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## **Inventories in agriculture: implications for rural development and estimation issues<sup>1</sup>**

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### **ABSTRACT**

*This paper covers the impact of inventories management and their time fluctuations on the rural development. Prices and quantities of agriculture commodities are affected by several events like physiological production activities and speculative behaviours in the global markets. The authors will discuss the economic implications, the available statistical data sources and the possible solutions in terms of estimation.*

**Keywords:** Inventories, Business Cycle, Agricultural Goods, Commodity Markets Speculation, National Accounts Estimations

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<sup>1</sup> The opinions here expressed are the authors' own and may not coincide with those of the institutions with which they are affiliated.

## 1 Introduction

Changes in inventories represent a very small percentage of Gross Domestic Product: for example, in 2010, in Italian National Accounts this statistic correspond to 0.57% of GDP (table 1). Nevertheless this variable is considered a revealing signal about the condition of future aggregated demand dynamics and, in general, on the state of future economic activity. For many scholars inventories is also an interesting object of study in itself<sup>2</sup>. As reminded by Christiano (1988) “...*the observation that the magnitude of fluctuations in inventory investment is to disproportionate to their small average size has inspired much of the literature on inventory investment*”.

These considerations suggest to the producers of statistics to take in serious consideration changes in inventory and undertake the effort, even if great and with many difficulties, to detect and estimate inventories and its variations over time<sup>3</sup>.

In agricultural industry changes in inventories are even more interesting for their implications on food security and economic stability of developing countries with a trade balance strongly dependent to primary sector commodities exports (cacao, coffee, rice, fruit, etc...). Natural disasters, climate changes but also prices volatility are strictly connected to agricultural inventories and they could be, in some cases, a better signal than just total economy inventories. Furthermore, in many countries quantities and prices are recorded with values in statistical accounts, allowing a potential good possibility of estimation<sup>4</sup>.

In this paper first National Accounts definitions are introduced on total inventories and then with a specific application in agricultural industry. After that, limited available data and estimation methods are critically presented and discussed. Some practical solutions are suggested in the final conclusions.

## 2 Changes in inventories: an heterogeneous aggregate

Changes in stocks are a small part of produced wealth estimated in a country (table 1) and normally are simply and trivially viewed as unsold commodities that becomes a useful variable in the final process of National Accounts balancing.

Actually the management of inventories is regarded as a fundamental item in modern industrial theory. The contemporary scientific organization of production, overcoming the Fordist vision of enterprises, is arrived to “lean production” vision or “just in time” management technique, in which an efficient management of inventories, to get a reduction in storing expenses, is a primary target of operators.

The changes in inventories are classified by European System of Accounts (ESA) into Gross Capital Formation aggregate but is not included in fixed capital that is held by producer units at a given moment. Changes in stocks are defined as the difference between the value of entries and the value of withdrawals, included any recurrent loss of commodities held in inventories (i.e. shoplifting or insurable accidental damage). A first distinction is made between *input stocks* and *output stocks*, where the former includes commodities which will be used at a later date as intermediate inputs in the production processes and the latter consists of finished goods.

An accurate classification of changes in inventories suggests that the very heterogeneous nature of this item should be better considered and at least the following four sub-categories should be defined:

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<sup>2</sup> For an introduction to these arguments see Keynes (1936), Metzler (1941), Abramovitz (1950), Blinder (1981), Mankiw (1989) and other economists referring to the *Real Business Cycle* theory. For some critical remarks consider, for instance, Summers (1986).

<sup>3</sup> On statistical prospective see a classical analysis by Burns et al. (1946).

