



MŰHELYTANULMÁNYOK
VÁLLALATGAZDASÁGTAN TANSZÉK

☒ 1053 Budapest, Veres Pálné u. 36., 1828 Budapest, Pf. 489
☎ (+36 1) 482-5901, fax: 482-5844, www.uni-corvinus.hu/vallgazd



Vállalatgazdaságtan Tanszék

Developments in global inventory investment

Attila Chikán, Tünde Tátrai

32. sz. Műhelytanulmány
HU ISSN 1786-3031

2003. April

Budapesti Közgazdaságtudományi és Államigazgatási Egyetem
Vállalatgazdaságtan Tanszék
Veres Pálné u. 36.
H-1053 Budapest
Hungary

Developments in global inventory investment¹

Attila Chikán – Tünde Tátrai
Budapest University of Economic Sciences and Public Administration
Budapest University of Economic Sciences
Veres Pálné u. 36.
H – 1053 Budapest
Hungary

Összefoglalás

A műhelytanulmány célja, hogy összefüggést keressen a készletadatok és más GDP komponensek között a makroökonómia szintjén.

A témához kötődő korábbi kutatások rövid összefoglalóját követően hat hipotézis kerül megfogalmazásra, a készletbefektetési ráta tendenciájára és a GDP növekedési rátájával, fluktuációjával, a fejlettség szintjével való kapcsolatára vonatkozólag. Az OECD adatbázison alapuló felmérés 14, a világ legfejlettebb országai közé tartozó gazdaságok adataira fókuszál. Az elemzés eredményeként a hipotézisek nagyjából elfogadásra kerülnek, ugyanakkor az adatbázis minőségével és a használt metodológiával kapcsolatos korlátok következtében az elmélet igazolása nem teljes mértékben megbízható, mely rávilágít a témával kapcsolatos további kutatások folytatásának fontosságára.

Kulcsszavak: készletgazdálkodás, készletbefektetési ráta, GDO összetevők, OECD adatok

Abstract

This paper analyses some of the connections between macroeconomic inventory data and other GDP characteristics. This issue has got until now relatively low interest, though we believe it can be important in understanding macroeconomic phenomena.

After a brief summary of previous research, six hypotheses are formulated regarding tendencies of the ratio of inventory investment to GDP and its relationship with the level of development, growth and fluctuations of GDP. Statistical methods are applied on an OECD database, containing 14 of the most developed economies of the world. The analysis mostly supports the hypotheses, however – due to the limitations by the quality of the database and the methodology used – this support is not very reliable. This calls attention to the need of further research on the subject.

Key words: inventory management, inventory investment ratio, GDP components, OECD data

¹ The article appeared in the International Journal of Production Economics, Vol. 81-82, January 2003, pp.13-26.

1. Introduction: Purpose and objectives of the study

Even though all economists agree, that inventories are important indicators of the nature and dynamics of economic processes, research on the economics of inventories is still relatively scarce. Out of the three major questions of inventory research (namely, the level, structure and fluctuation of inventories), there is only one field where we can claim achieving really substantial results: studying inventory fluctuations. There is a good reason for the relative advancement of this research area: it is the strong connection between business cycles and inventory fluctuations which leads to a very significant direct practical importance of this field.

The purpose of this paper is to throw some more light on the questions related to the general level of inventory investments of various countries. It is easy to see that there is a difference by country in this level, which can be measured with various indicators, the most common – and best explainable – is the annual ratio of inventory investments to GDP .

Seeing the difference in inventory levels we believe, it is a valid question to ask: what are the influencing factors of inventory levels? Our purpose is now to contribute to the understanding of these factors.

From among the several possible approaches to this question (like starting out from examining the behavior of firms or elements of economic policy) we have chosen to see what is the relation between inventory investments and other macroeconomic indicators.

The issue, as any macroeconomic question, however, is extremely complex. Our objective in this paper is therefore rather limited. It is to carry out a statistical analysis using macroeconomic data to answer some important questions about the nature of inventory level and its long term development in a set of the most developed economies of the world.

2. Background: research on inventory trends

After rather sporadic studies of the economics of inventories (from which the works of Eric Lundberg, 1937 and Lloyd A. Metzler, 1941 are outstanding) the first major study dealing with issues related to our subject is Abramovitz (1950). His conclusions, well supported by statistical data, have had a long term influence on inventory research in the decades to come. However, the 1950s were the high time of flourishing of operations research, so even economists like Kenneth Arrow published (very fundamental) works on optimal inventory behaviour at the micro level (See Arrow – Karlin – Scarf (1958) and a summary in Girlich – Chikán, 2000). The Lundberg-Metzler tradition's best known continuation is Lovell (1961). An important collection of papers was published in honour of Metzger (Horwich – Samuelson, (1974).

In recent years we can identify two basic approaches to the analysis of macroeconomic inventory phenomena. A number of papers study the impacts of the behavior of actors of the economy on aggregate macro inventories, making connections between micro and macro processes, while others concentrate directly on macroeconomic phenomena. In their seminal paper Blinder and Maccini (1990) examined the state of the art of macroeconomic inventory analyses and argued that improving the effectiveness of these analyses required the development of better links with microeconomic analyses of inventory behavior. Their paper offers a brief study of the history of macroeconomic analyses of inventories, notes „potential conflicts between theory and evidence” and provides a critical look at the well known production smoothing model. U.S. inventory data are analysed by inventory type, leading to questions about the applicability of the production smoothing model. Blinder and Maccini suggest that the future lies in taking a new look at the (S,s) model, and note that there may be other models which work better than the two which currently dominate macroeconomic approaches to inventory.

Lovell's 1994 „Researching Inventories: Why Haven't We Learned More?” is a direct response to Blinder and Maccini's question. Noting that the fundamental questions

have not changed in four decades, he questions basic assumptions underlying present research. Lovell's remark that („We are not inclined to look at what business firms do, why they do it, and how well it works”), suggests that attempts to do „research on the cheap” may help explain the lack of progress. He concludes with proposing that simulation of complex models may help work out the macroeconomic implications of diverse types of behavior.

Recognizing the importance of the Blinder-Maccini paper in 1994 the ISIR (International Society for Inventory Research) has organized a workshop to discuss the connection of macro and micro analysis of inventories (Chikán – Milne – Sprague, 1994). The workshop was attended by some of the best known researchers of inventories both from the economics and the management science areas and had an extremely interesting discussion, the conclusion of which, however did not go much further than understanding why the two groups talk about very different things and agreeing that further research is necessary. There was no follow up to this event.

