CENTRAL BUREAU OF STATISTICS
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THE UNOBSERVED ECONOMY AND THE NATIONAL ACCOUNTS IN THE NETHERLANDS

A SENSITIVITY ANALYSIS *)

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1. Introduction

In the second half of the seventies there has been a growing concern about the influence of unmeasured activities, fraud etc. on the economy. This issue can be looked upon from several points of view, one of which deals with macro-economic statistics as a basis for economic policy making.
For policy making one needs statistics. When these statistics are biased because of a large and growing unobserved sector, policy might miss its desired effects and sometimes even result in adverse effects. Feige and McGee (1982) give some examples of what might go wrong because of distorted information. Distorted information and its consequences for public policy are also studied by Alford and Feige (1982).
This paper studies the influence of fraud on macro-economic statistics, especially GDP. We use the term "fraud" as meaning unreporting or underreporting income (e.g. to the tax authorities; see also Tanzi, 1980). So, income which is generated by illegal activities, but which is known to the tax authorities (as is sometimes

the case with prostitution) is not considered as fraud in this paper. This paper does not investigate what GDP would have been if everybody would behave according to the law. This has consequences for our treatment of variables like taxes, gross value added of public transport etc.

In an investigation of the influence of fraud on macroeconomic statistics it is of great importance that a clear terminology is used. Following Heertje (see e.g. Heertje and Cohen, 1980), the C.B.S. attaches the adjective "unofficial" to all flows of goods, services and income which are not included in the National Accounts and speaks of "unofficial circuit". Understanding the results of this investigation will only be possible if one understands the difference between fraud and the unofficial circuit. We therefore devote section 2 of this paper to a more detailed explanation of the differences between these concepts. We conclude this section with a diagram showing a classification of productive activities. From this diagram it follows that GDP is only partly distorted by fraud.

Section 3 contains a sensitivity analysis of the GDP estimates for fraud. The sensitivity analysis concentrates on possible distortions of officially measured GDP, caused by fraud. To this end, GDP is divided into six components, dependent on either the estimation methods used or the sector of origin of the data. For each component plausible ranges of the distortions by fraud are indicated. In doing so we obtain a plausible upper bound for the distortion of GDP by fraud. The conclusion of this analysis is, that a distortion of more than 5% is very unlikely. The same kind of analysis can be carried out on the growth figures. Growth figures are more intensively used in macroeconomic policy than the levels of the variables. Discussions about the unofficial circuit should, and in fact do, involve the official growth figures. The conclusion of the analysis of growth figures is that a bias in the growth of GDP of more than 0.5% is very unlikely.

2. The influence of fraud on the National Accounts.

It is a widely held belief that fraud always distorts the National Accounts estimates. In this section we will argue that this is certainly not the case.

In order to form the National Accounts estimates, and especially GDP, several methods may be applied (for a more detailed exposition of the practice in the Netherlands the reader is referred to Algera et al., 1982). The CBS applies, in principle, the production method. In this method the measurement is directed at the producer. Ideally producers give information about their production and intermediary inputs. The method is used in order to make an input-outputtable yearly. This has the advantage that information from different sources can be

compared and hence can reveal sources of distortion (see also Van Eck, 1983). The input-output table serves as an intermediary product in the process of forming the National Accounts estimates. (Of course, it is also a product ready for use in analysis.)

The production method cannot always, at all instances, be applied. Statistical information does not cover all producers of goods and services. Hence, in some cases one has to be satisfied with other methods, which deviate from the ideal production method. Sometimes indirect methods have to be used. If one imagines the economic proces as a circular flow of goods and services, it is sometimes possible to estimate the production and intermediary inputs by laying the point of measurement not at the producers but at other places. As an example may serve the production of the trade sector. It is estimated by multiplying the value of goods (known from surveys, which mostly directly measure the production of these goods), which are available for trade, with a trade margin, which is dependent on the kind of good. Also, some parts of the agricultural sector are estimated by these kind of indirect methods.