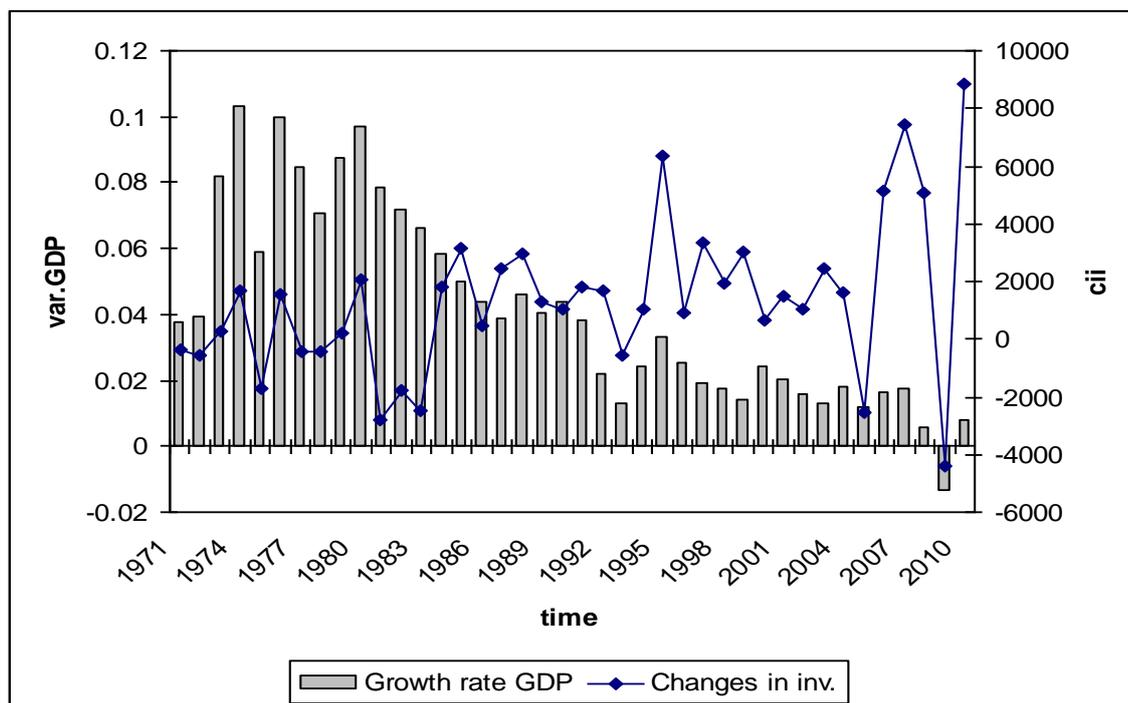
<sup>4</sup> See Eurostat (1997).

**Table 1** Annual Changes in Inventories, Italy. Years 1970-2010 (current values in millions of €)

Date	Changes in inventories	Gross capital formation	GDP	% GDP	Date	Changes in inventories	Gross Capital formation	GDP	% GDP
1970	246	8,895	35,267	0.70	1990	1,042	154,722	701,352	0.15
1971	-388	9,528	38,486	-1.01	1991	1,837	165,873	765,806	0.24
1972	-573	10,204	42,155	-1.36	1992	1,680	170,059	805,682	0.21
1973	254	13,098	50,911	0.50	1993	-579	156,310	829,758	-0.07
1974	1,659	17,466	64,586	2.57	1994	1,043	162,352	877,708	0.12
1975	-1,710	19,194	73,976	-2.31	1995	6,331	180,586	947,339	0.67
1976	1,528	23,087	93,078	1.64	1996	921	190,153	1,003,778	0.09
1977	-452	27,924	113,100	-0.40	1997	3,331	198,380	1,048,766	0.32
1978	-456	32,009	133,048	-0.34	1998	1,965	210,550	1,091,361	0.18
1979	183	39,271	162,759	0.11	1999	3,033	221,299	1,127,091	0.27
1980	2,068	52,007	203,383	1.02	2000	661	242,028	1,191,057	0.06
1981	-2,813	62,584	243,632	-1.15	2001	1,465	253,778	1,248,648	0.12
1982	-1,752	69,597	287,552	-0.61	2002	1,070	270,889	1,295,226	0.08
1983	-2,510	76,533	334,833	-0.75	2003	2,435	271,776	1,335,354	0.18
1984	1,808	86,879	382,831	0.47	2004	1,641	285,468	1,391,530	0.12
1985	3,179	95,709	429,649	0.74	2005	-2,561	296,375	1,429,479	-0.18
1986	435	102,139	475,031	0.09	2006	5,147	313,325	1,485,377	0.35
1987	2,440	111,745	519,651	0.47	2007	7,468	327,908	1,546,177	0.48
1988	2,979	126,448	577,455	0.52	2008	5,086	325,507	1,567,761	0.32
1989	1,279	139,127	634,021	0.20	2009	-4,424	289,680	1,519,702	-0.29
					2010	8,845	301,286	1,548,816	0.57

Source: National Accounts, ISTAT

**Figure 1** Growth Rate of GDP and Changes in Inventories, Italy. Years 1971-2010



- *materials and supplies*: are all the commodities maintained in stock to use them as intermediate inputs in a production process; materials such as gold or precious stones are considered an input when are employed in an industrial process;
- *work-in-progress*: are commodities not yet arrived at the end of their manufacturing cycle; for example are included in this group wine, livestock for slaughter or uncompleted structures as buildings, ships or oil rigs, or again, in the services, partially completed film production, incomplete consulting service or not completed computer software; clearly, at the end of production process, the work-in-progress turn into finished goods;

- *finished goods*: in this category are included all commodities assigned to sale, that have finished their processes of production, and that result *de facto* yet not sold;
- *goods for resale*: are finished goods, that are not subjected to any modification and are exclusively acquired for resale.

