NATIONAL ACCOUNTS
Environmental Accounts
Environmental Accounts in Physical Units

Update of the Economy-wide material flow indicators time series for Italy and Italian Physical Input Output Table feasibility study

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Abbreviations and Keywords

NA – National Accounts

GDP – Gross Domestic Product

SNA – System of National Accounts

ESA – European System of Accounts

SEEA – System of Environmental and Economic Accounting

NAMEA – National Accounts Matrix with Environmental Accounts

EW-MFA – Economy Wide Material Flow Accounting

EW-MFB – Economy Wide Material Flow Balance

MIOT – Monetary Input-Output Table

PIOT – Physical Input-Output Table

DE – Domestic Extraction (of used materials), measured in weight units

DMI – Direct Material Input (= DE + Imports, measured in weight units)

DMC – Direct Material Consumption (= DMI - Exports, measured in weight units)

PTB – Physical Trade Balance (= Imports - Exports, measured in weight units)

TMR – Total Material Requirement (= DMI + Domestic Unused Eextraction + Indirect Flows of Imports)

TMC – Total Material Consumption (= TMR - Exports - Indirect Flows of Exports)

PTBIF – Physical Trade Balance including Indirect Flows (= Imports + Indirect Flows of Imports - Exports - Indirect Flows of Exports)

APAT – (Italian) National Agency for Environmental Protection and Technical Services

CNx – Combined Nomenclature (EU classification of internationally traded goods) considered at the x^{th} digit

PRODCOMx – The classification used in the homonymous Survey on industrial production carried out in EU countries, considered at the x^{th} digit

NACE Rev.1 – The European classification of economic activities in use in the '90ies, now updated to NACE Rev.1.1

ATECO91 – The Italian version of NACE Rev.1 in use in the '90ies, now updated to ATECO 2002.

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Part I
Economy-wide MF-based indicators' time series for Italy, 1980-2001

I.1 Introduction

Indicators on material input and material consumption derived from Economy-Wide Material Flow Accounts (EW-MFA), have first been calculated for Italy in 2003, in the framework of a project cosponsored by Eurostat; they were referred to the period 1980-1998. The present part of the report illustrates the results of the work carried out hence for the updating of the series to 2001.

In order to maintain the continuity of the series, no substantial change has been introduced in this updating with respect to the methods of calculation of the indicators used in the previous project. Therefore, for details on the methodologies adopted and the data sources used, reference should be made to Femia (ed.), 2003.

Given the methods and data sources, the production of the EW-MFA-based indicators dealt with here can be considered routine work, as data acquisition and elaboration has been arranged in a semi-automatic way. However, the update work has revealed that some calculations will need some reconsideration, mainly as a consequence of changes in the availability of data. A thorough revision of the EW-MFA-based indicators is therefore foreseen, in order to make sure that the regular production of these aggregates will actually follow the best procedures and use the most trustworthy data. This revision will start after completion of the 1997 Physical Input Output Table (PIOT) prototype - currently under construction and subject of part II of the present report - which is expected to bring substantial improvements in our knowledge on how materials flow to, through and from the economy.

I.2 The data

Table 1 reports the figures for the main EW-MFA-based indicators from 1980 to 2001. As in the previous Report to Eurostat (Femia (ed.) 2003) we did not include in the table the indicator "Indirect Flows Trade Balance" but substituted it with the variant "Physical Trade Balance including Indirect Flows" which we consider more interesting, even if not included in Eurostat's Methodological Guide (Eurostat 2001).

MFA-based Indicators give remarkable information to study, monitor and target sustainability in an enlarged perspective, accounting for aspects of man-Nature relationship and ecological sustainability of economic development not covered elsewhere in Environmental Accounts and Statistics. The time series available for Italy are long enough to develop a long-run analysis. This type of study has been done in the previous report and we will update it, in the following paragraphs. We will also focus our attention on the medium term, pointing out the novelties of the emerging trends with respect to the long-run behaviour of the phenomena described by the indicators.

Table 1 - 1997-2001 Material Flow Based Indicators Italy – Tons

DMI ACCOUNT	1997	1998	1999	2000	2001
Used domestic extraction	**604.565.503**	**677.332.983**	**806.860.316**	**776.036.498**	**731.030.062**
Fossil Fuels	*19.646.815*	*19.091.616*	*17.514.870*	*16.074.565*	*14.945.721*
Minerals	*408.461.764*	*477.279.833*	*611.167.644*	*591.165.262*	*544.808.995*
Biomass	*176.456.924*	*180.961.534*	*178.177.802*	*168.796.671*	*171.275.346*
Imports	**289.397.845**	**304.265.097**	**307.843.454**	**329.027.983**	**330.035.125**
DMI - direct material input	***893.963.348***	***981.598.080***	***1.114.703.770***	***1.105.064.481***	***1.061.065.187***

DMC ACCOUNT	1997	1998	1999	2000	2001
Direct material input	**893.963.348**	**981.598.080**	**1.114.703.770**	**1.105.064.481**	**1.061.065.187**
Exports	**111.037.449**	**112.520.167**	**113.485.286**	**119.299.456**	**123.117.502**
DMC - domestic material consumption	***782.925.899***	***869.077.913***	***1.001.218.484***	***985.765.025***	***937.947.685***

PTB ACCOUNT	1997	1998	1999	2000	2001
Imports	**289.397.845**	**304.265.097**	**307.843.454**	**329.027.983**	**330.035.125**
Exports	**111.037.449**	**112.520.167**	**113.485.286**	**119.299.456**	**123.117.502**
PTB - physical trade balance	***178.360.396***	***191.744.930***	***194.358.168***	***209.728.527***	***206.917.623***

TMR ACCOUNT	1997	1998	1999	2000	2001
Used domestic extraction	**604.565.503**	**677.332.983**	**806.860.316**	**776.036.498**	**731.030.062**
Imports	**289.397.845**	**304.265.097**	**307.843.454**	**329.027.983**	**330.035.125**
Unused domestic extraction	**88.810.383**	**86.252.802**	**88.605.447**	**89.612.630**	**93.675.619**
from mining/quarrying	*16.715.068*	*17.950.420*	*23.738.638*	*22.828.241*	*19.682.377*
from biomass harvest	*27.166.039*	*26.978.951*	*27.337.534*	*26.909.824*	*26.501.942*
soil excavation	*44.929.274*	*41.323.431*	*37.529.275*	*39.874.564*	*47.491.300*
Indirect flows associated to imports	**1.034.351.668**	**1.184.907.390**	**1.091.688.928**	**1.171.812.445**	**1.156.049.017**
TMR - Total Material Requirement	***2.017.125.397***	***2.252.758.272***	***2.294.998.145***	***2.366.489.557***	***2.310.789.824***

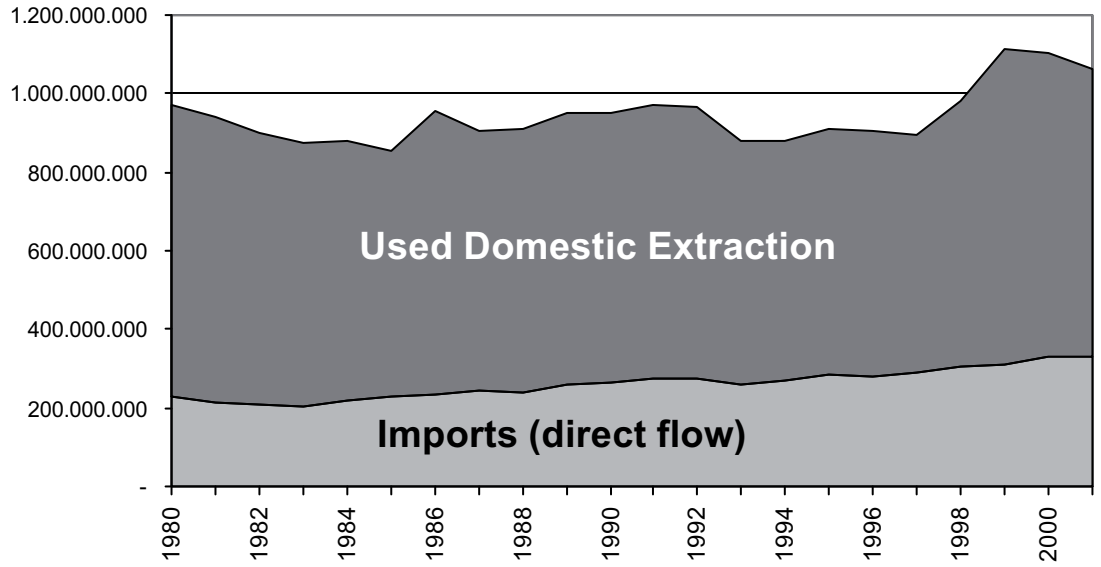
TMC ACCOUNT	1997	1998	1999	2000	2001
Total material requirement	**2.017.125.397**	**2.252.758.272**	**2.294.998.145**	**2.366.489.557**	**2.310.789.824**
Exports	**111.037.449**	**112.520.167**	**113.485.286**	**119.299.456**	**123.117.502**
Indirect flows associated to exports	**344.407.274**	**364.479.099**	**386.425.476**	**489.903.337**	**420.917.109**
TMC - Total Material Consumption	***1.561.680.675***	***1.775.759.006***	***1.795.087.384***	***1.757.286.764***	***1.766.755.213***

PHYSICAL TRADE BALANCE including INDIRECT FLOWS	1997	1998	1999	2000	2001
Imports and indirect flows connected to them	**1.323.749.513**	**1.489.172.487**	**1.399.532.382**	**1.500.840.428**	**1.486.084.142**
Exports and indirect flows connected to them	**455.444.723**	**476.999.266**	**499.910.762**	**609.202.793**	**544.034.611**
PHYSICAL TRADE BALANCE including INDIRECT FLOWS	***868.304.790***	***1.012.173.221***	***899.621.621***	***891.637.636***	***942.049.531***

I.2.1 DMI – Direct Material Input

Figure 1 shows the evolution of the indicator referring to the Direct Input of Materials of the Italian economy, considered as a unitary system, from 1980 to 2001. Observing the whole period the overall level of DMI seems not to have changed very much, fluctuating around an average of about 944 million tons. But looking at the closing five years, a rising dynamic begun in 1998 can be underlined: DMI has reached a peak in the year 1999, with 1.114 million tons, and it has remained over one billion tons in the following two years, notwithstanding a little decrease.

Figure 1 - Direct Material Input (DMI) Italy 1980-2001, tons

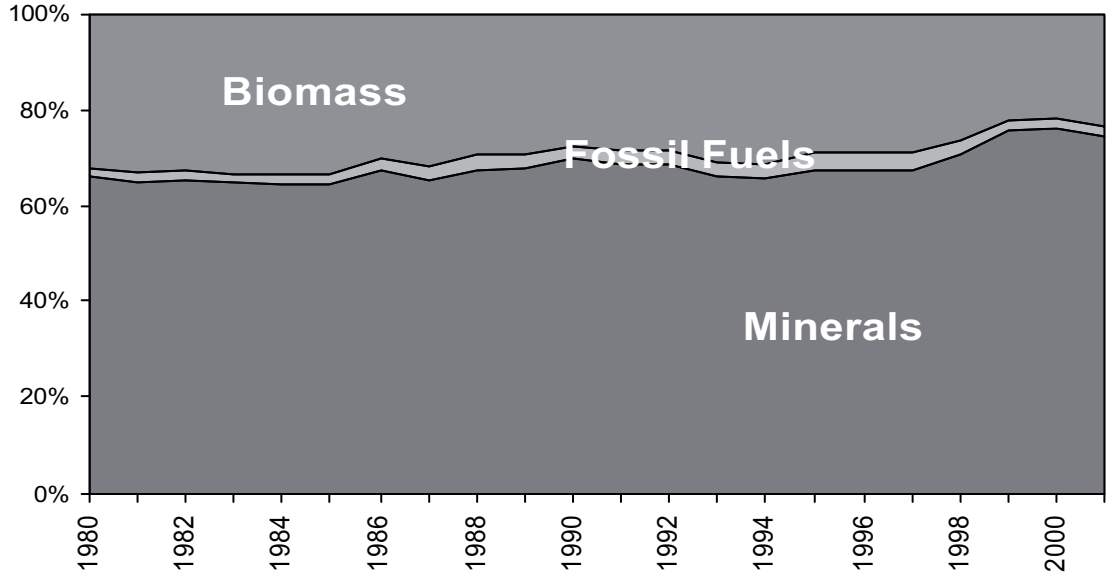


In order to understand better the importance of the domestic environment in supplying resources to the national production system, it is useful to refer to the first level disaggregation of DMI so defined: Domestic Extraction of materials (DE, all that is taken from Nature directly, i.e. from the national environment) and Imports (raw materials and finished products taken from abroad). DE parallels GDP as it also does not include Imports. The figures point out that this aggregate (DE) increases in absolute terms of around 21% in the closing five years: it passes from 605 million tons, in 1997, to 731 million tons in 2001, though having a floating profile with a peak in 1999 around 807 million tons and a decrease in the last two years. This tells us that in these years more value has been produced in Italy with more resources extraction from the national environment.

At a second level of disaggregation, DE, in turn, is decomposed in the following categories: Biomass, Minerals and Fossil Fuels. This allows to see, in particular, the kinds and quantities of used resources domestically extracted[1]. As shown in figure 2, in the 1997-2001 period the relative increase of Used Domestic Extraction as a whole has been mainly due to Minerals production, which increases of 33%, reaching more than 50% of overall Direct Material Inputs.

[1] Each of these can be further decomposed in sub-categories: for example the item Minerals is divided in Metals, Industrial Minerals and Construction Minerals.

Figure 2 - Percentage composition of Domestic Extraction Italy 1980-2001



The highest level is that of the year 1999 with 611 million tons. Only a little share of these materials is sold abroad; the rest is mainly used in construction activities (buildings, roads, railways) and remains in the national territory, so that each year a substantial accumulation of materials into the antroposphere takes place. On the contrary, in the same period we note a decrease (-24%) of Fossil Fuels production, which has always constituted a small share of Domestic Extraction anyway, that reaches a minimum value in the year 2001 with less than 15 million tons. This confirms the historical and strong dependence of Italy on the rest of the world for the supply of Fossil Fuels necessary to the national economic activities. Finally, looking at Biomass production in the last five years, it remains on the same levels around an average of 175 million tons. Nevertheless it has to be underlined how the relative weight of this kind of resources on the Domestic Extraction has decreased in the 1997-2001 period in comparison with the average level it had before (1980-1997); this, together with grown imports, reveals that Italy is suffering a progressive loss of its leadership in Biomass production (mainly agricultural products) in the EU countries, maintained for a long period due to a high competitiveness.

As usual in the specialised literature, in order to assess whether there is or not a relative *decoupling* of resource use from economic growth by comparing the long-term dynamics of DMI to those of Gross Domestic Product (GDP), the ratio of the former to the latter has been calculated. Indeed in the 1980-2001 period Italy's GDP at constant 1995 prices has grown around 50%. Looking at this ratio in the whole period, we can observe a clear trend of relative decoupling[2] of growth from Direct Material Inputs. However it must be pointed out how the growth of DMI accompanies GDP growth in the last five years, showing an increasing use of resources by economic activities in Italy: this dynamic highlights a slowdown of relative decoupling.

It must be recalled that since DMI includes the weight of Imports, it does not correspond to GDP, which does not include the value of Imports; so the comparison between DMI and GDP does not have a great explanatory value.