Estimates, formed by indirect methods are generally loaded with statistical errors. But at the other side there will be no systematic distortion because of fraud by the producers involved. Whenever information does not originate from the producers themselves, fraud by these producers does not distort the estimates based on this information. This does not mean that these estimates do not include any bias at all. In the next section we will treat these matters in more detail.

Restricting ourselves to statistical errors and distortions because of fraud we may conclude from the above the following.

It is not true that fraud always leads to distortions in the National Accounts estimates. In many cases the CBS uses indirect methods of estimation, which are (at least partly) insensitive to fraud. The relation between the unofficial circuit and fraudulent activities can be pictured in the following matrix. An elaborate version of it is presented by Van Tuinen (1981). It also occurs in Blokland (1982) and Van Eck (1983). The matrix is meant to be a classification of productive activities.

Diagram 1

Classification of productive activities*

	1.Official	Unofficial	
		2.To be included in the National Accounts	3.Not to be included in the National Accounts
1.Activities in which no fraud is involved	1.1 Production, recorded in official files	1.2 Statistical undercoverage of legal activities e.g. street-musicians	1.3 Do-it-yourself activities; household chores
2.Activities in which fraud is involved	2.1 Trading activities, not reported to tax authorities	2.2 Dabbling in the building sector	2.3 Clandestine subletting of rooms by private persons

* The cells only contain examples.

The total fraud consists of all activities which have to be classified in cells 2.1, 2.2 and 2.3. Some of these activities (the ones in cell 2.3) cannot distort the National Accounts estimates, because they should not be included according to the present definitions. By this we do not want to deny the obvious fact that the growth of activities outside the production boundary is very important both for policy making and for the development of the National Accounts in the future.
As a consequence of the use of indirect estimation methods some fraudulent activities (the ones in cell 2.1) are included in the estimates of GDP. In these cases we speak of "fraud, implicitly included in the estimates". This is the gross value added which is included in GDP but which is generated by activities which are not reported to the tax authorities. The sensitivity analysis carried out in the next section is concerned with a possible bias in the GDP estimate because of fraud. Hence, this analysis is concerned with the activities of cell 2.2.

3. Sensitivity analysis

3.1. General remarks

The sensitivity analysis of the National Accounts estimates is based on a detailed investigation of the method by which the estimates are formed or of the part of the

economy the figures relate to.
In our analysis we will examine in detail the composition of GDP as the sum of the gross value added of the sectors of the economy. We will divide the estimates into six categories, according to the estimation method or to the sector of origin. Sometimes figures originate from sectors in which distortion because of fraud is almost nihil, and sometimes estimates are formed by means of methods which are insensitive to fraud. This sensitivity analysis of the National Accounts estimates is inspired by comments made by Van Tuinen (1980) in public discussions about the unofficial circuit.
In sections 3.2. and 3.3. we will describe how GDP is divided into 6 categories, as mentioned above. The actual sensitivity analysis follows in sections 3.4. and 3.5.

3.2. Decomposition of GDP

3.2.1. Category 1, "Indirect methods"

This category contains the gross value added of all sectors and branches of industry, which is estimated by means of indirect methods. The following are included:

Agriculture (excl. horticulture), except for the value added generated by the production of agricultural seeds. The production is measured by multiplying the yield with the prevailing market prices. The yield is known e.g. by measuring (by independent observers) the acreage of crop and the average yield per acre.
Crude petroleum and natural gas production and exploration.
Although the information about quantities originate with the producers, numerous independent checks are made. For example, it is impossible to sell considerable quantities of gas via the existing net of pipelines without any control. The importance of this sector for the Dutch economy implies that there is a stringent control by the government. This would provide a strong argument for classifying this value added in category 2. Such a choice would not affect the conclusions of the paper.
Petroleum industry. The gross value added is almost completely dependent on imported and exported crude petroleum and petroleum and coal products. These quantities and values are known from e.g. customs declaration.
Operating of real estate. The production value is the total rent of rented houses plus the rental value of owner-occupied houses. This production is estimated by multiplying an average rent (rental value, respectively) with the total number of

rented houses (owner-occupied houses, respectively).
The common feature in the methods used to form the above mentioned estimates is, that the information is not systematically distorted by fraud, neither by the producers themselves nor by others. This means, that whatever may be the percentage of fraud in these major groups, this percentage equals the percentage of fraud implicitly included in the estimates. (We have explained this last term in the previous chapter.) Hence, the percentage of fraud by which the official estimates may be systematically biased is zero.

