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Analysis of Index Numbers applied to Agricultural Inputs in Syria

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1. Background

The process of concentration, specialization and coordination of agricultural production, technological changes and the increased openness of Syrian economy are factors which require the use of advanced scientific methods in the fields of economic & policy analysis especially in agriculture to deal with the complexity of agricultural operations. An example of such methods we mention the methodology of index numbers, which is used in short term analysis to assess the impact of policies on the level of the cost of production.

2. Objectives

This paper aims to analyze and quantify the impact of the various policies on the value of agricultural inputs comprising the policies of horizontal and vertical expansions as well as price policies. The change in the area reflects the impact of extensive (horizontal) policies, while the yield variations express the effect of intensive (vertical) policies. In turn, the alteration of input prices is the result of price policies. This research focuses also on differentiating between the absolute and relative impacts of policies on the level of production costs.

3. Methodology of index numbers

The **methodology** refers to the index of the value change of agricultural inputs and uses a combination of Laspyres and Paasche indexes for the interpretation of its components. Given the quantity of agricultural production or the cultivated area and the unit cost per kg or per hectare, let's assume, current time 1 and at base time 0, the index of the value change in agricultural inputs expressed as, I_V :

$$I_V = \frac{\sum q_1 c_1}{\sum q_0 c_0}$$

Where:

q and c represent the quantity (level of production or cultivated area) and unit cost of a given crop respectively;

$\sum q_1 c_1$ is the value of production cost or the value of agricultural inputs of a given agricultural production mix in current time;

$\sum q_0 c_0$ is the value of production cost or the value of agricultural inputs of a given agricultural production mix at base time.

Multiplying and dividing I_V by the same factor $\sum q_1 c_0$ and algebraically rearranging, I_V can be rewritten as follows:

$$I_V = \frac{\sum q_1 c_0}{\sum q_0 c_0} \cdot \frac{\sum q_1 c_1}{\sum q_1 c_0}$$

$\frac{\sum q_1 c_0}{\sum q_0 c_0}$ is a Laspeyres index applied to quantities or areas, while $\frac{\sum q_1 c_1}{\sum q_1 c_0}$ is a Paasche index applied to unit costs. The former measures the effect of just the quantity or area change over the change in the value of agricultural inputs between the current and base time holding the unit cost constant, the latter instead measures just the effect of the unit cost change holding the quantity or area of production constant.

Calling

$$I_Q \text{ or } I_A = \frac{\sum q_1 c_0}{\sum q_0 c_0}$$

$$I_c = \frac{\sum q_1 c_1}{\sum q_1 c_0}$$

I_V can be expressed as follows:

$$I_V = I_Q \cdot I_c \text{ or } I_V = I_A \cdot I_c$$

The impact of the individual components of the unit cost of agricultural production comprising agricultural operations and tradable inputs can be assessed by disaggregating the total unit cost into its individual parts and applying the same methodology explained above. Hence the unit cost of agricultural inputs can be written as follows:

$$c = c_o + c_{rq} + c_{oth}$$

Where:

c - The total unit cost of a product.

c_o - The unit cost of agricultural operations.

c_{rq} - The unit cost of production requirements (fertilizer, package, seeds, water and chemical control).

c_{oth} - Unit cost of other items.

Based on above, I_v can be assessed from the following equation:

$$I_v = I_A \cdot I_{c_o} \cdot I_{c_{rq}} \cdot I_{c_{oth}}$$

Where:

I_{c_o} - Index of the unit cost of agricultural operations $(\sum A_1 \cdot (c_{o1} + c_{rqo} + c_{otho}) / \sum A_1 \cdot (c_{oo} + c_{rqo} + c_{otho}))$.

$I_{c_{rq}}$ - Index of the unit cost of production requirements $(\sum A_1 \cdot (c_{o1} + c_{rq1} + c_{otho}) / \sum A_1 \cdot (c_{o1} + c_{rqo} + c_{otho}))$.

$I_{c_{oth}}$ - Index of the unit cost of the other items $(\sum A_1 \cdot (c_{o1} + c_{rq1} + c_{oth1}) / \sum A_1 \cdot (c_{o1} + c_{rq1} + c_{otho}))$.

Considering:

$$I_i > 0 \quad i = V, Q, A, C$$

If:

$0 < I_i < 1$ the effect of factor i on the change of the value of agricultural inputs is negative;

$I_i = 1$ factor i has no effect on the change of the value of agricultural inputs;

$I_i > 1$ the effect of factor i on the change of the value of agricultural inputs is positive.

The aforementioned indices assess the absolute impact of policies on the level of production costs. While the relative effect of these policies results from the change in the level of production or the change in the level of the yield. So, the relative cost increase or cost decrease is estimated from the following equation:

$$Cr = C_o * (q_1/q_o - 1) * 100$$

Where:

Cr denotes the relative change in the production costs. If Cr is positive, it implies a cost decrease, while the negative sign indicates a cost increase;

C_o represents the costs at base time;

q_1 and q_o express the level of production or yield at current and base time respectively.