The contradicting views are best summarized in Sprague and Wacker (1994) who look at inventories from the perspective of „non-economists who do specialize in inventory research ... seeking contradictions and links between microeconomic managerial behavior and macroeconomic outcome”. Citing inventory as the „graveyard of American business” they conclude, nonetheless, that inventories are not managed but are controlled at „highly disaggregated levels”. They also state that managers employ neither the production smoothing concept nor the (S,s) model in practice. In their summary, Sprague and Wacker concur with Blinder and Maccini that study of disaggregated inventories may yield greater insight into their behavior, particularly if new explanatory models can be developed for each of the separate inventory aggregates.

Another mainstream of research on macroeconomic inventories is based on studying interconnections between various macroeconomic indicators and inventories. Tobin (1988) examined the interconnection between income taxation, inflation and

inventories and the difference of the impact of income taxes and inflation on inventories and on fixed capital investment. Waters (1989) studied the role of manufacturing in inventory buildup in the UK, evaluating it on the basis of international comparison using various macroeconomic performance indicators. Abel and Székely (1990) find a strong connection between policies and inventories in the centrally planned economies and that change in import supply does not prove to be a cause of fluctuation of import inventories. Fiorito (ed, 1994) contains a number of related papers, mostly concerned with the dynamics of inventory fluctuations, making only some hints about long-term trends of inventory investments.

An important line of research looks for connections between elements of monetary policy and inventories. Louri (1996) summarizes research on the effects of inflation rate and interest rate on inventories (mainly via the changes in carrying costs). It is important to note that there is no agreement among authors about the existence of such an effect.

It is interesting to observe that since the very beginning of studying macroeconomic phenomena, very few studies dealt with the question: how inventory developments look like in various countries and what are the main macroeconomic factors influencing their formation. One of the authors of this paper has spent considerable time and efforts since the beginning of the 1980s to explore macroeconomic inventory behaviour. In Chikán, 1981, the main conclusion was that there is some stability of inventory trends in most countries, depending on some characteristics of the particular economies. The most important result was probably showing – based on the distinction between the „push” and „pull” markets by Kornai (1971) – that planned economies by rule accumulate far higher inventories than market economies. Furthermore statistical evidence was provided (with data from 117 countries) that there is no significant correlation between the level of development of a country (measured by per capita GDP) and inventory investments. Chikán-Kalotay-Paprika (1986) contains an analysis of connections between country characteristics (measured by data of GDP use) and inventory investment.

In Chikán (1996) we have found that despite of the many success stories published in the international literature about development of inventory methodology (MRP, JIT, etc.) at the company level, it is at least uncertain that there was a tendency in the developed countries to decrease inventories at the macro level.

In Chikán – Horváth (1999) a family of econometric models were used to evaluate the connection between various macroeconomic indicators and inventory investments, leading to a rather vague conclusion, saying that no strong statement can be made about the relationship of economic development and inventories. An interesting result of this paper is that variances of the variables play a key role in the interpretation of results.

3. Scope, limitations and hypotheses of the research

Our research is aimed to examine a few fundamental questions of macroeconomic inventory behaviour.

Namely, it deals with

- the trends and variances of aggregate inventory investments and
- the connection between economic development, growth and inventory investments.

We believe that the indicator {inventory investment (in some publications „increase of stocks”) per GDP} is the most appropriate one for characterizing aggregate inventory behavior of the various countries, for two reasons:

- It has a very clear economic interpretation: the proportion of annual GDP invested into inventories.
- On the long run its cumulative value determines the inventory position of the country.

The analysis is limited to 14 of the world's most developed economies, all OECD members, for which we had appropriate data.

We have used the National Accounts Statistics of the following 14 countries (in alphabetical order):

Belgium	Germany*	Spain
Canada	Ireland	Sweden
Denmark	Italy	United Kingdom
Finland	Japan	United States
France	Netherlands	

*West Germany until 1990

Our analysis is based on annual data, since no quarterly or monthly data were available in inventory statistics of OECD. This is of course a limitation, since inventories fluctuate considerably within a year. However, we believe that for our main objective – to see the long term tendencies – this data set is acceptable, it does not cause major judgment errors.

The main limitation of the research follows from the nature of macroeconomic inventory statistics. Many authors call attention to the difference and sometimes uncertain contents of calculating macroaggregates of inventories in the various countries. Because of this we have to be very cautious in the interpretation of results. Also, this is the main reason why we believe that the use of sophisticated methods for analysis will not necessarily lead to better (i.e. less uncertain) results.

Another – deliberately accepted – limitation is that we consider only a set of the most developed countries in this research. In previous studies we examined a larger and more heterogeneous sample (Chikán-Kalotay-Paprika, 1986 and Chikán, 1994). This time we wanted to see, how the trends come through in a more homogenous group.

Considering our objectives and limitations, we formulated the following hypotheses for our research:

H1: The level of inventory investment, measured by the ratio of increase of inventories / GDP, is relatively stable for the particular countries and serve as a kind of norm, around which the annual data fluctuate within a stability region.

H2: These norms of inventory investments have a decreasing trend in the developed world.

H3: The variance of annual inventory investments in various countries is decreasing in time, i.e. the countries of the developed world are getting closer to each other.

H4: The level of inventory investments are in adverse relationship with the level of development (measured by per capita GDP) i. e. more developed economies have lower inventory investment ratio.

H5: The faster is the growth of the economy, the larger inventory investment it goes together with, i.e. higher growth demands higher inventory investment.

H6: The variance of inventory investment relative to the variance of detrended GDP is decreasing over time, but this decrease is slower than that of the level of inventories.

In the following the above hypotheses are examined.

4. Inventory investment ratio, as a characterizing norm of economies

We share the view of Kornai (1971,1980) that some macroeconomic indicators have a relatively stable „norm” for the various economies and periodic fluctuation goes on „around” this norm. The value of these norms is derived from some structural characteristics of the economy (like its institutional system, market and industry structure, level of economic development, etc). These norms are standard for some period of development, then of course they can change – depending on the changes in those characteristics of the economy, which influence them. Norms serve as regulators of economic processes which have a tendency to maintain these norms on the long run.

The concept of norm is related to the equilibrium parameters used in macroeconomics. However, there are fundamental differences in their conceptual contents: equilibrium

is considered as a desirable state of affairs, while norms can be valued both positively and negatively (like, for example such “norms” as usual demand filling rate or time of various products – which can be very different by country)

Inventory intensity of a given economy is such a norm. If this is true, some economies have over a longer period of time larger, some others smaller inventory intensity. In some earlier publications it was clearly proven (Kornai 1971;1980 Chikán, 1981) that planned economies had much higher inventory investment norms than market economies and that with the transition in the early nineties their norms have changed relatively fast, shrinking to the level of market economies.