3.2.2. Category 2, "Government"

This category contains the gross value added of the government sector, state enterprises and firms which are subject to detailed government supervision. The following are included:

General government. The gross value added is the sum of compensation of employees, consumption of fixed capital and indirect taxes paid by the government (to it self).
Value added tax. This estimate is equal to the figure for the tax receipts on cash basis of the Ministry of Finance minus the value added tax on the intermediary inputs of some major groups (communication, banking, insurance, operating of and dealing in real estate and health services). For more details on this point, see CBS (1982).
Public utilities. These are under detailed government supervision.
Railways. These are organised in a corporate enterprise of which the state is the only shareholder.
Tramways and regular bus services and subsidized motor coach services
These are subsidized and hence are subject to detailed supervision.
Communication. This is organised in a state enterprise.
Banking and insurance. The production value is the commission for services plus the interest margin (banking) or the net receipts of premiums minus indemnities (insurance). These are under control of either the Central Bank (although it does not have control of all activities of banks, such as holding deposits of "black money") or the so-called Verzekeringskamer (Chamber of Insurance). By definition, the interest margin of banks does not contribute to GDP. So, it will be substracted as the negative value added of a group "interest margin".
Hospitals, mental homes and nursinghouses. These are financed by the government.
Subsidized welfare services, social-cultural and cultural institutions and coporate business organs. These are mostly subsidized. They all keep to

regulations concerning bookkeeping, staffing and salary policy, which are analogous to government regulations.
The estimates in this category are supposed almost not to be systematically biased because of fraud, the reason being that these sectors of the economy do not lend themselves to practising fraud which results in a distortion of GDP.

3.2.3. Categories 3 and 4, "Large firms" and "Small firms".

The figures in these categories are reported to the CBS by the economic subjects themselves. In order to explain the contents of categories 3 and 4 we have to digress and explain in more detail the process of data collecting and processing. Although these categories also contain estimates of sectors like horticulture, fishery and parts of the service sector, the exposition is only concerned with the industry.
The gross value added of the groups of industry involved is estimated as follows. Enquiries are sent out yearly to the firms which are classified in these groups. In some groups only firms employing 10 or more persons are questioned, in other groups all firms are involved in the survey.
The estimates obtained from these surveys, will now be raised, if necessary, in order to account for the gross value added generated by firms which are not covered by the surveys (firms employing less than 10 persons and own-account workers and non-paid family workers).
This is mostly done (e.g. in the case of production) by multiplying a production per worker, as obtained from data of the survey, with the number of persons in the uncovered group of firms. This number is known from social security funds and related institutions and, as for the own-account workers, from the labour force census.
In the way just described estimates for the gross value added per group of industry are obtained.
Recently the CBS has carried out an investigation with the purpose of splitting these figures into two parts: the gross value added generated by firms employing more than 100 persons and by firms employing less than 100 persons (see CBS, 1983). The results of this investigation are used to form categories 3 and 4.
Category 3 contains the gross value added of firms employing more than 100 persons, in groups of industry where these data originate from the producers and are not contained in categories 1 and 2. Category 4 contains the gross value added generated in firms employing less than 100 persons in the same groups of firms as are involved in category 3 (the data must originate from questionaries filled out

by the producers and are not contained in categories 1 and 2). This category also contains the value added generated by horticulture, fishery and the production of agricultural seeds. Category 5 contains the estimates obtained by raising the results from the surveys, i.e. the estimates pertaining to the uncovered firms. In our sensitivity analysis we treat the data of large and small firms differently because of the following reasons:

a) fraud by a large firm involves many people, maybe too many. This argument especially applies in the case of fraud which continues for some years;
b) in the Netherlands firms employing at least 100 persons and for which the balance sheet fulfils some requirements, are obliged to submit for approval their working account and balance sheet to a detailed control by a chartered accountant;
c) large firms have more and better means to take advantage of all possibilities offered by fiscal regulations. Hence, in these cases tax avoidance probably plays a more important role than tax evasion.