In the system of National Accounts inventories are calculated at annual and quarterly frequency. Learning from the experiences of many national office of statistics, there are several ways to estimate changes in inventories; common sources of information and methods are the following:

- data from business surveys or other enterprises declarations as, for example, marketing boards;
- deterministic models or stochastic statistical models that use some kind of indicator;
- qualitative data;
- indirectly estimated as residual measure at aggregated level;
- a mixture of some previous methods.

In Italian National Accounts the estimation of annual inventories is mainly produced in three steps:

1. business data are collected (sample surveys and administrative data);
2. some indicators are inserted in statistical models;
3. estimations are integrated in the final balancing process of the overall system of accounts<sup>5</sup>.

Following this complicate process, changes in inventories becomes a residual measure, that is to say is the variable used to find the “true” value of other key aggregates or, in other words, is the degree of freedom that allows the balance between demand and supply in the system of accounts. In this characterization, inventories is a fundamental adjustment variable (even the most important) but, as a consequence, necessarily loose is function of economy indicator of future scenarios.

Looking to infra-annual frequency data, there is a common opinion that an independent estimate of inventories is often not feasible at quarterly base, due to the lack of information for several sectors of the economy. At the moment, Italian quarterly changes in inventories are also estimated as residual statistic<sup>6</sup>: stocks are measured as the balance between gross domestic production estimate and the expenditure aggregate. Thus changes in inventories are an item derived from national accounts as the difference between uses and resources, subtracting final consumption, gross capital formation, public expenditure and the balance of international trade (uses) from the GDP estimate (resources). This approach is a simple solution to known and numerous difficulties connected to inventories estimation, but implies that estimates are affected by statistical discrepancies of all components of “GDP and Expenditure Account”. These discrepancies come from, for example:

- an incomplete coverage of sampling or simply by a sampling error;
- the influence of seasonal adjustment or other temporal domain interventions;
- the problem of time recording or attribution in statistical sources.

While inventory changes relating to an individual enterprise can provide some useful information on its future market development, the situation is much more complex for the economic system as a whole. Inventory dynamics, that is the inventory restocking and destocking periods that can have an impact on current and future GDP cycle, is often impossible to identify in Quarterly National Accounts due to the numerous other fluctuations disturbing the original signal. In the past years, in

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<sup>5</sup> Italian National Accounts estimation is based on Stone’s procedure that consists in a constrained optimization algorithm, modified in Italian version to meet computational problems (Stone et al, 1942; Stone, 1960; Nicolardi, 2000).

<sup>6</sup> See Eurostat (2008).

several occasions, an independent estimate of changes in inventories has been attempted but results has been regarded as unsatisfactory or incomplete<sup>7</sup>. A possible and likely explanation is the very heterogeneity of inventories aggregate, previously reminded, where each component follows its own dynamic, not necessarily and not exclusively explained by businesses production plans or by the time gaps that occurs between production, consumption and income distribution. Often in theoretical analysis and modelling these gaps are taken into account. To summarize, commodities sales included in inventories could be affected by three main causes:

- the business cycle and the dynamic of aggregated demand;
- an indirect speculative cause;
- a direct speculative reason.

Let us consider the impact of each of them. With respect to business cycle the most important questioning is if inventories are pro-cyclical or counter-cyclical. Their effect depends by many different factors: of course an increase in materials and work-in-progress could be an indicator of an increase (instantaneous or future) of aggregated demand. If the aggregated demand principle is not accepted then their rise could be understood as a real symptom of overproduction of commodities and value. In the same way we could interpret the increase in finished goods: as a sign of crisis in sales (unsold commodities) or an expression of a momentary time gaps between demand and supply. In relation to the purchase of materials and supplies, it could be introduced the idea of *indirect speculation*: materials could be bought to take advantage of momentary decrease in prices or because is expected a future increase in the same prices or, again, because is expected a rise of intermediate or final consumption. The term *indirect* is used to suggest that the speculative motivation is induced by efforts to keep industrial production costs within reasonable bounds and not to realize an immediate gain with the difference between purchases and sales. Certainly, goods for resale are stored for a pure speculative reason: this phenomena is more and more diffused, especially in relation to some agriculture goods, cereals for instance, of primary and strategic relevance for food and industrial production.

