, the prices are likely to be lower, and a shift e.g. from home market supplies to export supplies would therefore decrease the aggregated production price.

Though such effects from demand composition to supply prices does not fit very well into the model they could be accounted for by using the unmodified equations (1)-(6) and then, subsequently, define a modified p_Y to ensure (6). A similar procedure could be applied to each supply component using (13)-(22). They would, however, imply that the error terms in demand prices could be explained only by differences in the "mark-up" on different markets. Ideally, the original supply prices should then reflect marginal cost only, not profits. In a wider model context, the operating surplus of industries should be adjusted to conform with the modified prices.

Working with current price cells only

An apparently more radical solution would be to use current price i-o tables only, ignoring the information of fixed price i-o coefficients. This would mean that the model (13)-(22) should be reformulated to use a current price i-o table only, i. e. (using prefix *v* to denote current price i-o cells)

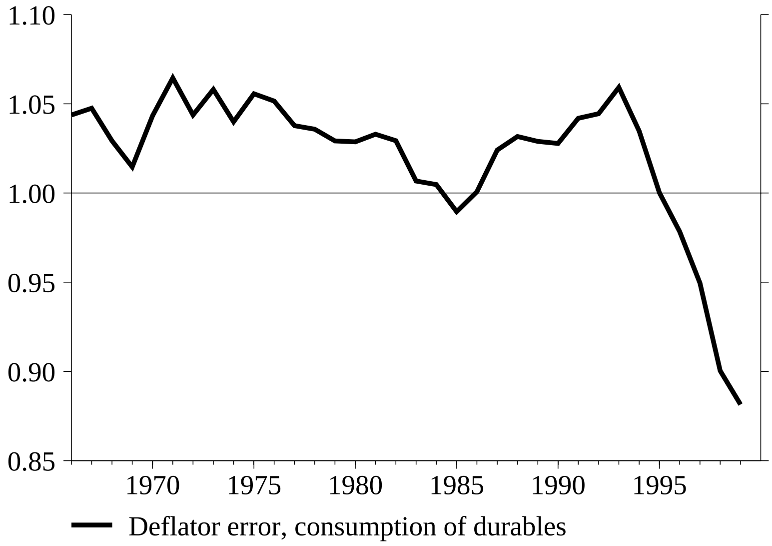
$$Y = (vC_Y + vI_Y + vE_Y)/p_Y \qquad (30)$$
$$M = (vC_M + vI_M + vE_M)/p_M \qquad (31)$$
$$vC_i = p_{iC}a_{iC}\ C \qquad \text{i=Y, M} \qquad (32)$$
$$vI_i = p_{iI}a_{iI}\ I \qquad \text{i=Y, M} \qquad (33)$$
$$vE_i = p_{iE}a_{iE}\ E \qquad \text{i=Y, M} \qquad (34)$$
$$p_{Yj} = p_Y + u_{Yj} \qquad \text{j=C, I, E} \qquad (35)$$
$$p_{Mj} = p_M + u_{Mj} \qquad \text{j=C, I, E} \qquad (36)$$
$$p_C = (vC_Y+vC_M)/C \qquad (37)$$
$$p_I = (vI_Y+vI_M)/I \qquad (38)$$
$$p_E = (vE_Y+vE_M)/E \qquad (39)$$

Thus, in effect, this solution is equivalent to a redefinition of the i-o coefficients, replacing the "true" fixed price coefficients a_{ij} by new "pseudo-fixed price" coefficients $p_{ij}\, a_{ij}/p_i$. But isn’t it a shame to discard the information embodied in the fixed price cells? Well, from economic theory we know that while the nature of the economic system imposes book-keeping constraints on value concepts (at current prices), there is no theoretical reason to expect that common fixed price indexes should satisfy such constraints as, e.g., $Y+M=C+I+E$. And on the other hand there is a wealth of expenditure models determining cost cells of the i-o table as a function of prices and total expenditure, with no need of fixed price cell information. So, if there is a problem in using current price i-o tables only, it may be nothing else than our unwillingness to depart from established professional tradition.

3. Experience

The simple and full general price correction models, in their multiplicative versions, have been tested in the danish model ADAM; the "Annual Danish Aggregate Model" has been used by the government for economic policy analysis, budgeting and forecasting purposes for more than 20 years. The model is in the econometric tradition of Tinbergen and Klein, but it contains an integrated, structural form static input-output system for determination of production and prices, in the way outlined in (1)-(5). This system uses 19 industry branches, 14 types of primary inputs and 27 categories of final demands (the numbers of primary inputs and final demands include 11 components of imports and 7 components of exports, respectively, with commodities broadly by 1-digit SITC).