It is an interesting question whether we can find differences in inventory norms among the most developed economies. There are obvious differences in the characteristics of these economies, some of them - according to a purely speculative analysis - may lead to deviating norms of inventory intensity. In this chapter we take a look at the data we have and see if some behavioral regularities can be discovered.

Figure 1. Average inventory investment/GDP in various countries (1968-97)

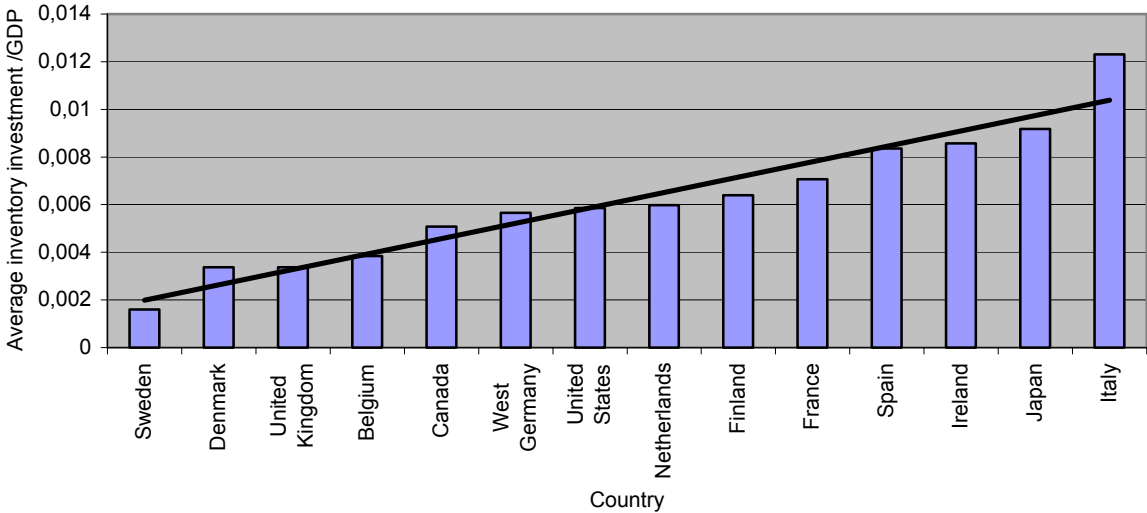
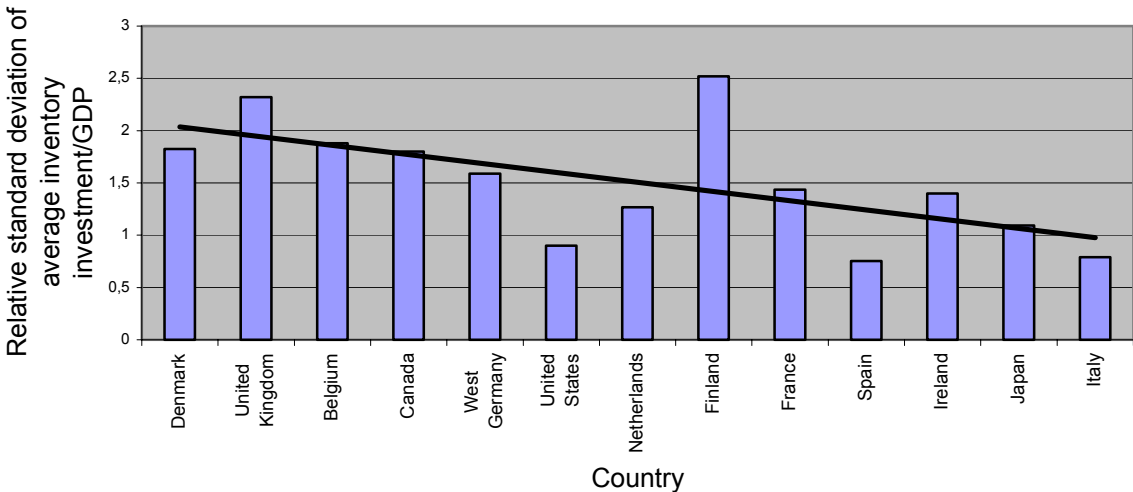


Figure 1 shows that there is a considerable difference between the lowest and the highest ratios of the 30 year average of inventory investment ratio to GDP in the group of countries we study: the ratio in Sweden is more than six times lower that that of in

Italy. Also, it is clear that values of the other countries are distributed relatively evenly between the two extremes. (It should be noted here, that the same indicators in the planned economies used to be several times higher than the highest value here, clearly indicating that the two groups of countries had been separate by their characteristics. It is clear also here that the differences in statistical calculation of inventory investments in the various countries may be responsible for at least some of the differences. However, our previous studies indicate (Chikán, 1994) that the differences in statistical methodology cannot be blamed on the long run differences in the inventory investment ratio.

So we can accept that there is a difference between the level of inventory intensity – we should examine now, how stable are the "norms" in the various countries. Figure 2 provides an important input for this analysis: it shows the relative standard deviation of the inventory data in the fourteen countries. One can see that leaving out Sweden as an outlier, relative fluctuation of inventories is rather standard (the line indicating the tendencies is almost horizontal) - we can consider that as an argument for the stability of norms.

Figure 2. Relative standard deviation of average inventory investment/GDP in various countries (1968-97)



We have carried out an other type of analysis as well. For each countries the moving averages of the inventory investment ratio were calculated using two different time

periods (3 and 5 years) for these averages. Comparing these tendencies one can see that the ranking of countries do change only very little over time: countries have higher or lower averages throughout the 30 year period examined.

The above results - suffering from the immanent uncertainty of data - can be considered as weakly validating our H1 hypothesis.

5. Inventory investment trends and fluctuations

Annual data of inventory investment / GDP are summarized in Table 1. The same data are plotted on Figure 3, which of course cannot be used for identifying the trends of the individual countries, but very clearly shows that both the average and the standard deviation of the individual countries from this average shrink.