### 3 Inventories in agriculture

Inventories in agriculture assume particular features with respect to industrial inventories or incomplete services products. Agricultural products are even constrained to natural events, to their physiological characteristics and some products have a short life cycle. These characteristics influence the producer behaviours who has to face the problem and the costs of storage with the risk of deterioration or damage of products. Furthermore, in the last decade the speculative behaviours in the global market of agriculture materials, in particular the cereals market, is influencing significantly prices of and size of agricultural inventories.

The SEAFa (acronym for *System of Economic Accounts for Food and Agriculture*) follows the general definition of National Accounts and identifies the agricultural changes in inventories as supplies and materials purchased by cultivators but not yet used in agricultural process, work-in-progress and livestock (more precisely young stock and animals for slaughter), and finally finished goods not sold. When crop is harvested before the end of the year, it is recorded as additional inventories in finished goods. Also for agricultural products a primary distinction is between *input* and *output stocks*. Into the agricultural output stocks are included:

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<sup>7</sup> For instance, Bacchini et al (2009) in Istat proposed an analytical framework to explore the feasibility to derive an estimation of change in inventories for Italy, starting from monthly data on industrial production and industrial turnover at disaggregated level (3 digits of Nace rev.2).

- finished products from agricultural “industry”: are classified in this way crop products, olive oil, grape must, livestock products, timber and other forestry products, finally non-agricultural goods produced in inseparable secondary activities;
- work-in-progress: are considered in this category wine, livestock for slaughter, all chickens and other poultry and all the animals not considered in fixed capital. Note that growing crops and standing timber are not considered as work-in-progress stocks in the annual economic accounts<sup>8</sup>.

Let us explain the last point: growing crops are not considered stocks because a very large part of crops have a production cycle basically shorter than an accounting period. Concerning standing timber, to the other end, the choice is justified by the long production process, which is extended over several human generations, and by the high value, social and environmental, of woodlands.

As remembered above, prices and quantities of agriculture commodities are influenced by several events: first of all their particular production cycle, associated to natural growing (seasonality) and to uncertainty (weather conditions), and, maybe, as well the speculative behaviours in the global markets. The speculative bubble is an economic event that shocks the dynamic of agricultural commodities markets. Many studies from scholars and supranational institutions found that it has had a great impact on the revenues of agricultural enterprises and their productive choices in the medium and long period. Furthermore, new agents appeared on these markets, the so called institutional investors (investment banks, hedge funds, pension funds), that produced to a great rise and a larger unpredictability in prices of agricultural materials. The Food and Agricultural Organization (FAO), between 2005 at present, has estimated an increase of about 98% in the Food Price Index<sup>9</sup>; the increase is higher for cereals (146%) and sugar (169%), after a brief two-years period of decrease in 2007 and 2009 (table 2): it is more and more evident that the great fluctuations of these prices in the last years are not correlated with fundamentals of agricultural real economy, but is connected with financial transactions that occur in the commodity exchanges in New York or Chicago.

Prices volatility and natural shocks on agricultural industry are producing a dangerous income instability on million of small producers around the world, that question the possibility for them to live in rural areas. In other words, the sustainability of rural development is negatively affected.

Given the undeniable great influence of speculative practice in the last years, not only on agricultural materials, next to other sources of fluctuations, it is fundamental to consider its effects in the estimation of changes in inventories, in context of National Accounts

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<sup>8</sup> In contrast with SEAFSA, in the ESA 95 these products are included in work-in-progress (Eurostat, 1996).