[2] *Relative decoupling* is defined, in relation to used materials, as decreasing DMI/GDP share; the decoupling is said to be *absolute* when the decrease of the ratio is achieved with decreasing DMI and non-decreasing GDP.

As in the previous report, let us therefore refer to a more correct comparison i.e. that between DMI and GDP *plus* the value of Imports, as DMI is given by Domestic Extraction *plus* the weight of Imports. It's clear that the overall positive dynamic of DMI (9%) in the whole 1980-2001 period is not sufficient to balance the parallel growth of GDP *plus* the value of Imports (around 66%) so that again a relative decoupling is confirmed.

It is worth recalling that:

> "also this comparison is not entirely satisfactory, as Imports have a very different meaning from that of Domestic Extraction as far as resource use (and environmental burden) are concerned. Indeed, one unit of Domestic Extraction represents, by definition, just one unit of matter that is taken from the (national) environment. One unit of Import, on the contrary, represents more than one unit of material taken from Nature. Therefore much importance must be given to the composition of DMI, in the assessment of decoupling" (Femia (ed.) 2003, pag.22).

Following this, we can highlight that trough time, the composition of the Italian DMI has indeed been slowly shifting in favour of Imports: they have grown from 23,6% (year 1980) to 31,1% (year 2001) of DMI. This is coherent with an economy based on transformation and poor of Natural Resources like the Italian one, in presence of economic growth. It is confirmed however, that the relative decoupling highlighted above

> "is at least in part the consequence of a shift to foreign countries of the growth of environmental burden connected to the growth of Italian production, rather than of a genuine change towards greater resource efficiency in the Italian production structure" (Femia A. ed 2003 pag.22).

I.2.2 DMC – Domestic Material Consumption

Figure 3 shows the evolution of Domestic Material Consumption, which is obtained by subtracting from DMI the quantities exported. Due to the law of matter conservation, DMC is equal to the sum of all the materials, extracted domestically or imported, that remain in the country and that are either accumulated in stocks or transformed into wastes, emissions, dissipative uses, and so forth. Therefore DMC gives a clearer measure of the material resources directly used by national activities, relevant for the direct generation of pressure.

In the whole 1980-2001 period Exports have almost doubled (+112%); also in the period 1997-2001 they increased constantly and more rapidly than DMI reaching 11.6% of DMI in the last year. However this growth has not been sufficient to offset the positive contribution to DMC given, especially in the closing years, by DMI's growth.

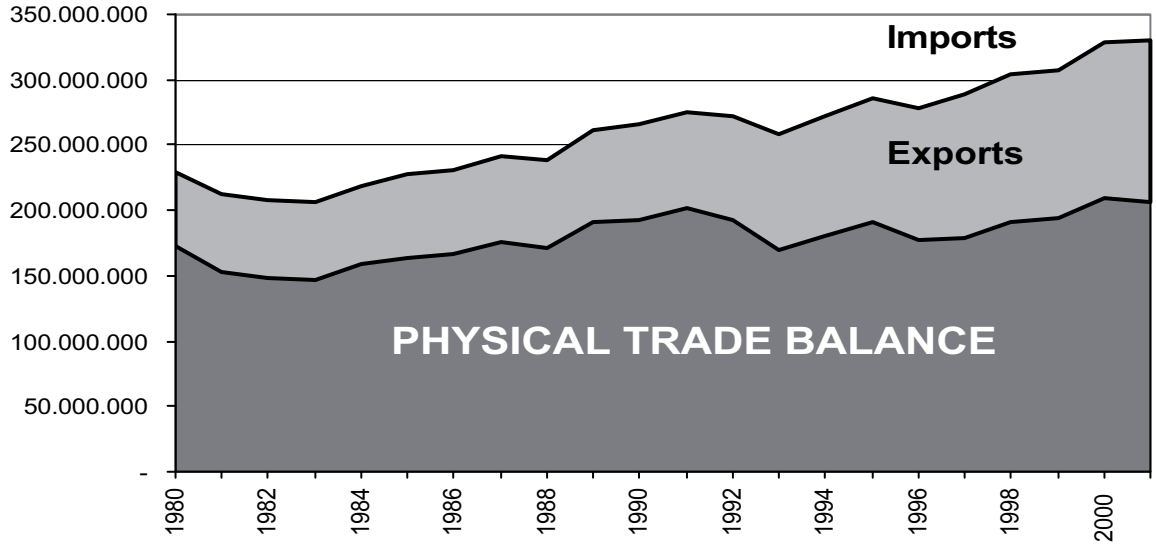
As pointed out in the previous report the monetary aggregate that parallels DMC is total resources for domestic use, given by GDP plus Imports minus Exports: in a long term analysis comparing 2001 values with 1980 ones, we observe that the former results more or less constant (+2,4%) while the latter grows by 48%. It means that there is a tendency to a relative decoupling of the weight of the materials that physically remain in the country from the value of the goods in which they are embodied and of the services for which they are used.

As far as the issue of disaggregation of DMC is concerned, three alternative ways are in principle available: two are connected to the way DMC is calculated, i.e. highlight the components DMI and (minus) Exports as figure 3 does, or the components DE and PTB; the third is given by the analysis of the indicator in an output-side perspective. The latter disaggregation presents practical difficulties as it expresses DMC as the sum of flows according to their destination (i.e. net addition to stocks, emissions and wastes, dissipative use of Products, dissipative losses). Splitting up DMC into these categories would require a complete balance to be drawn up for each year of the series including also the balancing items (see Eurostat, 2001). DE has already been discussed and PTB will be in the next paragraph, therefore let us refer to the first disaggregation that emphasises the role of Exports which make the difference from DMI.

I.2.3 PTB – Physical Trade Balance

The Physical Trade Balance of an economy is given by the difference between the matter that flows into the country as Imports and the matter that flows outside the country as Exports.

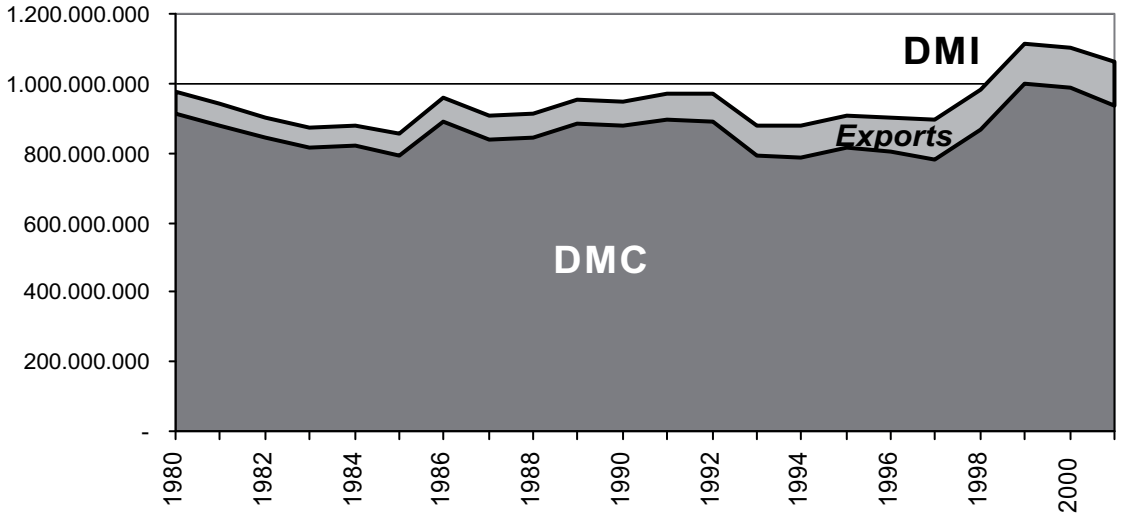
Figure 4 - Physical Trade Balance (PTB) Italy 1980-2001, tons



As can be seen from figure 4, both Italy's historical dependency from foreign material resources and that from foreign demand of transformed products have increased in the whole period analysed. In fact in the period 1980-2001 the Imports' growth is around 44% and the Exports' around 112% reaching respectively 330 million tons and 123 million tons in the year 2001. Looking at the last five years, it can be noted that the growth of the former (around 14%) has remained higher than that of the latter (around 11%) so that the PTB has grown by 16% in these five years, being equal to 207 million tons in 2001.

Also the comparison of PTB to the Monetary Trade Balance confirms the importance of material transformation in the Italian economy, whose function is mainly of adding value to imported materials. Indeed, there as been a surplus of Exports on Imports in the last five years, which has been on average of around 20.670 million euro-lire.

Figure 3 - Domestic Material Consumption Italy 1980-2001, tons

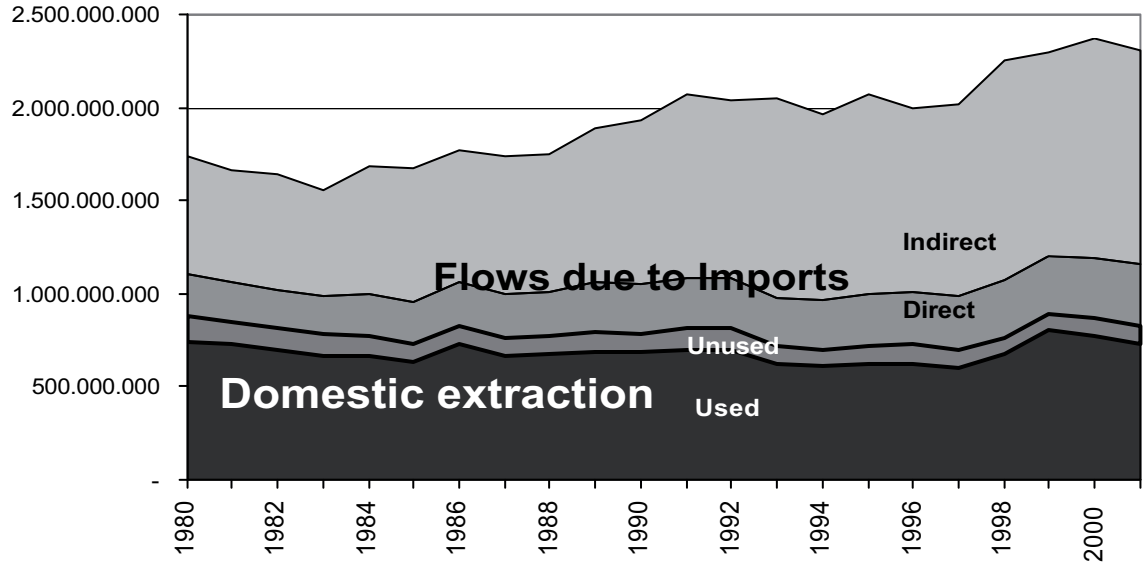


I.2.4 TMR – Total Material Requirement

Figure 5 shows the evolution of the Total Material Requirement of the Italian economy in the 1980-2001 period. We recall that this indicator is equal to all the quantities of materials (excluding water and air) that have directly or indirectly been moved in the country or abroad, in order to allow the realisation of the domestic production and consumption even though they have not actually been incorporated into products, at any stage of domestic production. Indirect Flows associated to Imports are included in this indicator so that it gives an overall measure of all the potential pressures exerted on the natural environment, in order to guarantee the metabolism of the national economic system not just at local but at global level.

In the whole period analysed, the TMR of the Italian economy has grown by almost 33%. Growing resources demand is therefore an important feature of the Italian economic growth of the last decades. It is confirmed that this growth is primarily due to the Indirect Flows associated to Imports, risen around 84% going from around 36% of TMR in 1980 to 50% in 2001, and secondarily to the growth of Imports risen around 44% but varying only from 13% of TMR in 1980 to 14% in 2001. The greater increase of the former with respect to the latter means that the Italian Imports have indirectly required the abstraction from Nature in foreign countries of a growing quantity of materials per unit of matter directly embodied in the Imports. This is due to the change in the composition of Imports, as the coefficients used for the calculation vary from good to good, but do not vary across the period.

Figure 5 - Total Material Requirement Italy 1980-2001, tons

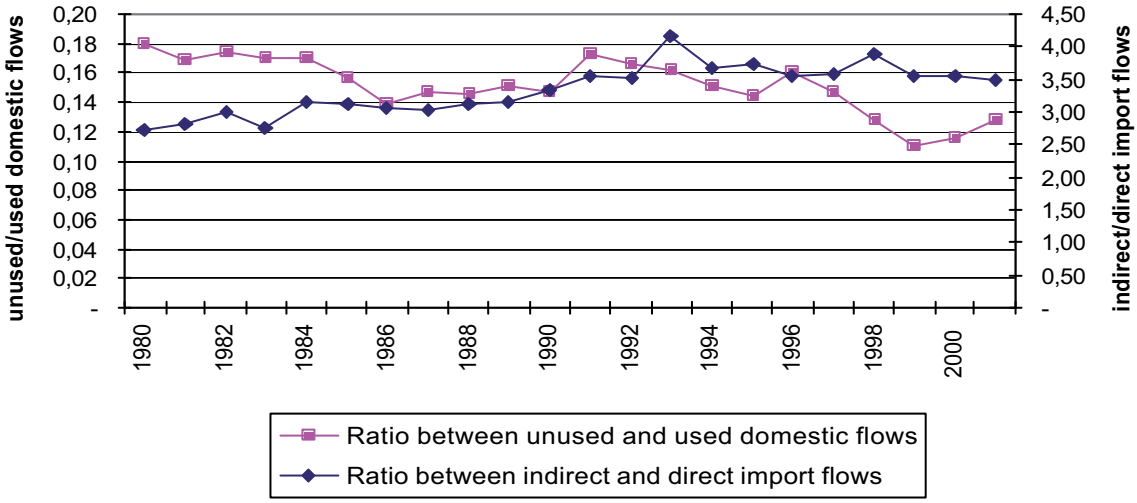


As far as the 1997-2001 period is concerned, the positive dynamic of TMR is confirmed with a growth of 14,6%, notwithstanding a little decrease in the last year: the peak of 2.366 million tons has been reached in 2000. It can be underlined that in these last five years the growth of the indicator has to be linked primarily to Domestic Extraction and only secondarily to Indirect Flows associated to Imports: in fact, the former has grown in absolute terms around 21%, changing from 605 million of tons in 1997 to 731 million of tons in 2001 and the latter has grown around 12%,.from 1.034 millions tons in 1997 to 1.156 million tons in 2001.

Figure 6 shows that in a long-run analysis the ratio between Unused Domestic Materials and Used ones has decreased trough time: it passed from 0,18 in 1980 to 0,13 in 2001. We recall that up to

1997, when the ratio reached 0,15, the reduction of the ratio was mainly due to the decrease of its "soil excavation" component (linked in turn to the slowdown of construction activities in Italy). In the last five years the ratio has continued its decreasing trend, but this is due to the fact that domestic extraction of Used Materials (DE) has grown more than that of Unused Domestic Extraction (respectively around 20,9% and 5,5%). In other words to the rise of the Domestic Extraction does not correspond an equivalent increase of the Unused Materials, and there is a shift towards extraction of resources requiring smaller quantities of Unused Materials per unit produced.

Figure 6 - Ratios between Unused and Used Domestic Extraction and between Indirect and Direct Flows of Imports Italy 1980-2001



Also TMR is usually compared to GDP: in the whole period analysed the comparison emphasizes a relative decoupling, as GDP (+49%) has grown more than TMR (+33%). However,

> "physical indicators that comprise import flows (whether actual or indirect) are more sensibly compared to monetary indicators comprising their value. Thus considered the relationship between monetary and physical measures, the relative decoupling is even more evident…" (Femia (ed.) 2003, pag. 25).