Figure 3. Inventory investment/GDP in various countries (1968-97)

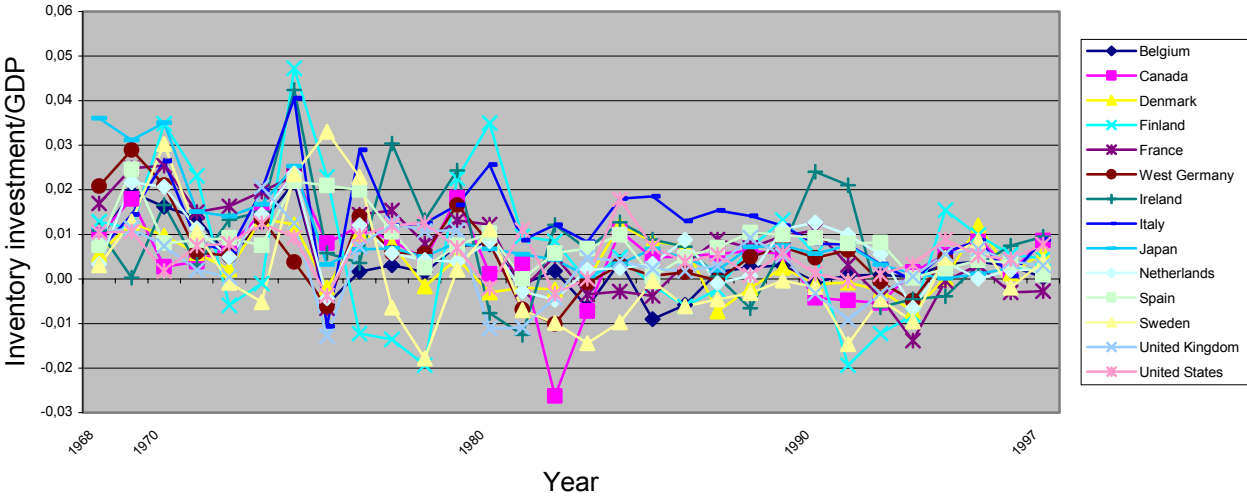


Figure 3 indicates that both the linear and polinomial trends are decreasing. The polinomial trend gives a better fit, mainly because of the sharp decrease at the beginning of the period and the drop in the beginning of the 90's.

This result provides a new answer to on old research question. In Chikán (1994) we had a different conclusion regarding the data from 1975 to 1989. There we said that there is no clear trend in the inventory investments in the developed countries and

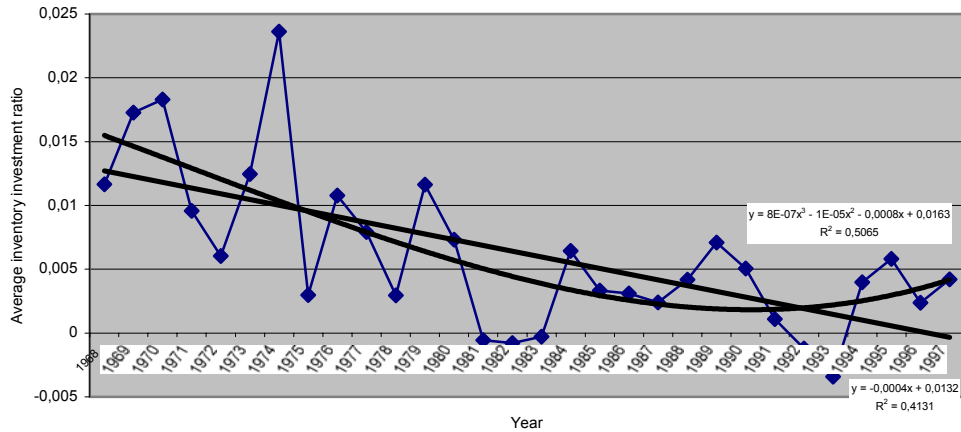
found several factors which push inventories upwards, balancing out the effects of the more and more efficient inventory management methodology. Now the trends seem to be clearly decreasing, even if we admit that after the sharp drop of the inventory investment ratio in the early 1990s, since then we actually have experienced an upward turn. No wonder, changes in the global economy are reflected in the fluctuating inventory investment ratio (actually, we can see that the inventory cycle is alive and well, but we do not go into that in this paper).

These results quite clearly indicate that there is a not too strong but definite tendency to decrease inventory investment, which can be observed not only in the main aggregates but also in the majority of individual countries.

The existence of the trend seen on Figure 4 is supported by analyzing the trends of the individual countries. We have calculated linear, logarithmic, quadratic and cubic trends, out of which the first two have given far better results. The main parameters of the analysis can be found in Appendix 1, for all the 14 countries plus for the average and the standard deviation of the 14 countries. The results can be interpreted as follows.

- The trend is decreasing for all countries.
- The regression coefficients of both the linear and the logarithmic trends are all negative (indicating a declining trend) and they are significant at the 5 % level in the majority of cases (8 out of 14). The coefficient of the average inventory ratio (see Figure 4 and the last but one row of Appendix 1) is also significant. The values of the R^2 and the Durbin-Watson statistics are more supportive.

Figure 4. Average inventory investment ratio of the 14 countries (1968-97)



What is at least as interesting as the analysis of the trends of the ratios, it is the examination of the standard deviation, as a measure of fluctuation, of the country data around the total average (Figure 5). This shows that the fluctuation is decreasing, which means that the country data are getting closer and closer to each other. This statement is supported by the results in the last row of Appendix 1. which indicate that there is a declining trend of the standard deviation. We consider the decreasing difference between various countries' data as an effect of globalization, in other words, a consequence of convergence of operation characteristics of the leading industrialized economies. This tendency is well observable also on Figure 6, which shows the inventory behaviour of the "triad": North America, Europe and Japan - they have got as close to each other as possible.

(There seem to be a slight - two years - time delay in Japan's behaviour in the 1990s.) It is very seldom that the unifying effect of globalization shows up in such a clear way.

Figure 5. Standard deviation of inventory investment ratio (1968-97)

