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How to measure tangible capital stock?

The choice between two methods

**Jim Frenken
CBS Netherlands**

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HOW TO MEASURE TANGIBLE CAPITAL STOCK? The choice between two methods

Jim Frenken
CBS Netherlands
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Economic analysis takes into account the stocks and flows of such variables as production, labour, imports, exports and capital. In general all these variables are measured by official statistics in a satisfying way with one exception: capital. In this field the statistical observation fell behind. Several facts caused this underdevelopment. But at the end of the 20th century no reason exists any more to leave capital in the rear of statistical development.

1. INTRODUCTION

In the June issue of 1985 of The Review of Income and Wealth Johan Lock of the Netherlands' Central Bureau of Statistics (CBS) announced the start of a project that aimed at the direct observation of capital stock. Two experimental investigations were carried out to test the possibility of direct measurement of capital goods. The first study concerned the capital stock in the cigar industry in the Netherlands at January 1, 1980. It started in that year and was completed three years later. The other study took place in the machinery packing industry.

These two studies formed the basis for further inquiries in the Netherlands. CBS developed a system for the direct observation that nowadays seems to have found its mature stadium. An important milestone was reached when statistics of tangible capital stock in manufacturing industry were completed. That was the stock at the beginning of the year 1986. This year marks the start of series of tangible capital stock figures. The figures cover the division by industry sections, vintage years, value in actual and constant prices, type of goods. Besides manufacturing industry without construction also figures about agriculture, mining and transport have come available.

Table 1 and the accompanying graph display a slight image of the available information. The classification of good types is explained in Annex 1. The figures of tangible capital stock in manufacturing industry are given some background by Table 2.

Table 1. Tangible capital stock in manufacturing industry in the Netherlands
Actual value by type of goods at January 1

	1986	1987	1988	1989	1990
	x 1000 million guilders				
Total	251	263	283	299	311
Land	18	19	19	20	21
industrial buildings	74	76	82	89	92
Other non-residential buildings	13	13	13	13	13
External transport equipment	4	4	4	4	4
Internal transport equipment	10	10	11	10	11
Computers	3	4	4	4	4
Other machines, devices and installations	113	121	131	142	150
Other tangible capital stock	16	17	18	17	16

Graph 1. Tangible capital stock excluding land in manufacturing industry in the Netherlands at January 1, 1990 per vintage period.

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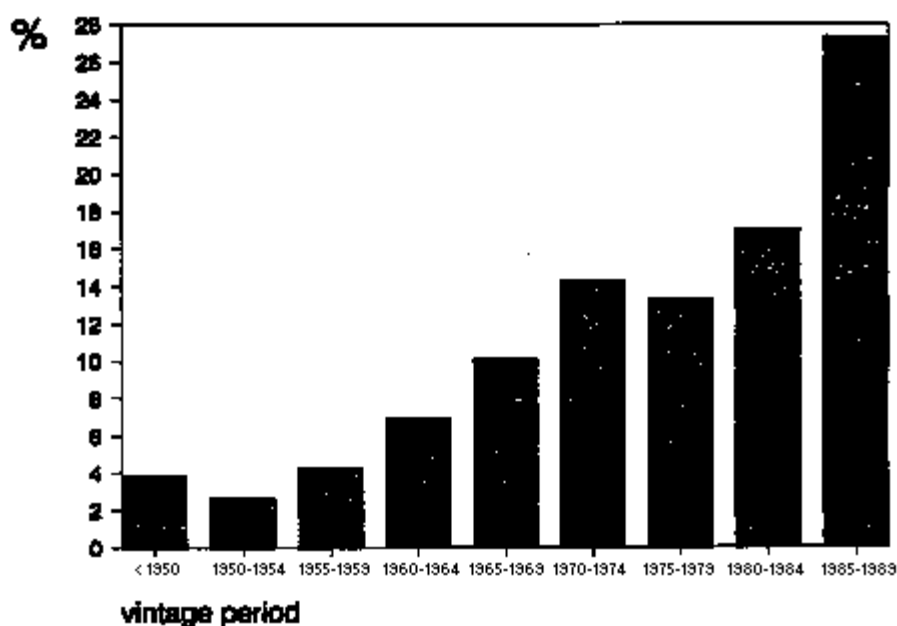


Table 2. Some macro economic figures of manufacturing industry in the Netherlands.

	1986	1987	1988	1989	1990
	x 1000 million guilders				
Added value	83	81	89	96	104
Investments	17	18	19	20	21
Tangible capital stock	251	263	283	299	311
	%				
Occupation of tangible capital stock	84	84	85	86	85
	x 1000 standard years				
Employment	907	914	921	937	955

After ten years of statistical research and experience time has come to wonder if the 'impossible mission' ended with a success. Are the methods used sound and reliable? Are the results of the project satisfying and useful? Of course more questions can be asked but those two are the most important ones. In this paper I just would like to answer the first question. Is the Dutch way to measure capital a good way?

To simplify the problem I will presuppose that only two methods are conceivable in measuring capital goods. The two methods are entitled PIM and DOC. PIM stands for Perpetual Inventory Method; a desk operation on available statistical material with many tricks but a small burden on the budget. DOC means Direct Observation of Capital; a field survey directed to entrepreneurs, difficult and comparatively expensive.

For the start both methods will be described in chapters 2 and 3. I will give my view on the qualities and disadvantages of the two methods. Chapter 4 goes into the common basis to compare the methods. Next (chapter 5) I shall give a more extensive insight in the method used by the CBS. That chapter can be skipped by the reader who just wants an overview. Comparison by figures is to be shown in chapter 6. The end will be an explanation and evaluation of the choice.

2. DIRECT OBSERVATION OF CAPITAL STOCK

The story won't start at the very beginning around 1980. Although it might be very interesting and amusing to hear about the 'brilliant' ideas we, the members of the project team, sometimes had and the many pitfalls we fell in it would extend the length of this description exhaustively. The department and its researchers gained a lot of experience and knowledge in this field of survey in one decennium. The most important lesson was: Don't be over-ambitious and don't aim at goals that are far out of reach for researchers and reporting firms.

In the year 1990 our aim was shrunk to the measurement of the actual value and the historical value of tangible capital stock. We would like to know the vintages of those tangible assets and not more but ten types of goods. The survey concerns Dutch manufacturing industry, agriculture, transport and mining leaving other activities unexplored.

It isn't easy to get a picture of the volume or value of capital stock. Tangible capital stock is in the first place a theoretical concept, not well-known as such in the practical world of business accounting. Tangible capital can simply be defined as those tangible means that contribute to production for more than one year. Then we may start our investigation at any plant and count the things that fit to this definition. We will probably find land, buildings, cars, tools, tables, machinery and computers. Quickly we will get aware of the first problem: you cannot add them. It is not possible to add computers with cars. Even the addition of cars with cars makes hardly sense for economic analysis, for the vehicles in capital stock will have different construction years and different technical qualities. Therefore an idea of the total volume of the tangible assets cannot be easily given.