…since, as already seen, GDP plus the value of Imports has grown by 66% in the 1980-2001 period.

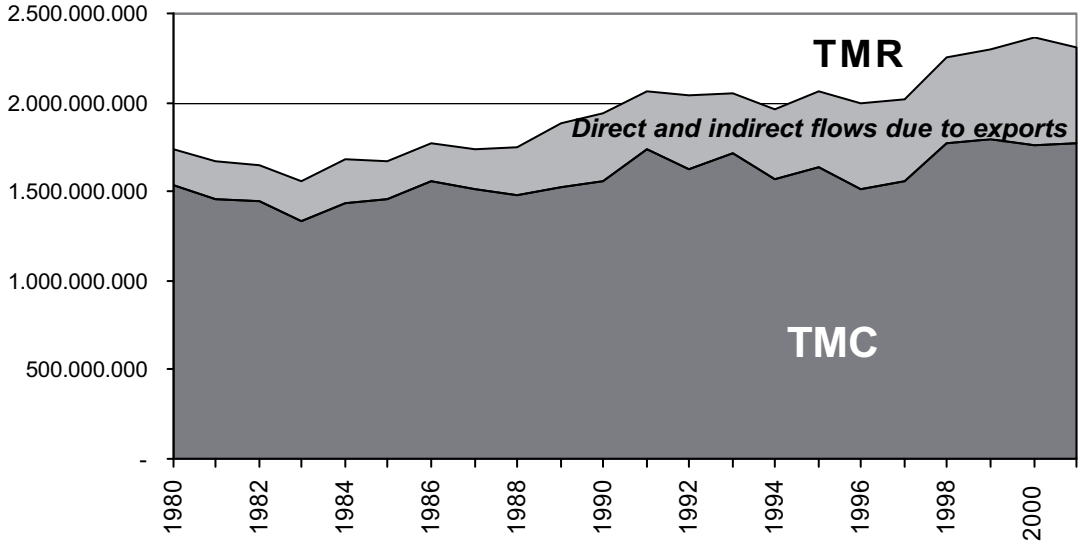
I.2.5 TMC - Total Material Consumption

Total Material Consumption is obtained by subtracting from TMR both the Exports and the Indirect Flows associated to them. In the 1980-2001 period the figures reveal that, notwithstanding the growth of the latter two items[3], the TMC time series has a clear upward trend, with an overall growth of 14.7%, due to the sensible growth of TMR (+33%) seen before. Moreover it can be noticed that while in Italy production and consumption activities grew without directly increasing the pressure on the national natural environment - as DMC remains more or less stable in the period - TMC raises, proving that trough time these pressures have increased at global level to satisfy the Italian domestic demand. Indeed, TMC as the other indicators including the Indirect Flows, is independent from the localization of the activities, as it refers to the whole production chain and not just to the domestic part of it. Thus when the Indirect Flows are included in the analysis, no absolute

[3] In the whole period analysed Exports grow around 112,5%, passing from 58 million tons in 1980 to 123 million tons in 2001, and Indirect Flows connected to them grew by almost 207%, passing from 137 million tons to 421 million tons in the last year.

de-materialisation is highlighted but rather we can observe a growth of the overall stress imposed on natural resources at the global level and also relative de-materialisation proves to be slower than otherwise would seem.

Figure 7 - Total Material Consumption, Italy 1980-1998, tons



In the usual comparison with monetary aggregates, as the growth of GDP plus Imports minus Exports has been of almost 24% it is clear that a relative decoupling has taken place. This confirms that the Italians have consumed and invested more (in value units), directly using about the same quantity of materials for that, but requiring more materials to be moved from foreign countries for the same purpose, though not as much more as if there had been grown in fixed proportions.

Examining the closing five years, figures shows an increase of TMC by almost 13,1% as it has gone from 1.562 million tons in 1997 to 1.767 million tons in 2001; it can be pointed out that the peak of 1.795 million tons, reached in 1999, also represents the highest value of the overall period. The growth of TMC is due to the growth of TMR, around 14,6% in the same period, that exceeded the positive dynamic both of Indirect Flows associated to Exports (+22,2%) and of Exports (+10,8%) that have reached respectively 421 million tons and 123 million tons in 2001.

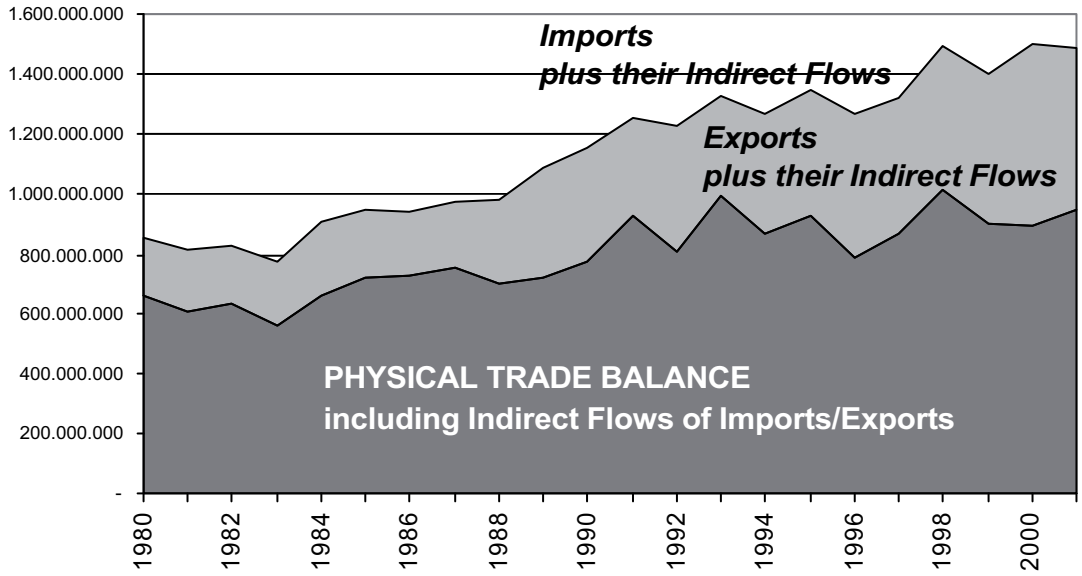
I.2.6 PTBIF - Physical Trade Balance including Indirect Flows

This indicator highlights the position of the country in international trade with respect to its effects on the worldwide movements of materials that support modern economies[4]. It is given by the "virtual" Physical Balance of foreign trade that can be calculated considering, besides the direct flows comprised in the PTB, also the flows indirectly due to international trade. This is a "total flows" kind of measure, parallel to PTB. Figure 8 presents the time series of this indicator, particularly meaningful for describing transformation economies like the Italian one.

[4] As pointed out above, the Methodological Guide does not include this indicator among the ones proposed. We consider it very interesting as a modified version of the balance of the Indirect Flows Trade Balance Account (see page 60 of the Methodological Guide), from which it is derived by including Direct Flows, or in other words summing the PTB to it.

Considering the 1980-2001 period, the PTBIF has remained largely positive and moreover it has

Figure 8 - Physical Trade Balance including Indirect Flows of Imports/Exports Italy 1980- tons



grown around the 42% showing in physical terms the dimension of the "ecological deficit" of the italian economy; figures emphasise that there is a growing gap between the Natural Resources demanded by Italy to the rest of the world in order to satisfy domestic demand and those necessary to produce the goods supplied to the rest of the world. Observing the closing five years, the indicator keeps its positive dynamic with an overall increase of 8,5%, though fluctuating in the period between a minimum value of 868 million tons and a maximum one of 1.012 million tons.

In the whole period, Imports plus Indirect Flows associated to them have grown by 73.1% while Exports plus Indirect Flows associated to them have grown by 179%; though through time total flows related to Exports grew faster in relative terms than those related to Imports, they have been always sensibly lower in absolute terms. The same considerations are valid when the medium term tendency is examined: from 1997 up to 2001 both Imports plus Indirect Flows associated to them (+12,3%) and Exports plus Indirect Flows associated to them (+19,5%) have grown, reaching respectively 1.486 million tons and 544 million tons in the last year.

Part II
Feasibility study of the Italian PIOT

II.1 Introduction

The work presented in this part of the report builds on the results of a previous project, co-sponsored by Eurostat, in whose framework an economy-wide Material Flow Balance for Italy, 1997 has been constructed. The realisation of that project showed, besides the general feasibility of the account – i.e. the availability of data for almost all items of the balance or at least the possibility of calculating sufficiently reliable estimates – that:

a) drawing sub-balances for particular kinds of materials and/or parts of the economy is useful and in some cases even necessary in order to draw and verify an economy-wide balance;

b) in some cases it is also necessary to trace the flow of a particular material from one part of the economy to the others up- or downstream;

c) a statistical discrepancy of 2% of Direct Material Input (DMI) remained after considering all items which could be accounted for. This discrepancy surely cannot be explained by the impossibility of including some items in the account and should be therefore regarded more as a measure of our ignorance of the real dimensions of material flows than as a measure of the balance of missing items.

In the light of the above, a deeper analysis of the circulation of matter through the economy was the natural continuation of the work started. Besides allowing amelioration of the economy-wide balance (in a disaggregated description, for instance, the discrepancy can be dealt with by using balancing procedures based on the principle of matter conservation and on mathematical statistical techniques) such an analysis has a value added in itself, as knowledge of how the matter circulates in the economy is crucial for understanding and managing the driving forces of the environmental pressures: matter is taken from the environment and transformed – a good part of it into substances which are harmful to the environment in which they are released – for someone to use or accumulate the products. It is exactly this that a Physical Input-Output table would tell us: who transforms the materials and who uses them.

A good deal of information exists that can be used for the construction of an Italian PIOT. It is not yet certain, however, whether these data are complete enough for the construction of a full-fledged and well disaggregated PIOT. Nor can this be assessed a-priori, i.e. before the attempt of putting together all useful information is actually made.

On the one hand, if for some variables data are not available at the start, this is not sufficient for declaring the unfeasibility of the table: the unknown quantities might turn up to be derivable from the known ones, just as a consequence of the principle of matter conservation and of the technical relationships that exist between the various types of inputs and outputs; the uncertainty attached to the derived data would then depend on the precision of the known ones in case of application of the principle of matter conservation, and also on the stability of technical relationships in case these are used.

On the other hand, even when information is available on all quantities to be included in the table, this information might nevertheless turn up to be so contradictory, and the input totals so far from the output totals, that no estimation of missing items and balancing procedure would hide the flaws of primary data.

Therefore, the results of the feasibility study described here cannot be final ones, while they enable us to design a project for actually trying its realisation, in addition to providing some "intermediate" results. Indeed, the main result of the feasibility study is that, on the basis of the information collected and the analyse carried out so far, "it is worthwhile going on" – which is what Istat is currently doing, with the institution of an *ad hoc* working group. In operational terms this means that it has been possible to formulate a fairly detailed project that, given what's known, has good

chances of success. This part of the present document discusses the project, as it appears at its current state of realisation.

The structure of this project, summarised in very broad terms and skipping the steps of going through the construction of Supply and Use tables, is summarised in figure 1, where the most important sources of information that have been considered and identified as useful are related to the parts of the table to which they should contribute. This figure anticipates the topics that are discussed in the chapters below.

As can be seen from the picture, an analysis parallel to that on physical data consists in considering the existing Supply, Use and symmetric monetary Input-Output tables of the Italian economy. After all, the phenomena studied are the basically same, as far as part of the table that describes the interrelationships between the economic activities are concerned: only the units of measure change from Euro to tons. In the construction of this part of the table – that involves the use of classifications and the attribution of specific flows to the different kinds of units involved – coherence must be granted with the principles and the current methods of realisation of National Accounts (NA), in order to grant comparability. Though a satellite module, moreover, the construction of the PIOT might turn out useful for improving NA, and this is another good reason to keep under control the relationship between the two.

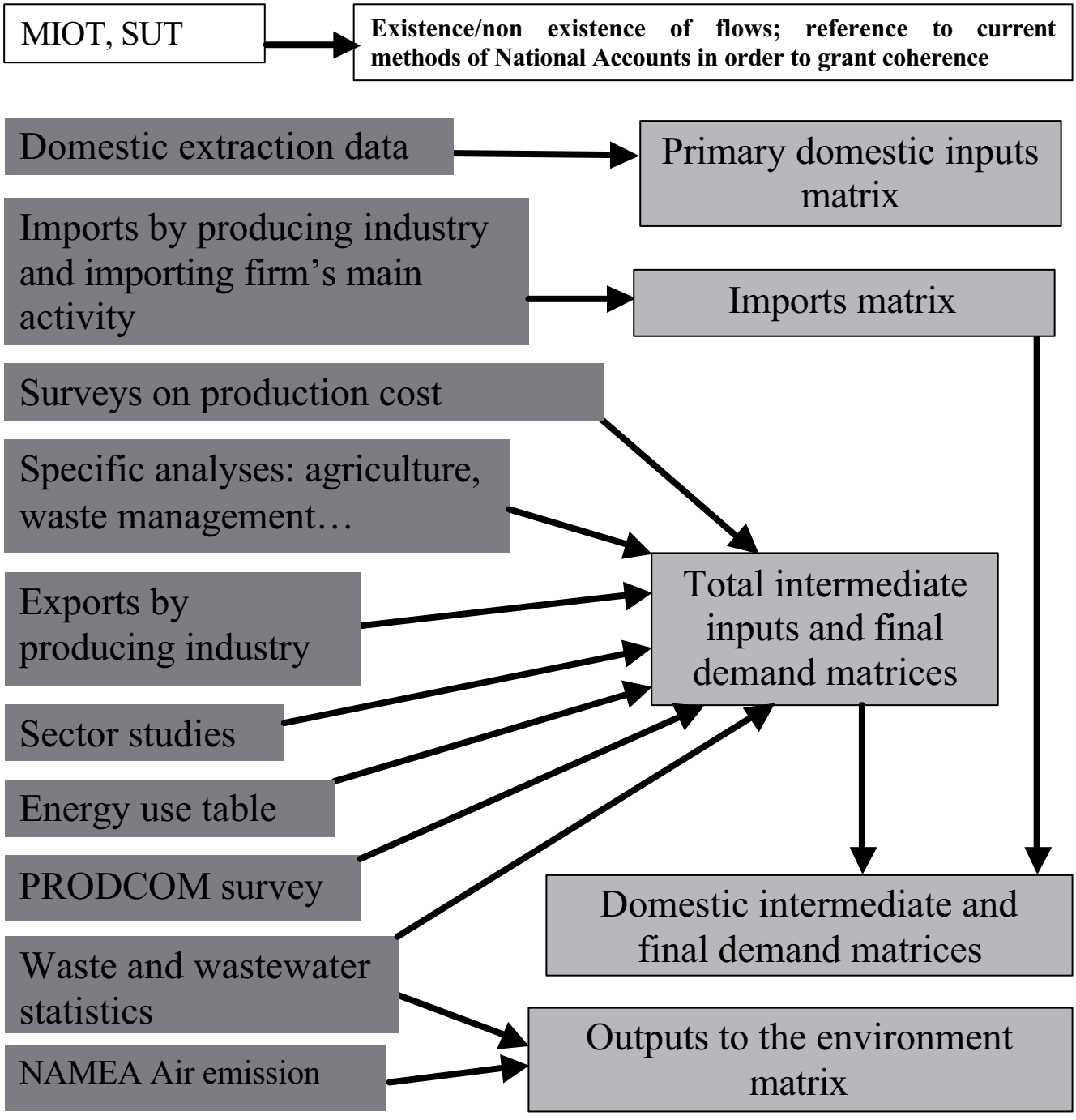
The other parts of the picture show how the different sources do contribute to the overall design of the PIOT, i.e. which module they feed or contribute to. Only the main sources and modules can be dealt with in such a picture, nor did we show in it how the data will be used: the details and the elaborations needed are partly described in the next chapters, partly need further work to be determined.