To the above exposition concerning categories 3 and 4 we have to make some remarks.

1. Category 4 also contains the gross value added generated by horticulture and by the production of agricultural seeds. In this sector the production is mainly determined by measuring the quantities which come up for auction. This information does not originate with the producers themselves but with the actioneers. Although it is a deviation of the method of estimation used in this category, the resemblance is close enough to justify the choice which has been made.
2. Data relating to firms in the service sector are not splitted into two parts. In these cases the gross value added is assigned to category 4. This is done, because mostly the estimation methods differ completely from those used in e.g. the manufacturing sector and make a distinction by size very hard. Moreover the percentage of the gross value added of the service sector generated by large, non-governmental institutions, for which data originate with these institutions themselves, is rather small.

The estimation methods described above are not insensitive to fraud. Underreporting by producers affects the figures. Ignoring the possibility that producers report higher production and gross value added to the CBS than to the tax office we may conclude that there is no fraud implicitly included in the estimates.

3.2.4. Category 5, "Very small firms"

As has been shortly mentioned in the description of categories 3 and 4, this category contains the gross value added generated by firms employing less than 10 persons and by own-account workers, for those cases in which these estimates are formed by raising procedures etc. Basis for these estimates are results of surveys of producers. The raising procedures are sketched in the previons section.
The method of estimation is partly insensitive to fraud. Let us explain this for the estimates for the value of the production. Given an estimated production per worker in very small firms, which is derived from the production per worker in the firms of the survey sample, the distortion by fraud is the same in both categories. In reality there might be an average fraudulent production per worker in very small firms which is higher than in small and large firms. So, some fraud is implicitly included in the estimates, namely the excess fraud per worker in very small firms above the fraud per worker in small and large firms. The total fraud (as a percentage of the gross value added) which is not implicitly included is obtained by adding to the fraud per worker (not implicitly included) the relative fraud in the number of working people (i.e. the relative difference between the actual number of working people and the official estimates).

3.2.5. Category 6, "Fiscal data"

In some groups the estimates of the gross value added are based on fiscal data. These figures are assigned to category 6. It concerns own-account workers in the following groups:
Part of hotels, restaurants, cafés, repair of consumer goods, business services, renting of machinery and other movables, health and veterinary services, social-cultural and cultural institutions and private households with wage-earning staff. The information on which the estimates in this category are based, is derived from tax files and hence originates with the producers themselves. Hence there is no fraud implicitly included in the figures.

3.2.6. The trade sector

The production value of the trade sector is equal to the sum of the following items:

a) trade margins on goods dealt in, as obtained by multiplying the value of goods available for trade with a certain percentage. These margins can be divided into margins on imported goods and margins on domestic products.

b) autonomously determined margins on certain categories of goods, like second-hand goods and gold for industrial use. Also the production of home and estate agents is included in the production value of the trade sector. This category is of minor importance.

c) indirect taxes paid on imported goods (excise taxes, import duties).

In order to divide the gross value added of the trade sector into 6 categories, we divided the production value and assumed that the intermediary inputs were divided proportionally.

In splitting the production value of the trade sector we proceeded as follows:

- the margins mentioned under b) above were omitted, as they are of minor importance; this implies that they are divided proportionally to the other margins;
- the indirect taxes paid on imported goods were assigned to category 2;
- the trade margins on imported goods were assigned to category 1, as the value of these goods is known from customs declarations;
- the trade margins on domestic products were divided according to the procedure described below.

Let there be N groups of industry and let g_i be the margins on goods of group i and

$$g = \sum_{i=1}^{N} g_i \qquad (1)$$

Let $A = \{a_{ij}\}$ i=1,...., N ; j=1,....,6 be a matrix such that a_{ij} is the proportion of the production of group i that belongs to category j.