One way to add different things is to give them a value and consequently add up the values. We could ask the manager of the plant about his impression of the actual value of the assets. If he has a good memory or a sound book keeping and if he is willing to spent us some of his time we might be able to construct a reliable image of the value of the capital stock at the end of our interview. But in the Netherlands as well as perhaps in more countries memories and books are in general not pointed to statistical definitions. The actual value of a two-year-old-car is somehow known by people, but certainly not the value of a two-year-old-computer.

However an advantage of the method of direct observation of capital stock (DOC) is the immediate contact with the manager who can give us information plus an impression of the reliability of this information. It makes it possible for experienced interviewers and desk-workers to improve individual incomplete information into trustworthy macro economic figures.

Direct contacts include also disadvantages. Visiting and interviewing with a broad back-up is time consuming and costly. Budgets of civil services in the Netherlands have been cut. In effect statistical services to the public have been limited. In the case of the statistics of tangible capital stock the limited budget was reason to keep the frequency of visits low and to focus on the big investors. It was decided to apply once in five years to the industrial firms with more than 100 employees.

DOC was preferred originally as the one method of measurement because of the fact that in this way the Dutch stock of capital could be inventorized quite precisely. It promised to deliver a high-quality result if enough means and skilled statisticians were available to carry out a complete survey in a short period. A standard of the national stock of tangible assets on a certain moment would get disposable by a census. After that achievement it might become relatively easy to make a good estimate of the stock in the next years with the figures of that first founding inventory as a basis.

The method of direct observation of capital as designed originally shows to full advantage if applied to a complete field of objects. The best condition for good results from DOC is drawing up an inventory of a certain sample without exclusions at one moment. Such an inquiry should be organized as a quick effective operation. A lot of external staff should visit the firms in the sample in a short period. But such a full application of DOC in the Netherlands would demand a budget that is about ten times the budget awarded.

It is ironic that the reach of the method that was initially chosen because of its advantages integral survey had to be limited. It puts some question-marks to the profitability of the results of DOC. But final conclusions will be delayed until the last chapter where all the relevant evidence can be taken into account. There it will be easier to oversee the method and its qualities.

By now it is sufficient to mention that each year by DOC tangible assets of about 300 Dutch firms are directly measured. With the available staff this number of visits can be paid and the results of those visits can be worked out. These 300 firms are the bigger investors in manufacturing industry, whose plants cover about 15% of the total of capital stock in manufacturing industry in the Netherlands. The five-year-cycle is therefore good for a three quarter coverage by direct observation.

3. INDIRECT OBSERVATION OF CAPITAL STOCK BY THE PERPETUAL INVENTORY METHOD

World-wide there has not been done much research work in the field of tangible capital stock statistics. Nevertheless the most applied and quite familiar receipt for measurement is the Perpetual Inventory Method (PIM). PIM uses existing official statistics and some critical hypotheses to construct an estimate of the stock of tangible assets. Essential is the availability of investment series. Combined with knowledge or more likely hypotheses about the lifetime of invested goods one can estimate figures of the capital stock.

In an ideal situation long time series of investment statistics and desinvestment statistics would set up the two cornerstones for PIM.

Investments defined as the addition to the stock of tangible assets mean an extension of the stock of capital goods whereas desinvestments form the deduction from the stock by withdrawals. The investments in a certain year give the starting figure for the total value of tangible assets of that vintage as part of the total stock. In the years to follow parts of tangible assets of that vintage will diminish by disinvestments until the vintage is totally vanished. So at a certain point in time the total stock can be calculated out of the time series of investments and disinvestments.

The charm of PIM lays in its low burden to the budget. If the wanted statistics are available PIM is a cheap way to estimate the capital stock. The broader the field of the statistics the broader the description of the stock of tangible assets can be. This great advantage of PIM is also under other circumstances its weakness. The availability of the statistics and the characteristics of these statistics delimit the features of capital stock statistics that are to be accounted from them.

Most countries possess good official investment statistics, however desinvestment statistics are rare. It makes hypotheses about lifetimes of tangible assets and their distribution crucial in the application of the method. This is an essential weak spot in PIM. There is firm reason to believe that lifetimes differ for the diverse types of goods and even differ for the same goods as they are applied in different economic activities. One might even imagine that lifetimes change over time, correlated with technical progress and business cycles. Most PIM studies don't incorporate hypotheses that include these specifications and correlations.

Time series to be used in the estimation of the stock of tangible assets should be long and without disturbances. Time series should be just longer than the lifetime of the longest living vintage of an asset type. And that lifetime can be quite long, even for the types of goods with a short average lifetime. Take the stock of cars and trucks in use in manufacturing industry in the Netherlands at January 1 1990 (to be more specific it concerns the good type 'external transport equipment'). The average age of this stock nears 5 years, whereas the range of ages expands

from 1 to 30 years. This means of course that vintages from 1950 to 1989 are used in production. For a good application of PIM investment, desinvestment and price series for this kind of asset should be at hand for more than 30 years. And only then we would be able to estimate the stock of vehicles in industry at the beginning of 1990. For time series of other capital stock goods we need as much longer series.

In a capital stock ages of assets in use can be observed. That kind of age has to be distinct from the age at the moment of withdrawal or desinvestment. If live of a particular good ends at the moment of withdrawal then the age at that moment of withdrawal is the same as its lifetime. If the asset is going to be used elsewhere lifetime exceeds age at the moment of withdrawal.

Figures concerning ages, lifetimes and lifetime distributions are rare. Researchers therefor often accept global hypotheses about lifetimes in the application of PIM, even though these variables are essential for the resulting estimated stock. The lifetimes of a certain type of goods differ significantly depending on the spot where it is used. Within manufacturing in the Netherlands an average lifetime of 9 years of vehicles is observed at the moment of withdrawal in the period between 1984 and 1990. But when the division Manufacturing is split up into sections it turns out that every section on that lower level marks the lifetime of the good with its own characteristics. As an illustration the figures of vehicles are shown in Table 3. Some sections are not mentioned in that table because the number of observations was too small to make a statement about the lifetime of vehicles in these sections.

Table 3. Average age of 'External means of transport' in sections of manufacturing industry in the Netherlands at the moment of withdrawal (1984-1990)

	Section	years
2/3	Total Manufacturing industry without construction	9
20/21	Manufacture of food, beverages and tobacco products	7
25	Wood products, including furniture	3
26	Manufacture of paper and paper products	4
27	Printing, publishing and allied industries	4
29/30	Chemical industry	17
31	Manufacture of rubber and plastic products	5
32	Manufacture of building materials, earthenware, glass and -products	9
33	Basic metal industry	9
35	Mechanical engineering	5
36	Electrical engineering	8
37	Manufacture of transport equipment	15

As important as disinvestments or lifetimes is the notion of the tangible assets that move between activity groups because of migration of firms in terms of the activity classification. A firm might change the center of its activities over time. For example a firm active in textile industry moves its main attention to industry. Such a migration causes a shift in statistics of production figures, labour hours, etcetera. In flow statistics each new edition is based on the most recent population of firms in the activity group. A stock calculated with PIM should also take these population movements into account.