As far as data sources are concerned, though the pilot study refers to 1997, this should be partly understood as a "pivot" year, around which, in case of missing information for this target year, we have been looking for data that provide information on the structure of the material flows connected to the Italian economic life of the nineties. It is important to underline the word "structure" in the previous sentence, by which we mean information that concerns ratios, percentage allocations, technical coefficients and the like; all information of this kind from years other than 1997 must be used for the elaboration of level data specifically referred to that year (e.g. for the allocation through using industries of some known total quantity of a certain good produced in 1997). After balancing, 1997 will be a benchmark year for Italy's MFA, to be considered as a reference point in the revision of the time series of economy-wide MFA-based indicators, which will have to be coherent with the 1997 PIOT (also see ch. I.1).

The construction of the 1997 PIOT will show that PIOTs are in general feasible for Italy. Such an indication, however, should be accompanied by some warning. Indeed, even though new sources of data appear through time and some existing tools and sources are improving (e.g. enterprises' registers, sector studies), some other sources which are suitable for contributing to the determination of 1997 material flows tables will not be such for later years, because of their occasional nature and distance in time from more recent years (e.g. Physical data in Istat's surveys on production costs of 1992 and 1996).

In the following chapter (ch. II.2) we discuss the reference models for the product we strive for; in the subsequent chapter (ch. II.3) we deal with some general issues about classification and system boundaries; in chs. II.4 and II.5 we describe the sources of data which can be used in order to fill in the Supply and Use tables respectively and the elaborations that will be necessary to do so; then (in ch.II.6) we discuss the issue of estimation of missing items, which shall be done in strict connection with the derivation and balancing of the Material Integration table (the symmetric PIOT properly said), discussed in ch. II.7). The elaborations that have already been performed are described in connection with the items they are relevant for.

Figure 1 - An image of the project



Balancing:

- Estimation of missing items
- Application of technical knowledge and of the conservation of matter principle
- Mathematical methods

II.2 Reference models

II.2.1 The SEEA

Chapter 3 of the System of Economic and Environmental Accounting (SEEA; see UN et al. 2003) deals with physical flow accounts and their linkage to the national accounts. This is the basic reference for the theoretical aspects concerning the Physical Input Output framework and for granting the maximum coherence with NA principles and comparability with NA aggregates.

In the following we will focus on the practical aspects of implementing an IO framework for material flows, nevertheless reference to the principles of SEEA will be implicit in the whole discussion.

II.2.2 Foreign experiences

PIOTs have been published by Germany (Stahmer et al. 1997; Statistisches Bundesamt, 2001) and Denmark (Gravgard, 1999). We will focus here mostly on the German example, as it is a PIOT model nearer to the one we strive for.

The German PIOT has been first elaborated at the Statistisches Bundesamt by C. Stahmer and others for 1990 and has recently been replicated for 1995. These tables offer a description of the circulation of materials from the environment to the economy, inside the economy and from the economy to Nature, disaggregating the productive activities in the same branches as in the country's monetary input-output tables.

One important aspect for which our project is inspired to the German PIOT is the logic of the MEFIS (Material and Energy Flow Information System) cube. The "faces" of this cube are matrices reporting the marginal distribution of flows that give the total Supply, Use and Material Integration (the PIOT properly said) tables. The classification of the materials that flow and of the concerned systems and sub-systems also allows to generate matrices for the partial distributions of flows (i.e. partial Supply, Use and Material Integration tables), namely those giving the breakdown into energy, water and other materials of the SUTs and those giving the breakdown into domestic and imported flows, as well as that highlighting energy flows in calorific power, for the PIOT properly said. Moreover, as the data in the cube are disaggregated at a much higher level than the published tables, more detailed analyses of flows of particular importance are possible, such as that of air emissions by branch.

The formulation of Supply-Use tables prior to integration of material flows into a Table where Input and Output flows of industries are interconnected is also corresponding to the use of physical commodity balances made at Statistics Denmark for the construction of the Danish PIOT, which also presents a disaggregation of the PIOT into detailed tables referred to the flows of the various different kinds of materials, as well as to the results of the analyses carried out on the data for air emissions with help of an input-output model.

The separate consideration of the supply and use aspects of the material flows occurring in economic transactions is indeed a highly useful step, for it allows gaining a deep understanding of the flows of Natural resources, Products, and Residuals, before going into the quantification of the physical interconnections between the activities. Indeed, the compilation of Supply and Use tables amounts to the formulation of two kinds of material balances that can be made explicit by jointly reading the Supply and Use tables:

- A balance by material, i.e. by market as far as the Products parts of the tables are concerned, whose resources and uses sides are given respectively by a row of the Supply table and the corresponding row of the Use table, detailed respectively by producing and using activities,

irrespective of the inputs of the former and of the outputs of the latter. The set of these balances parallels the usual goods and services account of National Accounts;

- A balance for each activity, i.e. by group of production, or consumption, or accumulation processes, whose resources and uses sides are given respectively by a column of the use table and the corresponding column of the supply table, which are detailed respectively by input and output materials, irrespective of the provenience of the inputs and of the destination of the outputs. The set of these balances parallels the usual production account of National Accounts (ESA 1995, § 9.05; see Eurostat 1996a, p.207).

One respect in which the Italian PIOT will very likely differ from the German example is the treatment of water, which – due to the lack of data – will be included in our accounts only to the extent that it is embodied in some material product[5].

II.2.3 Academic work

In the academia substantial work on an Italian PIOT has been carried out in the last decade by Prof. G. Nebbia, who has pioneered Material Flow studies in Italy, who proposing his prototypes in several occasions. In his most recent publication on the topic (Nebbia, 2003) prof. Nebbia presents a 26 x 26 symmetric table describing, with reference to the year 2000, the web of physical exchanges that interconnect natural bodies (air, water, soil and natural stocks), domestic economic activities (classified into 19 different branches), Households, Stocks (of produced assets) and the Rest of the world.

The table, reported below, is a balanced one (i.e. its row totals are equal to the corresponding column totals) and results from the combination of the skilful use of published statistical data with the application of the knowledge of matter transformation processes provided by the natural sciences in general and by commodity science in particular as far as production processes are concerned. Indeed, technical coefficients tying the different inputs with one another and with the outputs (both desired and undesired), constants and necessary relationships from physics and chemistry (given by the law of conservation of matter in the first place) can play an important role not just in checking the correctness of the existing data and balancing the table but also in estimating the missing ones. This is an important feature of the approach, that the present project aims at transferring in the toolbox of physical flow accounting from prof. Nebbia's experience, carrying it through to physical environmental accounting in general[6]. It can be noted that the application of technical coefficients is a method already in use in important areas of environmental statistics such as for instance the estimation of emissions of pollutants to air or water.

One specific application of these "non-statistical" tools is connected to the way agricultural production is included in the table. Its treatment, in fact, is different from that of EW-MFA. In the latter the harvested quantities are considered as inputs from Nature, whilst in prof. Nebbia's PIOT – as well as in the German one – the boundary between Nature and the economy is established at the level of plants' nutrition, so that the primary inputs are (mainly) CO_2 and water, rather than already formed biomass. In order to find how much CO_2 and water have to be accounted for as agriculture's primary inputs, coefficients expressing average composition and humidity of the different kinds of biomass have to be used.
Through time, prof. Nebbia's elaborations have become more and more compliant with the requirements of an accounting scheme in physical terms which parallels National Accounts in

[5] However, studies are currently going on at Istat, for the reconstruction of the circulation of water from and to the natural environment and within the economy, which could supply useful input, for the PIOT.

[6] Prof. Nebbia is member of the working group mentioned above.

		Air	Water	Soil	Natural Stocks	Agriculture	Livestock	Energy, Water	Metallic ores and metals	Non metallic mineral products	Chemical products	Metal products	Machinery	Transport equipments	Food, Beverages	Textiles, Leather products	Paper, Wood products	Rubber and plastics	Other manufactured products	Buildings and construction	Waste treatment	Trade services	Transport services	Services	Households	Stocks	Exports	Total uses
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Air	1					186	51	208	6	10	51	15	10	12	18	3	10	10	14	10	32	13	146	10	135			950
Waters	2						180	7	5		21	7			16	8	15		10	22	4			8	51			354
Soil	3					104																						104
Natural Stocks	4							59	8	457	31	10			12				5		7							589
Agriculture	5	86		32		3	91	1							93		2				5						6	319
Livestock	6	103	12	143											41						61						1	361
Energy, Water	7	279		1		3		179		3	7	24	4	6	5	1	1	1	2	3	2	7	41	2	30		26	627
Metallic ores and metals	8	2	2	2					2	2		20									8							38
Non metallic minerals and products	9	15	1	2				5		6	15	6			3				5	403	20						5	486
Chemical products	10	50	5	2		11	5	1	1	1	45	1	1	2	8	2	2	15	10	2	12	8				3	12	199
Metal products	11	48	7	9								50	10	5						20	1	1					7	158
Machinery	12	15																								10	3	28
Transport equipments	13	8	2					4													5	2				17	5	39
Food, Beverages	14	52	25	12			32								103		1		4		32	74					5	340
Textiles, Leather products	15	5	5											1		8					3	5					6	33
Paper, Wood products	16	8	2												2		10			3	4	8				10	6	53
Rubber and plastics	17	12									4			3	2			8		5	6	5				4	1	50
Other manufactured products	18	10									5			2	5	1	1	1	2	15		5				10	15	72
Building and construction	19	35	13	5																	5	9				413	12	492
Waste treatment	20	74	35	76		10		5				15				2	4	3	5		10					69		308
Trade services	21	5				2								2	10	1	1	2	5		5	5		11	86	20		155
Transport services	22	187																										187
Services	23	21	5	2																	3							31
Households	24	209	22	11																	55					5		302
Stocks	25																				26					5		31
Imports	26						2	162	16	7	20	10	1	6	22	7	6	10	10	9	2	13				35		340
Total inputs	27	1.224	136	297		319	361	627	38	486	199	158	28	39	340	33	53	50	72	492	308	155	187	31	302	601	110	**6.646**

Gross Domestic Material Product (GDMP) 2000 = X(n,22) + X(n,23) + X(n,24) + [X(n,25) – X(25,n)] + [X(n,26) – X(26,n)] = 860 Mt

monetary terms, and have also become more disaggregated. Nevertheless, there still is much room for improving the detail of the description of physical flows, by using the existing information, available in the Italian statistical system in a much more disaggregated way than published, or unpublished and unexploited at all. Also, some conventions of National Accounts have to be applied. For instance, in the table reported below, two of the economic activities, namely *Transports* and *Services*, are classified as final users, along with Household consumption. Moreover, the latter category of final users appears to receive goods only from two branches (*Energy, water* and *Trade services*), which is certainly correct in the chosen prospective, but does not correspond to the treatment of these transactions in National Accounts.

As shown at the bottom of the table, Prof. Nebbia derives from it an aggregate, the Gross Material Domestic Product, whose construction parallels that of GPD seen as final consumption plus Investments minus Imports plus Exports, which was equal to 860 million tons in 2000.

II.2.4 The Italian MIOT

Coherence with the Italian Monetary Input-Output Tables (MIOT) has to be considered a fundamental requisite for the Italian PIOT. In particular, the classification of industries will tend to be the same as that of the Italian MIOT, in order to grant comparability with it. It is likely, however, that the Italian PIOT will have to be more aggregated than the Italian MIOT, for reasons of availability of disaggregated data and/or lack significance of disaggregation (e.g. in the service sector not all activities featuring in the MIOT need be singled out when dealing with material flows, as these are often negligible in service branches).

The MIOT can be considered also a source of information for the construction of the PIOT as a consequence of the methodological coherence of the latter with it. In that it gives qualitative information that can be used in order to identify the cases where no relevant flow of Products is expected to occur. Indeed, for Products only (Natural Resources are supplied freely and Residuals are usually not paid for), a sufficient condition for a physical flow to be null is that the corresponding monetary flow be null.

II.3 Some general points on the classification of materials and system boundaries

In the following chapters we will often use the word "material" as a noun. By this we mean anything that has a physical mass. Our attention however is limited to the materials that are intentionally moved by man for no matter what human activity, with the exception of most of water and air.

Publishable aggregated Physical Supply (output) and Use (input) tables (PSOTs) will be the result of aggregation of much more detailed material-by-activity matrices, whose construction we discuss in the next two chapters. The Material Integration table (i.e. the PIOT properly said) will be the based on the elaboration of these material-by-activity tables.

In order to construct these matrices, it is first of all necessary to enumerate the materials of interest. A complete list of these materials shall include:

- all useful material Products deriving from economic activities, domestically produced or imported, both of primary nature (i.e. directly extracted from Nature) and resulting from transformation processes;
- all materials that are classified as "unused" in EW-MFA, as well as ancillary materials like oxygen for combustion and the like;

- all materials that derive from useful Products but are not embodied in other Products or stocks, being an undesired joint result of production or consumption activities, such as waste, emissions, water vapour etc.

In order to obtain a detailed classification of all relevant materials, it is sufficient to take the union set of the relevant classifications in use for the different kinds of materials, i.e. of the usual classifications of Products used in NA and of the classification of materials listed in the EW-MFA methodological guide (Eurostat, 2001). In the following, we refer by default to the most disaggregated classification level at which data are available. Most of the necessary analyses, indeed, are best carried out at the most disaggregated level; the aggregation into materials groups - necessary for making all data fit into a common framework, as to allow balancing and publication - can be done subsequently.

For purposes of exposition and organisation of data, it is useful to refer to the SEEA grouping of materials, i.e.:

1. Natural Resources
2. Ecosystems Inputs
3. Products
4. Residuals.

As in the German SUTs, we will consider Ecosystems Inputs under the same heading as natural Resources, as they have in common the characteristics that are most relevant for our purposes. We will use the term Natural Resources rather than Raw Materials as in the German case, for the reasons stated below.

Some material supply and use data have been collected or estimated in the framework of the Economy-Wide Material Flow Balance (EW-MFB) for Italy, 1997, mostly referred to the use of Natural Resources (harvest and extraction of primary resources, unused domestic flows connected to them, imports, input ancillary flows included as balancing items) and to Residuals released into the natural environment (waste, emissions to air and to water, farmyard manure, output ancillary flows). These however are only the flows that cross the economy-Nature boundary, while the PIOT describes the flows of many more materials, as it includes all Products, though some of these are also included in EW-MFB (imports and exports, dissipative uses and losses of solvents, seeds, and the like).

Moreover, in the PIOT slightly different borders from those of the EW-MFB are assumed between the two systems:

- cultivated plants are classified as Products and not as Natural Resources;
- controlled landfills are included in the economy, so that waste, though a Residual, is not released into the environment.

As a consequence, some materials which are not products and nevertheless were not included in the accounts have to be added to the list, such as plant nutrients on the Natural Resources side and emissions from controlled landfills on the Residuals side. Another consequence is that, next to the accumulation of the usual stocks of useful products considered in NA (Buildings, Infrastructure, Machinery…), also the accumulation of some Residuals must be considered. Indeed, as long as a landfill is managed, it constitutes the working object of an economic activity (namely, of the waste management activity), and therefore it must be considered internal to the economy. In our view, these boundary choices correspond to a characterisation of the interested systems (agricultural

landscapes and controlled landfills) as semi-natural ones, i.e. systems where neither man nor Nature rule entirely, but tightly interact[7].