Then g (being the total of trade margins on domestic products) is divided into 6 parts g^j (j=1,....,6) such that

$$g^j = \sum_{i=1}^{N} g_i a_{ij} \text{ for } j=1,....,6 \qquad (2)$$

3.3. Decomposition of GDP. Results

All calculations have been carried out on the National Accounts estimates for 1979. The results are shown in table 1 below. A more detailed table is presented in the Appendix.

Table 1

Decomposition of GDP (at market prices), into 6 categories

	Categories						
	1	2	3	4	5	6	Σ
GDP in millards of guilders	65.2	104.6	61.1	54.0	11.3	19.7	315.9
%	20.6	33.1	19.3	17.1	3.6	6.2	100

One sees that 53.7% of GDP is either estimated by means of indirect methods or is generated in sectors which do not lend themselves to fraud which distorts GDP.

3.4. Sensitivity analysis of GDP.

Let us start with a diagram which summarizes our conclusions in the previous sections.

Diagram 2

Fraud and the distortion by it.

	Categories						
	1	2	3	4	5	6	Σ
Total fraud	X_1	0	X_3	X_4	X_5	X_6	X
Fraud, implicitly included in the estimates	X_1	0	0	0	$X_5'-X_4$	0	Y
Fraud, which may bias the official estimates	0	0	X_3	X_4	X_4+Z_5	X_6	Z

In this diagram: X_i is the percentage of the gross value added included in category i, which is generated by fraudulent production; X_5' is the percentage of the gross value added per worker included in category 5, which is generated by fraudulent production; Z_5 is the relative number of manyears spent on fraudulent production.

Below the line the figures indicate the relative amount of fraudulent gross value added, which possibly distorts the estimates. The adverb "possibly" is used on

purpose. As a matter of fact, the percentage of fraud which really distorts the estimates is lower than Z in the diagram. This has the following reason. In certain groups, and especially (but not only) in those groups of which the estimates are based on fiscal data, the available data are raised in order to account for fraud. This means that the figures contain explicit estimates for fraud. The total of these estimates was in 1979 2.6 mld guilders, i.e. 0.8% of GDP. Hence in diagram 7 the real distortion of GDP is Z-0.8%.
We will now present some schemes of percentages $X_1,\ldots,X_6$ and investigate their implication for the distortion of GDP by fraud. As a matter of fact we will only present schemes of percentages as presented below the line in diagram 2: (0, 0, X_3, X_4, X_4+Z_5, X_6). The aim of this investigation is to get a plausible upper bound for the distortion of GDP by fraud.

Table 2.
Distortion caused by fraud, per category, in percentages of gross value added.

Scheme	Category					
	1	2	3	4	5	6
I	0	0	1	5	10	20
II	0	0	2	10	15	30
III	0	1	3	15	20	50
IV	0	1	5	20	40	60
V	0	0	2	10	30	40

Schemes I-IV are formed by increasing the percentages per category. The percentage of 1 in category 2 is added in order not to exclude some fraud, especially in the non-governmental institutions in this category. The percentages range from moderately low to extremely high. For this reason we added scheme V containing percentages which are high (but not as implausibly high as in schemes III and IV), especially in category 5. We consider this scheme as a reasonable upper bound for possible distortions of GDP. Considering the percentages presented here one must be aware of the fact that by making an input-outputtable numerous checks on the plausibility and reliability of the data can be made. For example data on the production of goods and services which have an intermediary use cannot be distored to a large extent, because, although incentives for underreporting might exist for the producers, they most likely do not exist for the users. This supports our opinion that the percentages

presented in table 2 are certainly not too low.
In table 3 the distortion of GDP as a consequence of the schemes of table 2 are presented. In these results the explicit fraud estimations are taken account for.

Table 3.
Distortion of GDP (at market prices), 1979

	Scheme				
	I	II	III	IV	V
Mld. of guilders	5.8	11.6	20.5	28.6	15.3
% of GDP	1.8	3.1	6.5	9.1	4.8

In view of what has been said about the plausibility of the schemes we conclude that a distortion of GDP caused by fraud of 5% seems to be an upper bound.