The value of the tangible assets is quite easy to derive at the moment of purchase in the context of investment statistics. When the aim is to achieve the actual value of assets in later years price index numbers are needed to transform the historical value into an actual value. Essential is the availability of figures that can be connected. Classifications and definitions should encompass.

A lack of the mentioned demands causes a qualitative devaluation of the results of PIM. The more ingredients are missing the more questionable the results become.

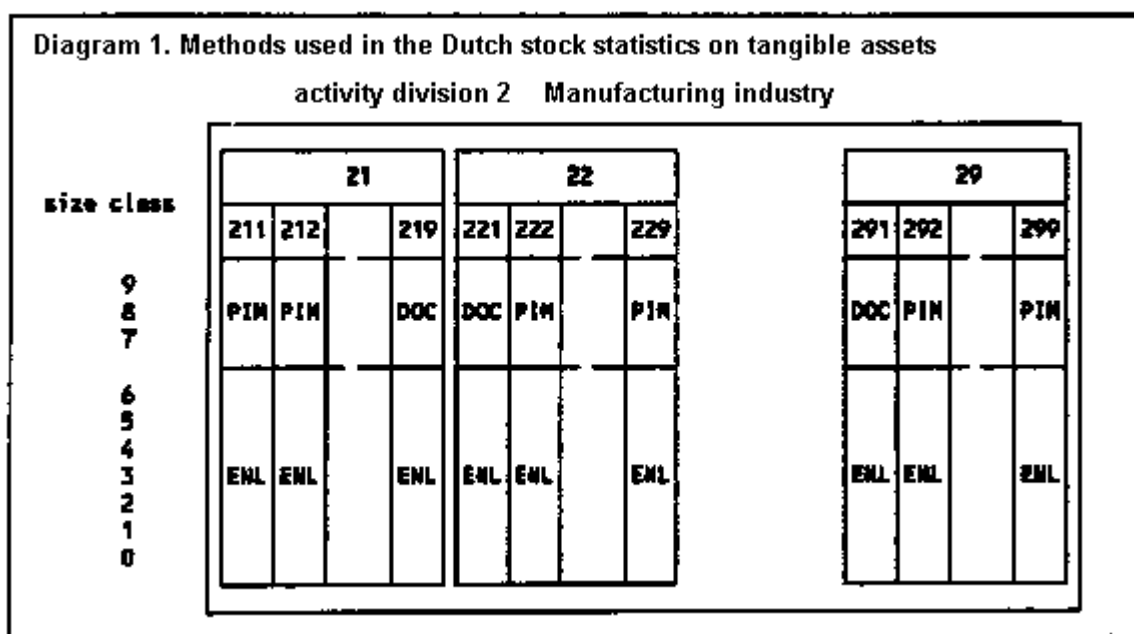
4. COMPARISON OF THE METHODS OF DIRECT AND INDIRECT OBSERVATION

It is not easy to compare DOC with PIM. What should be the standards? The truth is hidden. The figures that are generated by both methods cannot be checked by any objective standard. So at this stage it is not more than a modest preliminary statement that PIM is cheaper than DOC and that PIM is more complex with more reliability risks than DOC.

One risk of PIM ought to be stressed separately: a mistake in some of the used statistics would be carried along for many years and could even last the lifetime of a capital asset. An incorrect calculated investment will stay in the stock figures according to PIM until it is supposed to be disinvested. PIM doesn't incorporate a self correcting mechanism whether DOC, at least when used in an appropriate frequency, should detect at the next moment of observation that there was something wrong with the previous observation.

In our Dutch experience there was little room to apply DOC and PIM to the same fields over the same period. With the limited budget and means we were happy to get any estimate of the stock of tangible assets whether by DOC or by PIM. The first goal was to use DOC as much as possible, for with the knowledge we had it seemed that DOC was preferable over PIM. So DOC was applied in the activity groups within manufacturing industry with the highest investment-rates and in these domains the biggest spenders were examined. PIM and hybrid-PIMs were used to fill the gaps left by DOC.

How this was done can be demonstrated by a styled map of the survey field of one year. Firms in industry are listed in a register with their volume according to the number of employed persons. These size classes start with firms without employees as 'class 0', followed by firms in 'class 1' with 1 employee on a yearly base, 'class 2' with 2-4 employees, 'class 3' with 5-9 employees and so on until 'class 9' where firm possess more than 500 employees. Industrial activities can be subdivided according to the activity classification SBI in sections (two digits) and further in groups (three digits). A more detailed division is possible but not relevant for this survey. When the size classes are put in a column and the activity groups in a row the application of PIM and DOC can be visualized in the next matrix.



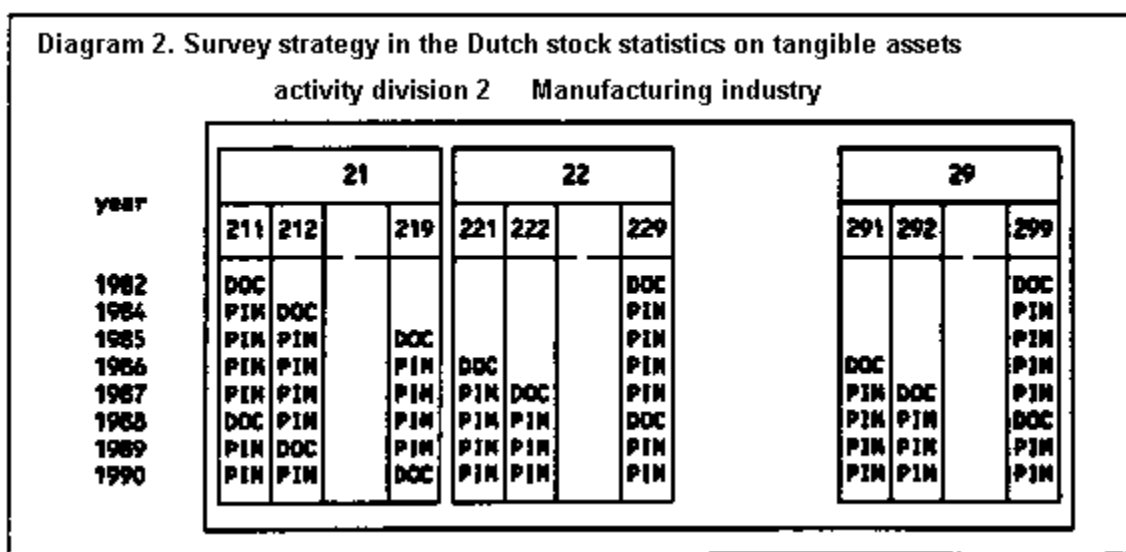
The information gathered by DOC on group level (3 digits) is used with other figures to apply PIM for the estimate on section level (2 digits) and at last for the manufacturing industry as a whole. In this way the figures of the stock of tangible assets in manufacturing industry on three levels are completed in one year of survey. The relevant parts and levels of the activity classification SBI are printed in Annex 2.