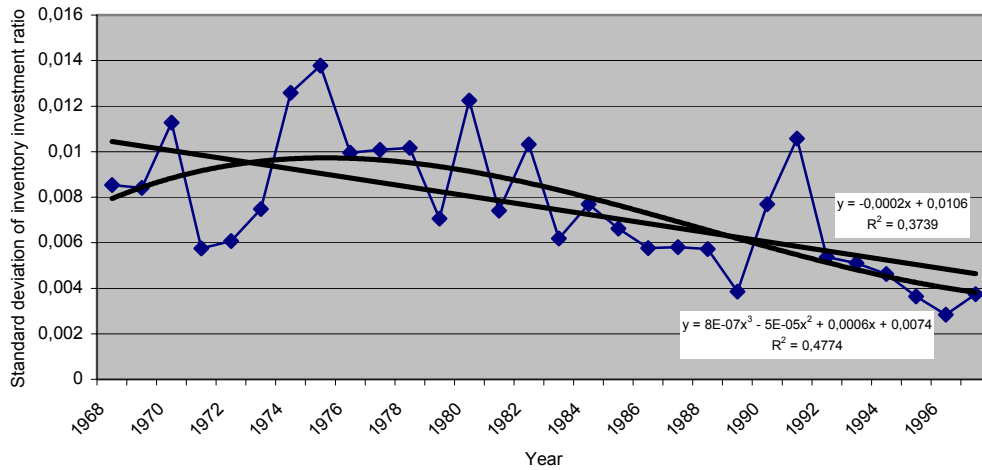
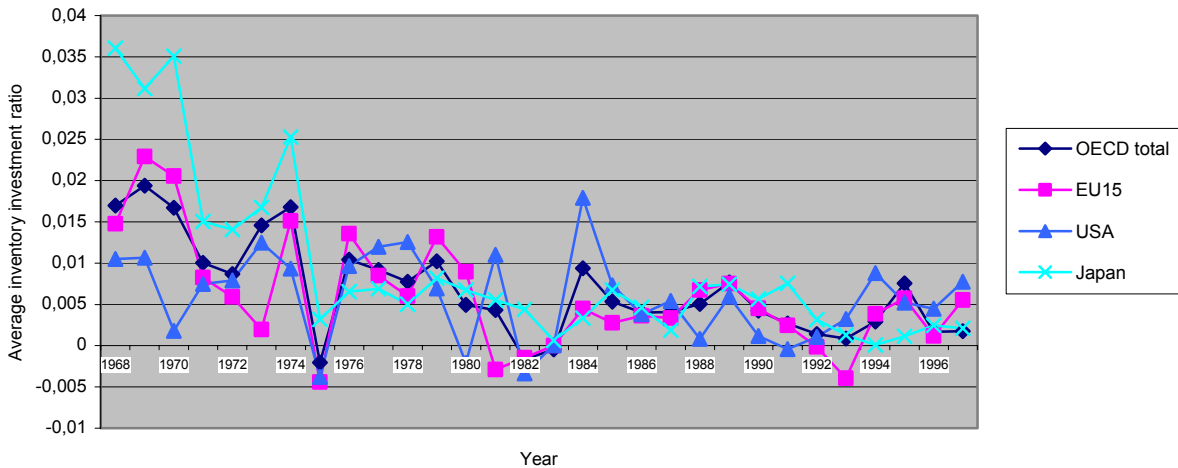


Figure 6. Average inventory investment ratio



6. Inventories and country characteristics: level of development, growth and volatility

The study of influencing factors of inventory investments at the macroeconomic level should certainly start with looking at the level of development and the speed of growth of the country's economy as the most aggregate factors. In the following these two characteristics are examined. Since on the long run there is an obvious connection between the two, some common conclusions can be drawn.

6.1 Inventories and level of development

A look at Figure 7 is clearly indicating that there is no strong correlation between long-term inventory investment level and the level of development (measured by the average per capita GDP over the 30 year period). The size of the data set here does not make it possible to calculate a correlation, but the figure is self explaining. This statement corresponds to several previous studies which also concluded similarly.

Figure 7. Connection of average per capita GDP and inventory investment ratios

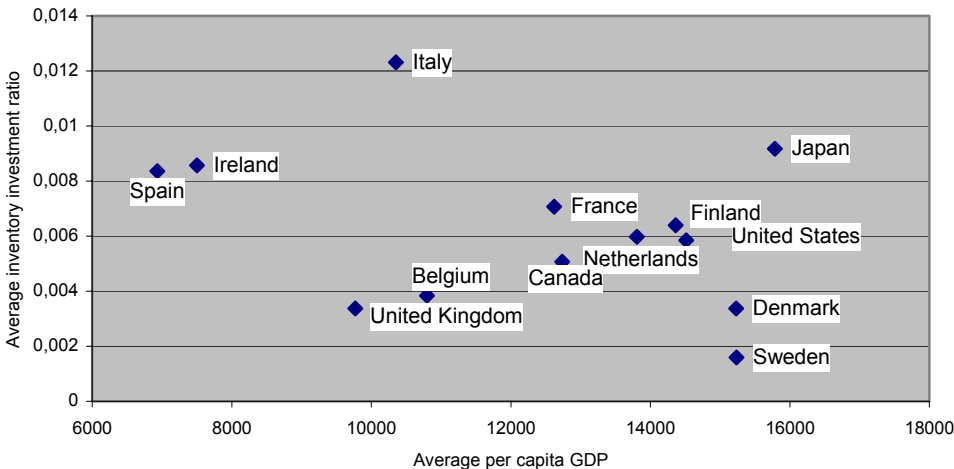
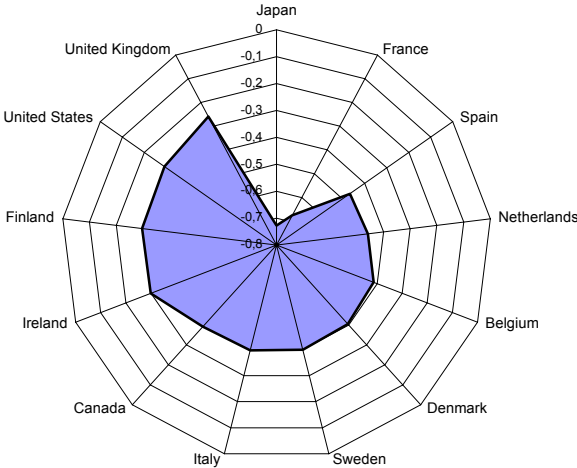


Figure 8. Correlation between per capita GDP and inventory investment ratio



However, there is an interesting conclusion if we calculate the correlation between the year by year data of inventory investment ratio and per capita GDP. Figure 8 shows that there is a medium to strong negative correlation between the two variables in the

various countries (the highest values are -0.72 for Japan and -0.67 in France, while the lowest is -0.28 and -0.45 for the UK and Spain, respectively).

The definite negative correlation indicates that the more a country moves towards higher development, the less inventory it needs. It must be mentioned here that the per capita GDP data contain a strong trend, which could not be filtered in the analysis and may disturb the specific data, but - according to our judgement - not the final conclusion. This negative correlation is supported by studying the countrywise regression functions, which puts the connection of the two variables into a time dimension.

The above result (which is characteristically different from our previous conclusions) is an important addition to further studies on long term influencing factors of inventory investments.

6.2 Inventories and growth

The long term connection between inventories and growth can be seen on Figure 9 which indicates a clear but not too strong connection: higher average growth rate goes together with higher inventory investments. This conclusion is supported by data on Figure 10, which gives us the correlation coefficients between annual inventory investment ratio and GDP growth rate of the 14 countries over the 30 year period. This figure shows, that in most of the countries (except three) the correlation is positive. However, the conclusion is less stable than it was for the connection between inventories and development, since the variance of correlations is far higher here.