3.5. Growth of GDP.

3.5.1. General remarks.

Until now the discussion has only been dealing with the size of the unofficial circuit, absolute and relative to GDP. But may be more important than its size is its growth. Its growth is supposed to distort official growth figures and this might have even more disastrous consequences for macroeconomic policy making (Feige and McGee, 1982). Also for macroeconomic model building growth figures are more intensively used than absolute quantities. For this reason the results of this section should be considered as being more important than those of the previous section. This section contains a sensitivity analysis, analogous to the one presented in section 3.4.
Our point of departure is the division of GDP into 6 categories. These categories have the property that methods classified in one category treat year-to-year changes in the same way or that the same conclusions about a possible systematic bias can be drawn because of the sector of origin of the data.

3.5.2. The 6 categories revisited.

Below we will consider the 6 categories from the point of view of year-to-year changes.

1. and 2. "Indirect methods" and "Government"

The yearly estimates in these categories are supposed to be unbiased as far as fraud is concerned. Hence, the change of the estimates is not systematically distorted.

3. and 4. "Large firms" and "small firms".

Data classified in these categories originate with the producers themselves. Hence, growth of fraud, exceeding reported growth, distorts the year-to-year change such as can be computed from the official estimates for 2 subsequent years. In our scenarios of section 3.4 we assumed that the fraud in the category of small firms is greater than in the category of large firms. In our "growth"-scenarios we also will assume that fraud in category 4 grows faster (relative to the officially measured growth) than in the category 3.

5. "Very small firms".

The yearly change of the estimates in this category is partly insensitive to fraud. As has been explained in section 3.2 the estimates in this category are formed by multiplying indicators (such as e.g. production per worker) with the appropriate factor (number of workers). Hence the relative change is equal to the relative change of the indicator plus the relative change in the factor. So, the systematic bias in the estimates of this category is equal to the systematic bias in the indicators as computed for category 4, plus the systematic bias in the factor. It implies that the difference between the growth of the figures in this category and the actual growth is the bias of category 4 plus a bias caused by fraud in the growth of the number of working people.

6. "Fiscal data".

For 1977 the estimates were based on fiscal data, which were raised in order to account for fraud. For the years after 1977 the production and intermediary inputs per own-account worker are multiplied by indices which reflect the development of the prices, number of own-account workers and of productivity. These indices, which are numerous and are different for different sub-groups, are determined from several sources of information about salaries (wage indices), prices (e.g. price regulations of the government), costs. However rough these indices may be, they are based on information which is independent from the producers themselves and is not systematically biased by fraud. Hence, the index of the change of the value added per man is determined in a way which is insensitive to fraud. So, the growth of the gross value added, being approximated indirectly is not influenced by a possible growth of the percentage

of fraud by own-account workers. What is left is a possible systematic bias in the growth of the number of own-account workers. Here the argument works the same way as in category 5.

3.5.3 Some calculations.

In our calculations we will use the following notation.

N GDP as officially measured.

$N_i, i=1,....,6$ gross value added classified in category i.

T GDP as it really is.

$T_i, i=1,....,6$ gross value added classified in category i, when everything that should be measured, would indeed be measured.

F absolute size of the distortion of GDP by fraud.

$F_i, i=1,....,6$ distortion of N_i by fraud.

We will use the following definitions:

$$f_i = N_i/N \quad i=1,....,6 \tag{3}$$

$$f_i^* = T_i/T \quad i=1,....,6 \tag{4}$$

$$a_i = (T_i-N_i)/N_i \quad i=1,....,6 \tag{5}$$

$$a = (T-N)/N \tag{6}$$

The first observation we make is

$$\tilde{T}-\tilde{N} = a(\tilde{F}-\tilde{N}) \tag{7}$$

The distortion of the officially measured growth is dependent on the difference in growth between fraud and the official estimates $(\tilde{F}-\tilde{N})$ and on the relative size of the distortion (a). It is clear that a fast growth of fraud affects the official estimates more when the amount of fraud is large than when it is small.