From the macro economic point of view investments in the lower size classes are not very important. Their contribution to the capital stock of activity groups and to manufacturing industry in general is rather small. The figures that in the first place are estimated in the size classes 7-9 (more than 100 employees) by PIM or DOC will be enlarged with the classes 0-6 by a method called 'enlargement' (ENL for short). This method and the others get some more attention in the next chapter.

In general no figures will be elaborated at group level (3 digits) before a direct observation is explored. But at section level (2 digits) figures can be produced as soon as the section is sufficiently covered. The situation described in Diagram 1 stays one year. Then the DOC-focus is zoomed to other industry groups trying to visit all groups in a five-year-cycle. Now there appears a possibility of comparison. The DOC-observation will be followed by PIM-estimates for four years and than the next DOC-review takes place. Diagram 2 gives an idea of the way the landscape of tangible assets is mapped.

In the Dutch situation PIM is generally used in the measurement of tangible capital stock as a supplement to DOC in the years that DOC isn't applied. Then PIM is a short term estimate with DOC-figures as a reliable basis. Pure estimates with PIM without a DOC-base were made of some parts of the capital stock. These applications were too scarce to serve as a foundation for systematical comparison with DOC. In this paper DOC will be compared with the short-term-DOC-based-PIM.

It should be repeated that for simplicity's sake both diagrams display a styled picture of the survey strategy. The path of trial and error had to be followed before the right trail was found. Therefore the figures in chapter 6 will show a different plan. Reality was sometimes more complicated.



After the first DOC application four years of PIM including updating follow. Then a confrontation year comes in which both DOC and PIM figures are available. Not that it is enough to give a straight verdict over DOC or PIM. If after 4 years DOC and PIM figures match it could mean coincidence or a sound use of both methods. If they don't match it is questionable whether PIM or DOC has to be blamed. Or maybe the method is good but the application was careless. I will go into this matter in Chapter 6 after the presentation of some figures from the statistics that might give a better insight into both methods.

5. THE METHODS

In the attempt to gather an estimate of the stock of tangible assets in Dutch manufacturing industry four methods have been used: direct observation, DOC; perpetual inventory method,

PIM; enlargement, ENL, of figures compiled by DOC and PIM; updating, UPD, of figures compiled by DOC and PIM; This chapter will show more detail and describe the way these methods have been applied by CBS to compile statistics of the stock of tangible assets in Dutch industry. The reader can skip this chapter if he is not interested in the inside of statistical observation. Chapter 6 will mention some comparable figures as far as available by both methods and the concluding chapter 7 contents an evaluation.

As mentioned before the Dutch experience stretches over a period that is about a decennium long. I pick up the story at its recent stage and neglect failures and misachievements. The paragraphs will concentrate on what is seen as the best and most efficient recipe to cook good capital stock statistics.

5.1. DOC

Direct observation of capital at CBS has got the shape of an inquiry into the installed tangible assets. The sample of enterprises is taken from the overall business register of the statistical office. In this way we know the selected firms':

- main business activity according to the SBI classification;
- size class by employed persons.

The business register is also used by other statistics. This enables to link figures of the stock of tangible assets with statistics about employed labour and investments.

The survey strategy is top down. First the attention is drawn to the most important activities within manufacturing industry. Production statistics and employment statistics point out the way to these activity groups. In these activity groups our interest is directed to the largest plants. In general these are also the big investors as can be traced from investment statistics.

When the firms to be investigated are located they get informed by mail of the existing interest. A member of the external operating staff makes an appointment by telephone. This interviewer visits the chosen managers and tries in a first attempt to make an inventory of the stock of tangible assets of this enterprise. The attention is pointed to:

- the type of assets: a classification of eight good types is used;
- the original value: the value of a new asset at the moment of instalment;
- the vintage: year of installation of a new asset;
- lease or ownership;
- the fact that assets are purchased new or second-hand.

The report of the interview gets processed in a desk operation in which the information is checked and completed. Investment statistics for example offer a good help for a check. Information about the value has often to be completed if the goods are rented or second hand. Interviewed firms generally miss exact details concerning the assets they rent or the assets they bought second hand. If a building is rented the original value might be unknown by the firm that uses the building. When a good was bought second hand it might be difficult to detect the vintage and the original value. Also the value of land causes trouble. The average Dutch manager is not aware of the value of the land he possesses in terms of the statistically defined original or actual value. To estimate the value of the land we can rely on governmental statistics and registers.

Besides the wanted original value several kinds of values are supplied by the interviewed firms. Interviewer and desk clerk transform those values to the original costs of the tangible assets; the historical value. For the purpose of stock statistics of tangible assets price index numbers are prepared by type of assets. With these price index numbers we can update the (historical) value of an asset at its birth to the actual value at the moment of measurement. Should only the actual value be present then the set of values is completed with the aid of the price indexes by calculating the historical value.

Directly from DOC we can produce at the end of the procedure a sample of enterprises in the

size classes 7-9 at 3-digit level of the activity classification. The measured variables of this sample are:

- the type of the assets;
- the original value (C);
- the actual value;
- the vintage;
- owned/leased.

The last of the listed variables has its merit especially in the observation process. For the right understanding of the measured values it is important to notify whether the tangible assets are owned or leased. Also the knowledge that the goods came in first or second hand contributes to the quality of the observation. Commonly these variables are not published.

To admit a quick view over the observation procedure the results of the collection will be put in the shape of a formula. But only the most relevant symbols show up in the formulas. Obvious details will be left out.

The original value of the assets (C) is summed up as found in a sample of (i) enterprises in a certain year in the explored size classes (s) of an activity. The aggregate value of the tangible capital stock at the start of a certain year of the (t) responding firms in the (s) upper size classes of an activity group is:

$$DOC_s^{RESP} = \sum^i C \quad (1)$$

In spite of the efforts to comprehend all wanted enterprises in the sample corrections have to be made for non-response. Fortunately individual figures from other statistics are disposable so expert estimates about some enterprises can be worked out. In these estimates by experts information from other statistics like investment and employment figures are taken into concern. These methods are applied when a non-responding firm might largely influence the overall outcome. It is only possible of course if this firm responds to other statistics, which is likely because for those statistics a legal obligation exists. When it isn't feasible to make an estimate at firm level or when it is too time consuming a general step is taken and non-response is simply corrected with a ratio based on the portion of employees (labour L measured in standard years) of the respondents.

$$DOC_s^{SAMPLE} = DOC_s^{RESP} * (L_s / L_{s, resp}) \quad (2)$$

We still don't have the aggregation of the value of assets in the whole activity. Again we turn to labour statistics for help. By way of a ratio of labour employed in the total activity and labour employed in the survey area (size classes 7-9) the value is enlarged. Therefore the reference to size classes in the formula can be dropped now. DOC includes subsequently the enlargement pictured in Diagram 1.

