

# Do Wild Fluctuations in Quarterly Inventory Investment Data Matter?: A Study of the Japanese GDP Statistics, 1994-2010

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## Abstract

- For more than half a century, inventory investment has attracted wide attention as a major cause of short-term macroeconomic fluctuations, and the mechanisms involved have been the focus of many major studies.
- Yet microeconomists and business people familiar with corporate behavior have frequently expressed misgivings about the enterprise.
- Using Japanese quarterly GDP inventory investment statistics both by commodity and by category, 1994~2010, I investigate the nature of quarterly inventory statistics and the inventory investment behavior, and draw two conclusions.

## Two Conclusions

- First, statisticians estimate the quarterly statistics under severe time constraints, and their resulting figures incorporate seasonal variations which dominate the quarterly fluctuations. This fluctuation mostly disappears in annual data.
- Secondly, when I examine the inventory variation after the Lehman Shock in the autumn of 2008, I find neither a notable increase in inventory stock nor a long-run stock adjustment process. Given the size of this unforeseen exogenous shock, most observers expected a large inventory stock accumulation to follow. That the accumulation did not follow suggests that the focus on inventory variation may be misplaced.

# Implications

- For inventory investment data estimation, Japan is an ideal OECD country, with generous statistics availability. The conclusions of this research, drawn from the quarterly GDP inventory statistics, will stimulate the interest both in the study of inventory data in other countries focusing on its estimation process and source statistics, and in the great variety of inventory investment.
- At the same time, the conclusions pose a grave implication not only for re-evaluation of the literature in inventory investment variations but also for other research topics in macroeconomics like monetary transmission mechanisms including “financial accelerator” theory, and also “financing constraints”, and New-Keynesian models...
- Even to the views of the market mechanism and its evaluations

# The dominant view

- Symbolically since “Metzler’s(1941) illuminating analysis of the inventory accelerator process and Abramovitz’s(1950) fundamental empirical analysis of inventory behavior” (Feldstein and Auerbach, 1976, pp.351-2), inventory investment has attracted wide attention of macroeconomists as a major cause of short-term macroeconomic fluctuations, and the mechanisms involved have been the focus of many major studies.
- Wen [2005, p.1534] begins: “Understanding inventory fluctuations is a key step towards understanding the business cycle. Blinder and Maccini (1991) show that the drop in inventory investment accounts for 87% of the drop in total output during the average postwar recession in the U.S.” Also see his survey article, Wen [2011], in *American Economic Journal: Macroeconomics*.

# Cont.

- Studies of past quarterly data often conclude that too high or too low inventory stock took on average 8 or 12 quarters for adjustment, with which the processes and mechanisms involved have attracted wide attention. Also the financial accelerator theory emphasizes as a monetary transmission mechanism the effectiveness of transmission channel through inventory variations.
- Referring to Table 5.2 Behavior of the components of output in recessions (p.191), the only place he focuses on inventory, Romer (2012) writes: “even though inventory investment on average accounts for only a trivial fraction (0.6%) of GDP, its fluctuations accounts for close to half of the shortfall in growth relative to normal in recessions: inventory accumulation is on average large and positive at peaks, and large and negative at troughs.” The average share in GDP was 0.6%, and the average share in fall in GDP in recessions relative to normal growth was 44.8%.

# Misgivings?

- Studies of mechanisms in inventory investment fluctuations, primarily using quarterly GDP statistics, have been under severe constraints in data availability.
- Many inventory studies use another type of data set on manufacturing firms' inventory, which provide no information on inventories non-manufacturing firms hold, for example, distributors' inventory of manufactured products or non-manufacturing firms' raw material stock and goods-in-process inventory.
- Blinder and Maccini [1991] conclude that the size of the latter is larger than the former.
- Most studies of inventory investment use the US data. The OECD dataset suggests that the data availability condition seems basically similar everywhere.

## Cont.

- Of their five basic characteristics of the inventory data, Feldstein and Auerbach [1976, p.356] points, “[T]he first, of particular importance, is that even major changes in inventories represent the outputs and inputs of only very short time periods”, raising questions about the dominant view that the adjustment of too much (or too small) inventory stock takes eight or twelve quarters.
- However, Feldstein and Auerbach[1976] use *Survey of Current Business* and the corresponding value of inventories of materials and goods in process is obtained by subtracting real finished-goods inventories from the value of total durable-goods manufacturing inventories reported in the national income accounts (p.353).
- Yet, no other paper than mine has asked: “what will happen if the estimation method, process, and source statistics are major causes of wild inventory fluctuations in quarterly GDP statistics?”



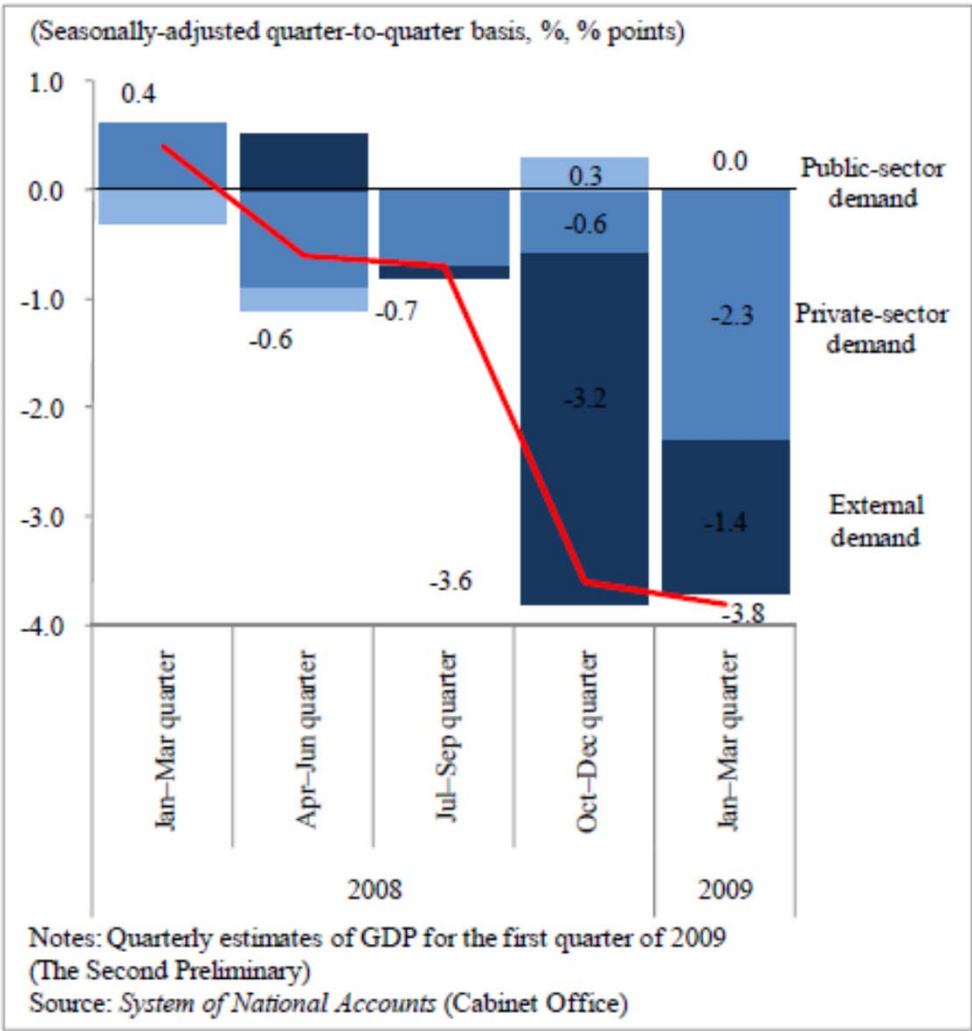
# Schedule

- (1) Aperitif: The Japanese Economy around the Period of Lehman Shock
- (2) Inventory (Investment) and Inventory (Investment) Statistics
- (3) Quarterly SNA(GDP) Inventory Investment Statistics and its Regular Seasonal Fluctuation
- (4) Inventory Investment Behavior around the Period of Lehman Shock.
- (5) Implications and Conclusion
- (6) Bonus, or a Tragic Comedy as Appendix?

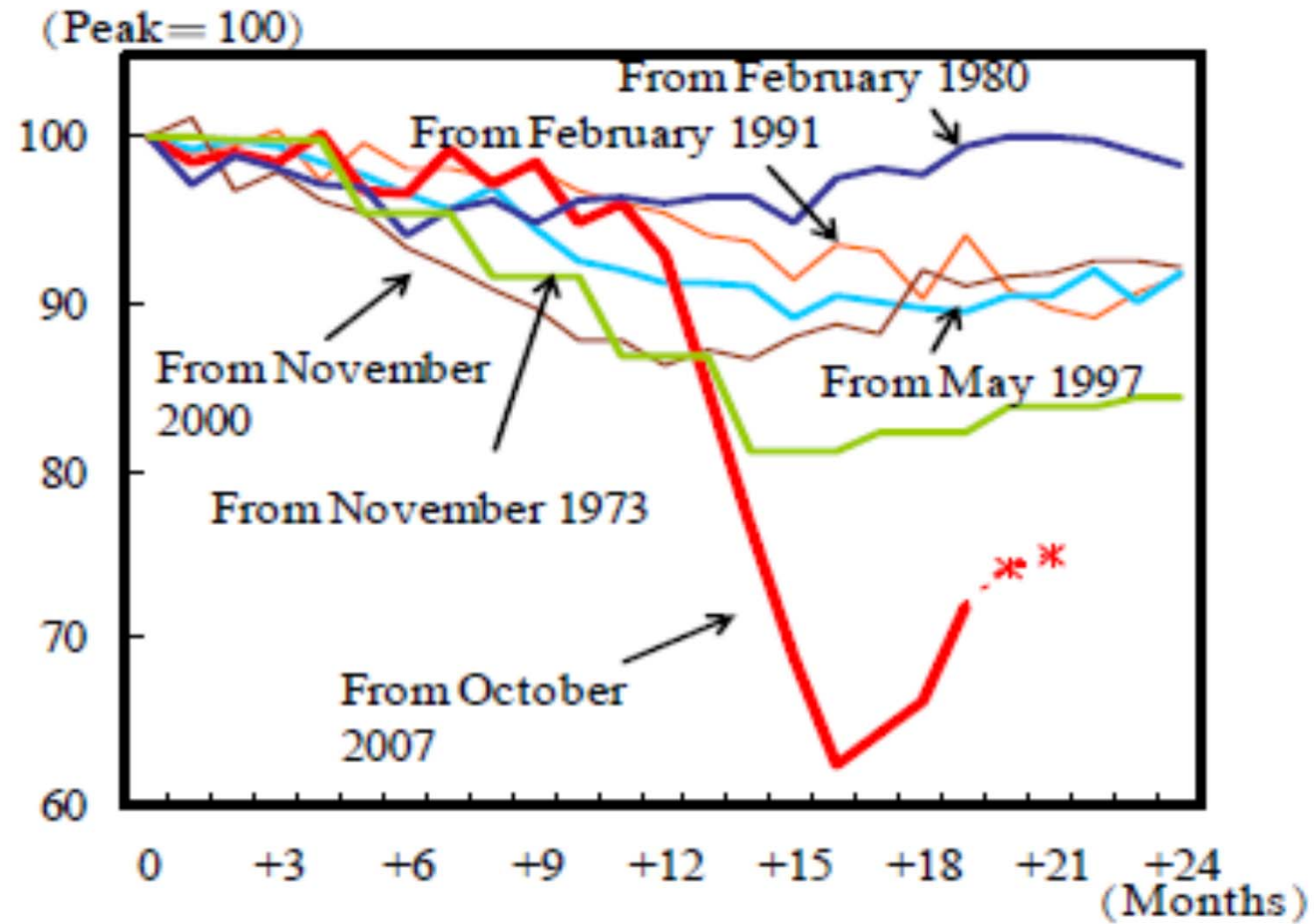
# (1) Aperitif: The Japanese Economy around the Period of Lehman Shock (p.12)

- The Japanese Economy around the Period of Lehman Shock: unexpected (unforeseen) event as an exogenous shock
- IIP (Indices of Industrial Production) and etc.
- Export- vs. Domestic Shipment

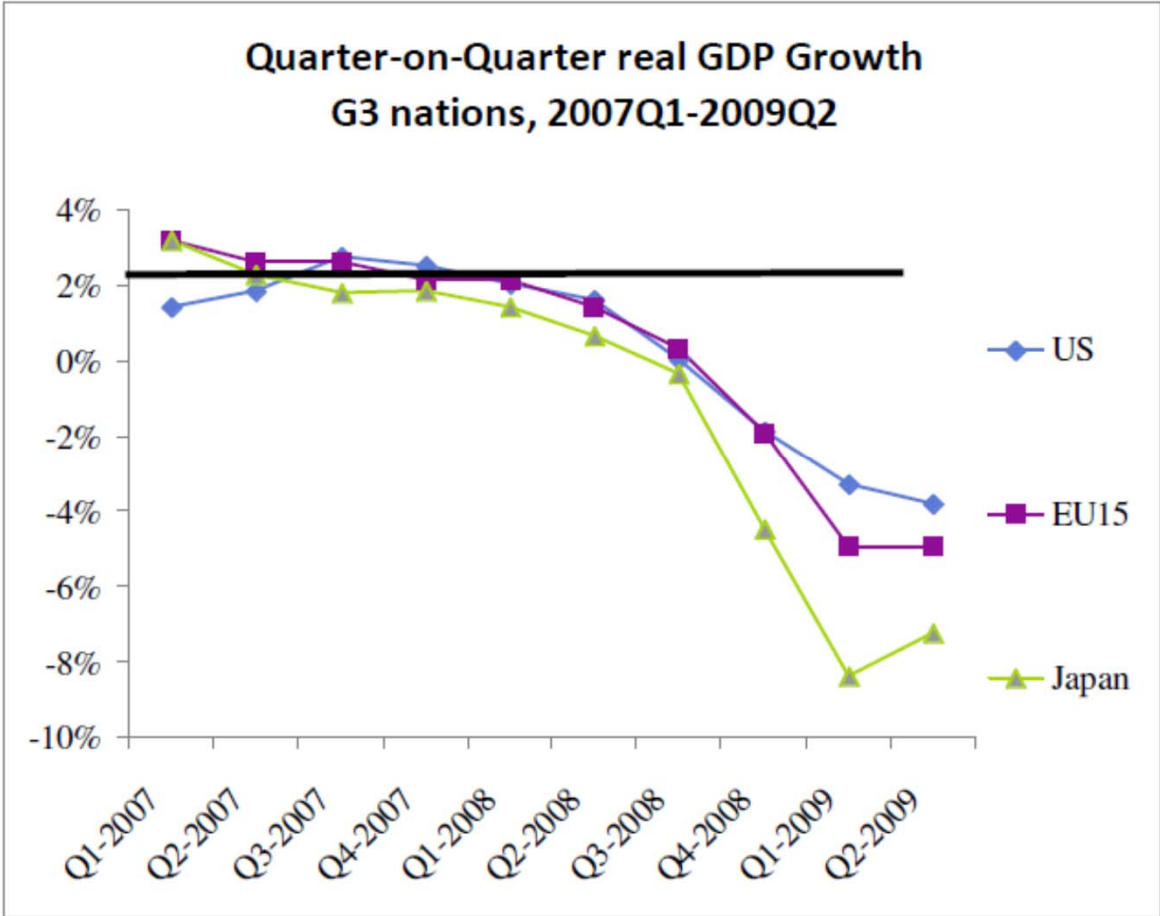
### Contributions to Japan's real GDP growth by type of demand



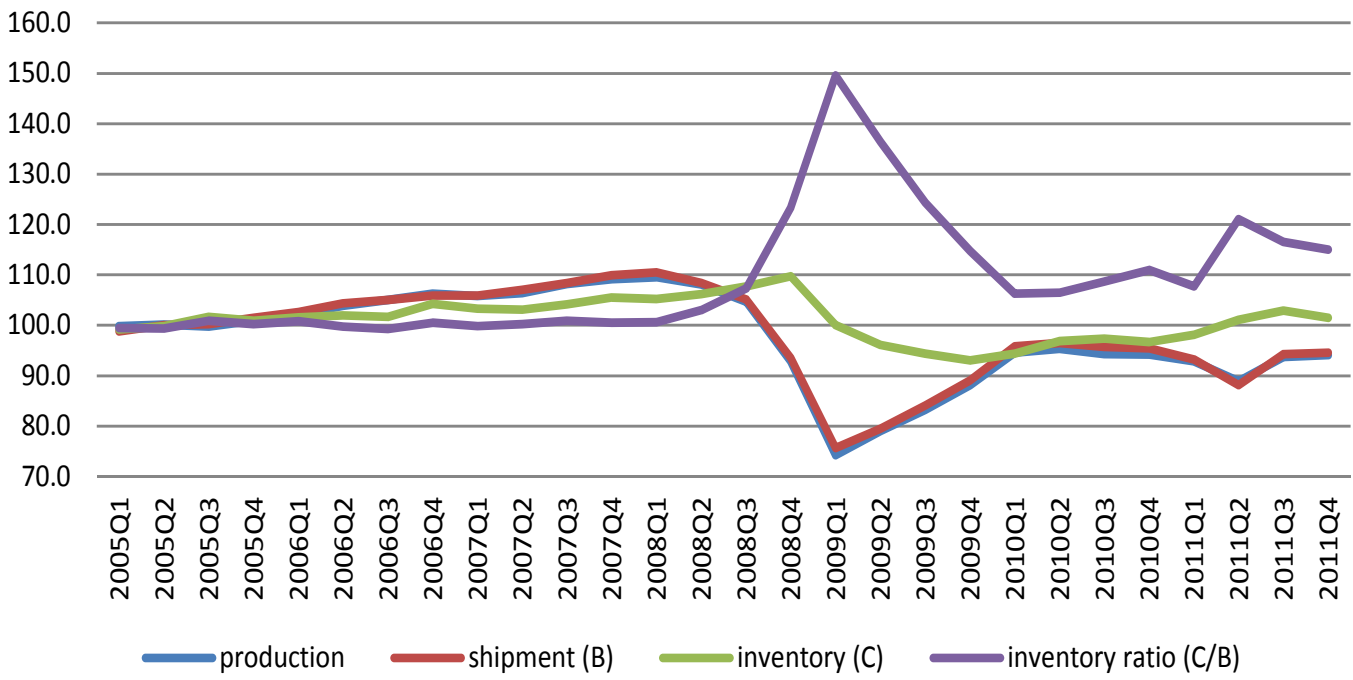
Comparison with Recession Phase of Production (Figure 1-1-4(2))



Source: "Industrial Production Index", Ministry of Economy, Trade and Industry



**Industrial Production, Shipment, Inventory, and Inventory Ratio:  
quarterly, 2005~2011, 2005=100, seasonally adjusted**