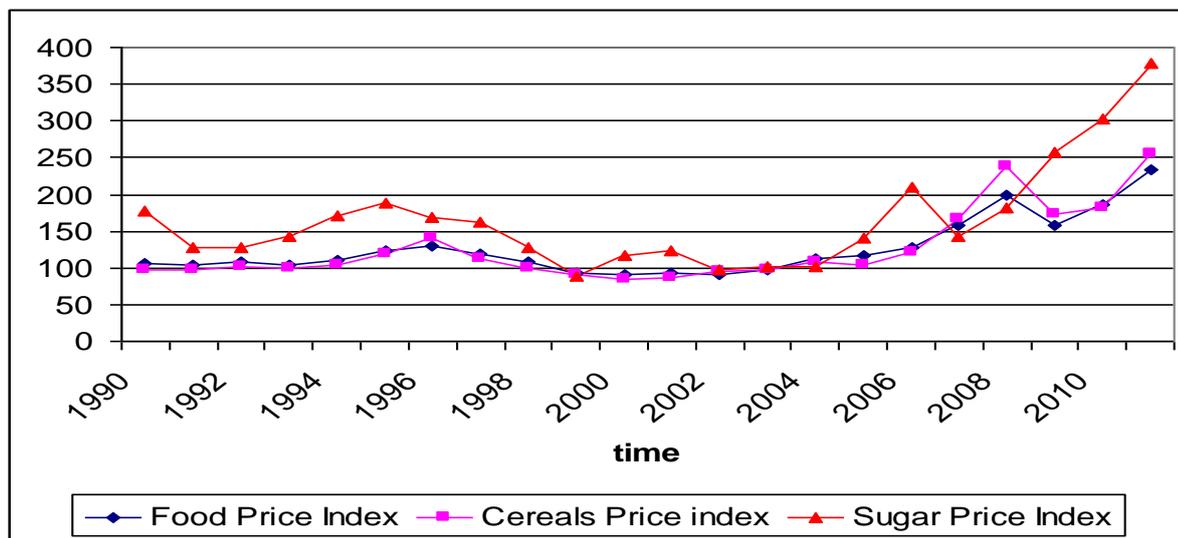
<sup>9</sup> The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices (representing 55 quotations), weighted with the average export shares of each of groups for the period 2002-2004.

**Table 2** Annual Series of FAO Price Indexes (2002-2004=100)

Date	Food Price Index	Meat Price Index	Dairy Price Index	Cereals Price Index	Oils Price Index	Sugar Price Index
1990	105.4	124.0	74.8	97.6	74.0	178.1
1991	103.6	125.4	79.6	96.9	79.1	127.2
1992	108.4	125.2	95.4	102.3	84.3	128.5
1993	104.6	118.1	84.6	99.5	86.0	142.2
1994	110.5	115.0	82.3	104.5	113.4	171.8
1995	123.2	118.4	109.6	119.4	125.0	188.5
1996	129.1	128.4	109.4	140.7	111.2	169.7
1997	118.4	123.2	105.1	112.1	112.5	161.4
1998	107.1	103.2	99.1	99.8	129.9	126.6
1999	92.3	97.8	86.3	90.2	91.6	89.0
2000	90.2	95.8	95.4	84.5	67.8	116.1
2001	93.3	96.5	107.1	86.2	67.6	122.6
2002	89.9	89.5	82.2	94.6	87.0	97.8
2003	97.7	96.8	95.1	98.1	100.8	100.6
2004	112.4	113.7	122.6	107.4	112.2	101.7
2005	117.3	120.1	135.4	103.4	103.6	140.3
2006	126.5	118.5	128.0	121.5	112.0	209.6
2007	158.6	125.1	212.4	166.8	169.1	143.0
2008	199.6	153.2	219.6	237.9	225.4	181.6
2009	156.8	132.9	141.6	173.7	150.0	257.3
2010	185.1	152.2	200.4	182.6	193.0	302.0
2011	232.8	176.3	228.2	255.0	260.9	377.5

Source: FAO

**Figure 2** Fao Index Series. Years 1990-2010



#### 4 Available data and estimation in agriculture

As mentioned before there are many ways to quantify changes in inventories: micro-data obtained from surveys or other enterprises sources (of course the best source of information), statistical model associated with some kind of indicator (temporal disaggregation techniques or other interpolation methods based on regression models, for example), qualitative data, indirect