$$DOC^{ENL} = DOC_s^{SAMPLE} * (L / L_s) \quad (3)$$

Essential for the degree of reality of formula (3) is the hypothesis that capital per capita (per unit labour L) is the same in large and small size classes. The original value of the assets was aggregated but we take an even wider interest in the actual value. Original values have to become actual values. That's why the last step is an update using price index numbers (P):

$$DOC^{UPD} = DOC^{ENL} * P \quad (4)$$

The price index numbers P give the relation between the original price at the moment of purchase of an asset and the actual value in the year of the survey. The actual value is equal to the price to be paid if a new asset of this kind with the same technical specifications would be bought again. It expresses the relation between the original vintage price and the actual price. Index numbers are worked out for industry as a whole and not on the level of activity groups. On the other hand types of goods are distinguished. For simplicity reason the formula above suggests an aggregated elaboration.

5.2. PIM

Diagram 2 showed that policy is to start with a DOC-survey. PIM isn't used over the complete period, but only over the years following the first observation with DOC. It is supposed that by doing this some weak points of PIM are evaded. For a good application of PIM long reliable time series should be available. In general they are not: disturbances of several kinds occur. Normally desinvestment figures are completely absent. By taking a DOC-observation as a benchmark large deviations from the right course are avoided. It makes the application of PIM in the Dutch case special.

Starting with DOC it is tried to estimate PIM in the next years. First the firms that were subject of DOC in the higher size classes (s) of this activity are looked over. Is the composition of the sample the same as last year? Enterprises will stop and start activities so a correction for immigration and emigration to and from this sample has to be made. It is quite easy to skip the drop outs, but on the opposite information in desired detail about the new-comers is scanty. To take into account the firms that leave and join the sample labour statistics again do good service. Labour statistics present the total labour in both years of the sample of firms in the chosen (upper) size classes in this activity. The observed value of the sample is adapted somehow like was done in the response-correction in the DOC-receipt (2), a process simplified here in a ratio r of labour volumes:

$$PIM_{s,t-1}^{SAMPLE} = DOC_{s,t-1}^{SAMPLE} * I_{s,t-1}^{SAMPLE} \quad (5)$$

In fact the foregoing step is a correction of the value of the sample with the intention to make it timely. We went one step back and estimated what the capital stock was in the year before of the firms that figure in the new sample.

Crucial in the application of the PIM is the addition of investments and the subtraction of disinvestments. Investments are adopted from investments statistics at the right level of aggregation. These figures are collected by surveys at the same enterprises the direct observation of capital stock took place in the year before. Because of the lack of information about disinvestments these figures must be estimated without the help of any exhaustive statistical survey.

Some insight can be gained from small surveys in the foregoing years. As a by-product of DOC slight information about scrap and second hand sales is available. This information is not representative for the whole manufacturing industry, nor for the activity group in concern.

Several methods to estimate disinvestments have been studied. The choice was made from the list of well-known survival statistics like the logistic curve, the gamma-distribution or the Weibull-distribution. It was tried to incorporate some in the PIM. Not only the qualities of these methods were important, but also the availability of reliable input data. With this background the gamma-distribution has been applied. Processing investments and disinvestments into the value is the next step:

$$PIM_s^{INV} = PIM_{s,t-1}^{SAMPLE} + INV_{s,t-1} - DESINV_{s,t-1} \quad (6)$$

In the enlargement and updating the same steps as in the DOC-procedure are taken. The sample focused on the upper size classes. To include firms of all sizes an enlargement is made with the help of employment years.

$$PIM^{ENL} = PIM_s^{INV} * (L/L_s) \quad (7)$$

The computation is concluded with the transformation of the original value of the assets into the actual value using price index numbers, the update:

$$PIM^{UPD} = PIM^{ENL} * P \quad (8)$$

With the updated PIM-figures the wanted result is reached in the year that follows the DOC-year. In the next year the question rises with which data the calculation should be started: DOC of year t-1 or PIM of year t. As a matter-of-fact the choice should not influence the results. Both calculations if well done have to come to the same conclusion. For the Dutch CBS it is easier to elaborate further the PIM data but this is fully related to organization of the project.

It is important to stress that both methods, DOC and PIM, as applied in the Netherlands contain many similarities but differ in the way they handle investments and desinvestments. The input for both methods is partly the same. An explanation for differences in the results from both methods should therefore particularly concentrate on the differing input-parts.

As demonstrated the promised comparison of DOC and PIM can only concern a short track in the Dutch case. PIM is not applied at CBS to long time series because of the mentioned failure risks. But is PIM doing well even on the short run?

6. FIGURES

Fortunately a modest stream of figures has become available to support the study of the quality of the methods DOC and PIM as applied in the Netherlands. The first direct observations that might be useful for a comparison draw back to the start of the year 1986. The 1982 DOC-figures of the stock of tangible assets used in the production of basic non-ferrous metals built the basis for PIM series that for the start could be compared with a direct observation in 1986. The comparison caused a deception. Conform the PIM the stock had an estimated actual value of more than 3 billion guilders, the results of DOC had a value of more than 4 billion guilders. PIM versus DOC gave a ratio of 0.74. (For reasons of confidentiality the precise figures of some activity groups cannot be printed in Annex 3.)

In later years the flow of figures with the possibility to compare gets going. Table 4 shows that it seems that PIM and DOC are nearing in 1987 and even come quite close to each other in 1988, but 1989 gives a dispersion. It turns out that DOC-results constantly overflow PIM-results in the first three confrontation years. The last two years display also higher PIM-amounts. PIM series depict in general a stable or slightly decreasing stock of tangible assets, whereas DOC pinpoints an evident higher level.

It is obvious that any confrontation will reveal differences. If it didn't both methods would be designed precisely and applied accurately. This might become reality once but mostly statistics have to pass through a period of adolescence problems before they reach adulthood. One should also be aware of the fact that in statistical results certain margins are accepted.

The comparison of PIM and DOC didn't only broaden the knowledge of the two methods but also cleared the view to the merit of the statistical work. It located the weak spots of the working process uncovering mistakes made in calculations and judgements by statisticians. By

incorporating more adequate control and checks in the procedures and by introducing a training program directed to the missing skills it is tried to visit pitfalls only once.