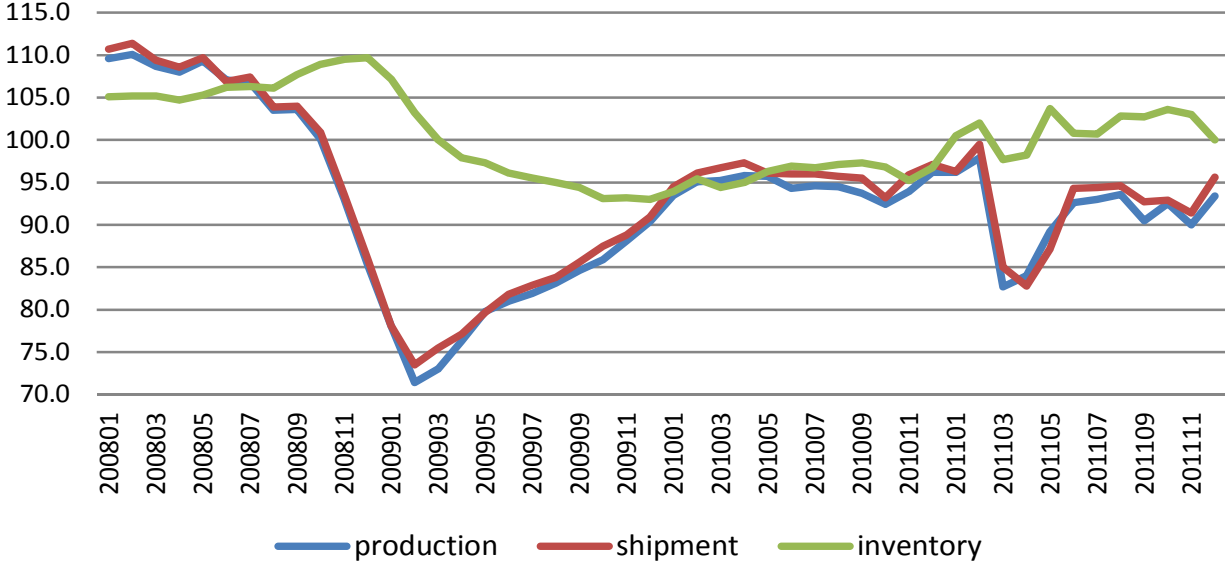


Industrial Indices: quarterly, 2008~2009, 2005=100, seasonally adjusted

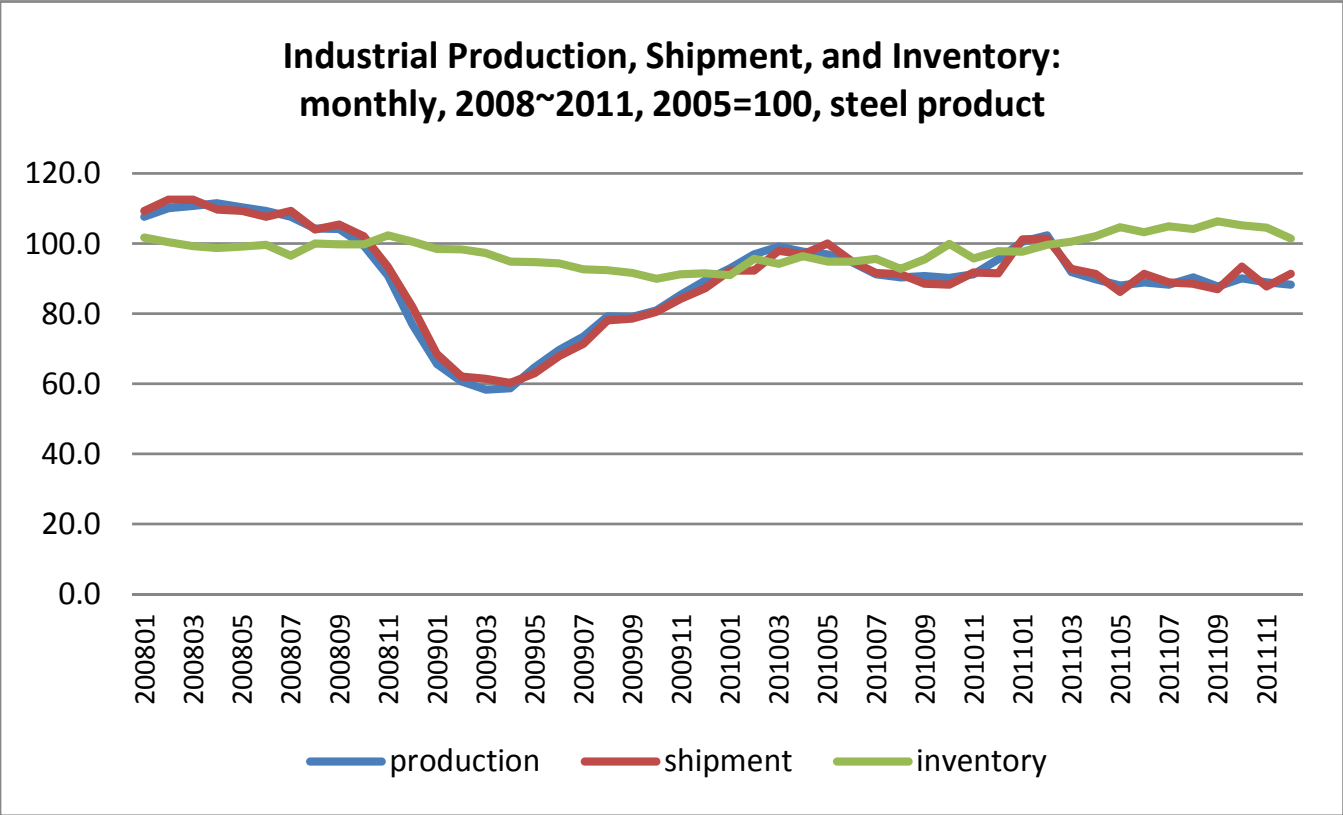
	2008				2009			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Production	109.5	108.1	104.6	92.8	72.3	78.3	84.1	87.9
Shipment	110.5	108.4	105.1	93.5	73.9	78.6	85.2	89.6
domestic	106.8	104.6	101.8	92.8	74.1	77.9	84.3	87.8
export	126.4	122.6	117.8	98.5	72.8	80.4	88.5	99.9
Inventory	105.2	106.2	107.7	109.7	99.8	95.3	94.7	93.6
Inventory Ratio	100.6	103.0	107.3	123.5	153.0	138.3	121.2	112.7
Capacity Utilization Ratio	105.6	104.0	100.4	87.1	63.4	71.4	78.8	82.6

adapted from *Analysis of Industrial Activities, Year Book 2009*, METI

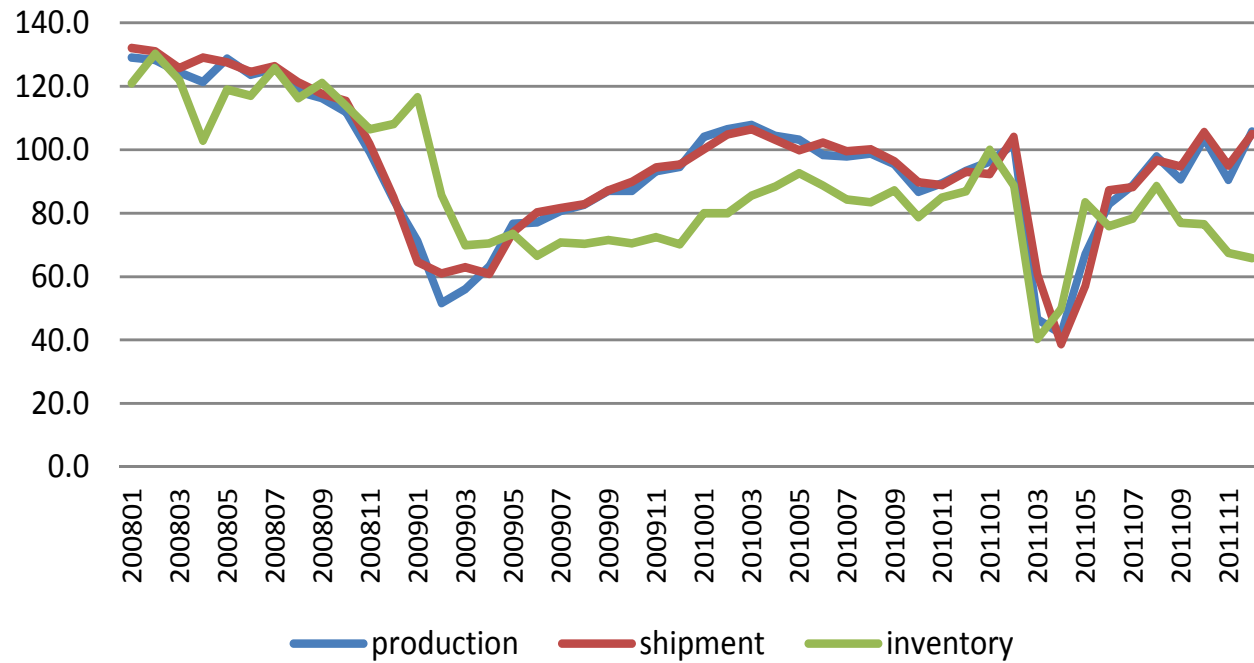
**Industrial Production, Shipment, and Inventory:  
monthly, 2008~2011, 2005=100, seasonally adjusted**



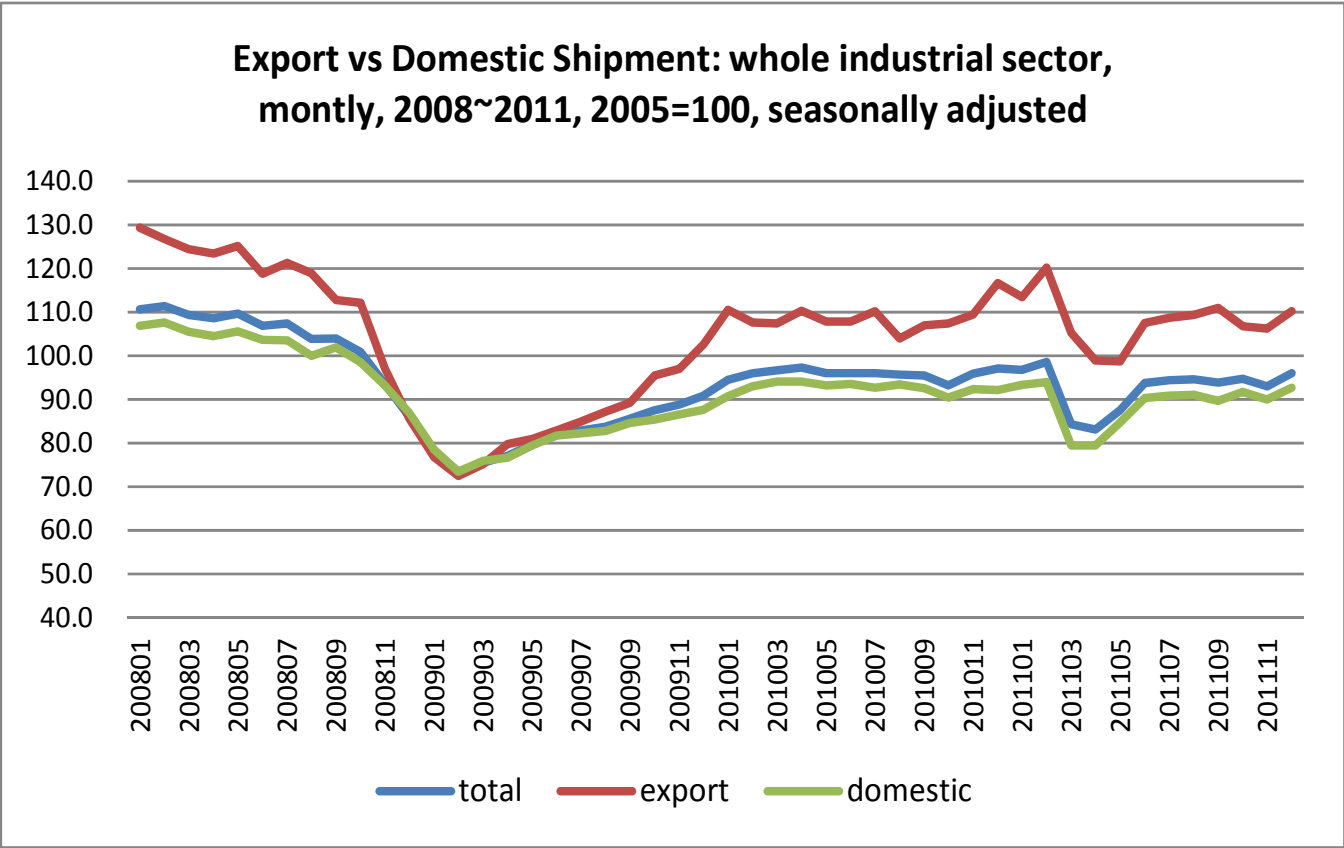




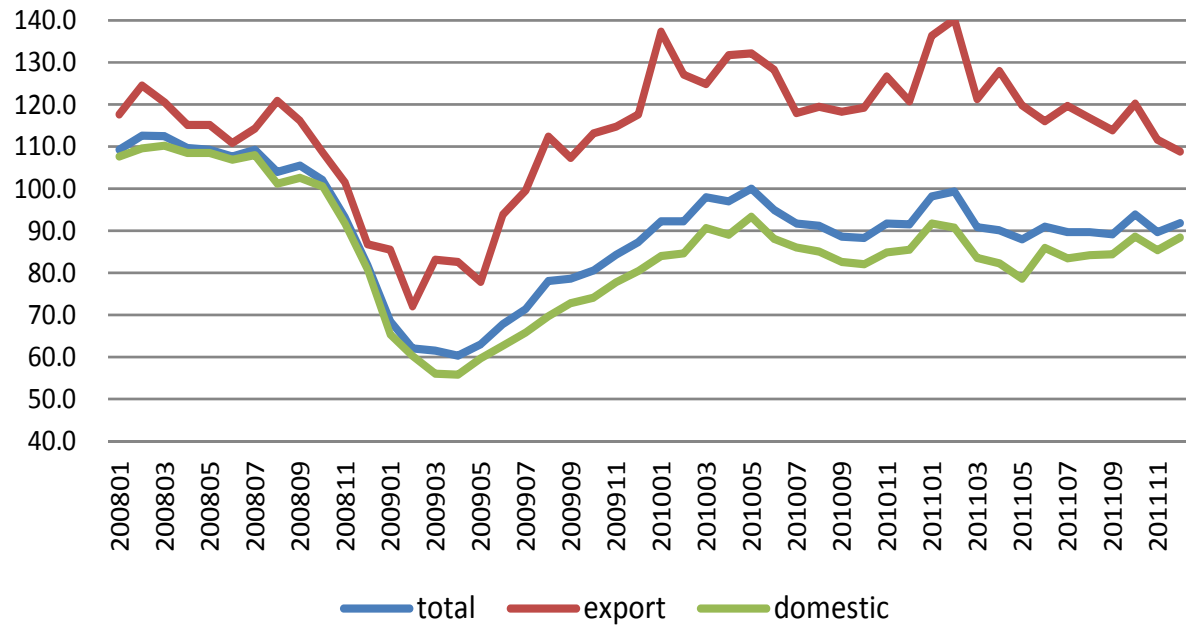
**Industrial Production, Shipment, and Inventory:  
monthly, 2008~2011, 2005=100, passenger car**

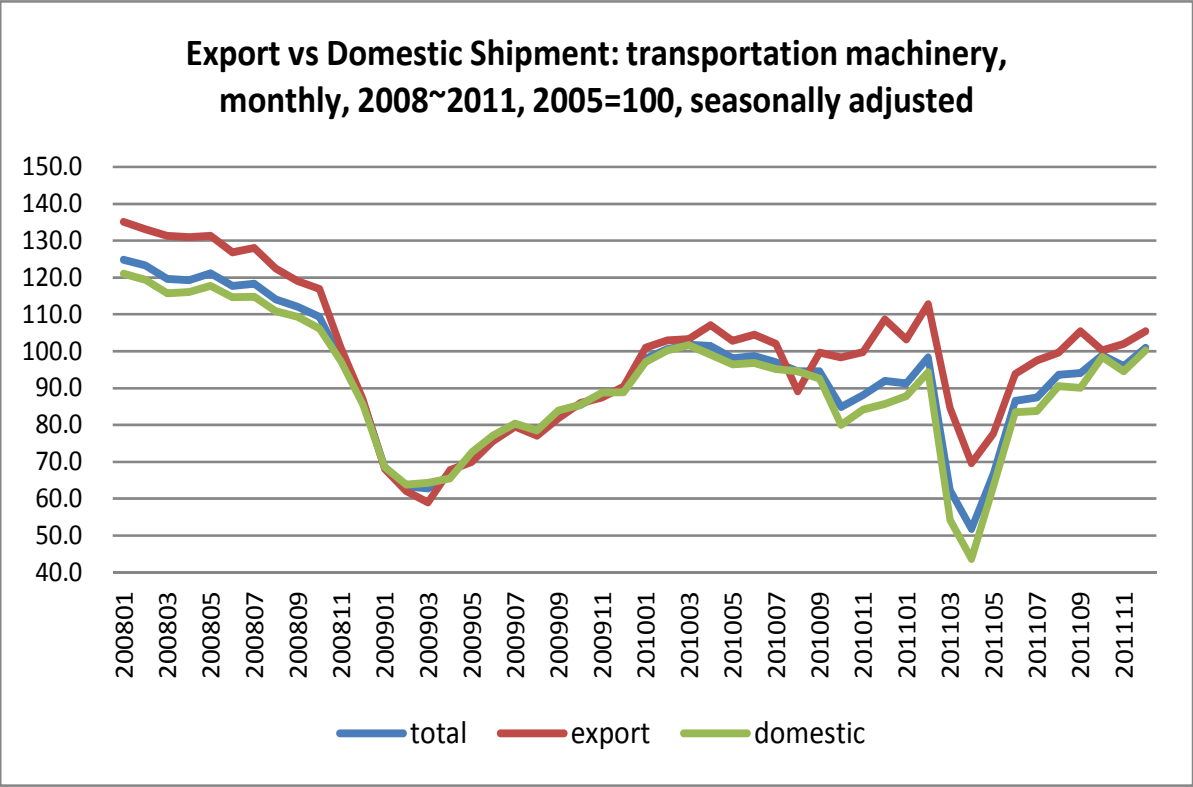


**Export vs Domestic Shipment: whole industrial sector,  
monthly, 2008~2011, 2005=100, seasonally adjusted**



**Export vs Domestic Shipment: steel products, monthly,  
2008~2011, 2005=100, seasonally adjusted**





## (2) Inventory (Investment) and Inventory (Investment) Statistics

[introduction]

- Inventory?---definition?---Not obvious.---Even among government statistics, there is no common definition. Actually, a great variety and difference among “inventory (investment)”.
- In CES (*Corporate Enterprise Statistics*), the value of inventory stock in construction industry in the 1980s was 30 trillion yen, most of which were not included in inventory in SNA. SNA classifies it as fixed capital formation. ----the corresponding value in manufacturing industry was 40 trillion yen.
- measurement (aggregation) unit: quantity or value?---when in value, estimates might be seriously influenced by re-evaluation and its timing.