In our view, it is important for the purpose of the PSUTs and the PIOT, Natural Resources to carefully keep distinct from Raw materials. Natural Resources are all the materials as they are found in Nature. These are freely supplied on human demand, be they useful for human activities or not. Raw materials are, in this prospective, the same materials once they have been transformed into a product, i.e. separated from the rest of Nature and from the Natural Resources that are not suitable for use but have to be moved anyway in order gain access to the useful ones. In EW-MFA Raw materials are accounted for as used inputs from Nature, while the other Natural Resources moved in order gain access to the useful ones are named "unused". In Supply and Use tables, this distinction between used and unused materials is reflected – *mutatis mutandis* according to the different boundaries – into that between Natural Resources and Products. Thus, a quantity that is accounted for only once, as input from Nature in an EW-MFB, appears twice in a Supply table, as it is once supplied by Nature as Natural Resource, once by the sector that extracts it as a Product (Raw material). This is not the case for most of biomasses however, which only appear as output of agriculture (i.e. Products), while Nature only supplies their nutrients and water and air.

Finally, it must be highlighted that the activities of households cannot be characterised as final ones from a material transformation point of view, so that in a PIOT (as well as in EW-MFB, actually) households play a quite different role than that played in a MIOT (and in NA in general). Indeed, in consumption activities the matter embodied in products is either accumulated (durable goods) or transformed into Residuals. This has the consequence that two columns are included for households in a PIOT, in order to describe how they purchase respectively non-durable and durable goods from the various activities; two rows are\also included to show, respectively, how households generate Residuals by using the former, and how accumulate and dismiss the latter kinds of goods.

II.4 Supply table: sources of information and elaborations needed

II.4.1 Natural Resources

Material resources of various nature are supplied by the domestic natural environment[8] directly to the activities that carry out extraction processes. These resources are transformed in the extraction process into Products (raw materials) and Residuals. The subsequent transformations and uses of the products deriving from these resources, lead to the accumulation of stocks in the economy and to the emission of further Residuals into the natural environment. Indeed, the intake of these resources, along with imports, is the other side of the coin of emissions and stocks accumulation.

Data on all but a few minor items of Natural Resources intentionally moved by man have been produced and included in the 1997 EW-MFB for Italy (Femia (ed.), 2001). Making reference to EW-MFB definitions and classifications these comprise:

- minerals and fossil fuels extracted from the domestic territory;
- unused by-flows of mineral extraction and construction activities (soil excavation);

[7] See Calafati, 2000, where the concept is referred to the agricultural landscape; we find it appropriate to extend it to controlled landfills.

[8] It should be noted that there is a coincidence between the expressions "domestic extraction of Natural Resources" and "extraction of natural resource by the domestic economy", as all imported materials are by definition Products and not Natural Resources.

- ancillary flows accounted for as input balancing items (oxygen and nitrogen for combustion and respiration processes, drinking water for animals[9]).

As a consequence of the different boundaries between the economy and Nature assumed in the PIOT framework, the minerals, water and air (CO_2) supplied by Nature for the production of biomass, both used and unused, will have to be calculated. These will include the quantities that are embodied in cultivated work in progress items[10]. In practice, it will be necessary to reduce the quantities of biomass produced to their constituent components, with a quite straightforward application of scientific knowledge on plants and fruits.

All these materials are supplied, by definition, by the natural environment (i.e. by the "non-produced natural assets" of NA), which can be partitioned in various ways, e.g. as in prof. Nebbia's table (see also below, §II.2.3).

II.4.2 Products

Many materials, namely the ones that are useful products, are produced exclusively by one branch of activity, due to the fact that the branches we want to describe in the SUTs and in the PIOT are homogeneous ones. In its "Products" part, the matrix resulting after aggregation both of the rows (Products) and of the columns (activities) of the Supply table will be – like the monetary one – an almost perfectly diagonal one: each family of products is the result of a single family of activities, identified precisely on the basis of their products.

II.4.2.1 Domestic output of agriculture, forestry, animal and fishery products

These data are regularly produced and published in the great detail by Istat. Excepting the ones on animal production, all of them are included into the DE aggregate. The allocation to production activities is trivial.

II.4.2.2 Domestic output of industrial products

The main source of information on useful industrial production is the PRODCOM survey. This survey supplies data on primary products (Raw materials) such as extracted minerals, as well as on other industrial products.

The products covered are those stemming from the activities of NACE divisions 13-36 (with the exclusion of division 23 which deals with energy transformation), and cover production of all firms with more than 2 job holders.

The data on production and sales are reported both in monetary and physical units. The latter however are not always weights, but can be linear, square or cubic meters, number of pieces or pairs, etc.

The data supplied by the PRODCOM survey on the physical quantities of industrial goods produced and sold therefore need two different kinds of elaboration before they can be included in a supply table:

a) they must be supplemented in order to include production of small firms, which are quite important in Italy for many activities;

b) for the products expressed in physical units other than weight, the data must be transformed into tons.

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[9] This drinking water is in reality not always directly supplied by the environment, but for simplicity we will deal with it as if this was the case, as this allows to balance the accounts without going into the complex problems of the circulation of water into the economic system.

[10] A project for estimation of biomass work in progress based on dendrometrics is currently ongoing at Istat.

In the EW-MFB for Italy, 1997, the integration of the data has been done at the 5-digit ATECO level of aggregation, by using as a leading variable the ratio between the total value of output, as determined in the framework of National Accounts, and the value of PRODCOM output. The transformation into weights of products expressed in different units has been done by using the correspondence with the commodity classification used in foreign trade statistics (the Combined Nomenclature - CN)[11]. The latter always include weights, besides values; moreover, the same quantities are often expressed also in an alternative unit, which is in most cases the same as the one used in the PRODCOM survey. It is thus possible to use the ratio between these two measures of the same quantity as a leading variable for the transformation into data in tons of the PRODCOM data that are expressed in units other than weight. The latter elaboration has been carried out at the product level, using export data (i.e. data on commodities domestically produced, as the ones in PRODCOM) so that this transformation can be considered quite reliable. In cases where the correspondence between PRODCOM and CN commodities is missing, other methods such as donation of unitary weight from similar products have been used[12].

II.4.2.3 Domestic output of energy products

Data on physical quantities of domestic production of energy products are supplied by the National Energy Balance. The products can be easily attributed to the producing branches, as also in this case the product identifies the activity.

II.4.2.4 Material products of domestic service activities

Some service activities, such as for instance preparation of meals, do provide something that is a service in economic terms, but also a material product in physical terms. This product is a material input to mostly households.

Unfortunately no direct source of data on these flows seems to be available; it will be therefore necessary to carry out ad hoc estimates.

II.4.2.5 Imports

These data are available at the 8-digit level of the Combined Nomenclature (CN8). Though in general it could be difficult to place the imported products in a Supply matrix whose rows follow the classifications used for domestic products, due to correspondences that are not one-to-one, when products are aggregated into groups according to the 5-digits ATECO of the producing activity which generate them, the correspondence does not pose any problem. Nevertheless, the possibility of using the more detailed correspondences between groups of goods present in the PRODCOM classification and established in other Istat works, will be studied.

For the purpose of the Italian 1997 EW-MFB, the imports have also been classified according to the prevailing kind of material they derive from (Biomass, Fossil fuels and Minerals plus the Composite products category for the goods that mix the three kinds of materials so that none prevails by far). This classification has\also been donated to the PRODCOM, and is at the basis of the possibility of drawing sub-balances (and hopefully sub-tables, see II.7.3) by kind of material.

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[11] A very similar transformation method has been used both by the Statistisches Bundesamt and by Statistics Denmark. A comparison of results, especially with those of the German application for 1995, which is the nearest as for reference period, will possibly provide a better understanding of its reliability.

[12] The method used is described in greater detail in Femia (ed.), 2003.

II.4.3 Residuals

Residuals are usually not the product of a specific activity; on the contrary, the generation of some Residuals – such as for instance air pollutants – is an inevitable result of most activities. Therefore, further analyses of the available data sources might be necessary for the attribution of some Residuals flows to the activities that produce them, such as that carried out on air emissions in the framework of the NAMEA.

II.4.3.1 Domestic waste production

Data on waste produced by activity are supplied by the Italian National Agency for Environmental Protection and Technical Services (APAT). A preliminary analysis of the data shows that they are sufficiently complete and detailed for the elaboration of a waste Supply table, where activities (in the columns) are classified at the 3-digit NACE level. All wastes (in the rows) are classified by type according to CER, but for a residual part which is classified according to the Italian classification in use before CER was adopted.

Waste management and data on waste supply in Italy

As data on waste derive from an administrative source set up in order to monitor the waste management system, it is useful to briefly recall how the institutional mechanism that produces the data works.

The national framework law on waste, issued in 1997, is Legislative Decree 22/97 (commonly known as the "Ronchi decree"), which implements the packaging directive (94/62/EC), the EU Framework Directive on Waste (91/156 EC) and the EU Hazardous Waste Directive (91/689 EC).

This law implements the integrated waste management policy set up by the European Waste Strategy and has changed completely the waste management system in Italy. In fact it promotes clean technologies, the Ecolabel, the EMAS certification system and voluntary agreements between public administrations and economic operators, in order to create real opportunities for waste recycling. As for waste disposal, in accordance with Article 4 of the Council Directive 91/156/EEC, it must be done without endangering human health and without the use of processes or methods likely to harm the environment.

Waste producers are obliged to handle waste on their own or to use an authorized waste management enterprise. Transporters are obliged to be registered with the National Register of Waste Management Enterprises and need a waste identification document for each waste transport. For waste recovery or waste disposal operations, waste management enterprises need a permit of the regional authority (some regions have delegated the provinces to provide the permits). The Italian system for recovery and re-use of packaging materials is based on the principle of producer responsibility; a specialised organisation (CONAI) co-ordinates the collection and recycling system. The CONAI system is based on the activities of six material consortia representing steel, aluminium, paper, wood, plastic and glass. The consortia, whose associates are the producers, include all the main companies and cover the entire life cycle of each material. CONAI directs and co-ordinates the activities of the six material consortia. The collection of packaging waste is carried out by the municipalities, on the basis of contracts with CONAI.

The framework law on waste also enforces the European Waste List as waste classification that shall be used in every permit and waste identification document by all authorities involved in waste management. Waste Act 22/97 has adopted Annexes IIA and IIB of

Council Directive 91/156/EEC, and intends to list disposal and recovery operations as they occur in practice. These are very important innovations in terms of availability of statistical information, because they allow checking the consistency of the information referred to the different stages of the waste cycles, and therefore to reconstruct a coherent picture of the flows to, between and from the various waste management activities.

Indeed, every year, all Italian municipalities and local units producing and/or managing waste have to fill an Environmental Compulsory Declaration called MUD; waste management enterprises have to register all information on nature, quantity, destination and transport of waste handled, and report yearly all this information to the National Waste Inventory by means of this questionnaire. Only some minor categories of local units are not required to fill in the questionnaire. This is the case, for example of agricultural farmers with a turnover lower than 7.800 Euro (15 million of old liras) and, as far as non hazardous waste is concerned, craftsmen with less than 3 employees.

The MUD must be sent to the Chamber of Commerce competent by area. The questionnaires must arrive not later than the 30th of April of each year, filled in with the data referring to the previous calendar year. The Union of Chambers of Commerce has to put the data in digital form and to transmit them to the competent administrations (i.e. the National Waste Inventory, the Regions, the Provinces).

This administrative source produces a great quantity of statistical information concerning the collection, treatment and disposal of waste, referred to municipalities and other waste producers and coded by economic activity. For economic activities, statistical units are Local Unit and data are available for sections, divisions, groups and classes of NACE Rev. 1.

Moreover, the Decree n. 372/1998 reorganizes the National Waste Inventory, which now is fully operational and is localized in the Italian Agency for Environmental Protection and Technical Services (APAT) at national level and in the Regional Environment Agencies (ARPA) at the regional one.

The MUD data set on waste has been extracted from about 400.000/450.000 declarations. The data coming from MUD need to be validated and in the last years IT tools that help to correct the systematic and random mistakes by using a bottom-up methodology have been established. In order to correct and validate the data coming from the MUD declarations, a standard common procedure has been developed, which has been followed by everyone involved in the correction of the data. This procedure has been drawn up together with the responsible of the Regional Waste Inventory of each Regional Environment Agencies (ARPA) at regional level. As a consequence the data on waste are validated in the same way at the different administrative levels.

The procedure is made by several steps. The first three steps are:

1. evidencing double declarations;
2. checking for possible wrong measurement units;
3. checking for possible wrong EWC and NACE Rev.1 code.

Subsequently the declared quantities of the single declarations made by managers of waste disposal, treatment plants and final disposal plants under permit are merged and compared with those derived from the permits issued by the Institutional Authority (pursuant to artt.27 e 28 of law n. 22/1997), in order to improve the quality of the data referred to these units.

Thanks to this double check, often performed at regional level, the final quality of the data set is quite high. A further improvement of the data set is expected from the realization of a local network and an appropriate telematic tool.

The available time series range from 1996 to 2001 for Municipal waste (whose Italian definition is very similar to that of the OECD). Data of waste generation on industrial waste are available from 1997 to 2001 coded by EWC or HWL (non-hazardous and hazardous waste) and by economic activity (NACE).

The following table shows some summary figures on waste supply in Italy in the period 1995-2001.

	Municipal waste		*Other*	*Hazardous*	*C&D*	*Total*
Year	*Total*	*Per capita*	*waste*[1]	*waste*		
	(1000 t)	*(kg/inh)*	*(1000 t)*	*(1000 t)*	*(1000 t)*	*(1000 t)*
1995	*25.780*	*449*	*31.136*[2]	*1.632*[2]	*18.106*	*75.022*
1996	*25.960*	*451*	*n.a.*	*n.a.*	*18.414*	*n.a.*
1997	*26.605*	*462*	*40.488*	*3.401*	*20.397*	*87.490*
1998	*26.846*	*466*	*47.977*	*4.058*	*21.286*	*96.109*
1999	*28.364*	*492*	*48.656*	*3.811*	*23.880*	*100.900*
2000	*28.959*	*501*	*55.809*	*3.911*	*27.291*	*112.059*
2001	*29.409*	*516*	*59.359*	*4.279*	*30.954*	*119.721*

Source: APAT
C&D: construction and demolition
[1] Without C&D waste [2] Source: ISTAT

In 2001 more than 110 million of tons of waste have been generated, with an increase rate of 100% in the last 10 years. Municipal waste amounts to about 30 million of tons (1/4 of the total waste generation) while about 60 million of tons are mainly industrial and commercial waste (representing 2/4 of the Italian total waste generation) and about 30 million of tons construction and demolition waste (C&D), i.e. 1/4 of the total waste generation.

II.4.3.2 Polluting air emissions from domestic activities

Data on air emission of the most important 10 pollutants (CO_2, SO_2, NO_x as NO_2, NMVOC, CH_4, CO, PM - Particulate matter (incl. dust), N_2O, NH_3, CFCs and halons) by branch of activity are produced by APAT. These are included – after attribution to production and consumption activities – in the Italian NAMEA, which gives the detail of the emissions by supplying activity. The 1997 NAMEA air emission matrix will be available by June 2004, when the 1990-2000 time series of these matrices will be completed.