Table 4. Comparison of tangible capital stock estimates in activity groups within manufacturing industry in the Netherlands conform two methods
Actual value January 1, PIM/DOC

	1982	1983	1984	1985	1986	1987	1988	1989	1990
activity groups									
334 Basic non-ferrous	>				0.74				0.90
261 Paper and board mills		>					0.90		
311 Rubber products	>						0.86		
271 Printing				>			0.99		
291 Synthetic fertilizers			>				0.91		
292 Synthetic resins			>				0.96		
294 Other basic industrial chemicals				>			0.91		
300 Artificial filaments				>			0.93		
202 Dairy products			>					0.78	
205 Sugar factories				>				0.84	
211 Starch industry						>		1.25	
212 Animal stock feeds				>				0.85	
281 Petroleum refineries					>				1.02
331 Basic iron and steel industry				>					0.86
369 Other electrical engineering				>					1.18

In Table 4 the symbol > marks the start of the survey by DOC followed by years of PIM. Sometimes short periods give an extreme result (1.25) whereas longer period estimates fit well (1.02). The length of the estimated period doesn't seem to matter to the results.

In basic non-ferrous metal industries a DOC-inquiry was already held thrice. Whereas PIM reached only to 74% of the observed value by DOC in 1986, it came much closer in 1990 with 90%. It could be an example of the above mentioned learning-by-doing, but on the other hand just one indication is a small basis for a general statement.

Estimates have been detailed to the level of eight types of goods. The results of these exercises are shown in Table 5. Again the values resulting from PIM and DOC are simply related. Overlooking the table one should bear in mind that in the average the type 'other machines'

covers somehow half of the total value. 'Industrial buildings' takes broadly one third of the total value.

Good estimates in the sense that the results from PIM and DOC are nearby the same are not rare. Especially 'land' and 'industrial buildings' reach to a fair score if a margin of 5% is accepted as a normal deviation. Of the sixteen efforts nine estimates are satisfying for 'land'. 'Industrial buildings' has seven acceptable scores. Within this margin only two times such an acceptable score is gained at the dominating type 'other machines'. By the weight of 'other machines' all over the good types there is a direct relation with the results of the overall comparison. Less important in value are 'other non-residential buildings', 'external transport equipment' and 'computers'. Nevertheless it is remarkable that these types are obviously difficult to assess. Not one of the sixteen possibilities brings a close result of PIM and DOC.

The passable results for 'land' and 'buildings' don't surprise remembering some remarks made before. The Netherlands is a densely populated country with little room for spectacular investments or disinvestments in land and buildings, at least in manufacturing industry. On top of that a long interest exists in statistics about the stock of these goods answered by a quite stable and continuing flow of statistics in this area. An ideal situation for a good guess.

The contrary position is taken by 'computers'. Computers in the sense used nowadays are a new type of goods. No long time series exist. Their lifetime is short. Table 1 showed that the value of the computer stock is quite small and stable. The input of computers in the production processes differs vigorously between activity groups even within manufacturing industry. Depending on developments in hardware and software, investments and desinvestment waves flock to and fro tangible capital stock. So a reliable estimate isn't easy to make as the relative column in Table 5 proves. Five of the PIM-series stay under half the value affirmed by DOC suggesting that disinvestments of computers are much lower than supposed by PIM.

Table 5. Comparison of tangible capital stock estimates in manufacturing industry in the Netherlands by type of goods and activity group conform to methods
Actual value January 1, PIM/DOC

		type of goods							
		Land	Indust'l bldgs	Other non- resid. bldgs	External transprt equipmt	Internal transprt equipmt	Computrs machines devices and installations	Other	Other tangible capital stock
activity groups									
334	Basic non-ferrous 1986	0.95	0.81	0.92	0.80	0.68	0.30	0.69	0.65
334	Basic non-ferrous 1990	0.95	0.98	1.13	1.44	0.82	0.81	0.81	1.98
261	Paper and board mills	0.54	1.01	1.18	1.92	0.96	0.52	0.88	0.94
311	Rubber products	0.59	0.86	1.10	0.94	0.98	0.34	0.88	1.03
271	Printing	1.02	0.98	1.10	1.36	1.11	0.84	1.00	0.94
291	Synthetic fertilizers	1.00	1.01	0.81	0.46	1.01	0.44	0.87	1.00
292	Synthetic resins	0.99	0.91	0.50	0.80	0.92	2.60	0.95	1.06
294	Other basic ind. chemicals	0.97	0.95	1.06	0.71	0.90	0.41	0.88	1.00
300	Artificial filaments	0.98	0.98	0.31	0.73	1.00	0.70	0.94	0.88
202	Dairy products	0.84	0.81	0.84	0.79	0.58	0.82	0.78	0.83
205	Sugar factories	0.72	0.84	1.01	0.69	0.73	0.77	0.87	0.82
211	Starch industry	0.47	0.68	3.73	2.07	2.06	0.44	1.62	1.73
212	Animal stock feeds	0.79	0.88	0.90	0.71	0.85	0.64	0.86	0.84
281	Petroleum refineries	0.99	0.77	1.27	0.90	0.32	0.67	0.94	1.61
331	Basic iron and steel ind.	0.95	1.03	0.77	2.82	0.31	0.85	0.82	11.66
369	Other electrical engineer.	1.09	1.07	1.03	0.82	1.48	1.49	1.28	1.34

This gives reason to believe that measurement by PIM is insufficient. It encourages the idea that measurement by PIM is unable to monitor tangible capital stock and even fails in picturing the

structural line of development. PIM hides more risk to be incomplete than the measurement by DOC. Does this mean that PIM as a way to estimate capital stock is inferior and cannot be brought to an acceptable level? Is even the experience of some years of dispersion not enough to correct sufficiently the ingredients of the PIM recipe? Or can't Dutch statisticians creatively assimilate the facts and figures?

In general PIM isn't doing well in the Dutch situation. DOC is needed as a benchmark once in a while to keep the right course. It is remarkable and frightening that in few years a PIM filled with unsuitable parameters causes strong deviations from reality. Maybe PIM can be used to fill the gap of the period between two existing DOC-applications, but it seems unable to forecast. PIM might be suitable to register and interpolate the results of industrial behaviour. It isn't likely to account well for changes in the desinvestment pattern if statistics in this field aren't available.

Although the start of the series is set by figures compiled from DOC this method isn't taken for granted. In the majority of the activity groups the DOC-figures of one year are followed by four years of PIM-figures. In the fifth year the DOC-exercise is repeated. So at that moment it is possible to compare the results of a repetition of DOC with 4-year time series according to PIM with a DOC-basis. Perhaps more important for the development of tangible capital stock statistics is that it also becomes possible to compare a DOC-approach with the DOC-approach of some years earlier. The field reports prove that DOC satisfies as a method and that its application was commonly appropriate. Non-respondents became respondents later and gave the opportunity to check the correction conform formula (2) in chapter 5 and eventual expert guesses made. Small firms became large firms by growth or merger with the chance to look over the enlargement (3).

Some worries exist around the hypothesis used in (2) and (3). This supposition, that the ratio between the stock of tangible assets and the volume of employment is the same for the average small and the average large firm, is essential but debatable. As far as figures became available they proved that there was no strong relation between the size classes and the capital/labour ratio. The firms in the larger classes didn't have significantly more capital and the smaller firms less. Among other exercises six complete surveys in the years 1983 and 1984 in all size classes were recalculated conform DOC imagining that figures of the lower size classes weren't available. Then the estimates and true figures were confronted. The calculated ratios were put against the estimated ratios of the higher and lower size classes parts. This confrontation resulted in general in small deviations per total and per type of goods.