## Cont.

- Whose inventory?---seriously influenced by the coverage of source statistics?---e.g., *Current Survey of Production* covers only producers.
- Objects and items surveyed?: enterprise vs. establishment? Corporate inventory value vs. inventory by commodity?
- Inventory survey of automobile producers provides no information of inventory on distribution stage. That of steel producers no information on construction company's steel stock for their activities.
- Practically, for obtaining an overall picture of inventory (investment), only SNA (GDP) statistics is useful...?

## Inventory Investment in Quarterly SNA (GDP) Statistics

- Estimation by commodity: Basically classified into over 2100 “commodities”.
- For QE (quarterly estimates), supply side estimation is conducted by commodity-flow method on 91 commodity level, where distribution channels are simplified.
- Quarterly- vs. Annual Statistics: Annual is the basic, where *Census of Manufacturers* is the most basic source statistics.
- Quarterly estimates are for “promptness” demand: two preliminary estimates (*sokuho*) series and two final estimates (*kakuho*) series, for each quarter. ---The second preliminary quarterly estimates, which is published two and half months after the end of the quarter, is the one the most widely used.
- The same holds internationally, for instance in OECD dataset.



## Cont.

- *Census of Manufacturers* (METI) annually surveys at the beginning of the next year the state of manufacturers at the end of each year and its activities during the past year.
- It is at the end of the next year that part of the survey becomes available (Report by Industry: *sangyo-hen*), and Report by Commodity (*hinmoku-hen*) one more year later.
- When annual statistics (called *kakuho*) is published, the quarterly first final estimates is published, called *kakuho*, and with its revision with *hinmoku-hen*, the quarterly second final is published, called *kakukakuho*.
- For 2008Q1 (January-March), *kakuho* is published in December 2009, and *kakukakuho* in December 2010, almost 3 years later.
- So.....quarterly SNA (GDP) estimates, including inventory investment estimates are obtained under extremely severe constraints of source statistics availability and time.

# Preliminary- vs. Final Estimates

- “Revision” for Final Estimates: First, obtain the difference between the sum of 4 quarter’s estimates and the annual estimates, and then add a quarter of the difference to each of the original values, that is, the preliminary estimates.
- It is not to replace the preliminary estimates with the estimates newly obtained with annual estimates. --- The variations in quarterly preliminary estimates within a year is perfectly maintained unaffected.
- Emphasizing the continuity with the preliminary estimates too much?----No information useful for quarterly inventory investment estimates improvement becomes available with annual estimates.--  
--*Census of Manufacturers* is an annual survey, and provides no information in quarterly values.

# Estimation by commodity and by category

- Estimated in 91 commodities.
- Estimated in 4 categories: product-, goods-in-process-, raw material- and distribution stock; and sum up.
- Inventory investment value = change in inventory stock values
- The estimation method and source statistics differs greatly across inventory category.

## The data for this study

- This research uses quarterly inventory investment estimates for 17 years, from 1994 to 2010, separately in four categories and in 91 commodities, which is estimated as part of estimating the quarterly Final values. ----unpublished intermediate estimates series.
- The data is estimated along the existing estimation method revised at the time of publishing the quarterly First Preliminary of 2002Q2.
- In what follows, I place special focus on real inventory investment values and nominal shipment values.

## Three points for avoiding confusion, pp.25-26

- (1) Despite the efforts for improving the consistency, however, the quarterly GDP Preliminaries and the annual SNA (GDP) accounts are estimated separately upon different source statistics with different methods. No change on this key point occurs with the revision from the Preliminary to the Final.
- (2) Inventory investment values (=net increase or decrease in inventory stock values) are estimated by commodity, that is, commodity-based. Neither firm nor industry is the estimation unit. Therefore, for example, raw material inventory of steel products is not iron ore and coal steel manufacturing companies possess but steel products construction companies or shipbuilders and machine makers possess as production materials. Likewise, raw material inventory of petroleum products is not crude oil manufacturers (refineries) possess but petroleum products firms like power companies possess as raw fuel.

## Cont.

- (3) By definition inventory investment value is the change in investment stock value. It is not the change in inventory stock volume, for example the number of machines-in-process or quantity of steel product stock in tons, but the change in their value. With fair-value adjustments at the end of accounting period, for example, without any change in inventory stock volumes, the inventory stock values may decrease dramatically, recording a huge negative value in inventory investment. As I show below, the dominant portion of wild fluctuations in quarterly GDP inventory investment could have been the result of regularly conducted fair-value adjustments.

### (3) Quarterly GDP Inventory Investment Statistics and its Regular Seasonal Fluctuation pp.27~

- (1) Quarterly GDP inventory investment statistics shows sharp and stable regular seasonal fluctuations (hereafter, I call it M-shaped).
- (2) Its investigation by category reveals more or less in inventory investment of every category regular seasonal fluctuations, of which those of goods-in-process inventory is the sharpest and most remarkably regular. The dominant portion of regular seasonal fluctuations in total inventory investment is due to those of goods-in-process inventory investment.
- (3) Annual inventory investment statistics, the sum of four quarterly estimates (or their annual average), shows a dramatic decrease in the size of fluctuations.

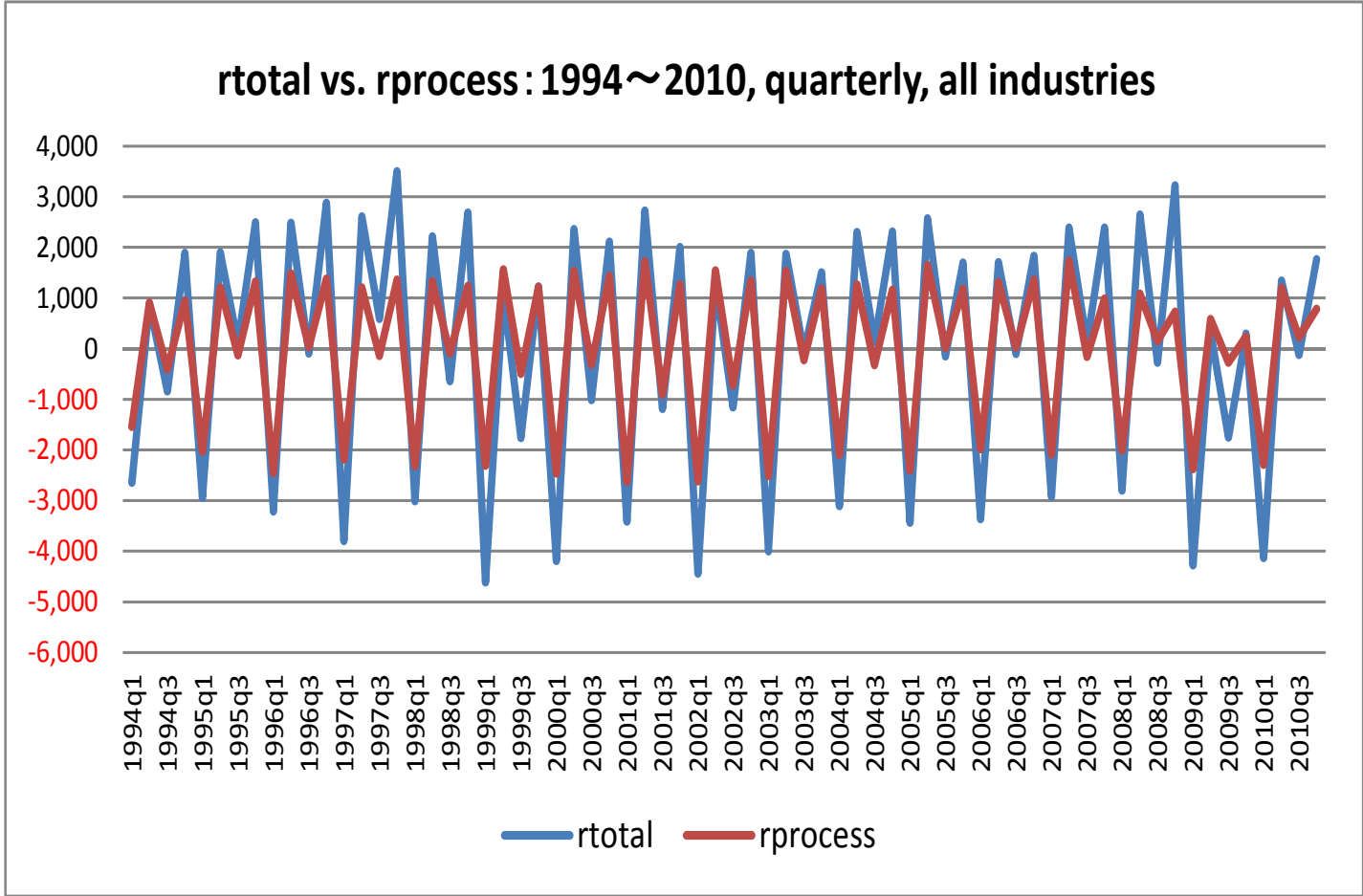
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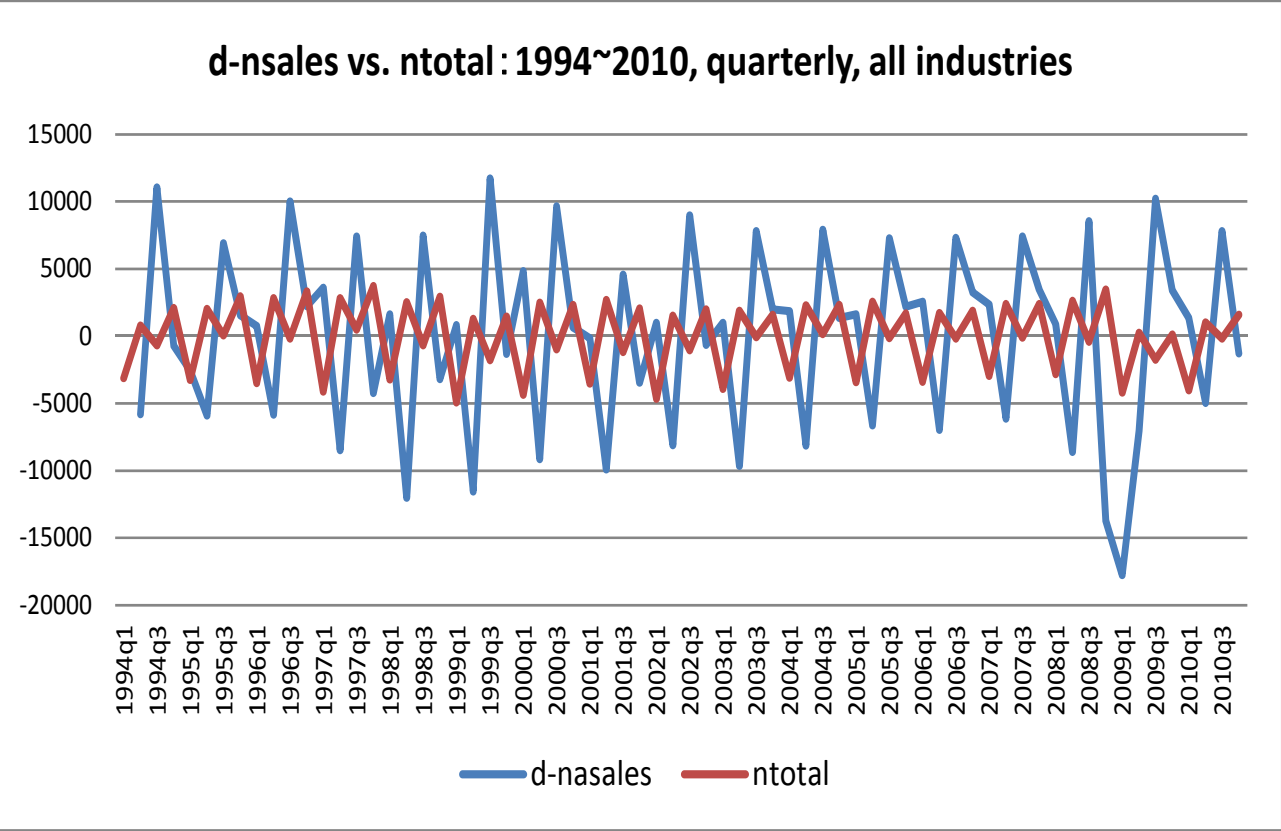
- (4) Because of sharp regular seasonal fluctuations, I classify quarterly data into four groups, from the first quarter ( $q_1$ ) to the fourth quarter ( $q_4$ ), and examine the fluctuations respectively. The standard deviation of inventory investment in each group is dramatically smaller everywhere than that of quarterly inventory investment throughout the period. Moreover, this standard deviation in each group is still all larger than that of the annual average.
- (5) Annual statistics shows that the biggest factor of total inventory investment fluctuations is the distribution inventory, where those of goods-in process becomes a figure in the background.



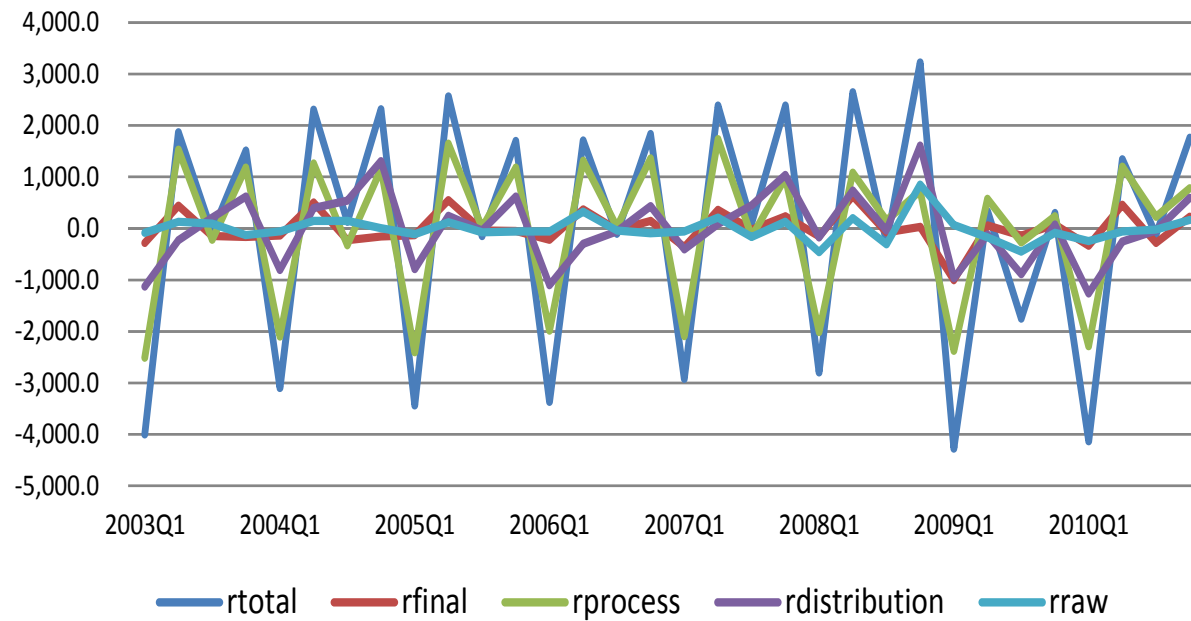
# Conclusion from the study of the first subject

- Aside from the SNA annual estimates for accurate description of the national economy, quarterly SNA (GDP) statistics are published in response to strong demand for quickness as a basis of characterizing the state of the economy.
- Wild fluctuations in inventory investment are observed in the quarterly estimates, and in the SNA annual estimates the inventory investment variations dramatically decrease.
- Studies of inventory investment variations and their mechanisms, including the precious studies, with little necessity of quickness, should make the shift from the quarterly GDP inventory investment data to annual SNA data, also using other micro data such as IIP (Indices of Industrial Production) and *Hojin kigyo tokei* (Corporate Enterprise Statistics, quarterly and annual).
- In using quarterly GDP inventory investment statistics, we should be more careful about the regular seasonal fluctuations.

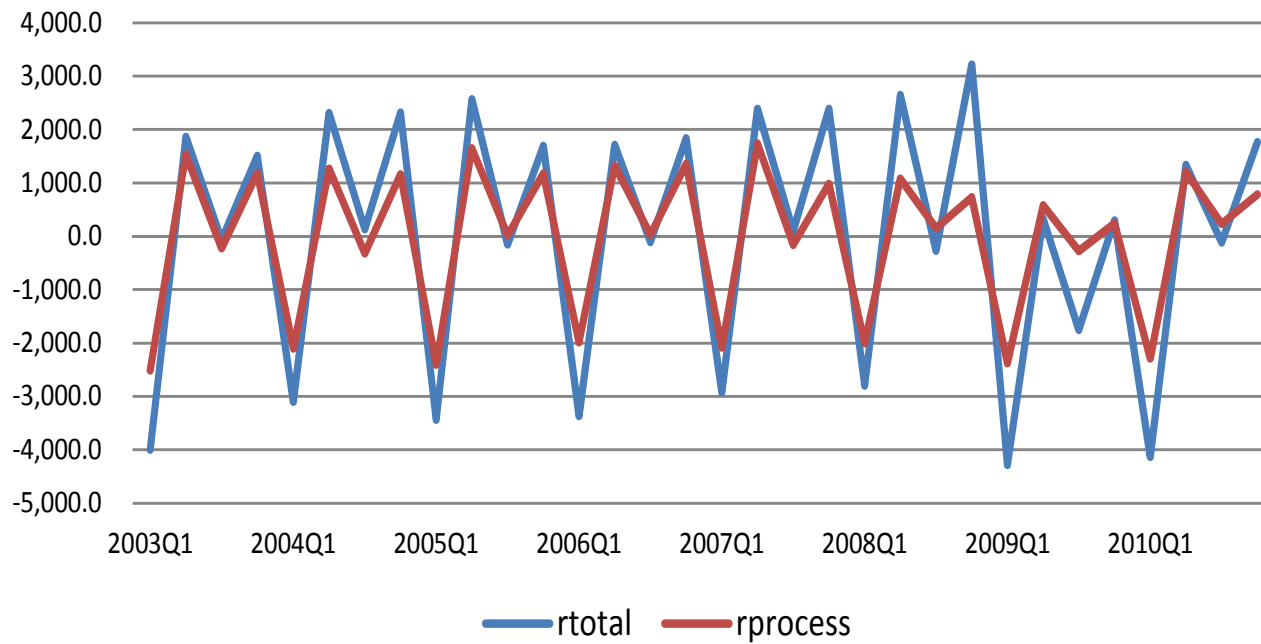




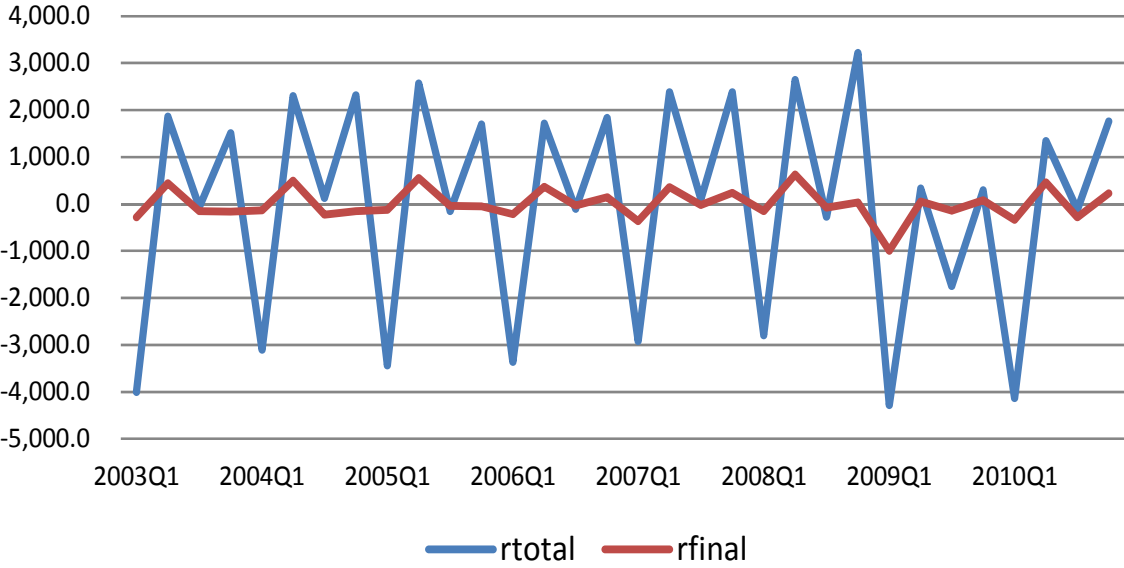
**Inventory Investment: all industries**  
**rtotal and by category, 2003~2010, quarterly**