4. Analysis of the absolute and relative impacts of policies

There is no data available about the production costs disaggregated by the various groups of agricultural production. Therefore, the analysis is focusing on the aggregate value of agricultural

inputs¹ related to agricultural production and the value of inputs of some selected crops relying on the cost assessment of the Annual Agricultural Statistical Abstract (AASA) of the MAAR.

4.1. Total agricultural inputs

Table 1 traces the evolution of the value of agricultural inputs at current prices and at constant prices of 2000 during 2000-2006. The table indicates an increase in both the quantities of agricultural inputs and the prices of these inputs, but the augmentation in the consumed quantities of inputs is higher than that of input prices. In addition, the enhancement in agricultural inputs occurred at a lower pace than that of agricultural production indicating a good performance. This good outcome led to a decrease in the unit cost of agricultural inputs from 8.4 SP/kg in 2000 to 8.2 SP/kg in 2006. The total value of agricultural inputs increased by 36% during 2000-2006 because of the boost in the level of production (+39%). On the other hand, the decline in the unit cost of agricultural inputs led to a decrease in the total cost of these inputs by 2%.

Table 1. Evolution of the value of agricultural inputs at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR % 00-06	Index % 06/00
Value 1	117	133	141	140	138	147	159	5.2	136
Value 2	117	120	123	117	127	133	140	3.0	120

Source: Elaborated from the Central Bureau of Statistics (CBS). *The Annual Statistical Abstract (ASA) 2007*.

Value 1: Value of agricultural inputs at current prices.

Value 2: Value of agricultural inputs at constant prices of 2000.

AGR and index are calculated for the period 2000-2006 (base 2000).

The aforementioned interpretation investigates only the absolute changes in the level of the cost of agricultural inputs. In addition to that, there is a relative impact on the level of the cost resulting from a good or a bad performance of agricultural production. The improvement in the level of agricultural production from 2000 to 2006 led to a relative cost decrease by 39%. This decline equals 45,560 million SP, when related to the total value of agricultural inputs and 3.3 SP/kg, when related to the unit cost of agricultural inputs.

4.2. Agricultural inputs of crop production

Table 2 illustrates the evolution of the value of agricultural inputs of crop production at current prices and at constant prices of 2000 during 2000-2006. The table shows an enhancement in both the quantities of agricultural inputs of crop production and the prices of these inputs, but the increase in the consumed quantities of inputs is higher than that of input prices. Furthermore, the enlargement in the agricultural inputs of crop production was lower than that of crop production indicating a good performance.

Table 3 gives an idea about the index numbers showing the impact of the quantity, area and unit cost on the value of agricultural inputs related to crop production during 2000-2006.

¹ Central Bureau of Statistics (CBS). *The Annual Statistical Abstract (ASA)*.

Table 2. Evolution of the value of agricultural inputs of crop production at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR % 00-06	Index % 06/00
Value 1	80	103	109	105	94	92	111	5.6	139
Value 2	80	93	96	88	86	84	99	3.6	124

Source: Elaborated from CBS. *The ASA 2007*, MAAR. *Follow-UP of the Unified Plan*, Various Issues and the State Planning Commission. *Analysis of the Current Situation of the Agricultural Sector 1990-2003*.

Value 1: Value of agricultural inputs of crop production at current prices.

Value 2: Value of agricultural inputs of crop production at constant prices of 2000.

AGR and index are calculated for the period 2000-2006 (base 2000).

Table 3. Impact of the quantity, area and unit cost on the value of agricultural inputs of crop production, 2000-2006

Index numbers in relation to the level of production			Index numbers in relation to the cultivated area		
Index of the quantity	Index of the unit cost	Index of the value	Index of the area	Index of the unit cost	Index of the value
1.38	1.01	1.40	1.04	1.34	1.40

Source: Elaborated from MAAR. *The AASA 2006* and CBS. *The ASA 2007*.

From Table 3, it can be concluded the following for the changes in the value of inputs related to crop production:

In relation to the produced quantity of agricultural production and the unit cost per kg:

- The value of agricultural inputs (production cost) increased by 40% during 2000-2006 because of the changes in the quantity produced and the unit cost per kg.
- The increase in both the quantity produced and the unit cost per kg led to an augmentation of the total cost by 38% and 1% respectively. The improvement in the quantity produced is due the amplification in both the area and yield. The boost in the unit cost is because of the higher rate of growth of the value of agricultural inputs compared with the growth rate of the crop production.

In relation to the cultivated area and the unit cost per hectare:

- The production cost increased by 40% during 2000-2006 because of the changes in the cultivated area and the unit cost per hectare.
- Expanding the cultivated area induced an increase of the production cost by 4%, whereas the enlargement of the unit cost per hectare raised these cost by 34%.

In relative term the value of agricultural inputs decreased by 38% during 2000-2006 given the cost of inputs in 2000. This means that the relative decline in the cost of crop production amounted to 30282 million SP because of the improvement in the quantity produced of crop production during 2000-2006.

Table 4 quantify the impact of the changes in the area, total unit cost, unit cost of agricultural operations and unit cost of production requirements on the total cost for some representative crops of crop production expressed by index numbers during 2000-2006. The unit costs are assessed per hectare. The selected crops constitute 72-76 % of the total cropped area.