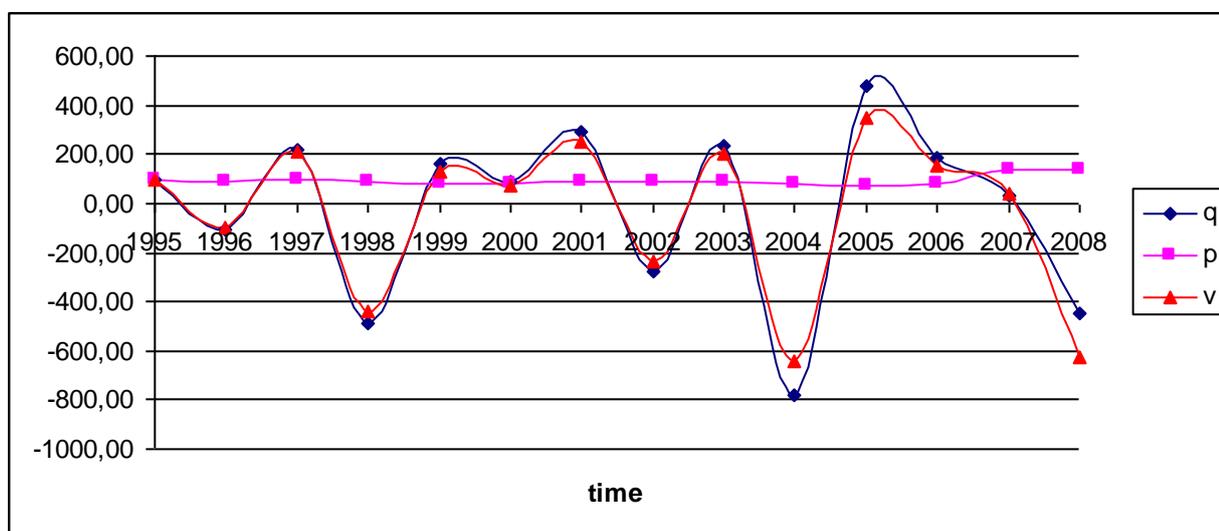
estimation considering stocks as residual measure of the balancing process between supply and demand at aggregated level, finally a mix of previous methods.

In Italian national accounts a preliminary estimation of agricultural inventories is conducted in relation to finished goods, materials and goods for resale and is connected to micro-data resulting from several business survey as:

- REA (“Risultati Economici Aziende agricole”, agriculture business survey);
- SCI (“Sistema dei Conti delle Imprese”, large firms accounts survey);
- PMI (“Piccole e Medie Imprese”, small and medium firms survey);

Data sources are available form main products on quantities and prices and inventories can be calculated at this disaggregated level. For example, for durum wheat in Italy inventories estimation and decomposition between price and quantity component is the following:

**Figure 3** Durum Wheat Inventories Index in Italy: Quantities, Prices and Values. Years 1995-2008



At this level the emerging speculative effect is clear observing the increasing variability of inventories and increasing gaps in the trend of quantities and values.

In the future it will be also possible to use as well qualitative information form, for instance, “Indagini qualitative ISAE” (ISAE businesses and tendencies surveys) or further qualitative data.

The next step is to evaluation the size and sign of adjustment process in the first balancing trials of all variables and industries in National Accounts.

In table 3, are reported values regarding crops and zootechnical products, before and after the final balancing process:

**Table 3** Impact of Balancing Agricultural Products Stocks in Italy. Years 2008-2010 (current values in millions of €)

Date	Crop production			Animal production		
	Pre-balance	Post-balance	Difference	Pre-balance	Post-balance	difference
2008	593	587.6	-5.4	152.3	151.4	-0.9
2009	-219	-219.7	-0.7	155.8	156.1	0.3
2010	228	232.8	4.8	171.5	173.1	1.6

Source: National Accounts, ISTAT

With respect to agricultural products, inventories adjustment relatively small in Italy and does not seem to change significantly the first estimations, at price and quantity level. This suggests that a greater attention should be kept on inventories estimations at main products level.

Unfortunately, also for inventories in agriculture no more information is available on their different components considered in the previous paragraph.

## 5 Final remarks

Several considerations could be drawn from economic studies and statistical practices on inventories estimations. First of all, inventories should be better and carefully measured as they could be a key signal in business cycle analysis, even if in National Accounts is a small numerical aggregate. Given the great difficulties in identifying inventories fluctuation, which could be the solution for estimation? A recommendation is to return to a more detailed level of aggregation that involves, in the first place, an attempt to identify inventories in their individual components: materials, work-in-progress, finished goods and goods to resale. A further step could be to directly ask to data producers comments on available information, producing qualitative data that could be extremely useful. Finally, keep attention to any balancing tentative at aggregated National Accounts level.

For the agricultural industry, inventories could be better measured as quantities and prices indexes are also available at product level together to value indexes in many national statistics.

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