Differently from EW-MFB, as a consequence of the different system boundaries, gases and other Residuals that leave controlled landfills have to be accounted for as Residuals (going to the natural environment), to which a negative accumulation in the controlled landfills entry under the man-made assets shall correspond.

II.4.3.3 Material residues contained in domestic wastewater

Data on this kind of flows at the economy-wide level have been calculated with some sectoral disaggregation in the framework of the construction of the 1997 material flow balance for Italy, both before and after depuration (though this has been possible only thanks to some simplifying assumption). The determination of the discharge of materials into wastewater by branch of activity

can be done on the basis of the data on emissions by branch in terms of inhabitant equivalent figures.

II.4.3.4 Water vapour

Water vapour is one result of processes such as combustion and respiration (including by humans). Water vapour output has been calculated in drawing the 1997 material flow balance for Italy, keeping the different processes separated. The attribution to the various activities can be done following the same procedure, based on stochiometric calculation, used for the Italian total.

II.5 Use table: sources of information and elaborations needed

II.5.1 Natural Resources

Natural Resources are used by the activities that extract them from the natural environment and transform the useful part of them in Raw materials, i.e. in products, and the remaining part in Residuals such as extraction waste and unused biomass. As far as the materials classified as used in EW-MFA are concerned, these are extracted only by a few activities, which transform Natural Resources into raw materials for the rest of the economy to use them. The attribution of the use is in these cases straightforward, as the activities are identified precisely on the basis of the materials they extract. A special case is that of agriculture and forestry, which use minerals and water from the soil and air from the atmosphere in order to create the plants and fruits which constitute their material output, both of Products (including work in progress) and of Residuals.

The allocation to using activities is straightforward also for the materials that are classified as unused domestic extraction in EW-MFA, as these are by-flows of mineral extraction and construction activities (soil excavation).

As far as the ancillary flows of air and water that are accounted for as input balancing items in EW-MFA are concerned:

- oxygen and nitrogen inputs for combustion processes have been calculated in drawing the 1997 material flow balance for Italy, keeping the different processes separated. The attribution to the activities that use them can be done following the same procedure, based on stochiometric calculation, used for the Italian total;
- oxygen consumed by animals and humans, also present in the 1997 economy-wide MFA for Italy, is straightforwardly attributed to animal farming and household consumption activities;
- drinking water for animals will be considered as directly abstracted by the animal farming activities, even though this is probably not always the case.

II.5.2 Products

As far as the Use matrix is concerned, the part where most data sources and analyses converge is that concerning products. Indeed, many different products flow into each domestic activity and final use, and no unique and complete data source exists on the cost structures of industries and compositions of final uses. Nevertheless, several potential sources exist, that can be used in order to determine the destination of the products. In the following we will not take a univocal approach, but rather we will deal with the problem of constructing the Physical Use Table "by column" (i.e. we will discuss about cost structures or compositions of final uses) or "by row" (i.e. we will discuss about destination of products) as suggested by the characteristics of the available data, also with the purpose of highlighting some cases of special interest or particularly challenging.

II.5.2.1 Istat's surveys on the 1992 production cost structure

Surveys on the production costs structure of Italian firms have been carried out by Istat expressly for the construction of the (monetary) 1992 Input-Output Table, covering all categories of economic activity but agriculture. This survey includes data both in monetary and in physical quantities. The latter were included for checking purposes, and have been used to correct incoherent monetary data. The 1992 Input-Output Table, based on this survey, is at the basis of the balancing of the Italian National Accounts of the 1990ies, as it provided the benchmark structure of the economy for those years.

This survey is the most complete source of information on the structure of the Italian economy of the '90ies also as far as physical flows are concerned. However, since our focus year is 1997, we will consider this survey's results as a last resort, to be used only in case no information is available for 1997 or years less distant from that. Moreover, they will provide a control benchmark for doubtful results.

II.5.2.2 Destination of agricultural, animal, forestry and fishery products

II.5.2.2.1 Istat's annual agriculture business survey

The Italian annual business survey in agriculture (RICA-REA) by Istat, Inea and Regions started in 1999 with 1998 as reference year. The sample population of the survey includes all farms involved in vegetable and animal production (fishing and forestry excluded) and allows estimations for NACE Section A.01 "Agriculture, hunting and related service activities".

In its short-form questionnaire, designed to satisfy National Accounts requirements (SEC95), this survey includes a section on the structure of costs of farms. The data thus collected, however, cannot be used as such in the construction of the agriculture column of the use table, as the quantities of products used are expressed in monetary units only. Nevertheless, the survey is useful in order to identify the inputs used in agricultural activities, though not to quantify them directly in physical units. In case of lack of more direct methods, prices could be used in order to estimate quantities starting from surveyed values.

As far as the destination of the farms' Products is concerned (agricultural Products' rows of the use table), the questionnaire includes information in physical terms that is potentially useful. In fact, in order to get proper information and reliable estimates of money values of some economic flows of the farms, the data collectors have to fill up an auxiliary part of the questionnaire that includes information expressed in physical units. A page of the questionnaire (reported below) is devoted to reporting the quantities, while in the subsequent, equal in structure, the corresponding values have to be reported. For each kind of products and animals included, a balance for the reference year is drawn up in the corresponding row, including:

- on the resource side: opening stock, farm's production (for animals: births), and purchases;
- on the use side: reuse and transformation, own consumption (for animals: deaths and slaughtering), sales and closing stock.

SCHEDA AUSILIARIA PER IL RIEPILOGO DELLE QUANTITA' DEI PROOTTI E DEGLI ANIMALI NELL'ANNO 2002

I.PRODOTTI	RISORSE DELL'ANNO 2002								IMPIEGHI DELLE RISORSE NELL'ANNO 2002							
	GIACENZE INIZIALI (ALL'1/1/2002)		PRIDUZIONE DELL'AZIENDA		ACQUISTI		TOTALE RISORSE=IMPIEGH		EGHI E TRASFORM		AUTOCONSUMO		VENDITE		GIACENZE FINALI (ALL'31/12/2002)	
	1		2		3		4=1+2+3=5+6+7+8		5		6		7		8	
	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg	Q.li	Kg
1.PRODOTTI VEGETALI																
1.1 PRIMARI																
1.2 SOTTOPRODOTTI																
1.3 IN CORSO I TRASFORMAZIONE																
1.4 TRASFORMATI																
2. PRODOTTI ZOOTECNICI																
2.1 NON TRASFORMATI																
2.2 SOTTOPRODOTTI																
2.3 IN CORSO DI TRASFORMAZIONE																
2.4 TRASFORMATI																

II.ANIMALI (esclusi quelli da riproduzione, da latte, da lana e da lavoro)	GIACENZE INIZIALI (ALL'1/1/2002)	NATI	ACQUISTI	TOTALE RISORSE=IMPIEGH	MORTI	MACELLATI	VENDUTI	GIACENZE FINALI (ALL'31/12/2002)
	1	2	3	4=1+2+3=5+6+7+8	5	6	7	8
	NUMERO	NUMERO	NUMERO	NUMERO	NUMERO	NUMERO	NUMERO	NUMERO

This information can be used in order to determine a broad allocation of agricultural output between use of own products for transformation, own final consumption, sales and changes of stocks. Such a broad allocation would be preliminary to a more detailed one between the users of the sold production (see the next section).

Since the auxiliary pages of the questionnaire are currently not registered, a preliminary analysis will be carried out in order to decide whether making this information available on electronic support is worth the cost. This analysis will consist first of all in counting the questionnaires with a filled auxiliary part, and analysing the coverage in terms of Products; the registration of a sample of these auxiliary pages might also be useful before going into the registration of the whole set, in

order to carry out a preliminary analysis of the contents and to determine the reliability of the information.

After registration, it will be possible to check all the individual data, make the necessary corrections and integrations for wrong or missing values, and finally estimate the aggregate variables via population expansion coefficients.

II.5.2.2.2 Destination of agricultural, animal, forestry and fishery Products: other sources

An *ad hoc* analysis has been carried out in order to identify possible sources of data on physical flows of Products from Agriculture, Forestry, Fishery and Animal farming (from now on only "agricultural Products", unless necessary) to the production branches of the Italian economy and to final uses. The sources considered here are only the ones that are specific to the uses of agricultural Products and do not comprise other possible and more general sources such as surveys on industry cost structures or the sector studies dealt with elsewhere in the present report.

The first step in reconstructing the material flows of agricultural Products to other sectors and branches of economy consists in identifying the industrial branches which use agricultural Products as inputs for production. Since many of these inputs may have substitutes - depending on the kind of use to which they are assigned - and many Products may have several competing destinations, it has been necessary to track directly the flows of agricultural products to the industrial branches of the economy. For this purpose a specific analysis of the destination of these products has been carried out. This has been realised mainly on the basis of the 1995 monetary input-output table of the Italian agribusiness sector elaborated by ISMEA[13]. In this table ISMEA subdivided the agribusiness system into 51 branches, of which 24 belonging to the agricultural sector (including forestry and fishery) and 13 belonging to the food industry.

ISMEA's agricultural sector breakdown identifies agricultural branches on the basis of groups of agricultural products (i.e. cereals, oilseed, fruits etc.). This structure relies on the results of a sample survey realised by ISMEA, targeted on Italian farms included in 1990 census. ISMEA utilised a similar survey also to determine the relevant breakdown of the food industry; the groups of economic activities identified by this industry breakdown correspond to NACE industrial divisions or groups or classes, as a result of ISMEA's survey design.

This table cannot be taken as direct source of material use data, because the flows are expressed in monetary terms. Nevertheless it provides an essential contribution to the knowledge of the Italian agribusiness sector, defining a structure for the breakdown of the flows of agricultural products to the Italian economy. It is as such, indeed, that it has been used in order to identify the most important agricultural products' flows to other branches (mainly manufacturing industries) and final consumption.

The analysis of the 1995 ISMEA table and the use of technical manuals allowed to track the uses of different agricultural products in the Italian economy of the 1990s, by singling out the economic activity that processes exactly that group of raw materials; subsequently the correspondent NACE code has been assigned to the activity.

This NACE labelling procedure of all identified uses has been necessary in order to assign each flow to one of the 92 branches of the economy, according to the architecture of the 1992 Italian input-output table, taken as reference structure in the present study.

The breakdown framework of the agricultural products' rows of the Physical Use Table

The following table reproduces the breakdown framework adopted for the agricultural products' rows of the physical use table, to be used in the pilot construction of the 1997 PIOT.

[13] See ISMEA 1997. ISMEA is a member of the Italian Statistical System (SISTAN).

Uses/ n° I-O Branch/Ateco codes

Production\ Import	Agriculture	Animal farming	Meat proces.	Other food Industries	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders	Beverages & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
	1	2	7	8	9	10	11	12	13	14	19	20	23	25	94
Wheat & Rice	01.1	1.2					15.6								
- prod.	x	x					xxx								x
- import	.						xxx								x
Total	x	x					xxxxx								xx
Maize & other c.	01.1	1.2		15.4			15.6	15.7	15.96 -97						
- prod.	.	x		.			.	xxxx	x						x
- import	x	.		x			x	x	x						x
Total	x	x		x			x	xxxx	xx						xx
Sugar beet.	01.1			15.83											
- prod.	x			xxx											x
- import	.														x
Total	x			xxx											xx
Oilseeds crops	01.1			15.4				15.7							
- prod.	.			xx				xx							x
- import	x			x				x							x
Total	x			xxx				xxx							xx
Other ind. crops															
incl. Textile crops	01.1			15.4						17					
- prod.	.			xx						x					x
- import	x			xxx						x					x
Total	x			xxxx						xx					xx
Tobacco	01.1								16						
- prod.	xx								xxx						x
- import	.								.						x
Total	xx								xxx						xx

Uses/ n° I-O Branch/Ateco codes

Production\ Import	Agriculture	Animal farming	Meat proces.	Other food Industries	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders	Beverages & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
	1	2	7	8	9	10	11	12	13	14	19	20	23	25	94
Potatoes	01.1	1.2			15.3		15.6								
- prod.	.	x			x		.								x
- import	xx				x		.								x
Total	xx	x			xx		.								xx
Tomatoes	01.1	1.2			15.3										
- prod.	x	.			xxx										x
- import	x														x
Total	xx	.			xxx										xx
Other vegetables	01.1	1.2		15.8	15.3										
- prod.	x	x		x	xxx										x
- import					x										x
Total	x	x		x	xxxx										xx
Flowers & others	01.1			15.8					15.9						
- prod.	xx			xx					xx						x
- import	xx			xx					xx						x
Total	xxxx			xxxx					xxxx						xx
Citruses p. crops	01.1				15.3				15.9						
- prod.	x				xxx				xx						x
- import															x
Total	x				xxx				xx						xx
Fruit p. crops	01.1	1.2		15.8	15.3	15.5			15.9						
- prod.	x	x		xx	xxx	x			x						x
- import	x			.					x						x
Total	xx	x		xx	xxx	x			xx						xx

Uses/ n° I-O Branch/Ateco codes

Production\ Import	Agriculture	Animal farming	Meat proces.	Other food Industries	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders	Beverages & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
	1	2	7	8	9	10	11	12	13	14	19	20	23	25	94
Vineyards	01.1								15.9						
- prod.	x								xxxx						x
- import	x								.						x
Total	xx								xxxx						xx
Olive growing				15.4/15.8	15.3										
- prod.				xxxx	x										x
- import				.	.										x
Total				xxxx	x										xx
Permanent grassland	01.1	1.2						15.7							
- prod.	x	xxxxx						xx							x
- import															x
Total	x	xxxxx						xx							xx
Forest wood prod.											20	21	24.1		
- prod.											x	xx	x		x
- import											xxxx		.		x
Total											xxxxx	xx	x		xx
Forest non-wood products		1.2													
- prod.		xx													x
- import															x
Total		xx													xx

	Uses/ n° I-O Branch/Ateco codes														
Production\ Import	Agriculture	Animal farming	Meat proces.	Other food Industries	Vegetab. & fruit proces.	Milk processing	Cereals processing	Fodders	Beverages & tobac.	Textile fiber & tissues	Wood products	Paper	Basic Chemicals	Pharmac. products	Final consumption
	1	2	7	8	9	10	11	12	13	14	19	20	23	25	94
Animal farming		1.2	15.1	15.4/15.8		15.5				17				24.5	
- prod.	xx	x	xxxx	x		xxxx				x				x	x
- import		.	x	x						x				.	x
Total	xx	x	xxxxx	xx		xxxx				xx				x	xx
Fishery				15.2									24.1		
- prod.				.									x		x
- import				x									.		x
Total				x									x		xx

Notes

. =	negligible
x =	not very small
xx =	small
xxx =	medium
xxxx =	large
xxxxx =	very large

shades of grey

official data / Istat - Sistan
administrative data / Government, Mipaf - Ismea
Estimates / Producers assoc - others

The columns of this framework are the same of those of the 1992 IO table and in particular they represent all branches of the economy and final consumption which receive and process physical inputs of products from Agriculture, Forestry, Fishery and Animal farming. The rows represent the different sets into which it is convenient to group these products in order to study their destination.

This framework has been designed for the 1997 PIOT pilot construction; should the same framework be applied to the construction of a PIOT of another (distant) year, it would be necessary to carry out a preliminary analysis, in order to verify whether the relationships between sectors and branches had structurally changed in the meantime. For instance, new uses of agricultural products, in branches of the economy not comprised in the framework could intervene, or some current uses could disappear.