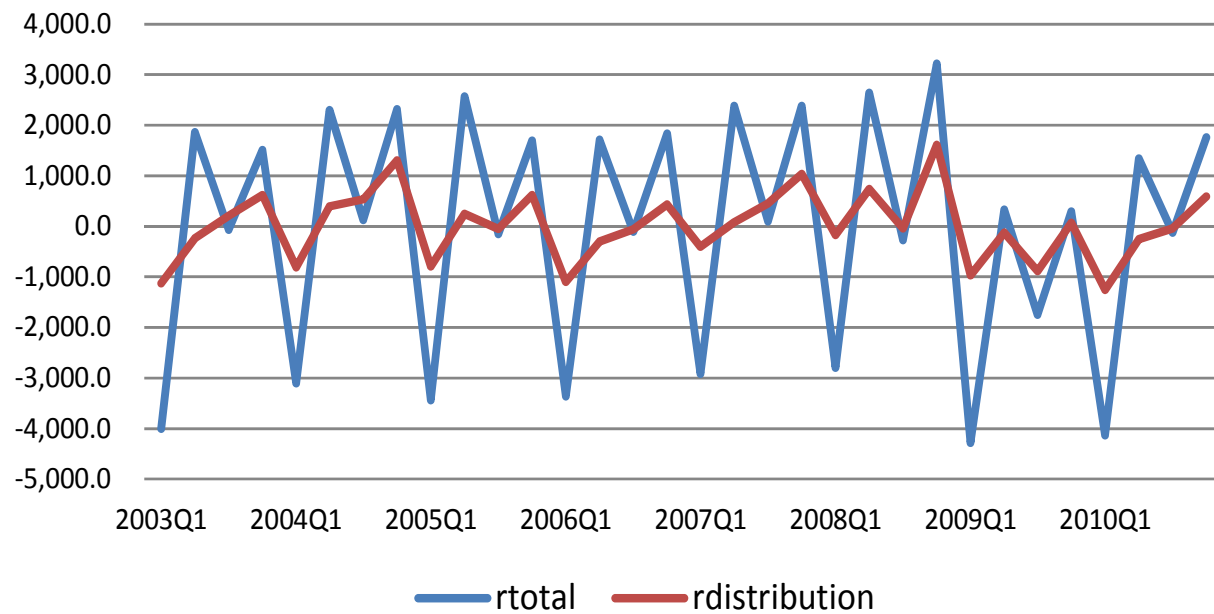
### Inventory Investment: all industries rtotal vs. rprocess, 2003~2010, quarterly



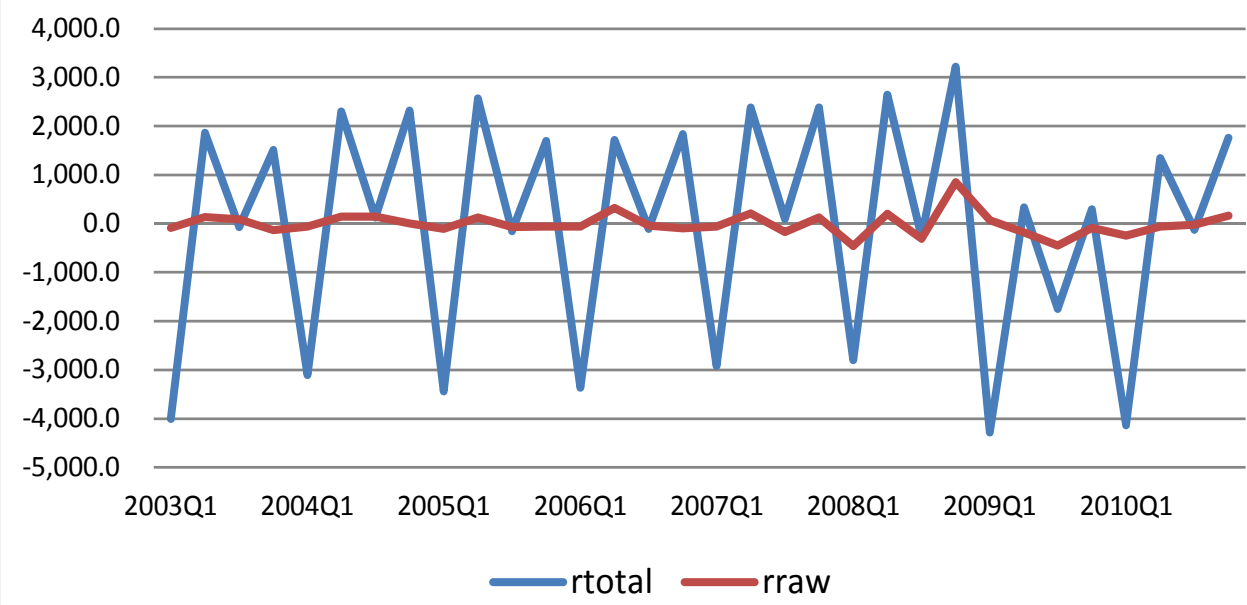
### Inventory Investment: all industries rtotal vs. rfinal, 2003~2010, quarterly



### Inventory Investment: all industries rtotal vs. rdistribution, 2003~2010, quarterly

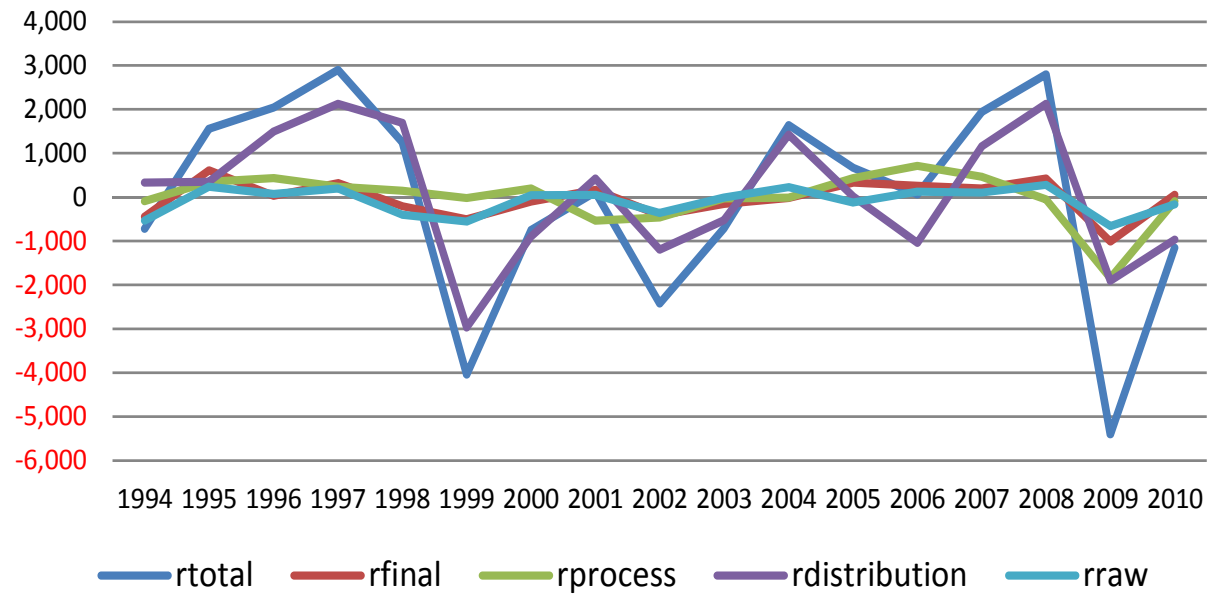


### Inventory Investment: all industries rtotal vs. rraw, 2003~2010, quarterly

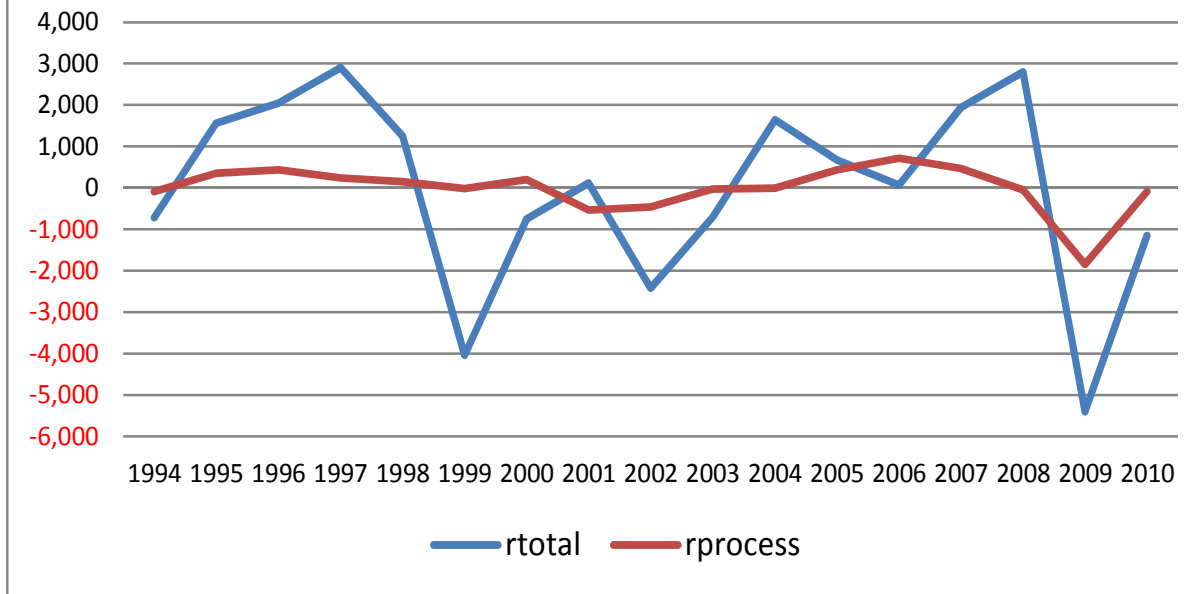




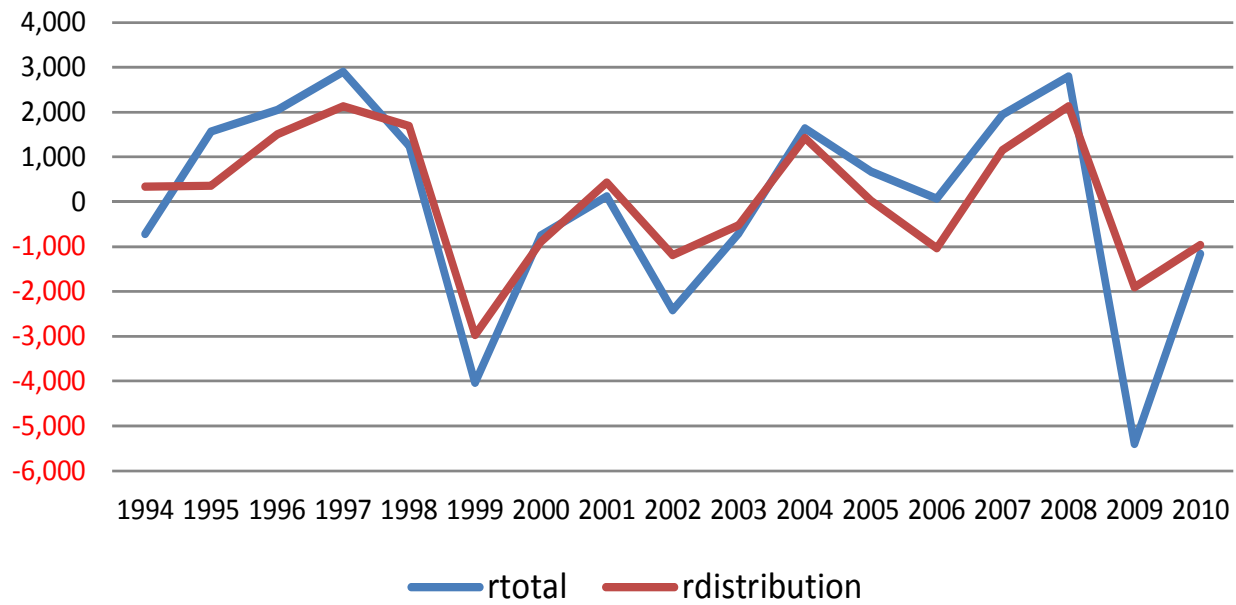
### Inventory Investment: all industries rtotal and by category, 1994~2010, annual



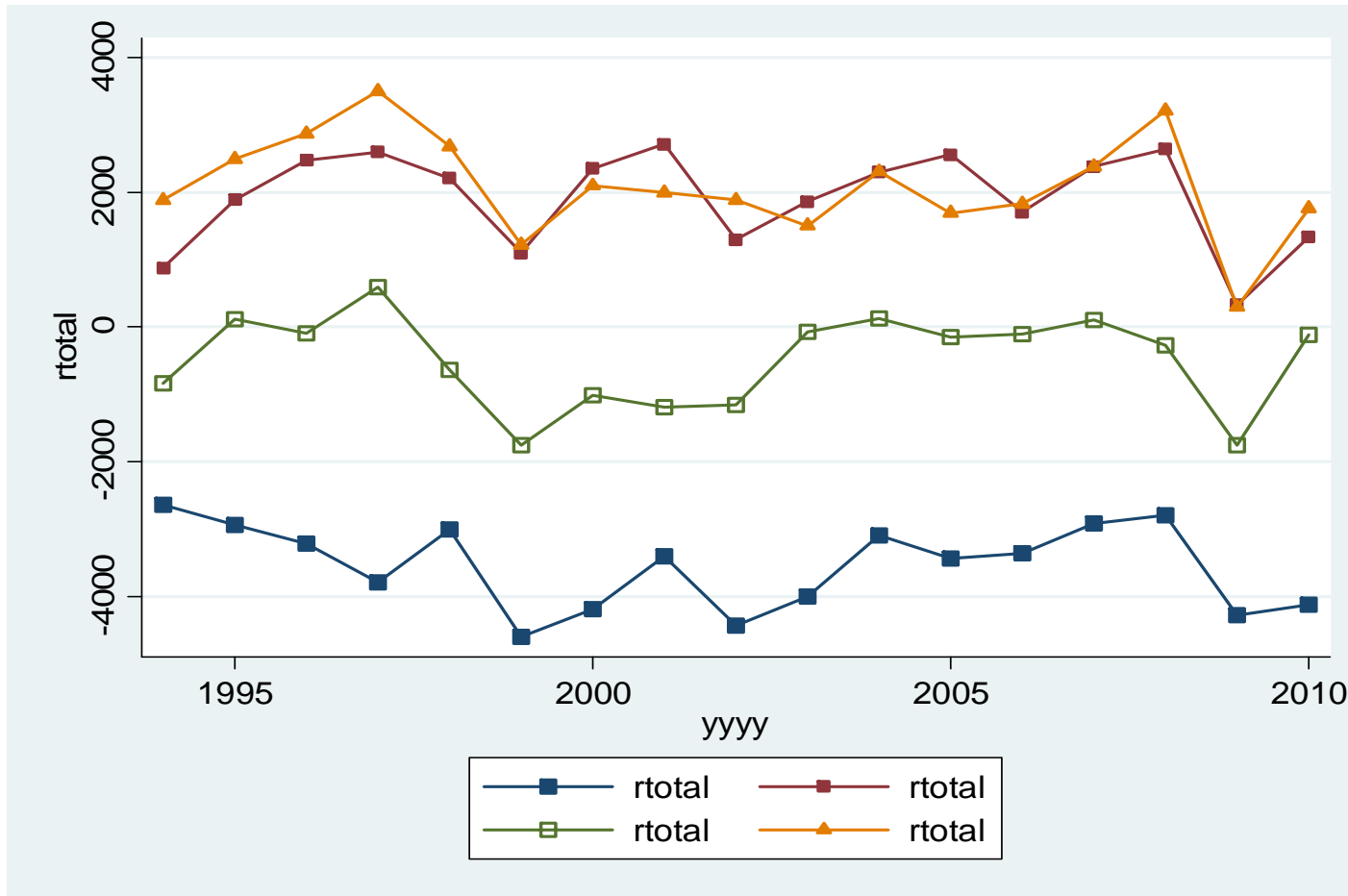
### Inventory Investment: all industries rtotal vs. rprocess, 1994~2010, annual