At first thought this seemed astonishing, but a second evaluation brought an acceptable explanation. The statement that larger firms have more capital than smaller firms is trivial. But if large is defined as done here by number of employment years there is no reason to believe that there is more capital per capita in the large firms. It is also relevant that this comparison is done within the boundaries of a particular industry group covering enterprises with many similarities. In the six surveys mentioned for example two activity groups had even a higher capital/labour ratio in the lower size classes. This gives faith to the macro results from DOC.

7. CONCLUSION

The conclusion is that measurement of the stock of tangible assets is possible nowadays. There is more than one way that can be followed from the theoretical concepts to the practical measurement. Every country that has the apparatus to carry out statistical surveys can do it with relatively low costs. Industrialized countries can surely do it and if they did it it would contribute enormously to the data flow for economic science.

In the preceding chapters is outlined how Dutch statisticians tried to measure capital stock during the last decade. They succeeded in measuring the stock of tangible assets in manufacturing industry. Relating the figures with other macro and meso economic variables make them look quite reliable on those levels. Tables 1 and 2 give some broad information. The yearly publications *Kapitaalgoederenvoorraad* go more into detail. The available material proved to do good service in economic studies on meso level. However desegregation of activity sections makes contradictories and improbabilities appear.

Figures on the level of activity groups are published here and elsewhere to give an insight in the quality of the statistics on tangible capital stock. The figures clear up the strong and the weak sides of these statistics. For the present the use of figures on this aggregation level bears risks. On the other hand the figures on the higher level of activity sections (2 digits of the SBI classification) seem quite reliable demonstrating a strong correlation with other crucial variables in the economic process.

PIM has disadvantages that just partly can be overcome. It needs ingredients that not always are disposable in an acceptable quality. Disinvestments and lifetime statistics are not available in the right shape and especially this lack has a bad influence on the results from PIM. DOC does not carry this disadvantage but is expensive and time consuming: too much a burden for statisticians and reporting managers.

In future CBS intends to elaborate the measurement of tangible capital stock further to yield a balanced mix between the input van DOC and PIM. In spite of the use of PIM for the short track its results are poor, so improvement is a prominent aim. It is hoped to gain this by the introduction of figures from desinvestments statistics as an element in PIM. The direct observation of disinvestments started in the Netherlands in 1991.

As most civil services the CBS' budget was lowered in the recent years. So certain choices were not free but forced. CBS prefers DOC because of its qualities but can not afford it. The result is a mix of PIM and DOC. The method used by the CBS is DOC supported by PIM. DOC sets the benchmarks and PIM guesses the sequel. Using both methods next to each other brings the strong and the weak sides of the methods to light. Using both methods is convenient for failures and weaknesses can be compensated and balanced. In this sense DOC and PIM can very well be complementary and give a good result in the measurement of the stock of tangible assets altogether.

References

Bekker, Peter, 1991, A lifetime distribution model of depreciable and reproducible capital assets

Berends-Ballast, Mieke, 1989, Afstootcurves voor kapitaalgoederen, CBS Statistische Katernen no.II

CBS, Kapitaalgoederenvoorraad, 1992

Frenken, Jim, 1989, Overkapitaalcoëfficiënten, in: Maandschrift Economie, volume 53, 1989, number 5

van Leeuwen, G, and Nieuwenhuijsen, H, 1992, Using capital stock data in estimating production functions, in: Netherlands Official Statistics CBS, volume 7/2, 1992

van Leeuwen, G, and Nieuwenhuijsen, H, 1992, Produktiefuncties voor de Nederlandse en Chinese industrie, in: Maandschrift Economie, volume 56, 1992, number 2

Lock, Johan, 1985, Measuring the value of the capital stock by direct observation, in: The review of income and wealth, series 31, number 2, June 1985

Smeets, Eric, 1991, Capital goods; stocks, ages and lifetimes, CBS, paper for the OECD-meeting of national accounts experts in Paris July 1991

Annex 1. Good classification

Land	Land, ground and sites.
Industrial buildings	Buildings on behalf of their construction meant for the housing of enterprises (like farm-buildings, factory-buildings, offices, shops, garages, shed, hangars and halls).
Other non-residential buildings	Buildings resulted from earthwork (like land suited for building, building-sites, ditches and grooves). Buildings needed for the functioning of waterworks (dam, sluices), and transport (paths, car parks, bridges, greens, forest, platforms, drains, pipelines). Auxiliaries for buildings (like traffic lights, illumination).
External transport equipment	Means of transport meant for the transport of persons and goods on the public road, on water, or by air (like cars, trucks, boats, planes and trains).
Internal transport equipment	Means of transport meant for the transport of persons and goods in or in the neighbourhood of the industrial site (like winches, pulleys, cranes, lorries, transport systems, pile systems, internal mail systems, conveyors).
Computers	Data handling hardware as far as programmable by the user, including all devices (like printers, keyboards, disc units).
Other machines, devices and installations	Machinery, apparatus, equipment, installations, manufacture plants, in general characteristic for a certain industrial activity (offices machines, packing machines, welders, generators, transformers, communication apparatus, telematics, transmission devices, refineries).
Other tangible capital stock	Office furniture and other furniture, scaffolding, storage accommodation, silos, containers, packing material, pallets, clothes, personal tools and instruments.

Annex 2. Relevant parts of the Dutch activity classification SBI

Divisions	Section	Group
0 Agriculture and fishery	01 Agriculture 02 Forestry 03 Fishing	
1 Mining and quarrying	11 Coal mining 12 Crude petroleum and natural gas production and exploration 13 Other mining and quarrying	
2/3 Manufacturing industry except	20/21 Food, beverages and tobaccos	201 Slaughtering 202 Dairy products 203 Canning of fish 204 Flour mills 205 Sugar factories 206 Manufacture of margarine 207 Canning of fruits and vegetables 208 Bread, pastry, biscuit baking 209 Manufacture of cocoa, chocolate 211 Manufacture of starch 212 Manufacture of animal feeds 213 Manufacture of other food products 214 Distilling of ethanol 215 Brewing and malting 216 Manufacture of soft drinks 217 Manufacture of tobacco products
	22 Textiles	221 Manufacture of wool 222 Manufacture of cotton 223 Knitting and hosiery mills 224 Finishing textiles 225 Manufacture of carpets 226 Manufacture of Linoleum 227 Manufacture of made-up textile goods 229 Manufacture of other textiles
	23 Wearing apparel, except footwear	231 Manufacture of ready-made clothing 232 Contract manufacture of ready-made clothing 233 Manufacture of tailor-made clothing 234 Pelt dressing and dyeing industries, manufacture of fur and fur garments 235 Manufacture of hats, caps and millinery novelties
	24 Leather, footwear and other leather products (except clothing)	241 Tanneries and leather finishing 242 Manufacture of leather products (except clothing) 243 Manufacture of footwear
	25 Wood products, including furniture	251 Contract sawing and planing 252 Manufacture of plywood, veneer, fiberboard, chipboard and wood preserving 253 Builders' carpentry and joinery 254 Manufacture of wooden containers 255 Manufacture of other wood products, except furniture 256 Manufacture of cork products, articles of plaiting material n.e.c. 257 Manufacture of wooden furniture
	26 Paper and paper products	261 Paper and board mills 262 Paper converting 263 Corrugated board and folding carton converting
	27 Printing, publishing and allied industries	271 Printing 272 Publishing 273 Binding
	28 Petroleum Industry	281 Petroleum refineries 282 Manufacture of miscellaneous petroleum and coal products