The number at each crossing point (cell) between the rows and the columns is the NACE code that identifies the activity processing the products in the row. This NACE activity is included in the 1992 IO branch named on top of the column. For each use of agricultural products, the flows are distinguished between domestic and foreign (import) origin, in order to asses separately their relevance.

A preliminary evaluation of each flow's importance is represented by the number of "x"s in the corresponding cell; a dot "."means that the flow's amount should be negligible. The different shades of grey in the cells indicate the kind of data source that can supply data on the corresponding flow for the 1997 use table

Specific data sources for the agricultural products' rows of the Physical Use Table

This section describes the data sources represented by the different shades of grey in the table, read by column. As the uses of agricultural products in Italy are not always registered by official data sources, especially for what concerns physical quantities, the use of administrative data is foreseen. A role is also assigned to experts' knowledge of the using sectors; however this should be seen as a last resort, should the other sources not suffice for covering all flows.

Uses in the Agriculture branch

Data about flows of agricultural and forestry products to Agriculture are supplied by official sources of the Italian Statistical System (Istat surveys on products of forests and cultivation). These sources can provide data on flows of domestic production whereas trade statistics can supply data on imports. Only to account for flows of Animal farming by-products (manure) to Agriculture data must be supplied by expert estimates or computed by applying technical coefficients to cattle's stock figures, as has been done in computing the economy-wide material flow balance for 1997.

Uses in the Animal farming branch

Data about flows of agricultural products to the Animal farming branch can be retrieved from product balance sheets. These balances are endorsed by Government approval (Ministry of Agriculture and Forestry Policy) with ISMEA technical support and supplied yearly to Eurostat and European Commission. Data on the uses of forage (from permanent grassland) in the Animal farming branch are supplied by official statistical data (Istat's survey on permanent grassland and forages), whereas as far as Forest non -wood products' uses in Animal farming are concerned, we have to rely mostly on expert estimates or farmers/breeders associations.

Uses in the Meat processing branch

Data on flows of animal products to the Meat processing branch may be retrieved from Istat survey on slaughtering and/or estimated from the production of the using branch surveyed by the PRODCOM.

Uses in the Other food industries branch

Flows from many agricultural cultivations to the Other food industries branch may be retrieved from the specific product balance sheets (i.e. those on oilseeds, cereals, sugar beet, olive oil etc.). Data about some minor flows such as fruit, vegetables and flowers can be supplied mostly by expert estimates or industrial producers' associations. Data about flows of fishery products to the Other food industries branch can be retrieved from ISMEA yearly sector report, estimated from PRODCOM surveyed production or provided by Industrial Associations.

Uses in the Vegetables and fruit processing branch

Flows of agricultural products to the Vegetables and fruit processing branch may be retrieved from the specific product balance sheets (i.e. those on fruits, citrus, tomato, etc.).

Uses in the Milk processing branch

Data on flows from Animal farming to the Milk processing branch can be retrieved from Istat survey on milk and milk derivatives and/or estimated from PRODCOM surveyed production. Data about some minor fruit flows can be supplied mostly by expert estimates or sector's associations.

Uses in the Cereal processing branch

Flows of agricultural product to the Cereal processing branch can be retrieved from cereals balance sheets.

Uses in the Fodder branch

Data on flows from Agriculture to the Fodder branch can be retrieved from cereals balance sheets.

Uses in the Beverages and tobacco branch

Data on material flows from Vineyards to the Beverages and tobacco branch can be supplied by official sources of the Italian statistical system. Data on flows from tobaccos to Beverages and tobacco branch can be retrieved from product balance sheets or administrative archives (those of AGEA, the national agency that controls the application of the Common Agricultural Policy), as tobacco is a product subject to Common Agricultural Policy regulation. For data about other flows of agricultural products to this branch, we will have to rely on expert estimates or sector's associations.

Uses in the Textile fibres and tissues branch

Data on material flows from Agriculture and Animal farming to the Textile and tissue branch can be estimated by applying technical coefficients to the statistics supplied by the survey on the area of textile crops, assuming that all sold domestic production not exported is used in this branch. On the basis of the same assumption, another potential source of data is the survey on cattle stocks and other variables (wool), whereas for other minor flows we will have to rely on estimates.

Uses in the Wood product branch

Data on flows from Forestry to the Wood product branch will be provided by official forestry statistics (survey on wood removals), which specifies the use to which the wood is destined.

Uses in the Paper branch

Data on flows from Forestry to the Paper branch will be provided by official forestry statistics (survey on wood removals).

Uses in the Basic chemical branch

Data on flows from Forestry and Fishery to the Basic chemical branch will be supplied by estimates provided by expert and sector's associations, coupled with statistics from the PRODCOM survey.

Uses in the Pharmaceutical products branch

Data on flows from Animal farming to the Pharmaceutical products branch will be supplied by estimates provided by expert and sector's associations, coupled with statistics from the PRODCOM survey.

Uses by Final consumption

For data about all flows from Agriculture, Forestry, Fishery and Animal farming to Final consumption we will have to rely on the available product balance sheets and/or statistical estimates based on the commodity flow approach.

II.5.2.3 Use of industrial products by economic destination and useful material stocks accumulation

Some important intermediate results for the Physical Use Table, and especially for its rows concerning industrial products, have been obtained in the framework of the Italian 1997 EW-MFB. These results consist in:

a) the allocation to economic destinations of the total resources available for domestic uses of each industrial product, i.e. the determination of this total and its split into the components intermediate consumption, household consumption and gross investments; this allocation has been obtained by applying the method and tools in use in National Accounts;

b) the calculation, also on the basis of the allocation under a), of the "Additions to stocks" aggregate of the EW-MFB. For this, we had to further split the household consumption component into the non-durable goods part, which is an intermediate input for the "household material transformation" activity, and the durable goods part, which contributes to the build-up of stocks. Also, the additions and subtractions to the components Inventories, Buildings and infrastructures and Machinery have been separately assessed.

The premises for these operations are in the transformation of all PRODCOM data into weight units and integration for incomplete coverage, described in §II.4.2.2.

Though a revision of this work is foreseen for its use in the realisation of the PIOT, it is worth recalling the procedures followed, which provide a starting point for further work.

The first step consisted in the calculation of total resources by type of commodity, i.e. imports had to be summed up to national productions, and exports subtracted. As this cannot be done at the commodity level, due to the existence of several many-to-many correspondences between the PRODCOM and the CN classification, both the data on domestic industrial production and on foreign trade have been aggregated at the 5-digit ATECO level, using simple correspondence keys telling what ATECO activity is the one producing any particular good. It is clear that in both the industrial production and foreign trade cases, the activities thus defined are homogeneous ones from the point of view of the products they give. One aim of the foreseen revision is the use of correspondences between groups of products smaller than those defined by ATECO categories, as to allow calculation and allocation of resources available for domestic use at a more detailed level.

Once the total resources available for domestic use have been thus determined by ATECO category, we did split them again by PRODCOM8 products, as it is for these that the use destinations are known. This has been done by using the relative weights of the individual PRODCOM products in the total weight of each ATECO's national production.

Finally, the uses by kind of economic destination have been determined by using the percentage allocations that had been determined for the use in NA (see Istat, 2000, pag. 16) by an *ad hoc* Working Group on the basis of their individual characteristics and of the results of Istat surveys.

Possible destinations of the resources available for domestic use, according to these allocation quotas, are intermediate or final consumption and investments. As hinted above, we further split goods going to final consumption into durables and non-durables; this has been done by considering as durables all the goods that also have a quota going to investments, and on the basis of the results of a former study by Istat for the cases that could not be settled in this way[14].

On the basis of this allocation, we produced estimates for the main categories of material accumulation in the technosphere. The following descriptions of the procedures used for obtaining the subsequent estimation of Gross and Net Additions to Stocks are textually reported from Femia (ed.), 2003 (pp.44-46)[15].

II.5.2.3.1 Infrastructures and Buildings

This item has been calculated on the basis of the results of the elaborations of PRODCOM and foreign trade data described above. Construction activities are not covered by the PRODCOM survey, but all materials embedded in constructions come from some activity included in it. Therefore, it is among intermediate uses of the products of PRODCOM industries that the relevant data have to be searched. No attempt has been made to include the use of metals for construction purposes in the estimate. For other building materials, a simple flow model has been developed, showing that these either go directly from the activities of NACE groups 14.1, 14.2 and 14.5 to construction activities (e.g. sand and gravel, marble), or flow through the activities of division 26 (e.g. clay is transformed in bricks, limestone in cement…). In this passage, part of the materials are transformed in waste, and this has been accounted for by subtracting the waste produced by these industries. Moreover, part is delivered directly from division 26 to final uses, and also these have been subtracted, and allocated to the corresponding accumulation categories (other investments and consumer durables) when suited. The remaining part is assumed to be accumulated in the products of construction works.

Data on removals for this item have been drawn from the sector study on demolition waste in ANPA (1999a), based in turn on a study by CRESME (1998). Reused quantities of demolition waste have been excluded from the removals, as they go back into new constructions and are probably not among the materials accounted for under gross additions.

II.5.2.3.2 Machinery

The gross additions to this item are given by the sum of all investments and durable consumer goods produced by the NACE divisions 28-35, as resulting from the elaboration of PROCOM and foreign trade data described above.

The removals computed only cover demolished vehicles; data by ANPA (1999b).

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[14] This distinction between durable and non durable goods is mostly based on an economic concept of durability, and therefore needs to be revised for our purposes, as a classification based on the physical concept of durability does not necessarily coincide with that based on the economic concept (e.g. a needle is not durable as such, and therefore is classified as non-durable in economic terms; however it still is an addition to useful physical stocks when driven into a wall, and must be classified as such in MFA applications).

[15] The items that have been subtracted in order to go from Gross to Net Additions to stocks are actually Residuals that are supplied by the individual stocks; in the Use table they appear in the columns of the activities that use them, e.g. external environmental protection services and recycling.

II.5.2.3.3 Consumer durables

This item has been set equal to the products of all NACE divisions except 28-35 destined to investments or characterised as durable consumer goods, according to the elaborations of PRODCOM and foreign trade data described above.

Removals have been accounted only as far as separate collection of bulky wastes in Urban wastes is concerned (ANPA, 1999a).

II.5.2.3.4 Inventory changes

The PRODCOM survey reports both produced and sold quantities. Inventory changes have been estimated as difference between these two quantities. No estimate concerning intermediate inputs bought in 1997 but not used in that year has been attempted

II.5.2.4 Istat's survey on the 1996 industrial production cost structure

A survey has been carried out by Istat in order to collect information to be used in the construction of an updated MIOT. This survey deals with the industrial sector only, its scope being limited to the activities inherent the PRODCOM classification, i.e. sections C and D of NACE Rev. 1 (Mining, Quarrying and Manufacturing Industries, except subsection DF - Manufacture of coke, refined petroleum products and nuclear fuel and of division 37 - Recycling), plus the section F - Construction.

The degree of coverage varies from branch to branch. It is therefore not possible to draw a general conclusion on the possibility of using the results of this survey; rather, it will be necessary to assess it case by case, also taking into account that the distribution of the average unit value of a same commodity used in the various production activities often shows a wide variability.

The branches with a better coverage in terms of job holders are the following:

Denomination of the branch	% Coverage
Tobacco products	67.7
Basic chemicals	37.9
Pharmaceuticals	23.2
Home appliances	19.8
Man-made fibres	18.8
Rubber	18.7
Metals	18.0
Beverages	15.7
Ceramic products	15.4
Electric transformers	12.8
Electronic products	12.1

Many categories, however, have a number of surveyed firms that is insufficient both for a revision of average unitary values of raw materials and of per-capita values of their uses classified by 3-digit ATECO groups, and for an adequate coverage of the economic activities surveyed.

As can be seen from the following frequency table:

No. Of surveyed firms	No. of ATECO91 categories
0	29
1	32
2	33
3	26
4	24
5	21

165 ATECO91 categories on 388, i.e. 42.5% of the total, are represented by a number of firms lower than 6.

It can be noted that the sample is not representative for the oils and fats industry (ATECO 15.41.3: Manufacture of crude animal oils and fats and ATECO 15421: Manufacture of refined olive oil have frequency 0, while ATECO 15.41.1: Manufacture of crude olive oil is present with only 1 firm), and for Costruction (NACE 45.21: General construction of buildings and civil engineering work has frequency 0, while the number of firms surveyed covers 0.58% of the job holders).

Among ATECO categories with frequency 0, the following deserve highlighting:
24.20.0 Manufacture of pesticides and other agro-chemical products
29.11.2 Manufacture and putting in place of hydro- and thermoengines and turbines, and other machines producing mechanical energy, comprised parts thereof, reparation etc.
33.20.3 Manufacture of instruments and appliances for navigating, hydrology, geophysics and e meteorology.
36.22.2 Working of precious and semi-precious stones for jewellery for industrial use

Also the industry of transport vehicles (motor vehicles, ships, railway and tramway rolling stock, airplanes) is not adequately represented as firms of particular relevance as FIAT and FINCANTIERI have not answered.

As for the data, these in principle include both quantities (opening stocks, closing stocks and current uses) and values (current uses). The commodities included in the questionnaires (concerning raw materials, semi-finished goods, detached parts, ancillary materials and packaging) have been registered in three distinct files:

- a file of 31.931 records, containing data both in value and in quantity, with their respective measurement units;
- a file of 2.389 records, without measurement units;
- a file of 8.048 records with quantities but without values.

Assuming that a measurement unit can be properly attached to the quantities reported in the second kind of records, and that those of the third kind are checked (e.g. against the firm's output) there is a total of 42.368 potentially useful records to be further analysed.

II.5.2.5 Ministry of Finance sector studies

II.5.2.5.1 General features

Since 1998 the Ministry of Finance carries out a survey on small and medium enterprises and professions for taxation purposes. To each respondent a specific presumed taxable income is assigned, that depends on the results of the relevant sector study to and on the information collected on the unit through the survey.

The procedure used for constructing the sector study has three phases. Firstly, for the reference year the data are collected and the reference data set is created. Then the data are reduced through a principal component analysis and a cluster analysis is carried out on the principal components to define groups of homogeneous enterprises. Lastly, for each cluster the function for the determination of the presumed taxable income is calculated with a multivariate regression; enterprises having extreme values for the relevant variables are excluded from this stage. Some elements of correction are introduced in the income functions depending on the geographical location of the enterprise. The data set is annually updated and via a discriminatory analysis the enterprises are assigned to the appropriate cluster and, as a consequence, to the appropriate income function and corrections.

While considering the calculation of the presumed taxable income is useful to correctly understand the meaning of the available variables' set, we are basically interested in the annually updated data set. Let us therefore consider the Ministry of Finance sector study just as an administrative source on small and medium enterprises and professions[16].

The scope of the survey is defined by a turnover ceiling, equal to € 5.164.569, and a filter on the economic activity code. The economic activity nomenclature used is more detailed than ATECO91, and perfectly fits into the structural and hierarchical framework of the latter[17]. By appropriately grouping the activity codes, industry segments are defined (the sectors), that fit in four general areas of activity labelled as Services, Manufacturing, Trade and Professions. For each sector a questionnaire is provided.