Figure 9. Average GDP growth rate and Inventory investment ratio

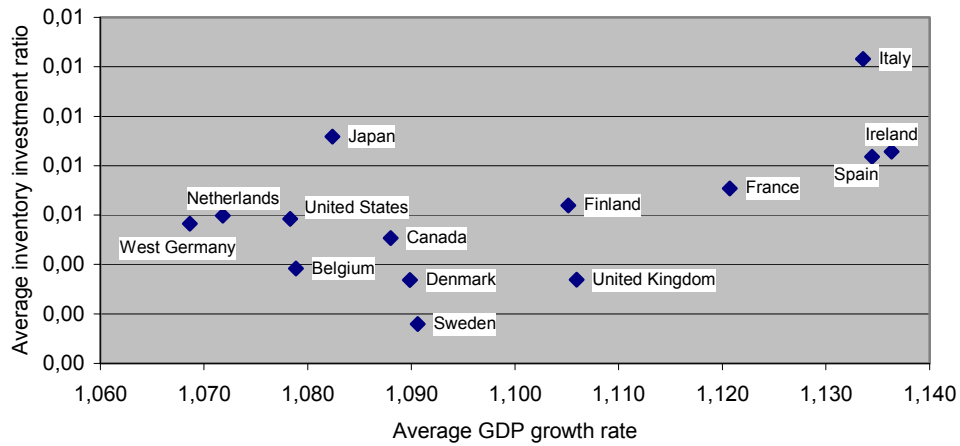
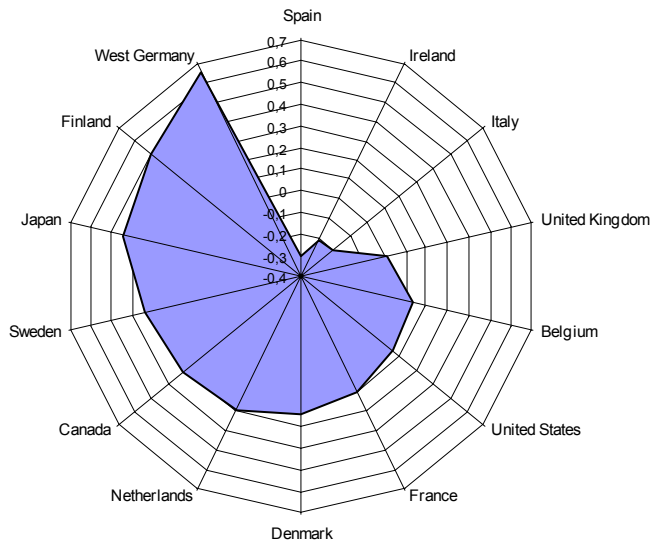


Figure 10. Correlation between GDP growth rate and inventory investment ratio



6.3 Inventories and the volatility of the economy

The fluctuation of inventories have got far more attention in the academic literature than their level. It is understandable: inventories, as probably the most important indicators of short-term business cycles, play their fundamental role in the economy via their ability to fluctuate faster than most other components of the economy.

Not going into the studies of inventory cycles here (which requires a different approach taken in this paper), we draw a picture of some of those conclusions which regards inventory fluctuations as seen from the overall perspective of this paper. (We

are grateful to Professor Louis Maccini for calling our attention to the importance of this approach.)

If one compares the variance of inventory investment with that of GDP, can get an indication of the importance (share) of volatility of inventory investment in the volatility of GDP - which is an important indicator of the role of inventories in business cycles.

Figure 11 captures this relationship. It shows that there is a relatively large difference by country: while the ratio is practically zero in Germany, the highest one is slightly over 0.05 (in the US).

Figure 11. Variance of inventory investment/variance of detrended GDP in various countries (1968-1997)

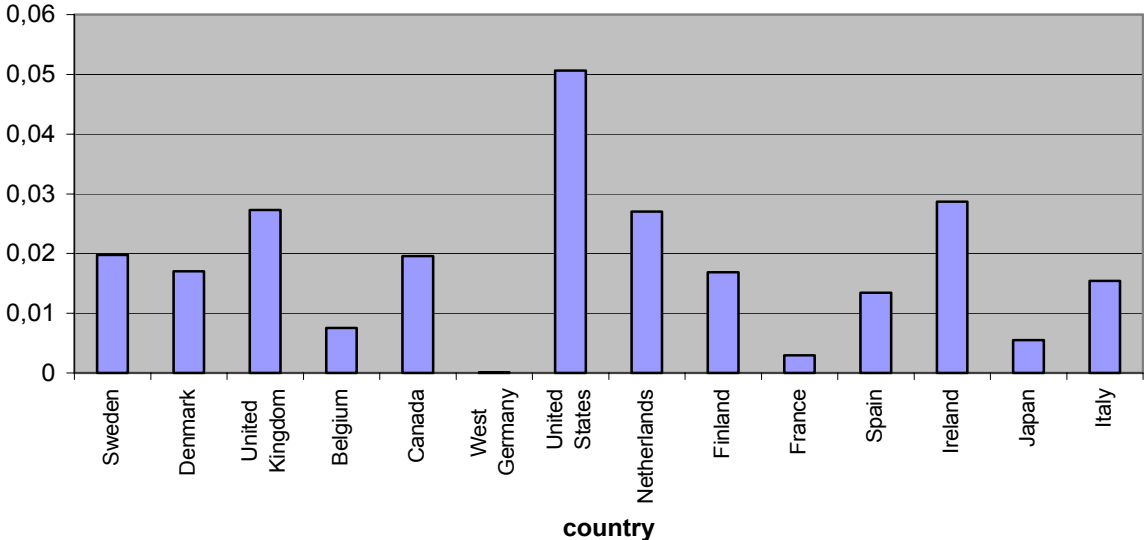
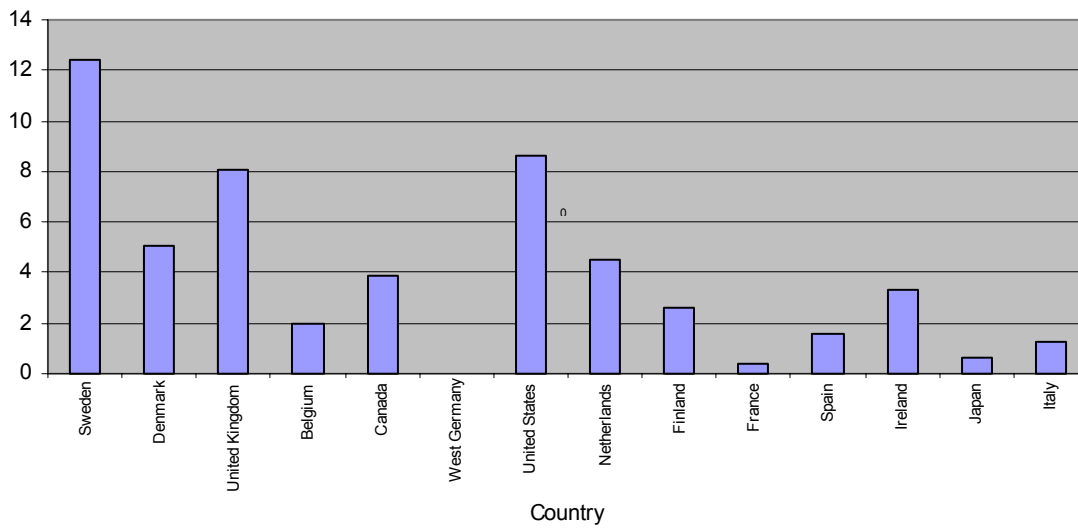