The above shows that a sensitivity analysis on growth estimates can only be carried out in combination with an analysis of levels. This enforces the cogency of the argument, because a great distortion of official growth estimates is possible only in case of a very (implausibly) fast growing fraud in a situation where this fraud is already very extensive.

From the above definitions and equalities we infer the following:

$$\tilde{T}-\tilde{N} = \Sigma_i f_i^*(\tilde{T}_i-\tilde{N}_i) + \Sigma_i (f_i^*-f_i)\tilde{N}_i \tag{8}$$

It can be argued that the second term at the right hand side probably is negative. Indeed, for the scenarios we presented in section 3.4 we have:

$$f_i^* \leq f_i \text{ for } i=1,2,3 \tag{9}$$

Moreover, in the seventies the highest growth figures have been realized in the first three categories. So, most probably

$$\Sigma_i (f_i^*-f_i)\tilde{N}_i \leq 0 \tag{10}$$

A second argument to neglect this term is its size and especially the size of its coefficients.

For scheme V in section 3.4 $f_i^*-f_i$ ranges from -0.0097 to 0.0209. So, in the rest of our calculations we use the term $\Sigma_i f_i^*(\tilde{T}_i-\tilde{N}_i)$ as an approximation from above for $\tilde{T}-\tilde{N}$.

Rewriting this expression gives:

$$\tilde{T}-\tilde{N} \underline{\leq}(\approx) \Sigma_i \, (1+a_i)/(1+a).a_i f_i(\tilde{F}_i-\tilde{N}_i) \qquad (11),$$

where $\underline{\leq}(\approx)$ means "is approximated from above".

In the next section we present the actual sensitivity analysis.

3.5.4. Sensitivity analysis on growth figures.

Below we present 5 schemes of growth percentages $\tilde{F}_i-\tilde{N}_i$ for i=1,....,6. Every percentage $\tilde{F}_i-\tilde{N}_i$ indicates the excess growth of the distortion of the official estimates. In every scheme $\tilde{F}_1-\tilde{N}_1 = \tilde{F}_2-\tilde{N}_2 = 0$, because the official estimates are (almost) not systematically biased by fraud. $\tilde{F}_3-\tilde{N}_3$ and $\tilde{F}_4-\tilde{N}_4$ indicate the excess growth of fraud in large and small firms respectively. This excess growth is fully reflected in the distortion of the official estimates. $\tilde{F}_5-\tilde{N}_5$ can be decomposed into two parts. At the one side there is the excess growth of fraud per worker in category 4 and at the other side the excess growth of the number of working people (in terms of manyears) who are not registered as such. Hence, the difference between $\tilde{F}_5-\tilde{N}_5$ and $\tilde{F}_4-\tilde{N}_4$ is at most the excess growth of the total employment in category 5 above the official estimates. Finally $\tilde{F}_6-\tilde{N}_6$ is equal to the excess growth of the total employment in this category above the official estimates.

Table 4.

Excess growth of fraud.

Scheme	Category					
	$\tilde{F}_1-\tilde{N}_1$	$\tilde{F}_2-\tilde{N}_2$	$\tilde{F}_3-\tilde{N}_3$	$\tilde{F}_4-\tilde{N}_4$	$\tilde{F}_5-\tilde{N}_5$	$\tilde{F}_6-\tilde{N}_6$
A	0	0	2	5	10	0
B	0	0	5	10	10	5
C	0	0	5	10	15	10
D	0	0	10	15	25	10
E	0	0	5	10	20	5

When we compare the above percentages with the officially measured growth e.g. between 1979 and 1980 (GDP: 6.3%), then the supposed growth of the unofficial circuit is rather high, especially in scheme C, D and E. Scheme E is added to provide a "high" scheme which we consider to be a reasonable upper bound for the excess growth percentages.
The influence of these schemes on the official growth estimates can only be measured if one knows the size of the unofficial circuit. Hence, we combined these "growth schemes" with the "level schemes" of section 3.4. For each combination we may compute the approximation from above of the bias in the officially measured growth.

Table 5.
Bias in the officially measured growth, given the relative size of fraud (I,....,V) and the excess growth of fraud (A,....,E). Bias expressed in percentages.