### Inventory Investment: all industries rtotal vs. rdistribution, 1994~2010, annual



# All industries rtotal by quarter



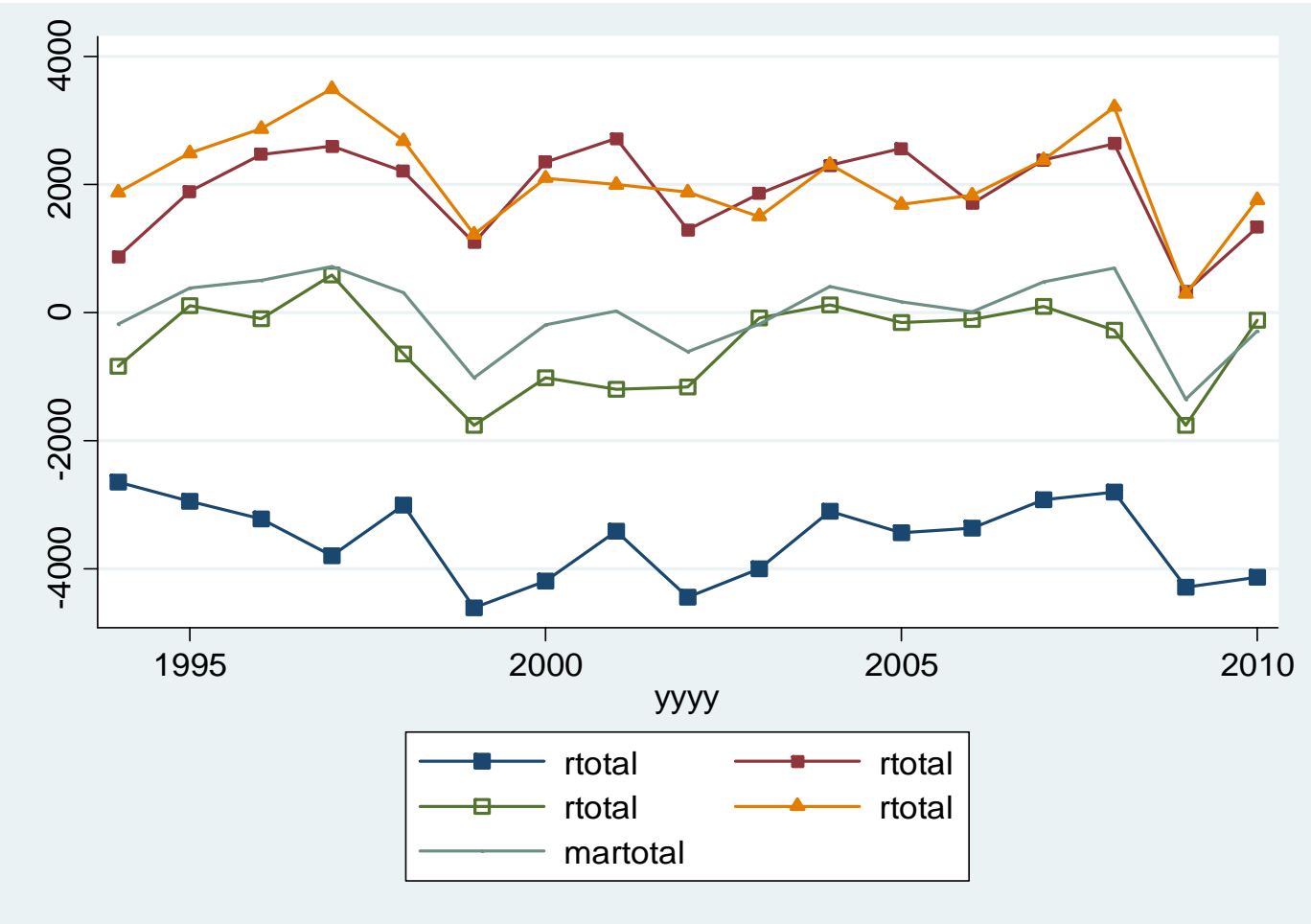
	N	rtotal	rfinal	rprocess	rdistribution	rraw
		17	17	17	17	17
q=1	mean	-3,545.0	-235.7	-2,251.7	-873.7	-184.0
	sd	626.9	277.5	275.3	386.3	158.6
	p50	-3,409.7	-153.7	-2,303.1	-807.5	-109.0
	p25	-4,130.9	-363.4	-2,451.0	-1,124.9	-288.6
	p75	-3,006.8	-53.1	-2,086.9	-650.5	-61.5
q=2	mean	1,921.5	413.6	1,342.3	60.3	105.2
	sd	708.7	229.8	303.4	379.8	132.6
	p50	2,213.4	437.1	1,325.7	79.8	91.8
	p25	1,337.7	343.4	1,206.1	-232.8	51.1
	p75	2,476.4	500.7	1,538.1	379.7	200.1
q=3	mean	-483.1	-207.6	-219.0	9.4	-65.8
	sd	689.3	143.9	296.9	429.2	157.2
	p50	-147.9	-221.9	-157.4	-37.3	-55.7
	p25	-1,013.5	-330.2	-323.3	-170.4	-118.5
	p75	-73.1	-78.6	13.7	211.1	64.9
q=4	mean	2,096.7	6.4	1,123.2	904.9	62.1
	sd	760.5	142.7	307.9	492.6	248.0
	p50	1,999.5	-12.4	1,216.6	919.2	-39.3
	p25	1,760.2	-84.3	981.5	563.9	-89.0
	p75	2,494.3	128.2	1,340.7	1,304.4	130.5

quarterly		rtotal	rfinal	rprocess	rdistr $\tilde{n}$	rrow
inventory investment value	N	68	68	68	68	68
	mean	-2.5	-5.8	-1.3	25.2	-20.6
	sd	2,401.2	330.5	1,469.6	757.5	209.4
	p50	314.5	-50.0	232.9	-1.4	-57.3
	p25	-2,201.3	-220.0	-1,224.4	-513.2	-113.8
	p75	2,051.1	204.5	1,267.6	516.3	115.8
revised quarterly		Rrtotal	Rrfinal	Rrproc $\tilde{s}$	Rrdist $\tilde{n}$	Rrrow
inventory investment value	N	68	68	68	68	68
	mean	-0.0	0.0	0.0	-0.0	-0.0
	sd	682.2	202.0	289.4	414.7	175.5
	p50	157.1	15.0	56.3	16.9	-9.0
	p25	-557.1	-107.8	-148.2	-300.1	-116.6
	p75	546.6	130.1	215.8	294.6	103.6
year-to-year change		L4rtotal	L4rfinal	L4rpro $\tilde{s}$	L4rdis $\tilde{n}$	L4rrow
in quarterly inventory	N	64	64	64	64	64
investment value	mean	-6.8	7.8	0.0	-20.3	5.7
	sd	910.3	276.2	303.8	573.0	244.0
	p50	142.7	10.8	8.3	43.3	7.4
	p25	-383.6	-138.8	-185.0	-332.4	-129.4
	p75	650.9	189.6	223.3	384.8	165.2

# Annual average of four quarterly GDP inventory investment estimates

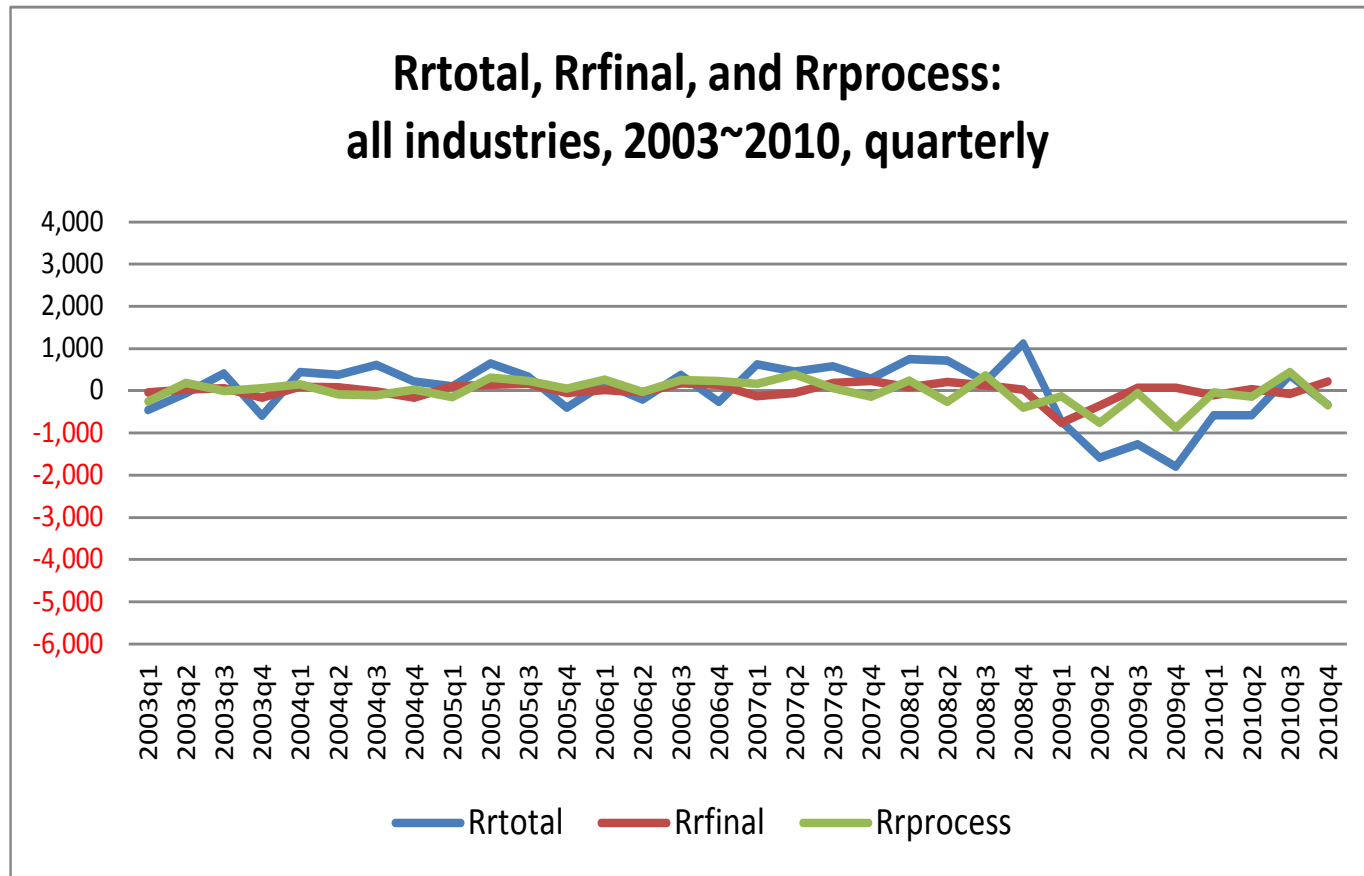
annual average		martotal	marfinal	marpro $\tilde{s}$	mardis $\tilde{n}$	marraw
of four quarterly GDP	N	17	17	17	17	17
inventory investment	mean	-2.5	-5.8	-1.3	25.2	-20.6
estimates	sd	578.3	100.9	143.3	368.4	76.2
	p50	30.2	8.5	-1.1	84.5	11.6
	p25	-186.6	-49.4	-21.2	-241.0	-89.1
	p75	409.8	66.3	90.0	357.0	31.0

# Adding martotal . . .

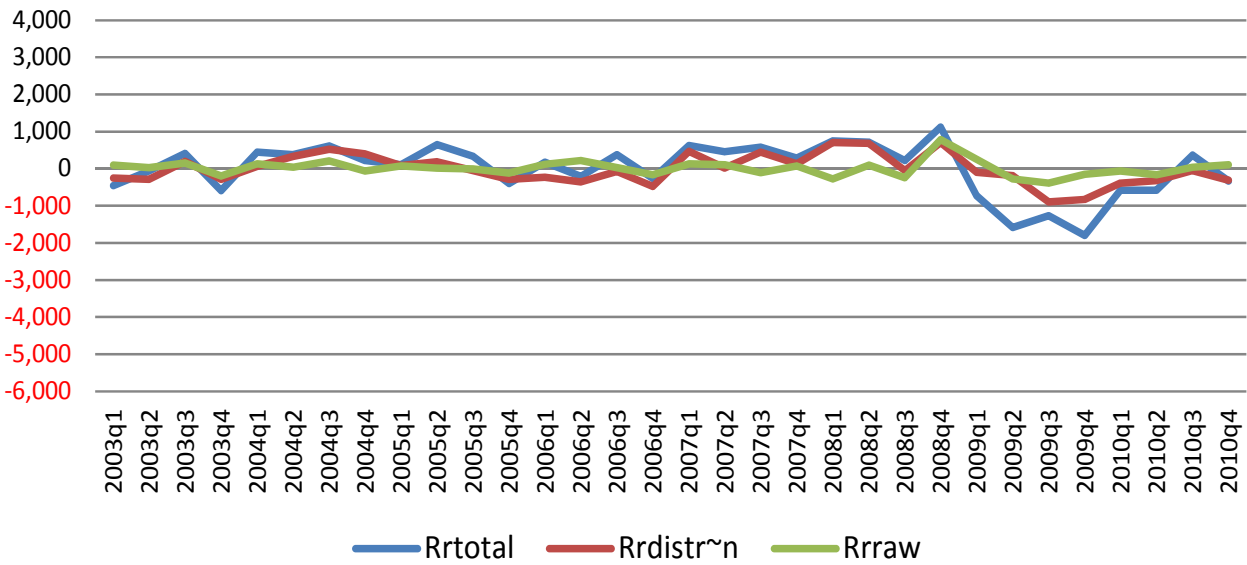




# Revised rtotal and . . .



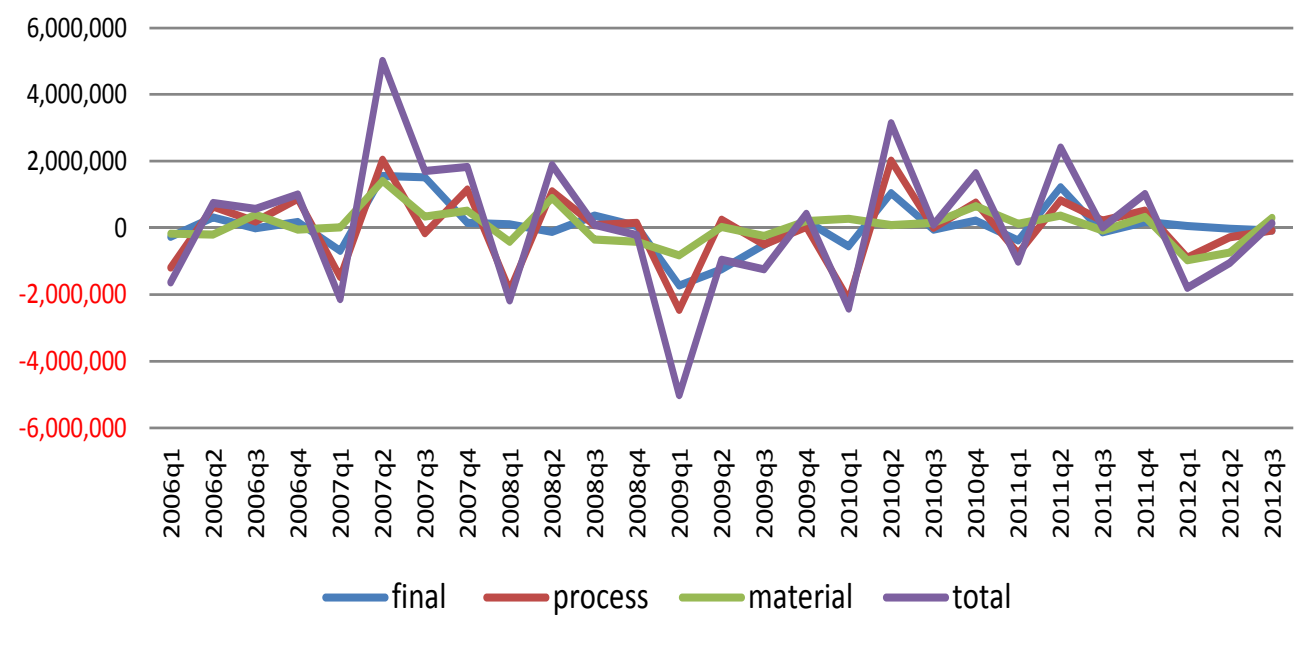
### Rrtotal, Rrdistribution, and Rrraw: all industries, 2003~2010, quarterly



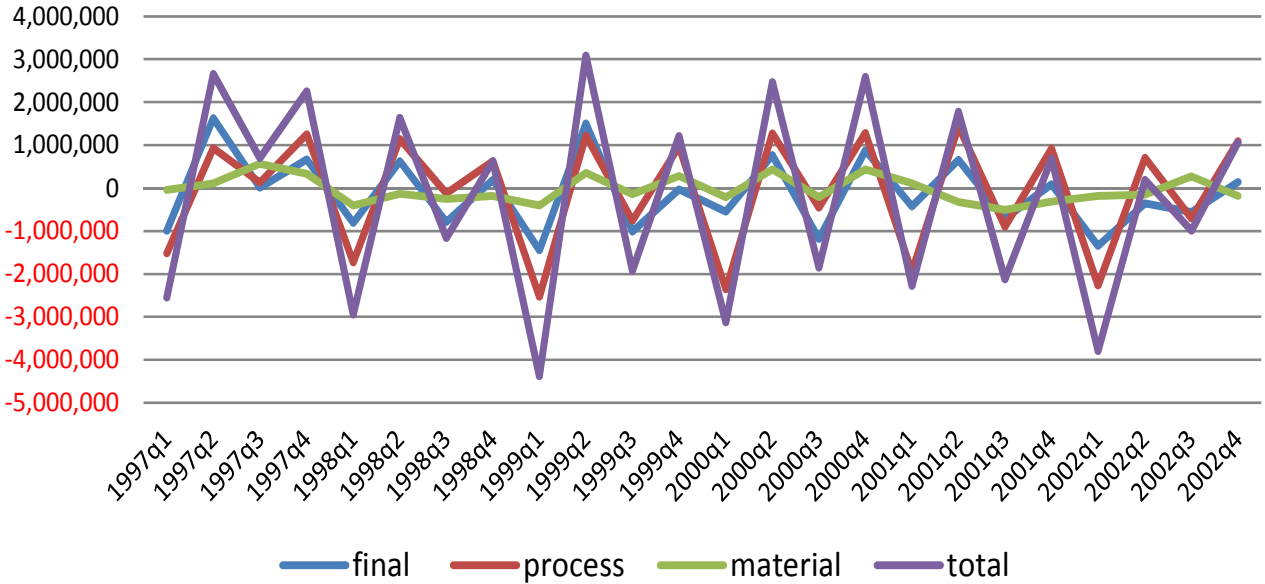
# Sources of Wild Fluctuations in Quarterly GDP Inventory Investment Statistics, pp.45~

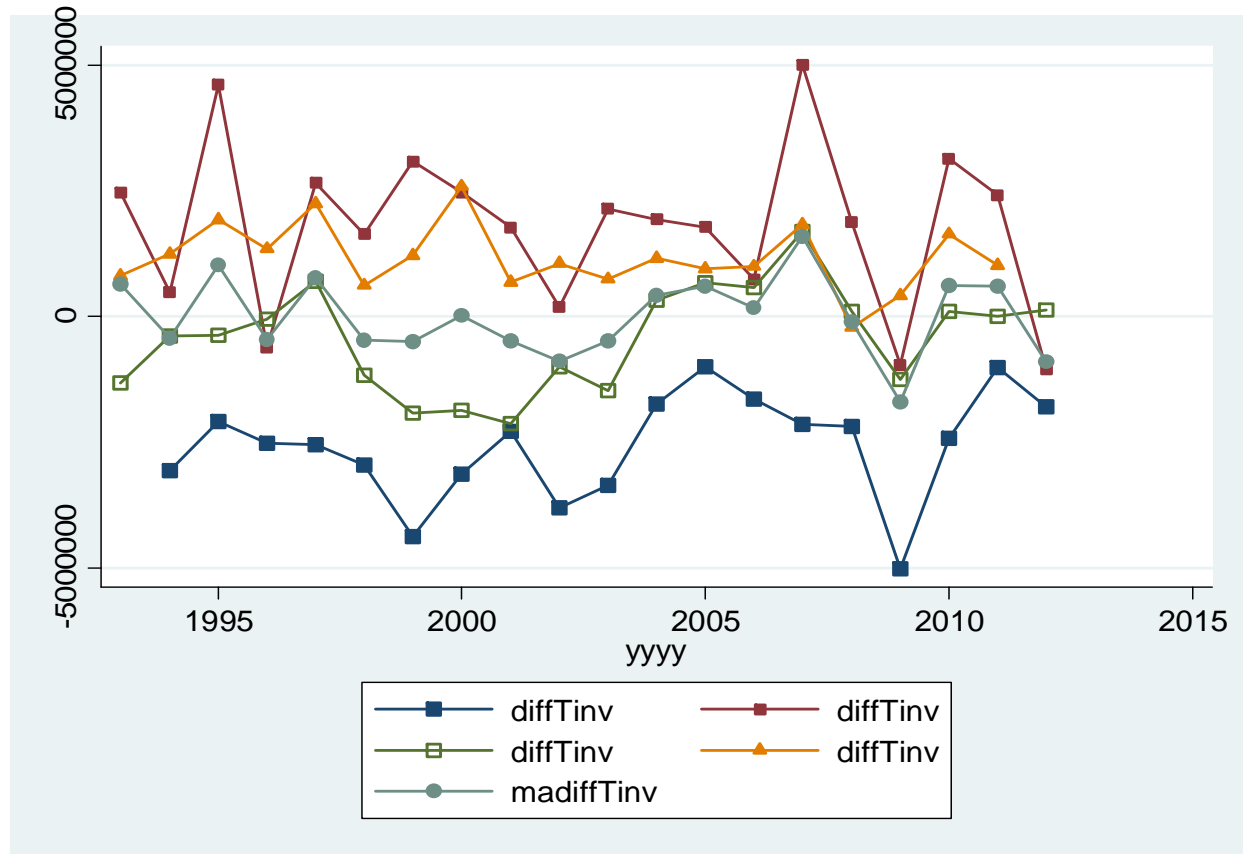
- Primary source of inventory stock (or investment) statistics is firm's accounting information.
- There might be serious influence of inventory stock re-evaluation, particularly at the end of accounting year (in Japan at the end of March, the end of the first quarter), primarily for fair value accounting.
- To some extent, also at the end of the mid-term, September, the third quarter.
- In contrast, in the other quarters, particularly in Q2 and Q4.
- Not always accurate information is commonly held inside the company. All accurate information are not always reported to the statistics offices
- All the inventory stock, rather than the newly added stock, are the object of re-evaluation, leading to huge variation in stock value.