Table 4. Impact of the changes in the area and unit cost on total cost for selected crops, 2000-2006

Item	Index number of area	Index number of total unit cost	Index number of unit cost of agricultural operations	Index number of unit cost of production requirements	Index Number of the other costs	Index number of total impact on total cost
Irrigated wheat	1.17	0.96	0.99	0.97	0.99	1.12
Rain-fed wheat	0.99	1.08	1.01	1.05	1.02	1.07
Rain-fed barley	0.96	0.92	0.96	0.98	0.99	0.89
Rain-fed lentils	1.23	1.07	1.04	1.02	1.01	1.31
Rain-fed chickpeas	0.61	1.02	1.01	1.01	1.00	0.62
Sugar beet	1.19	1.03	1.03	1.00	1.01	1.22
Cotton	0.80	1.11	1.05	1.04	1.02	0.89
Potato	1.22	1.05	0.96	1.08	1.01	1.28
Tomato	0.82	1.29	1.09	1.13	1.05	1.06

Source: Elaborated from MAAR. *The AASA 2006*.

Index of total impact is calculated either by multiplying column 1 and column2 or column1 and the other columns excluding column 2.

Table 4 indicates that the combined effect of the area and unit cost led to a decrease in the total cost by barley, chickpeas, and cotton and to a cost increase by the other crops. The increase in the cultivated area induced an amplification in the total cost by irrigated wheat, lentils, sugar beet and potato, whereas the decline in this area reduced the total cost by rain-fed wheat, barley, chickpeas, cotton and tomato. Considering the unit costs, the increase in these costs led to an increase in the level of the total cost by most of the crops. Irrigated wheat and barley witnessed a decline in the total cost resulting from the diminishing unit costs.

Table 5 illustrates the impact of the change in the level of production during 2000-2006 on the level of total cost in 2000. Hence, the improvement in production led to an enormous relative cost decrease from the observed cost level in 2000 by all products mentioned in the table excluding chickpeas and cotton, which witnessed a reduction in the production leading to an increase in the total cost.

Table 5. Relative impact of the changes in the level of production on the level of the total cost, 2000-2006 (%)

Item	Irrigated wheat	Rain-fed wheat	Rain-fed barley	Rain-fed lentils	Rain-fed chickpeas	Sugar beet	Cotton	potato
Increase					21		37	
Decrease	49	92	451	1.49		22		25

Source: Elaborated from MAAR. *The AASA 2006*.

4.3. Agricultural inputs of animal production

Table 6 illustrates the evolution of the value of agricultural inputs of animal production at current prices and at constant prices of 2000 during 2000-2006. The table shows an increase in both the quantities of agricultural inputs of animal production and the prices of these inputs, but the increase in the consumed quantities of inputs is lower than that of input prices indicating a substantial impact of prices on the value of inputs. Furthermore, the amplification

in the agricultural inputs of animal production was lower than that of animal production pointing out to a good performance.

Table 6. Evolution of the value of agricultural inputs of animal production at current prices and at constant prices of 2000, 2000-2006 (billion SP)

Item	2000	2001	2002	2003	2004	2005	2006	AGR % 00-06	Index % 06/00
Value 1	37	30	32	35	44	55	48	4.4	130
Value 2	37	27	28	29	41	48	41	1.7	111

Source: Elaborated from CBS. *The ASA 2007*, MAAR. *Follow-UP of the Unified Plan*, Various Issues and the State Planning Commission. *Analysis of the Current Situation of the Agricultural Sector 1990-2003*.

Value 1: Value of agricultural inputs of animal production at current prices.

Value 2: Value of agricultural inputs of animal production at constant prices of 2000.

AGR and index are were calculated for the period 2000-2006 (base 2000).

Table 7 gives an idea about the index numbers showing the effect of the quantity and unit cost on the value of agricultural inputs of animal production during 2000-2006. Accordingly, the value of inputs related to animal production increased by 29% during the studied period because of the expansion in animal production by 47%, which represents also the relative cost decrease. This boost in the produced quantities of animal products led to a decrease in the unit cost, which in turn induced a decline in the total cost by 12%.

Table 7. Impact of the quantity and unit cost on the value of agricultural inputs of animal production, 2000-2006

Index of the quantity	Index of the unit cost	Index of the value
1.47	0.88	1.29

Source: Elaborated from MAAR. *The AASA 2006* and CBS. *The ASA 2007*.

5. Concluding remarks

The performance of the provision and utilization of agricultural inputs was adequate during 2000-2006 because these inputs were used with a rate lower than the rate of growth of agricultural production. The overall impact of the produced quantities, cultivated area and unit costs led to an increase in the level of total cost of agricultural production. On the other hand, the substantial increase in the quantity produced of agricultural products led to an enormous relative cost reduction.

References

- MAAR. *The Annual Agricultural Statistical Abstract*. Various issues.
- CBS. *The Annual Statistical Abstract*. Various issues.
- NAPC. *State of Food and Agriculture 2005*.