Figure 12 shows the relationship of the above volatility index to the size of inventory investment per GDP, i.e. measures whether the relative volatility of inventory investment is increasing or decreasing with the inventory investment ratio. It is interesting to see that the importance of volatility seems to be higher in those countries where there is a relatively lower inventory investment ratio. Technically it is a consequence of the fact that the relative deviations of inventory investment ratio is larger than those of the variance measures (especially if the two outliers, USA and Germany are excluded). Economically it may mean that those countries where inventories are at a relatively lower level, are more sensitive to fluctuations. However, these issues need further investigations.

Figure 12. (Variance of inventory investment/variance of detrended GDP in various countries)/Average inventory investment ratio (1968-97)



Furthermore it is interesting to see, what kind of trend of this indicators can be discovered. Such an analysis discloses whether there is a rising or declining role of inventories in business cycles. Because of the relative shortness of our time series, we used just a comparison of the first and second half of the period to see the main tendency.

Figure 13. Variance of inventory investment/variance of detrended GDP in various countries: change between 1968-82 and 1983-97

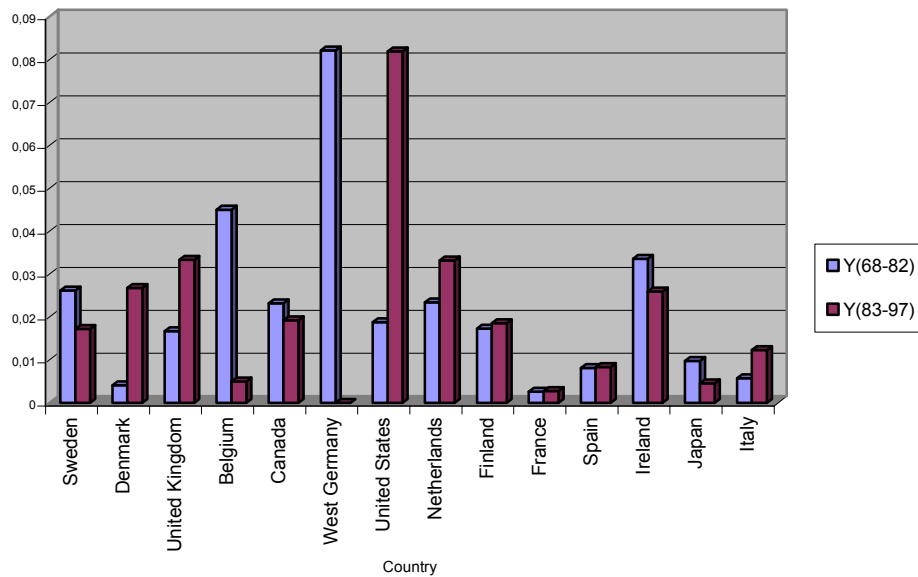
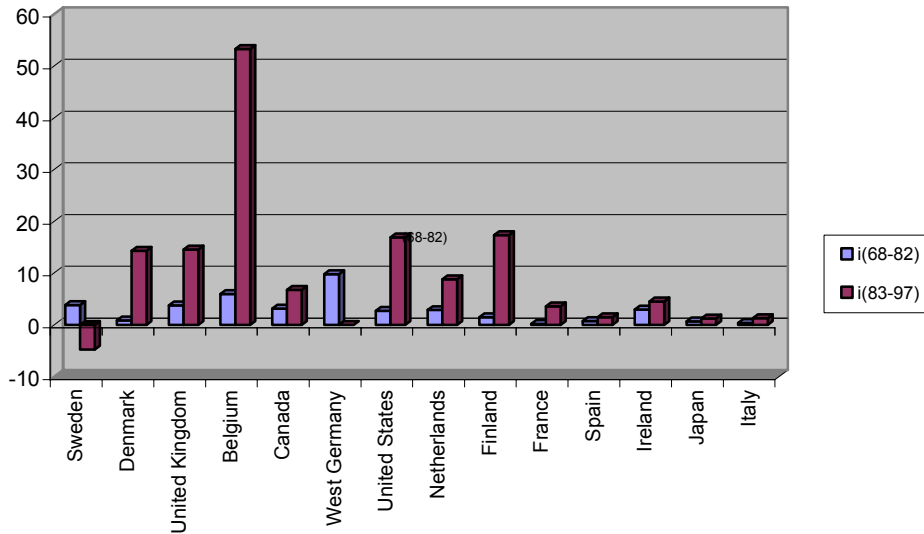


Figure 14. (Variance of inventory investment/variance of detrended GDP in various countries)/Average inventory investment ratio change between 1968-1982 and 1983-97



It can be seen on Figure 13 that while there are relatively large differences between the changes in various countries (e.g. the ratio has dramatically decreased in Germany while there was an almost identically large increase in case of the USA), the total average of the 14 countries did not change a lot. This directly leads to a sharp decrease of the importance of volatility relative to the size of inventories, since the latter have declined in the last decades. (Figure 14). It is worth noting that the two statements made about the importance of volatility relative to size of inventories (i) across countries and (ii) through our time period logically support each other.

Conclusion

Our paper's objective was to develop some theses about inventory investment trends across 14 countries and over a 30 year time period. The ambiguity of the data base and the relatively small sample size and the lack of research background on the subject made us to limit our approach to elementary statistical evaluation.

We had formulated six hypotheses for our analysis. The results are mostly supportive, but this support is not very often strong.

H1 is about the level of inventories as a characterizing factor of the economy – here we see that the ranking of countries by their inventory investment ratio and also the fluctuation of standard deviation by countries are rather stable. However these are

soft measures, so H1 is only weakly supported by our analysis. Our methodology did not provide conclusions regarding the norms of fluctuations.

H2 is strongly supported: inventories relative to GDP tend to decrease in the developed countries. This result is important, all the more since in our previous studies we did not manage to show this relationship.