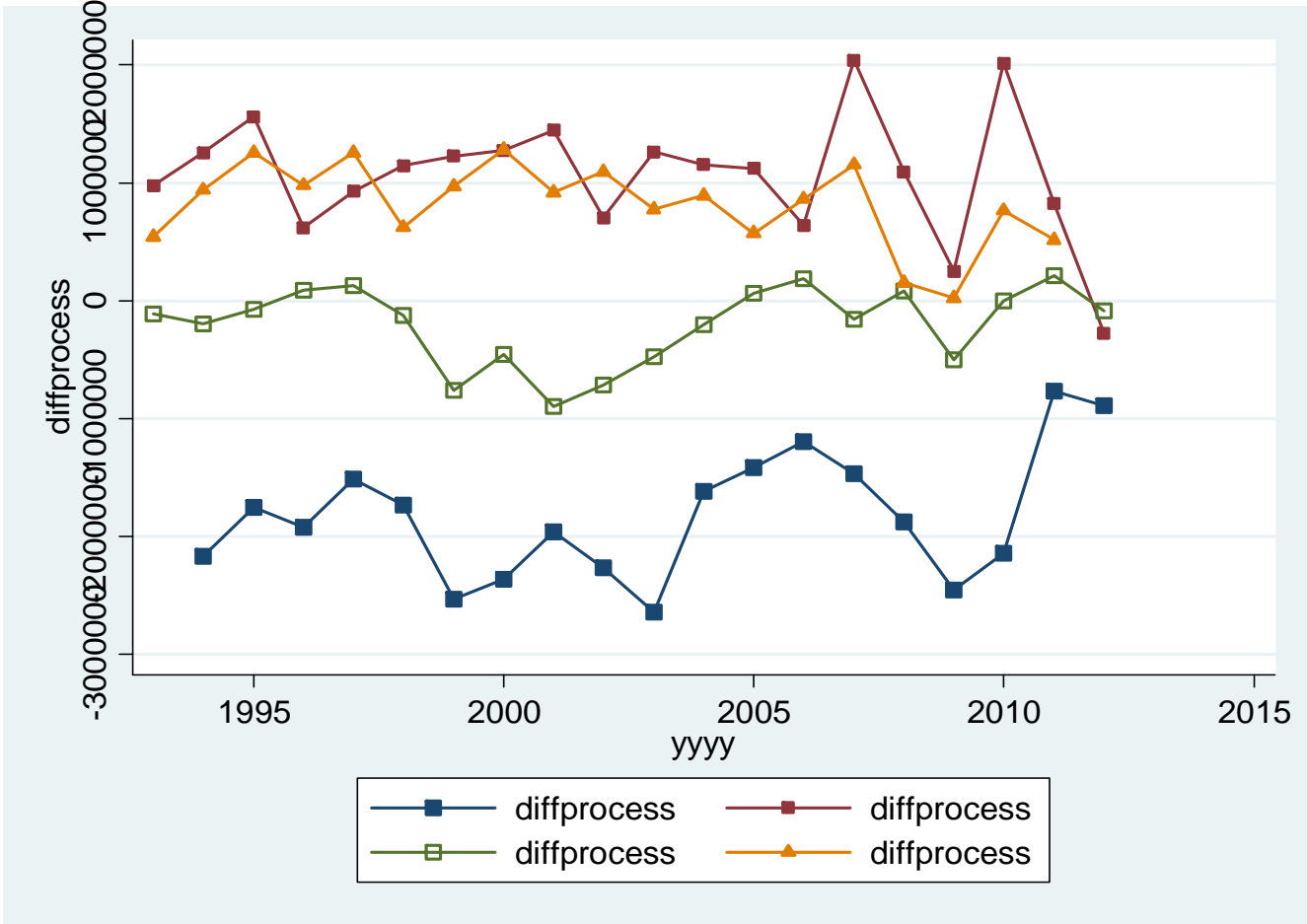
### Inventory Investment: manufacturing, all size, quarterly, 2006Q1~2012Q3, CEQS



### Inventory Investment: manufacturing, all size, quarterly, 1997Q1~2002Q4, CEQS







## (4) Inventory Investment during the Period around Lehman Shock

- (1) At the manufacturers stage, in many industries monthly data show that a dramatic fall in shipment paralleled a fall in production of an almost equal size and speed. Dramatic shipment fall observed in many industries ended in a short period, and shipment made a sharp recovery that paralleled production recovery of almost an equal size and speed. During this time, the manufacturers' stock level remained almost unchanged.
- (2) Examination of quarterly GDP inventory investment statistics by commodity, either by individual quarters independently or by accumulation over sequence of quarters, reveal that in or around the 4<sup>th</sup> quarter of 2008 rarely I find large inventory stock accumulation. In the 1<sup>st</sup> quarter of 2009 I find almost everywhere a dramatic fall in inventory investment (a huge negative investment) and huge accumulation of negative inventory investment since then.



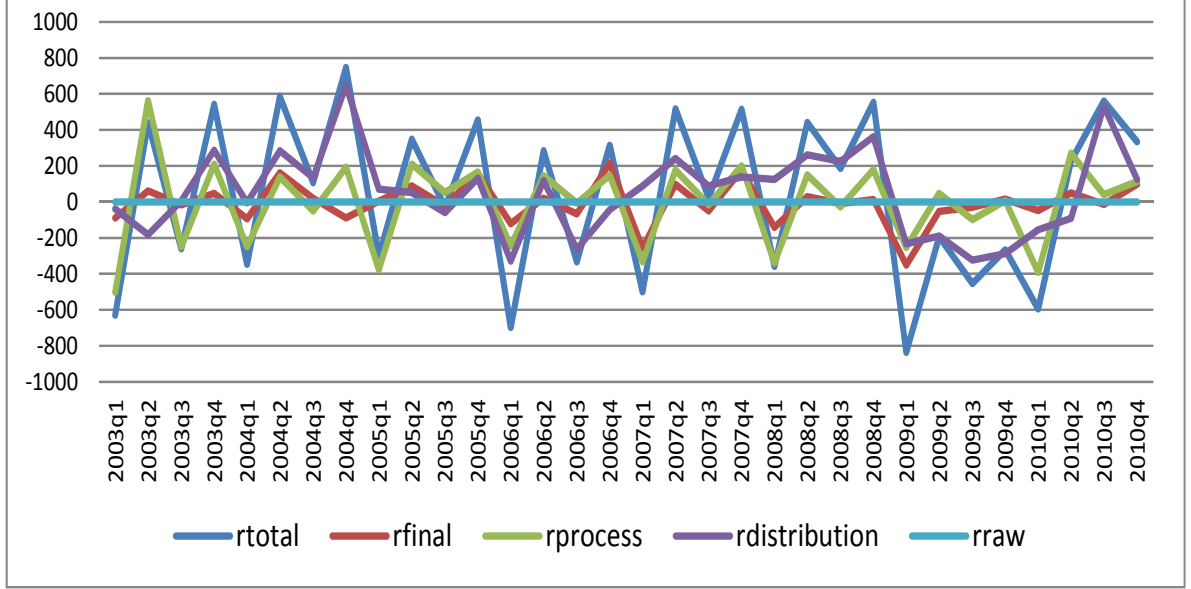
## Cont.

- (3) Above two points of observations, (1) and (2), apply not only to total inventory investment but also to each of four inventory categories, product-, goods-in-process-, raw material-, and distribution inventory. With few exceptions this applies also to inventory investment by commodity.
- (4) For comparison I also studied the Financial Crisis period of Japan, from the end of 1997 to the beginning of 1999, and draw the similar conclusion.
- (5) In the first subject of the study, as a part of M-shaped regular seasonal fluctuations, I point that inventory investment is the largest in the 4<sup>th</sup> quarter and the smallest in the 1<sup>st</sup> quarter. Because of this, both the increase in inventory stock accumulation in the 4<sup>th</sup> quarter of 2008 and its fall in the 1<sup>st</sup> quarter of 2009 pointed in four conclusions above tend to be exaggerated.

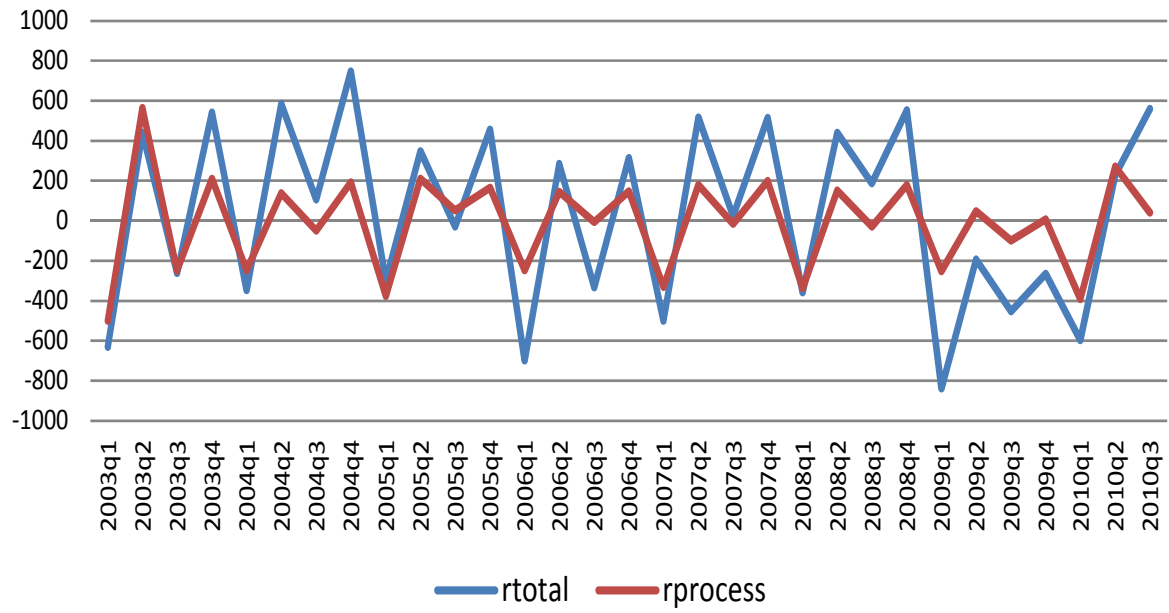
## Conclusion from the study of the second subject

- It raises a grave doubt to the validity of the view of large unforeseen exogenous shock as a major cause of observed wild fluctuations in quarterly GDP inventory investment data.
- The view that a large unforeseen exogenous shock causes wild inventory variations that accompany a long-run adjustment process has activated the study of inventory investment fluctuations, attracting the interest of macroeconomists. This conventional wisdom often leads to a claim that this slow stock adjustment process badly needs active government intervention into the market for macroeconomic stability. This conclusion raises grave doubts to the basic picture and mechanisms of inventory stock accumulation and its long-run adjustment process.

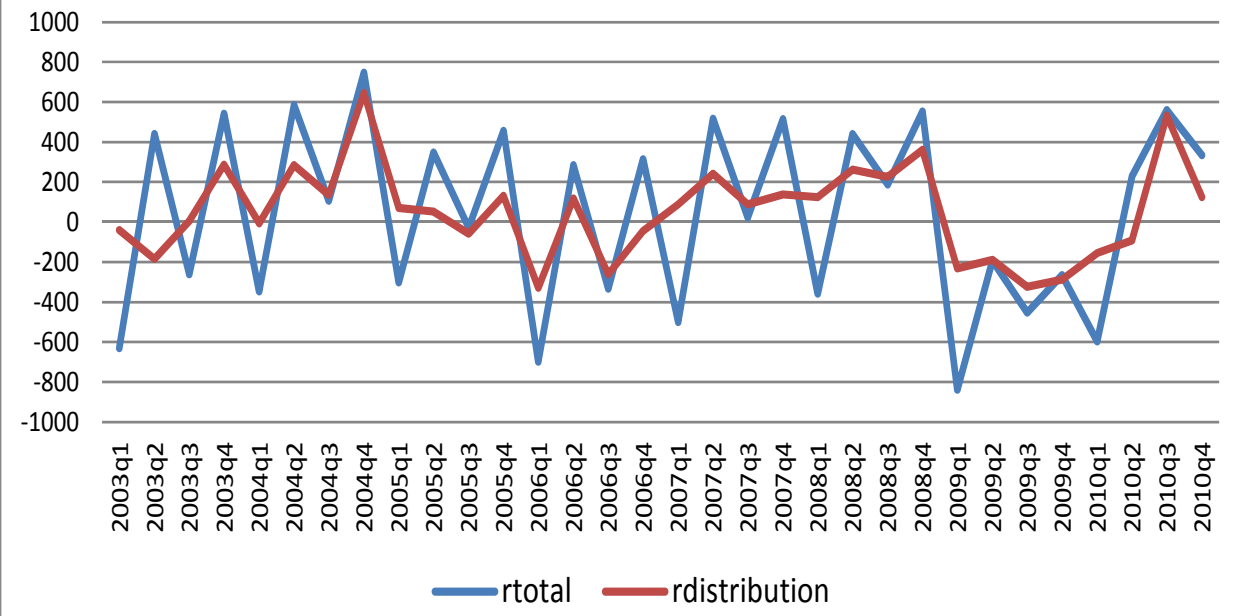
inventory Investment : automobile  
 rtoal and by category, 2003~2010, quarterly



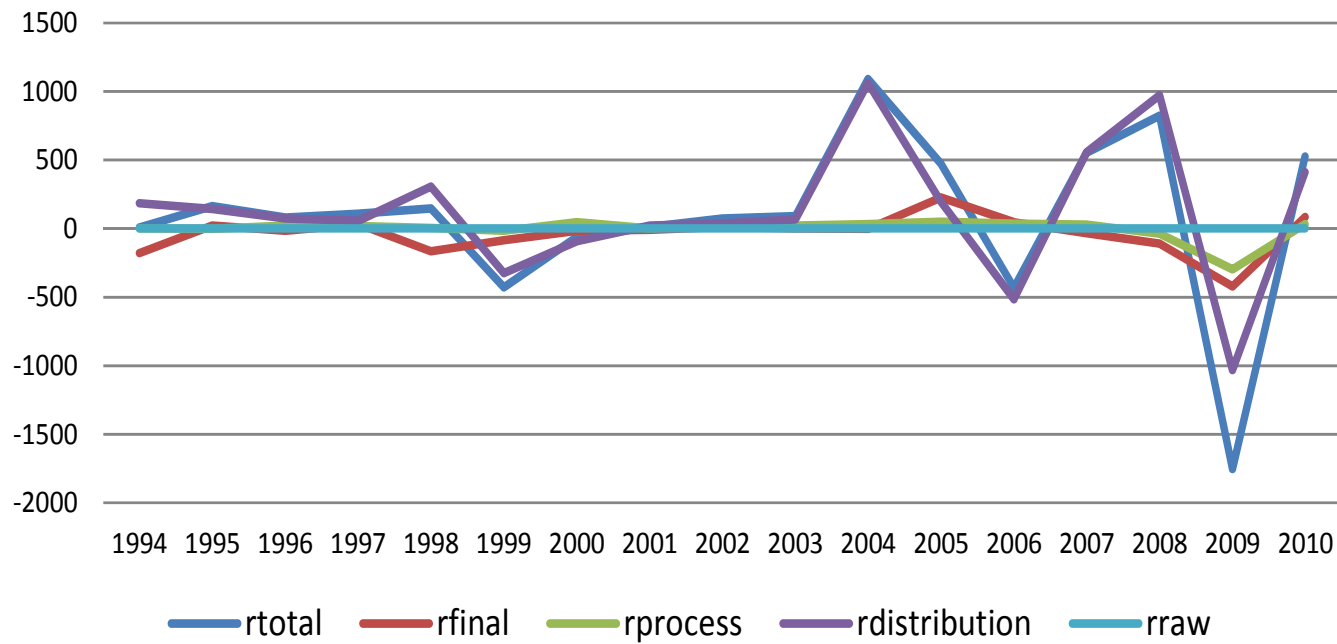
**Inventory Investment: automobile  
rtotal vs. rprocess, 2003~2010, quarterly**