29	Chemical industry	291 Manufacture of synthetic fertilizers 292 Manufacture of synthetic resins and similar primary plastic materials 293 Manufacture of pigments and dyes 294 Manufacture of other basic industrial chemicals 295 Manufacture of paints, lacquers, varnishes and printers' ink 296 Manufacture of drugs, medicines and antiseptic dressings 297 Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations 298 Manufacture of chemical pesticides and similar products 299 Manufacture of other chemical products
30	Artificial and synthetic filaments and staple fibers (except glass)	300 Manufacture of artificial and synthetic filaments and synthetic filaments and staple fibers (except glass)
31	Rubber and plastic products	311 Manufacture of rubber products 312 Tire retreating 313 Manufacture of plastic products
32	Building materials, earthenware, glass and glass products	321 Manufacture of bricks and roofing tiles 322 Manufacture of pottery, china and earthenware 323 Manufacture of sand-lime bricks 324 Manufacture of cement, lime and plaster 325 Manufacture of concrete and cement articles 326 Manufacture of worked monumental or building stone 327 Manufacture of non-metallic mineral products 328 Manufacture of glass and glass products including further processed flat glass
33	Basic metal industries	331 Basic iron and steel industries 332 Manufacture of steel pipas and tubes 333 Ferrous wire drawing and steel cold rotting 334 Basic non-ferrous metal industries
34	Fabricated metal products, except machinery and transport equipment	340 Foundries 341 Forges, stamping and pressing 342 Manufacture of screws, bolts, nuts and technical springs in mass production 343 Manufacture of tanks, reservoirs and industrial piping 344 Structural engineering, except manufacture of tanks, reservoirs and industrial piping 345 Manufacture of metal furniture 346 Manufacture of metal packaging 347 Manufacture of non-electrical heating and cooking appliances 348 Manufacture of hand tools, cutlery, lock and key sets, builders furniture, domestic and general purpose hardware 349 Blacksmith's workshops, welding, grinding and surface treatment of metals
35	Mechanical	351 Manufacture of agricultural machinery and equipment engineering 352 Manufacture of metal-working machinery and interchangeable machine tools 353 Manufacture of machinery and equipment for the food, chemical and allied industries 354 Manufacture of lifting machinery and other handling equipment, machinery and equipment used by the mining, construction and basic metal industries 355 Manufacture of gears, bearings and other power transmission equipment 356 Manufacture of wood-working machinery, textile machinery, commercial laundry machines, dry cleaning and pressing machines; leather-working machinery, paper industry and printing-trade machinery 357 Manufacture of steam-boilers, engines and turbines 358 Manufacture of office machinery (except data-processing equipment) 359 Manufacture of machinery and equipment, except electrical not elsewhere classified
36	Electrical engineering	361 Manufacture of insulates wires and cables 362 Manufacture of electric motors, electricity generators transformers, switchgear and other basic electrical equipment 369 Other electrical engineering

37	Transport equipment	371	Manufacture and assembly of motor vehicles and motor vehicles engines
		372	Manufacture motor vehicle bodies and motor-drawn trailers
		373	Manufacture of motor vehicle parts and accessories
		374	Shipbuilding and repairing
		375	Manufacture and repair of railway equipment
		376	Manufacture of bicycles and motorcycles
		377	Manufacture, assembly and repair of aircraft
		378	Manufacture of other transport equipment
38	Instrument engineering	381	Manufacture of medical equipment and orthopaedic appliances (except orthopaedic footwear)
		382	Manufacture of measuring, controlling and other precision equipment n.e.c.
		383	Manufacture of optical and photographic goods
		384	Manufacture of clocks and watches
39	Other manufacturing industries	391	Diamond cutting and polishing and manufacture of goldsmith's and silversmith's wares and jewellery
		392	Manufacture of musical instruments
		393	Photographic and cinematographic laboratories
		394	Manufacture of toys and sporting goods
		395	Social workshops
		399	Miscellaneous manufacturing industries
7	Transport	71	Railways
		72	Road transport
		721	Tramways and regular bus services
		722	Taxis and motor coach services
		723	Freight transport by road
		724	Business allied to road transport
		73	Sea transport
		731	Ocean going transport
		732	Coastal shipping (shipping on coasting and short sea routes)
		733	Business allied to sea transport
		74	Inland water transport
		741	Inland water transport business
		742	Business allied to inland water transport
		75	Air transport
		751	Air transport business
		752	Business allied to air transport
		76	Supporting services to transport
		761	Travel agents
		762	Shipping-agents, ship-brokers, freighters and other agents in transporting services
		763	Storage and warehousing
		77	Communication
		770	Communication

Annex 3. Tangible capital stock in activity groups of manufacturing industry in the Netherlands conform two methods
Actual value at January 1

		1986	1987	1988	1989	1990
		million guilders				
334 Basic non-ferrous	PIM/DOC	0.74				0.90
261 Paper and board mills	PIM		4704			
	DOC		5231			
	PIM/DOC		0.90			
311 Rubber products	PIM		1413			
	DOC		1633			
	PIM/DOC		0.86			
271 Printing	PIM			4463		
	DOC			4490		
	PIM/DOC			0.99		
291 Synthetic fertilizers	PIM			5665		
	DOC			6242		
	PIM/DOC			0.91		
292 Synthetic resins	PIM			4555		
	DOC			4762		
	PIM/DOC			0.96		
294 Other basic ind. chemicals	PIM			27354		
	DOC			30041		
	PIM/DOC			0.91		
300 Artificial filaments	PIM			4360		
	DOC			4684		
	PIM/DOC			0.93		
202 Dairy products	PIM				6265	
	DOC				7981	
	PIM/DOC				0.78	
205 Sugar industry	PIM				3546	
211 Starch industry	PIM				2415	
	DOC				1932	
	PIM/DOC				1.25	
212 Animal stock feeds	PIM				3136	
	DOC				3681	
	PIM/DOC				0.85	
281 Petroleum refineries	PIM/DOC					1.02
331 Basic iron and steel industry	PIM/DOC					0.86
369 Other electrical engineering	PIM/DOC					1.18