The validity of H3 is probably the most interesting result of the analysis: it tells that inventory investment characteristics of the various countries converge.

H4 and H5 captures the relationship between inventory investment ratio and (i) level of development, (ii) growth dynamics. We mention them together, because – though the results of both are interesting in themselves – there is an important contradiction between the two: higher development goes together with lower inventories, but higher growth (which is an important factor of catching up) goes together with higher inventories. This contradiction is between status and dynamics and needs further investigation.

H6 can provide some input for inventory cycle analysis. It tells us that as the ratio of inventory investment to GDP decreases, variance of inventories still remain important even if at a lesser and lesser degree compared to the variance of GDP. This result is logical, but it can lead to interesting implications regarding business cycles, especially if other components of business fluctuations are involved in the analysis.

All in all, we believe that our analysis led to interesting results and that it is important to continue analyzing statistics of macroeconomic inventory data.

References

- Abel, I.-Székely, I. (1990): Credit, Imports and Inventories in CPEs (Causality Test for the Hungarian economy)
In: Chikán, A. (ed, 1990) Inventories: Theories and Applications, Elsevier Science Publisher, Amsterdam, etc, 11-18 pp
- Abramovitz, M. (1950): Inventories and Business Cycles. New York, National Bureau of Economic Research
- Arrow, K. J.-Karlin, S.- Scarf,H. (1958): Studies in the Mathematical Theory of Inventory and Production. Stanford University Press, Stanford, California
- Blinder, A. S.-Maccini, L.J. (1990): The Resurgence of Inventory Research: What Have We Learned?
NBER Working Paper, No 3408 August
- Chikán, A. (1981) Market disequilibrium and the volume of stocks.
In:Chikán,A. (ed. 1981) The Economics and Management of Inventories. Elsevier Scientific Publishing Company, Amsterdam and Akadémiai Kiadó, Budapest 73-85 pp
- Chikán, A. (1994) Judging global inventory trends: a connection of macro and micro analysis. In: Chikán-Milne-Sprague, 1994 133-141. pp
- Chikán, A.-Kalotay, K.- Paprika, Z. (1986) Macroeconomic Factors Influencing Inventory Investments – An International Analysis. In: Chikán, A. (ed.): Inventory in Theory and Practice. Elsevier Scientific Publishing Company, Amsterdam and Akadémiai Kiadó, Budapest, 55-71.pp
- Chikán, A.-Lovell,M. (eds 1988): The Economics of Inventory Management. Elsevier Scientific Publishing Company, Amsterdam, etc.
- Chikán, A.-Milne, A.- Sprague, L.G. (1994): Reflections on Firm and National Inventories, International Society for Inventory Research, Budapest
- Chikán, A.-Horváth, Cs. (1999): A multi-country analysis of aggregate inventory behavior. International journal of Production Economics, Vol.59 No 1-3, 1-11 pp
- Fiorito, R (ed, 1994): Inventory, Business Cycles and Monetary Transmission. Springer-Verlag, Berlin etc.

- Girlich, H-J.-Chikán, A. (2001) The origins of dynamic inventory modelling under uncertainty (the men, their work and connection with the Stanford Studies). *International Journal of Production Economics*, Vol.71, 351-363 pp
- Horwich, G.- Samuelson, P.A. (1974): *Trade, Stability and Macroeconomics (Essays in Honor of Lloyd A. Metzler)*, Academic Press, Inc. New York and London
- Kornai, J. (1971) *Anti-equilibrium*. North Holland Publishing Co. Amsterdam
- Kornai, J. (1980) *The Economics of Shortage*. North Holland Publishing Co. Amsterdam
- Louri, H (1996): *Inventory Investment in Greek Manufacturing Industry: Effects from participation in the European market*. *International Journal of Production Economics* 46, 47-54 pp
- Lovell, M.C. (1961): *Manufacturers' Inventories, Sales Expectations and the Acceleration Principle*. *Econometrica* Vol. 29, No 3 (July) 293-314 pp
- Lovell, M.C. (1994): *Researching Inventories: Why Have Not We Learned More Engineering Costs and Production Economics*, Vol. 35, 33-41 pp
- Lundberg, E. (1937): *Studies in the Theory of Economic Expansion*, Velly and Millman, New York
- Metzler, L. (1941): *The Nature and Stability of Inventory Cycles*. *The Review of Economic Statistics*, Vol. 23, No 1, February, 113-125 pp
- Sprague, L.G.-Wacker, J.G. (1994) *Microeconomic Underpinnings of Macroeconomic Analyses of Inventories*. In: Chikán-Milne-Sprague (1994)
- Tobin, J. (1988) *Inventories, investment, inflation and taxes* In Chikán-Lovell (Eds. 1988), 285-304 pp
- Waters, C.D.J. (1989): *Stock Holding of Manufacturing Industry within the United Kingdom*. In: Chikán, A. (ed, 1989): *Progress in Inventory Research*, Elsevier, Amsterdam, etc. 127-132 pp
- National Accounts Main Aggregates 1960-97 (1998) OECD
 National Accounts Main Aggregates 1970-97 (1999) OECD
 National Accounts 1983-95 (1997) OECD
 National Accounts 1984-96 (1998) OECD

Appendix 1.

Evaluation parameters of trend calculations

Country	Linear trend			Logarithmic trend		
	R ²	P	DW	R ²	p	DW
Belgium	.2947	.0019	1.602	.3880	.0002	1.892
Canada	.1152	.0666	1.454	.1265	.0537	2.300
Denmark	.1508	.0339	1.685	.1746	.0216	2.437
Finland	.9584	.0960	1.470	.1036	.0828	1.488
France	.5094	.0000	1.685	.5031	.0000	1.744
(W) Germany	.2930	.0035	1.229	.4429	.0002	1.306
Ireland	.0735	.1472	1.822	.0397	.2911	2.155
Italy	.1219	.0586	2.663	.0472	.2487	1.776
Japan	.5498	.0000	.847	.7832	.0000	1.424
Netherlands	.1991	.0134	1.856	.2095	.0110	1.942
Spain	.2861	.0023	1.610	.2236	.0083	1.922
Sweden	.1663	.0253	1.155	.1862	.0173	1.787
UK	.0757	.1413	1.497	.1086	.0755	1.754
USA	.0718	.1523	2.118	.0794	.131	2.359
Average	.4131	.0001	1.753	.4456	.0001	2.396
Standard deviation	.3742	.0003	1.513	.2008	.0130	1.341

R²: coefficient of determination

p: significance level of t test of x (inventory investment ratio)

DW: Durbin-Watson test

Bold figure means regression parameter is not significant