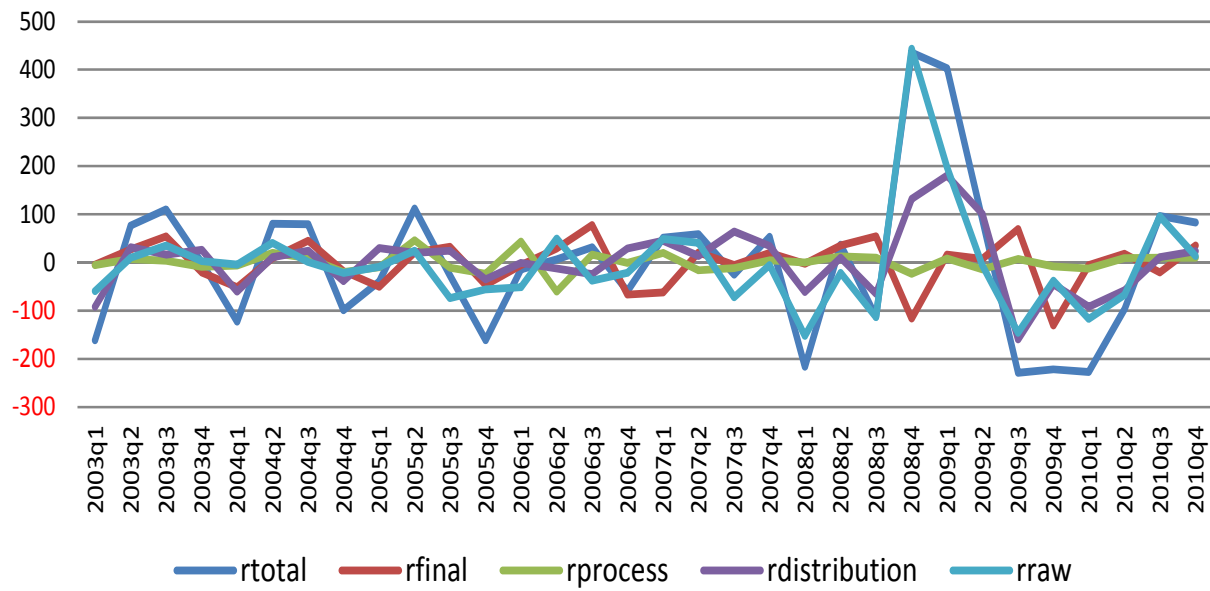
**Inventory Investment: automobile  
rtotal vs. rdistribution, 2003~2010, quarterly**



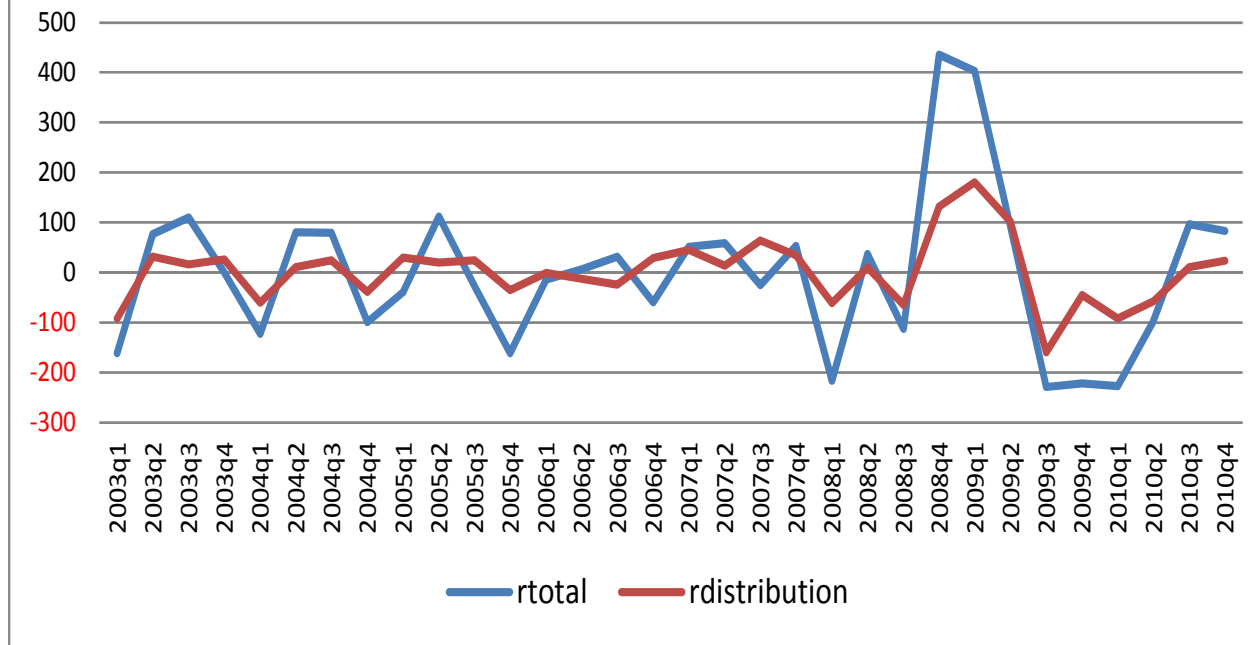
### Inventory Investment: automobile rtotal and by category, 1994~2010, annual



**Inventory Investment: petroleum**  
**rtotal and by category, 2003~2010, quarterly**

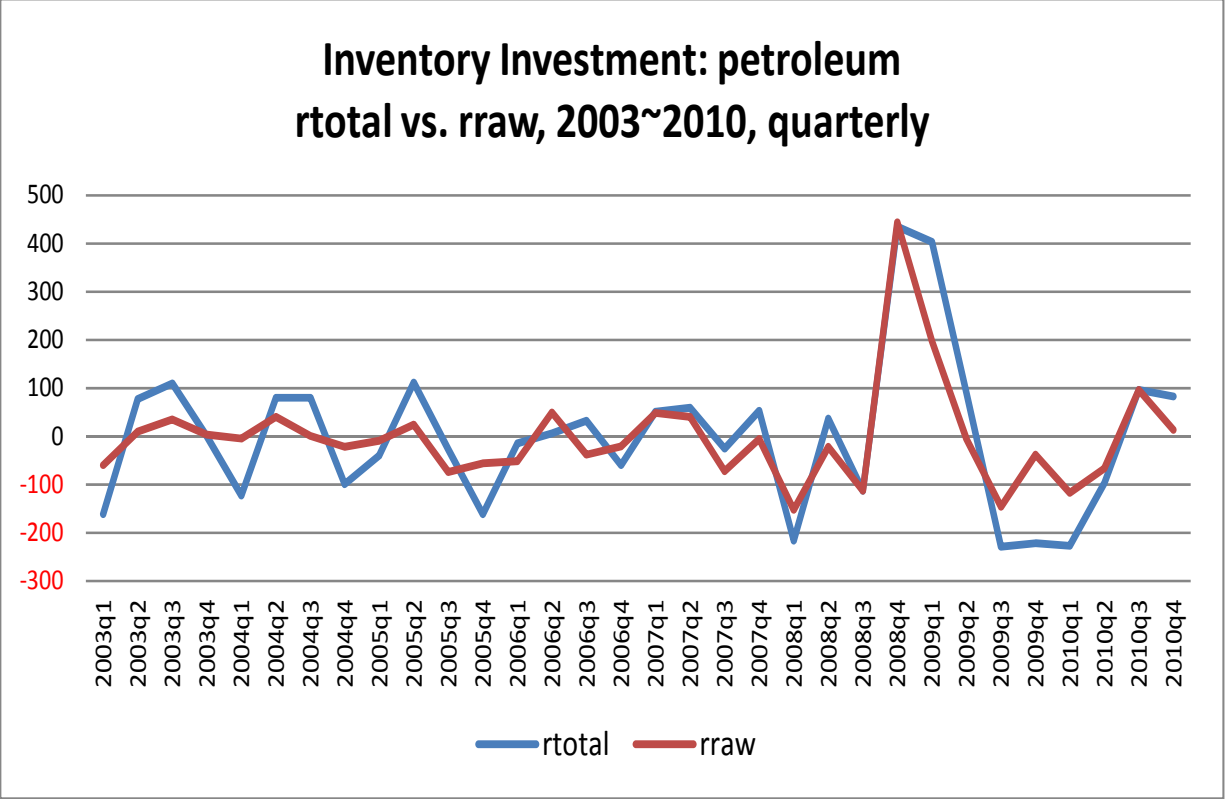


### Inventory Investment: petroleum rtotal vs. rdistribution, 2003~2010, quarterly

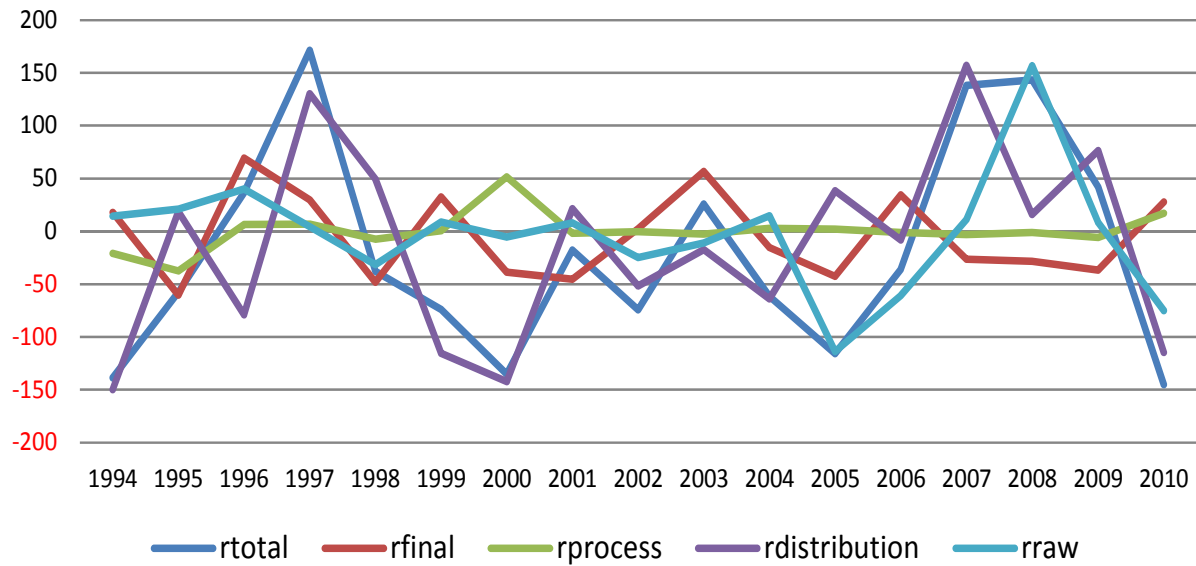




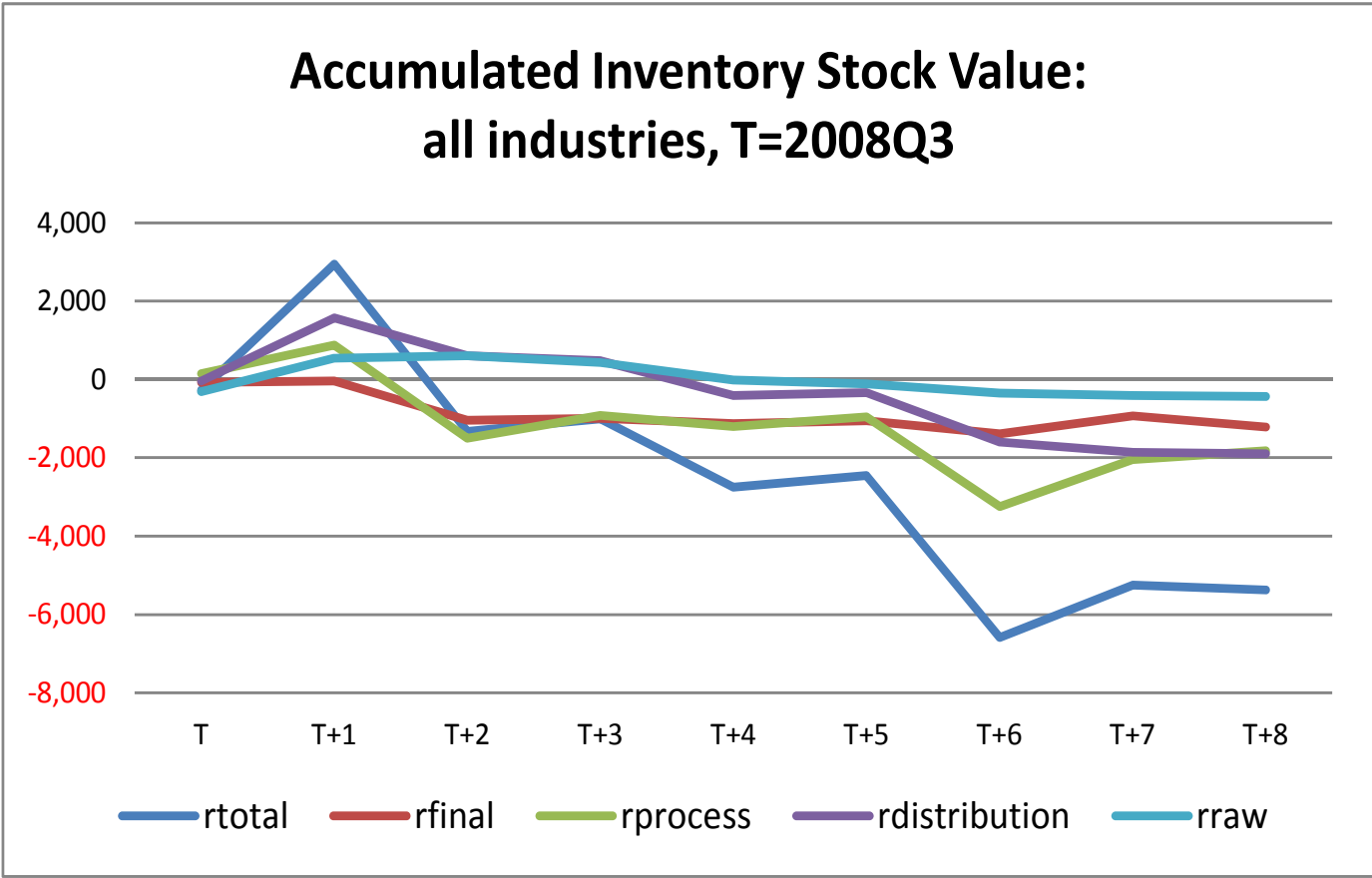
**Inventory Investment: petroleum  
rtotal vs. rraw, 2003~2010, quarterly**



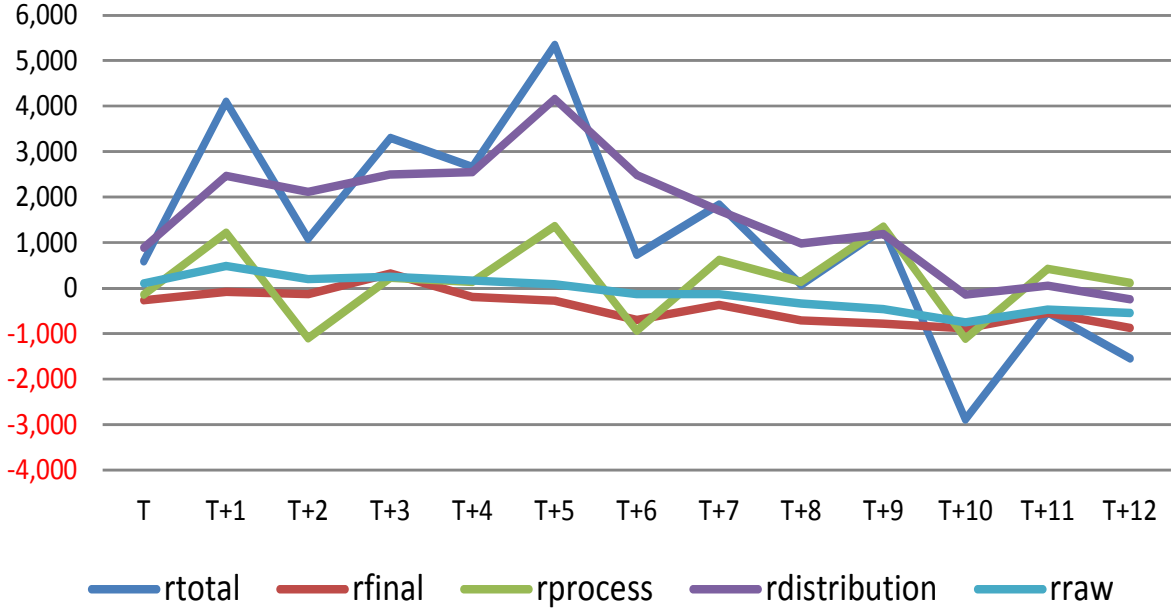
**Inventory Investment: petroleum  
rtotal and by category, 1994~2010, annual**



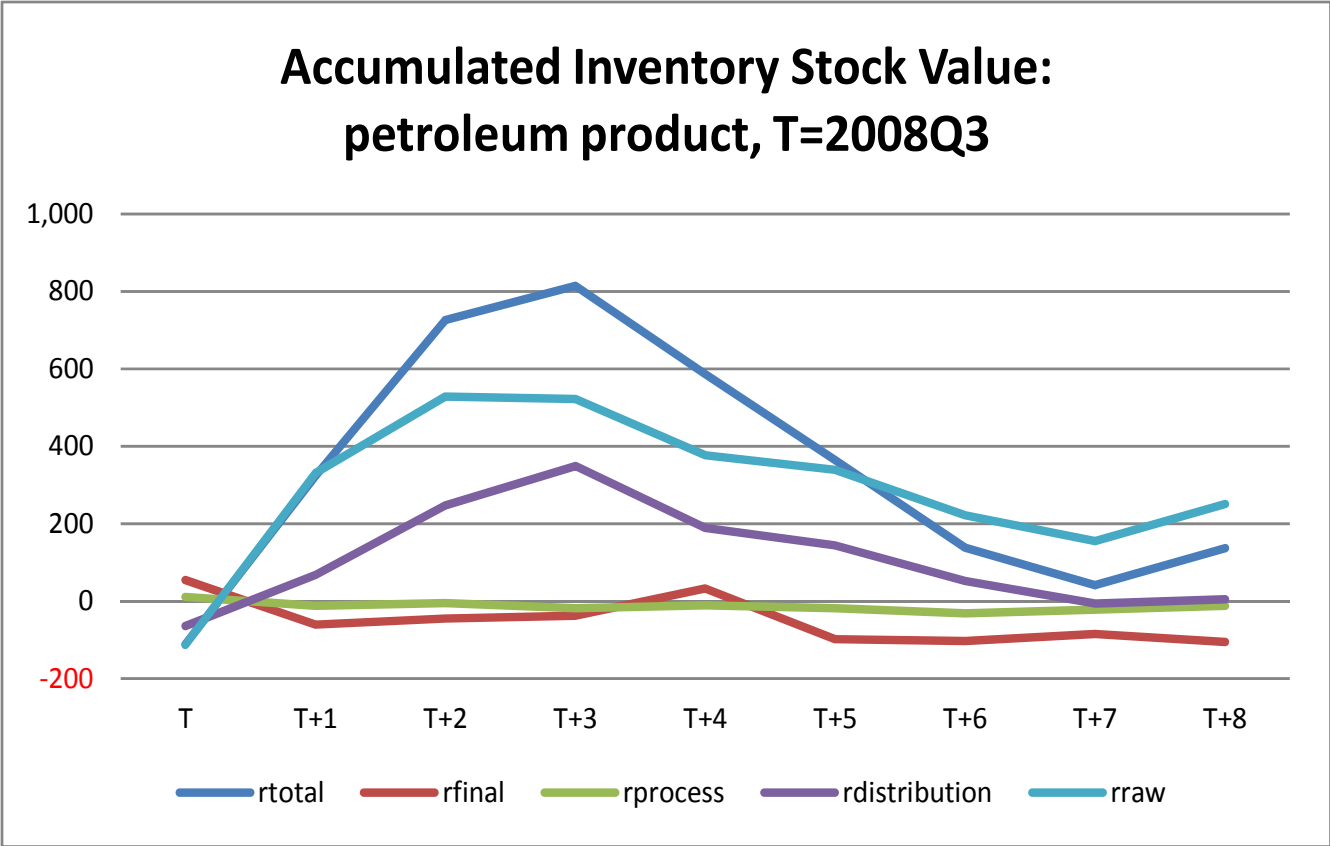
# Inventory Stock Adjustment Process: all industries