Figure 1. Relative price error on consumption of durables in ADAM

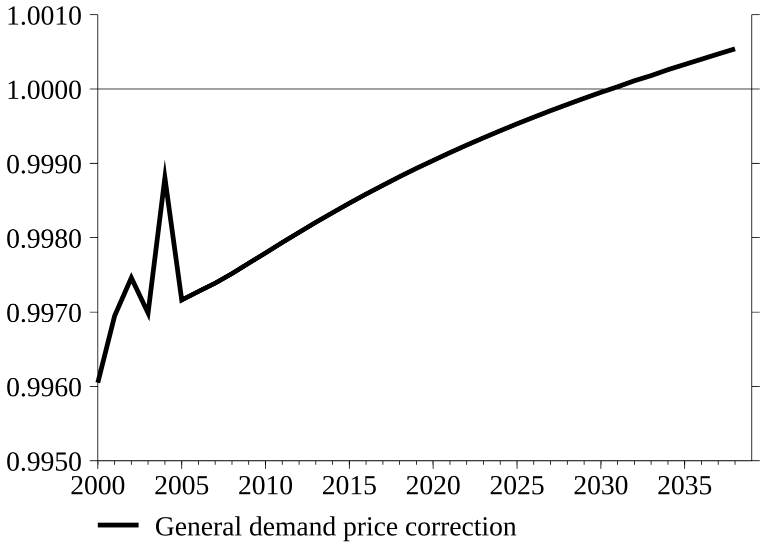


As an example, the (relative) demand price error on consumption of durables from ADAM is shown in figure 1. The error term is 1 in 1995, since this is the base year of the national accounts fixed price indexes. It displays, however, considerable drift over time in a way more compatible with a hypothesis of aggregation problems than with any clear hypothesis of price discriminination. The sudden drop below 0.9 at the end of the period is likely to be due to the recently adopted practice of using hedonic computer price indexes in the deflation of the danish national accounts; while such computer price indexes fall at dramatic rates in the nineties, the conventional price indexes on other durables develop more slowly; in turn, this price split exposes the differences in product composition of the final demand categories in the model, since consumption of durables contains relatively more computers than other demand categories supplied from the same ADAM supply sources.[4]

The simple general price correction, in the multiplicative version as in (2.9)-(2.11) in appendix 2, has been implemented in ADAM versions of march 1995 onwards. Figure 2 shows a quite typical profile of the general demand price correction factor in a forecast scenario.

In the first year of the forecast period the general correction factor drops by 0.4 pct due to a twist in the demand components away from components with a relative error greater than 1. Such first year movements are quite typical reflecting the phase of the busisness cycle embodied in the data for the most recent historical period. As the model solutions tend to the steady state level, the general correction factor slowly drifts to a stable level, which is typically closer to 1.

Figure 2. A forecast profile of the general demand price correction factor.



Though, as expected, the price movements caused by the general price correction are quite small, they have been found annoying by the users. One reason for this is that the political demand for inflation convergence embodied in the EMU, in conjunction with the very low rates of inflation in the Euro countries, creates public interest in even small deviations in consumer prices. Another reason is that the model users sometimes want to turn the model "upside down" in order to use flash indicators of export and consumer prices to compute

[4]Except, perhaps, investment in machinery, which shows a similar pattern of price errors.

early estimates of domestic inflation; such a procedure becomes technically more difficult when the general price correction is present.

Therefore, the main users have adopted a complicated procedure which is, in effect, equivalent to the simple residual price model. They have chosen the price on investment in inventories as the residual demand price. In most cases, this price is a relatively harmless one to determine residually; however, since (fixed price) investment in inventories can sometimes be negative, or zero, the correction has to be carefully formulated to function properly in such cases.

The full general price correction has been implemented in tests only. It works in a way quite similar to the simple correction, and therefore the simple correction was preferred.

Current work is aimed at changing the formulation of the i-o system to use current price i-o cells only. While simultaneously solving the problem with the current price identities it is expected that this solution will ease the transition to the use of chained quantity indexes recommended by the SNA93/ESA95 manuals.

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Appendix 1: Formulations including error terms in the quantity relations

If, in addition, the quantity equations contain error terms, the equations from the main text should be modified as follows

$$Y = a_{YC}C + a_{YI}I + a_{YE}E + u_Y \tag{1.1}$$

$$M = a_{MC}C + a_{MI}I + a_{ME}E + u_M \tag{1.2}$$

$$u_C C + u_I I + u_E E + p_Y u_Y + p_M u_M = 0 \tag{1.7}$$

$$u_I = -(u_C C + u_E E + p_Y u_Y + p_M u_M)/I \tag{1.8}$$

$$u = -(u_C C + u_I I + u_E E + p_Y u_Y + p_M u_M)/(C+I+E) \tag{1.12}$$

$$C_i = a_{iC} C + v_{iC} \qquad \text{i=Y, M} \tag{1.15}$$

$$I_i = a_{iI} I + v_{iI} \qquad \text{i=Y, M} \tag{1.16}$$

$$E_i = a_{iE} E + v_{iE} \qquad \text{i=Y, M} \tag{1.17}$$

$$vC_i = p_{iC}(a_{iC} + v_{iC})C \qquad \text{i=Y, M} \tag{1.32}$$

$$vI_i = p_{iI}(a_{iI} + v_{iI})I \qquad \text{i=Y, M} \tag{1.33}$$

$$vE_i = p_{iE}(a_{iE} + v_{iE})E \qquad \text{i=Y, M} \tag{1.34}$$

All other formulae, including (25), (28) and (29), are unchanged.