Level of fraud	Excess growth of fraud A	B	C	D	E
I	0.1	0.2	0.3	0.4	0.2
II	0.2	0.4	0.5	0.7	0.4
III	0.2	0.6	0.9	1.1	0.7
IV	0.4	0.9	1.2	1.7	1.1
V	0.2	0.5	0.7	1.0	0.6

These percentages are computed without regard to the explicit fraud estimations per category. However, the total explicit fraud estimation is taken into account. The explicit fraud estimations influence the bias in the growth in downward direction: taking them into account would lower the percentages in table 5 slightly (at most 0.1%).
In our presentation of the schemes I-V and A-E we stressed the magnitude of the percentages of schemes III-V and C-E. Although we presented schemes V and E as reasonable upper bounds for the "level" schemes and growth schemes respectively, we may not conclude that the combination of V and E yields a reasonable upper bound for the distortion of the growth figures. We must take into account that such a combination of rather high percentages is very unlikely to occur for some years. At most a combination of schemes II and B might occur during a longer period.

It follows that a bias of more than 0.5% is only possible in the unlikely event that both the excess growth of fraud and the magnitude of the relative distortion of the official GDP estimates exceed reasonable upperbounds. We therefore may draw the conclusion that a bias in the growth because of excess growth of fraud is most likely below 0.5%. Higher percentages are improbable.

4. Conclusions.

In this paper we presented a sensitivity analysis of the National Accounts estimates in the Netherlands. This analysis concentrates on the bias in GDP and the growth of it because of fraud. The bias in GDP is investigated by dividing it into 6 categories, according to either the sector of origin or the methods of estimation which are used.

In some categories fraud is implicitly included in the estimates. In other categories the figures relate to parts of the economy which do not lend themselves to practising fraud. Finally in some categories explicit estimations for fraud are made. Giving some schemes of percentages of fraud, which is not implicitly included in the estimates, we obtain some indications for the size of the distortion of GDP. Our conclusion is, that a bias in GDP which amounts to more than 5% is very unlikely.

In the second part of our analysis we concentrate on growth figures. A bias in the relative change of GDP can only be quantified if one both knows the excess growth of fraud (not implicitly included in the estimates) above official growth, and the relative amount of fraud which distorts the official estimates of GDP. So, we combine some schemes of excess growth of fraud with the schemes of relative distortion of GDP itself. Our conclusion is that a bias of more than 0.5% in the growth of GDP is only possible in the unlikely combination of a very great distortion in the level of GDP with improbably high percentages of excess growth of fraud.

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Appendix*

Decomposition of GDP (at market prices), 1979, into 6 categories.
Milliards of guilders

First digit(s) of major group	Categories I	II	III	IV	V	VI	Σ
0	8.5			2.8			11.3
1**	0.5						0.5
2/3***	19.9		38.3	12.1	3.9		74.2
4		6.6					6.6
5			7.3	8.1	6.1		21.5
61/66	21.0	2.9	10.4	5.9	0.9	0.0	41.1
67/68			0.7	6.4	0.4	0.7	8.2
7		7.6	4.4	8.4			20.4
8	15.3	15.0		0.8		12.8	43.9
9		17.4		9.5		6.2	33.1
Government		44.4					44.4
VAT on final exp.		21.3					21.3
Interest margin of banks		-/-10.6					-/-10.6
Σ	65.2	104.6	61.1	54.0	11.3	19.7	315.9
%	20.6	33.1	19.3	17.1	3.6	6.2	100

* The figures may differ slightly from the National Accounts estimates, due to rounding off.
The first digits of the major groups refer to the following:
0 Agriculture and fishing; 1 Mining and quarrying; 2/3 Manufacturing except construction; 4 Public utilities; 5 Construction; 61/66 Trade; 67/68 Hotels, cafes, restaurants and repair of consumer goods; 7 Transport, storage and communication; 8 Banking, insurance and business services; 9 Other services. The reader is referred to CBS (1974) and CBS (1982) for further details.

** Excluding oil and gas production;

*** Including oil and gas production;

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