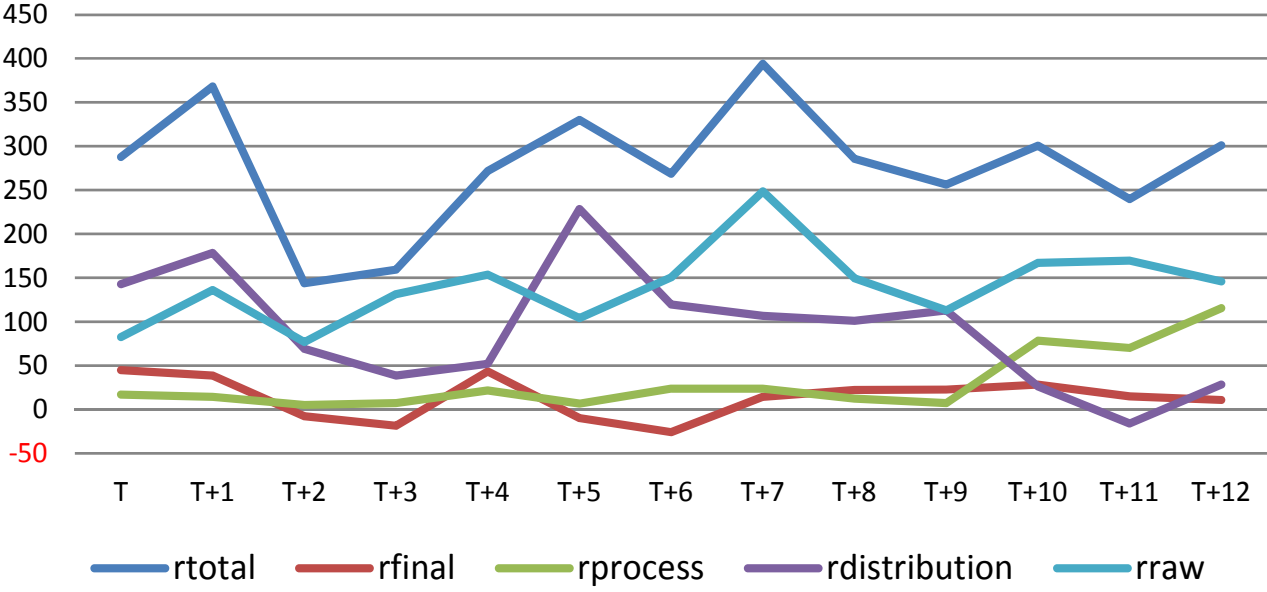
### Accumulated Inventory Stock Value: all industries, T=1997Q3



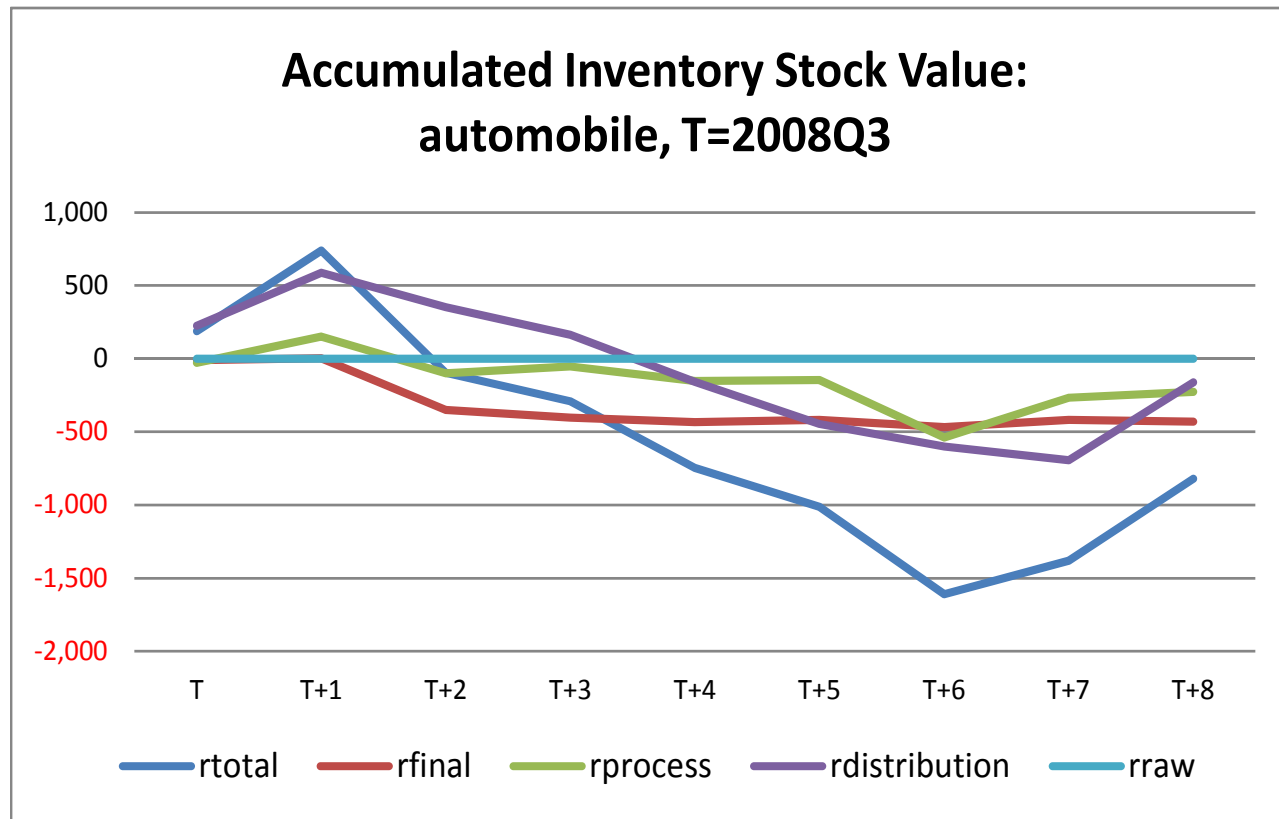
# Petroleum product



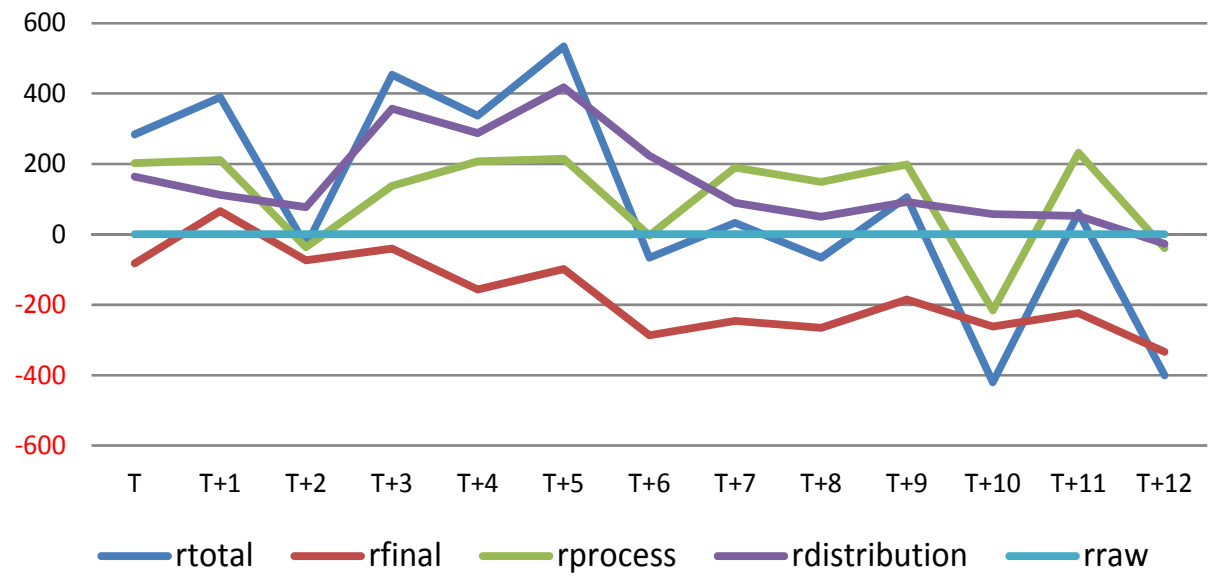
### Accumulated Inventory Stock Value: petroleum product, T=1997Q3



# automobile

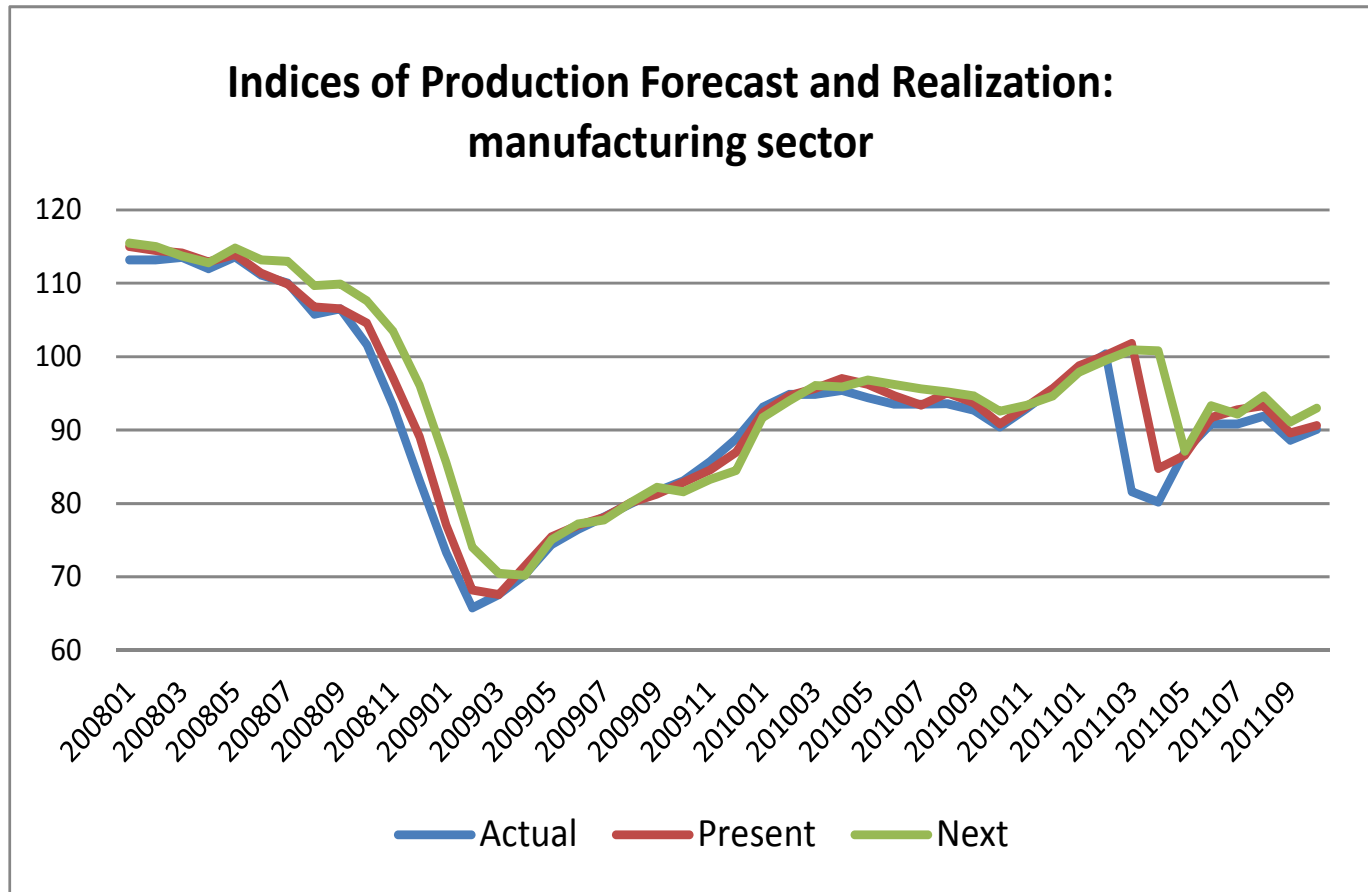


### Accumulated Inventory Stock Value: automobile, T=1997Q3

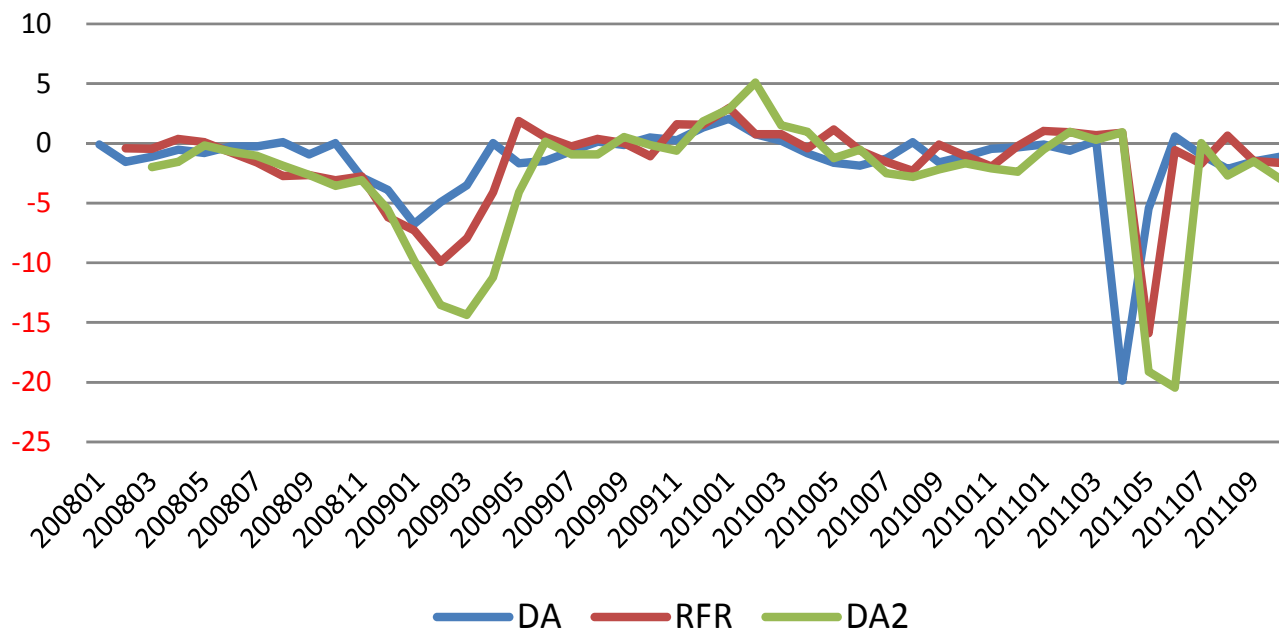




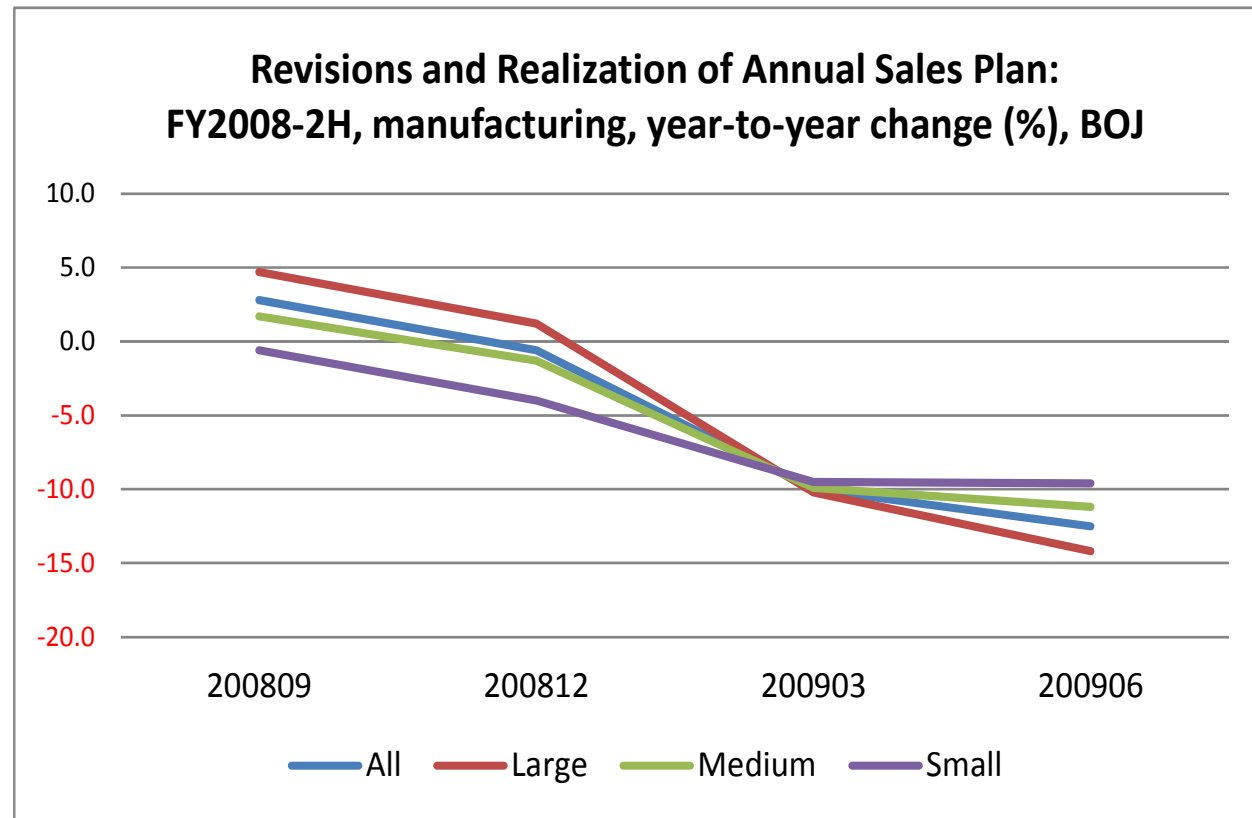
# METI's *Indices of Industrial Production Forecast*, p.108



### Revised- and Realization Rates of Production Forecasts: manufacturing sector



# BOJ's *Tankan* "annual projections" p.110



## (5) Implications and Conclusion

- Time-up.....
- “Knowledge is not like a stock or ore, sitting there waiting to be mined. It is an extremely heterogeneous assortment of information in continuous flux. Only a small part of it is of any use to someone at a particular point of time, and it takes effort and resources to access, retrieve, and adapt it to one’s own use. ... A major aspect of learning is that the unknown keeps expanding as we learn. This should be looked at positively. It is much better this way --- especially for those of us who are engaged in research” (Griliches, 1994, pp.16, 18).
- Also no time for (6), either.