Appendix 2: Formulations with multiplicative error terms

In this appendix the formulae are quite analogous to those in the main text, except that multiplicative error terms are used in stead of additive error terms. Such multiplicative error terms are perhaps the most common type in practice. The treatment of them is slightly more technical. Only formulae that differ from the main text are shown, and they carry the same numbers as their analogues, preceded with a ’2.’.

$p_C = (p_Y a_{YC} + p_M a_{MC}) k_C$ (2.3)
$p_I = (p_Y a_{YI} + p_M a_{MI}) k_I$ (2.4)
$p_E = (p_Y a_{YE} + p_M a_{ME}) k_E$ (2.5)

> The value of total supply equals the value of total demand for arbitrary exogenous C, I, E, p_M og p_Y if and only if
>
> $$(k_C - 1)p_C C/k_C + (k_I - 1)p_I I/k_I + (k_E - 1)p_E E/k_E = 0$$
>
> i.e. that the deviations of multiplicative error terms in the demand price equations from 1, weighted with the appropriate uncorrected demand components at current prices, must sum to 0.

Proof: The condition that the value of total supply equals the value of total demand is

$p_Y Y + p_M M = p_C C + p_I I + p_E E$ (2.6)

$= (p_Y a_{YC} + p_M a_{MC}) k_C C + (p_Y a_{YI} + p_M a_{MI}) k_I I + (p_Y a_{YE} + p_M a_{ME}) k_E E \Leftrightarrow$

$0 = (k_c - 1)p_C C/k_C + (k_I - 1)p_I I/k_I + (k_E - 1)p_E E/k_E$ (2.7)

(using (2.1)-(2.5) and collecting terms).

The formula determining the residual error term, analogous to (8) is simple, but tedious and it is not shown here. Instead we will show the simple form of the multiplicative general price correction model. First a general correction term k, defined to be 1 in the historical data set, is added to (2.3)-(2.5):

$p_C = (p_Y a_{YC} + p_M a_{MC}) k_C k$ (2.9)
$p_I = (p_Y a_{YI} + p_M a_{MI}) k_I k$ (2.10)
$p_E = (p_Y a_{YE} + p_M a_{ME}) k_E k$ (2.11)

In model computations the general correction term k is determined using (6) which, after some term collection, yields the unsurprising formula

$k = (p_y Y + p_M M)/(p_C C + p_I I + p_E E)$

which obviously ensures the aggregated identity (6).

To ensure all the current price identitites the extended framework of (13)-(22) is needed. In the multiplicative case we need only to modify (18) and (19) as

$$p_{Yj} = p_Y\, k_{Yj} \qquad j=C, I, E \qquad (2.18)$$
$$p_{Mj} = p_M\, k_{Mj} \qquad j=C, I, E \qquad (2.19)$$

In the case of the supply component Y we find that (24) yields

$$p_Y Y = p_{YC}C_Y + p_{YI}\, I_Y + p_{YE}\, E_Y$$
$$= p_Y\, k_{YC}\, C_Y + p_Y\, k_{YI}\, I_Y + p_Y\, k_{YE}\, E_Y \qquad \Leftrightarrow$$

$$k_{YC}C_Y/Y + k_{YI}\, I_Y/Y + k_{YE}\, E_Y/Y = 1 \qquad \Leftrightarrow$$

$$k_{YI} = (Y–k_{YC}\, C_Y–k_{YE}\, E_Y)/I_Y$$

A similar condition applies to supply component M.

The multiplicative version of the full general price correction model is found from (13)-(17), (20)-(22) and the modified formulae

$$p_{Yj} = p_Y\, k_{Yj}\;\; k_Y \qquad j=C, I, E \qquad (2.26)$$
$$p_{Mj} = p_M\, k_{Mj}\;\; k_M \qquad j=C, I, E \qquad (2.27)$$

from which we can determine the general correction factors for Y and M

$$k_Y = Y/(k_{YC}C_Y+k_{YI}\, I_Y+k_{YE}\, E_Y) \qquad (2.28)$$
$$k_M = M/(k_{MC}C_M +k_{MI}\, I_M +k_{ME}\, E_M\,) \qquad (2.29)$$

The Working Paper Series

The Working Paper Series of the Economic Modelling Unit of Statistics Denmark documents the development of the two models, DREAM and ADAM. DREAM (Danish Rational Economic Agents Model) is a relatively new computable general equilibrium model, whereas ADAM (Aggregate Danish Annual Model) is a Danish macroeconometric model used by e.g. government agencies.

The Working Paper Series contains documentation of parts of the models, topic booklets, and examples of using the models for specific policy analyses. Furthermore, the series contains analyses of relevant macroeconomic problems – analyses of both theoretical and empirical nature. Some of the papers discuss topics of common interest for both modelling traditions.

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