The unit of observation is a sort of local kind of activity unit, i.e. the part of the enterprise carrying out a single activity and having a specific location. At a micro level it may be difficult to identify the enterprise as a unit. However, the majority of the enterprises involved are simple organizations with a sole (main) activity and a unique location. Some 'clauses of exclusions' are also foreseen, i.e. conditions by which an enterprise belonging to the theoretical scope is exempted from responding. The scope of the survey is in progress, as each year new studies are added: the studies were 45 in 1998 and went up to 168 in 2001. In the same period the collected observations grew from 1.058.899 up to 2.718.306. According to the Tax Authority, in 2003 almost 4 millions taxpayers have been concerned by the studies. The following table shows the development of the scope in terms of number of concerned 5-digit ATECO91 activities by division of economic activity.

[16] The method used to check the tax declaration is interesting for our purposes to the extent that they contain coefficients which tie variables known at the sector level (such as revenues, or labour force employed) to the material inputs used (or outputs produced, for the material supply table), as to find the latter from the former. However, these results might not be applicable for our purpose, because the focus variables – the dependent ones – of our study are different from taxable income; moreover, our analysis can profit from linking the sector studies' data set with other archives. It is therefore advisable to formulate our own analysis strategy in the first place, and decide thereafter whether further considering sector studies' results and methodologies.

[17] Due to the higher degree of detail of the Ministry of Finance nomenclature, it is possible that some activities in the survey scope cover only partially the corresponding 5-digit ATECO91 activities.

NACE division	Sector Studies			
	1998	1999	2000	2001
14	8	9	9	9
15	8	8	8	8
17	4	20	20	20
18		8	10	10
19	3	3	5	5
20		7	7	7
21				3
22				7
26	3	6	9	13
27			1	11
28			28	28
29	1	1	36	36
31			1	1
33		2	2	3
35				1
36	6	6	8	9
45	3	12	12	17
50	5	9	9	9
51	5	9	42	71
52	30	35	40	64
55	4	13	13	13
60	1	1	5	5
63				4
64				1
70	1	1	2	2
72				7
74	2	2	11	13
80				1
85			3	9
92			1	1
93	3	5	5	5
Total	87	157	287	393

The survey proves to be a precious source also when its coverage vis-à-vis ASIA is considered. We evaluated the coverage by considering the ratio between the number of enterprises present in the sector study and the number of enterprises present in ASIA and belonging to the 5-digit codes that each year define the scope of the Ministry of Finance survey. No condition has been set on ASIA enterprises' size. Moreover, due to the difficulty of identifying the enterprise as a whole when it has more than one activity or more than one location, only mono-activity mono-location enterprises data sets are considered among the enterprises present in the sector study. The small average dimension of the Italian enterprises nevertheless implies that the coverage thus calculated is only slightly an underestimate. The following table shows that it is very good.

NACE division	Sector Studies			
	1998	1999	2000	2001
14	68,7	69,3	72,7	69,7
15	64,6	69,3	78,0	71,6
17	65,9	72,4	75,1	77,2
18		72,0	75,1	74,3
19	73,8	74,8	71,6	71,5
20		70,4	74,8	73,6
21				68,8
22				72,9
26	73,8	71,8	71,7	73,0
27			(*)	89,8
28			74,3	75,9
29	76,5	74,3	67,9	69,2
31			61,2	61,9
33		63,7	70,1	90,7
35				63,0
36	65,0	68,9	71,1	73,2
45	79,6	76,2	78,9	78,2
50	77,9	74,2	78,3	76,7
51	75,1	73,8	74,3	72,8
52	77,8	74,0	78,5	72,0
55	72,7	71,4	76,4	70,2
60	78,1	77,5	80,1	80,9
63				54,2
64				64,7
70	66,3	69,1	74,9	78,5
72				51,9
74	(**)	(**)	73,7	72,7
80				82,4
85			(***)	(***)
92			86,0	87,1
93	84,4	82,8	84,4	84,1
	72,6	72,8	77,3	74,7

(*) The data are omitted because they refers to very few units active in a sole 5-digit code
(**) The data are omitted because the Sector Studies scope covers only partially the corresponding 5-digit codes
(***) The data are omitted because the scope of ASIA covers only partially the units active in this division

The data collected in any given year refer to the taxation period, which coincides with the previous year[18]. By now Istat has acquired the data sets referring to four years, namely from 1998 to 2001.

The questionnaires tend to be strictly tailored to the activities they refer to[19]. The source is rich in information because it tries to fully describe the activity of the enterprise and the economic context in which it takes place. The high specificity of the studies entails that each sector's questionnaire has to be considered individually and that it is not always possible to reduce specific pieces of

[18] In what follows the word 'year' is used for 'taxation period of reference'.

[19] The questionnaires were drawn up by the trade associations representatives, who are deemed to have an in depth knowledge of the sectors they are delegated for.

information into an overall comprehensive item. In general it can be said that for each sector plenty of information is collected, including very important pieces referring to:

- employment
- features of the local unit
- machinery
- inputs and/or outputs and/or process of manufacturing
- organization
- main accounting variables.

II.5.2.5.2 Analysis of the questionnaires

The analysis has interested all the sector studies carried out so far, including also the year 2002. With reference to this year, 202 questionnaires have been examined. Some of these questionnaires have been used to collect information already from 1998, as shown above, and all of them will probably be used in the future.

A thorough analysis of these questionnaires has been made, in order to find the possible physical input (or output) variables that can be used in the elaboration of the Italian PIOT.

The questionnaires are different depending on the category of productive activity they refer to. Their analysis has allowed to highlight number and type of the potentially useful variables. In particular the attention has been concentrated on the frequency and structure of information on raw or semi-finished materials (input variables) but also information on the finished products obtained (output variables) has been considered. Moreover, special attention has been paid to the indications on the measurement units.

The results of the analysis have been fixed in a comprehensive table that examines all the Manufacturing macro-sector and is based on the ATECO91 classification. The following is a translated example of the table, that evidences the scheme used for our collection of meta-information.

ATECO91 activity	Description	Covered by the sector studies	Sector studies code	Input Materials	Unit of measure	Output Materials	Unit of measure	Beginning year
15.13.1	PRODUCTION OF MEAT AND SLAUGHTERING PRODUCTS (EXC. FOWL)	YES	SD05U	D01 Bovines and bovine meats	100 kgs	D33 Half cuts	% revenues	98
						D34 Quarters	% revenues	
				D02 Ovines and ovine meats	100 kgs	D35 Other cuts	% revenues	
				D03 Pigs and pig meats	100 kgs	D36 Precooked or ready to cook food of meat products	% revenues	
				D04 Equines and equine meats	100 kgs	D37 Deep frozen food		
						D38 Meats in gelatin	% revenues	
				D05 Ostriches and ostrich meats	100 kgs	D39 Gourmet meat products	% revenues	
				D06 Birds and rabbits and the like and game meats	100 kgs	D40 Birds and rabbits and the like; game	% revenues	
						D41 Ostriches	% revenues	
				D07 Game	100 kgs	D42 Others	% revenues	
15.20.1	FISH, CRUSTACEANS AND CLAMS CONSERVATION	NO						

The following table summarizes the results, grouping the activities in the same macro-sectors as the sector studies (professions are included in the Services macro-sector), with some reference to the coverage of activities by the sector studies in 2002.

Macro-sector	No. of ATECO91 activities	No. of ATECO91 activities comprised in the sector study	No. of activities for which data on physical inputs are present
MANIFACTURING	379	194	148
COMMERCE	204	141	0
SERVICES	295	145	0
Totale	878	480	148

As can be seen from the table, Services and Commerce prevail, as a consequence of the specific purpose of the sector studies. Unfortunately, for none of these two macro-sectors the surveyed units are requested to report data on physical inputs or outputs.

Indeed, only for the Manufacturing macro-sector are the questionnaires used for collecting information that is useful in relation to material flows accounting. Let us therefore focus our attention on this macro-sector.

The following table summarizes the results for the manufacturing sector.

ATECO Sub-sections	No. of ATECO91 activities	No. of ATECO91 activities comprised in the sector study	No. of activities for which data on physical inputs are present
CA Mining and quarrying of energy producing materials	8	0	0
CB Mining and quarrying, except of energy producing materials	16	9	9
DA Manufacture of food products, beverages and tobacco	48	19	17
DB Manufacture of textiles and textile products	43	30	8
DC Manufacture of textiles and textile products	5	5	1
DD Manufacture of wood and wood products	9	8	1
DE Manufacture of pulp, paper and paper products; publishing and printing	20	10	10
DF Manufacture of coke, refined petroleum products and nuclear fuel	6	0	0
DG Manufacture of chemicals, chemical products and man-made fibres	26	4	4
DH Manufacture of rubber and plastic products	7	5	5
DI Manufacture of other non-metallic mineral products	29	13	13
DJ Manufacture of basic metals and fabricated metal products	46	39	39
DK Manufacture of machinery and equipment n.e.c.	36	35	35
DL Manufacture of electrical and optical equipment	34	4	2
DM Manufacture of transport equipment	20	1	1
DN Manufacturing n.e.c.	26	12	3
Total	379	194	148

On the whole it can be said that the information present in the sector studies has a sufficient level of completeness, so that this source can be seen as a valid input for the construction of a Use table for the Italian economy. In fact, the sector study covers approximately 50% of the activities of the Manufacturing macro-sector and for 148 of the 194 activities considered, there is information at least for the input variables. Nevertheless, it must be underlined that for some activities of the Manufacturing sector the survey does not provide information on the raw material inputs, so that its results will not suffice to cover the macro-sector, but need be integrated with other sources. Moreover, while for the inputs a quantitative expression of numerical type is nearly always present (kg, tons, etc.), for the output variables there is nearly always only an indication of presence (yes/no) or the percentage on the total of the revenues. When information on the volume of products obtained as output is present the measurement is in monetary units. This implies that it will not always be possible to derive unitary input coefficients from the sector studies alone, but linkage with other archives will be required. This can be done, for instance, by using the fiscal codes that identify the units.

II.5.2.6 Destination of energy products

An energy Use table is already being constructed in the framework of National Accounts. It describes the use of energy products by 101 activities, including household consumption. Disaggregated by function (transport, heating, other uses) it contributes to the attribution of air emissions to the activities, done in the framework of the NAMEA.

II.5.2.7 Data on exports by commodity

Foreign trade statistics supply all data necessary on exports by commodity – which are straightforwardly assigned to the producing activities.

II.5.2.8 Imports' Use Matrix

This matrix can be seen as composed by two pieces, reflecting the two-step approach that will be followed in its construction:

- the matrix of imported products going to accumulation, comprising a column for durable goods going to households;
- the matrix of products imported for intermediate use, comprising non-durable goods used in households consumption activities.

The first of these two matrices describes the imports which are directly built in the stocks, the second describes the imports that are further transformed before going either to accumulation or to Nature as Residuals.

The two-steps procedure foreseen, consisting in first splitting total imports by commodity as to determine contextually the columns of the first matrix (stock accumulation) and the totals by commodity for the second (intermediate uses), and then determining the destination by economic activity of intermediate imports, corresponds to the methodology used in the construction of the Italian 1992 MIOT and of subsequent years' NAs, with the variant described in §II.5.2.3 concerning the split of household's demand into durables and non-durables, which can be easily extended to the whole of products from industrial ones.

As far as the first step is concerned, we briefly describe in the next section the premises and ideas that guide the foreseen revision of the tool currently in use at NA.

The subsequent section describes method and results of an elaboration specifically carried out for the purpose of the PIOT on the micro data on import flows, which leads to a matrix of imports by commodity (8-digit NC codes) and by main activity of the importing firm, which is an important input for both the steps described above.

The problems to be solved in this transformation can be thus summarised:

- Identifying the real destination of the goods when these are imported by traders;
- Identifying the real use of the intermediate imported input when this is imported for purposes other than the main production activity of the firm.

The realisation of these operations might require going back to the micro data and linking them with the information present other archives, in order to deal correctly with the data concerning firms that operate in more than one ATECO category.

The second problem is certainly less important when the IO classification is considered rather than the 5-digit ATECO categories, as many firms operate in activities that are similar to one another and therefore end up in the same IO industry.

II.5.2.8.1 Developing a new method for the allocation of imports between intermediate and final uses

A working group has been set up at Istat on the Rest of the World account; one of the aims of the group is the development of a new methodology for the estimation of the matrix of Imports of goods. One of the innovations introduced in the compilation of the 1992 Italian MIOT has been the direct construction of an Import matrix, from which it has been possible to derive, by difference, the matrix of domestic production flows. As already seen, from the methodological point of view two phases can be distinguished in the current way of compiling the Import matrix. In the first phase for each imported good (imports are collected at a detail level of about 10.000 goods) the destination between intermediate and final (consumption, investment and valuables) use has been determined. The allocation by economic destination has been done on the basis of the content of the product, according to knowledge from commodity science. In the second phase the imports destined to intermediate use have been detailed by branch on the basis of the economic activity to which the importing firm belongs according to the "Documento amministrativo unico del Ministero delle Finanze". The shares by economic destination fixed for the compilation of the 1992 Import matrix have subsequently been used to split imports between final and intermediate uses for the years following this benchmark year.

Since an important part of domestic demand is estimated by using the commodity flow method, i.e. by adding to the net resources made available by domestic production (final production minus exports) the imports for final uses, the allocation between final and intermediate uses of imported products plays a crucial role. The relevance of this is even larger in the light of the intensification of production internationalisation and delocalisation processes which has taken place in the last decade.

The objective in the estimation of the new Imports matrix is therefore to determine, as far as possible, the allocation among final and intermediate uses on the basis of the actual use of the products in the economic circuit, rather than on the basis of the characteristics of the commodity. In particular the aim is to analyse whether the purchase from abroad of a good x done by a manufacturing firm whose principal activity is the production of goods of the same kind, should be considered as an input of its production process or rather as a purchase for re-selling the good without further transformation (in this case, this would be a secondary activity of the firm). In the first case, if the good is classified, by the shares of economic destination, as a good not going to intermediate uses, we would have a duplication in final demand calculated by the commodity flow method.

For the analysis of these processes it will be necessary to link and cross-check foreign trade data by commodity and by firm with data from surveys on firms (surveys on Structural Business Statistics and on small firms).

II.5.2.8.2 The construction of the matrix imports' by product (CN8) and by economic activity of the importing enterprise

This section describes the sources of information used and the procedure followed in order to obtain the matrix of the quantities of imported products by kind of product and main economic activity of the importing enterprise (from now on "imports by main activity"), as well as the results obtained.

The sources of information used

To get the "imports by main activity" matrix it is necessary to combine information present in two different registers: the Enterprises Business Register and the Foreign Trade Operators Business Register.

The main problem to be taken into account with reference to the linking of these two registers is the different definition of the statistical unit and of the field of interest of the two registers.

The enterprise is the basic statistical unit of the Enterprises Business Register, in which it is identified on the basis of its fiscal code. The field of interest of the Enterprise Business Register is given by the enterprises belonging to a subset of economic activities, which does not include agriculture and fishing activities and the Public Administration.

The field of interest of the Trade Register is given by commodity trade. The Trade register refers to the foreign trade operator as basic statistical unit, which is identified by the VAT code. A single economic operator can have different VAT codes within the fiscal year according to changes of location of its business headquarter. It is clear that this may cause both an overestimation of the number of foreign trade operators and problems in linking the two Registers.

The Trade Register derives indirectly from the micro data of the foreign trade survey. From a technical point of view this procedure is very easy to carry out. Indeed it is sufficient to sort all the records by the variable "VAT code" and to aggregate information on micro data in order to obtain a single record for each VAT code. Nevertheless this presents some statistic problems. In fact, for some records the VAT code information can be incomplete, so the value and the quantity of the import flows of the operators included in the Trade Register is often lower, for a given NC8 code, than the total imports flow of that code. It is necessary, also, to consider that the origin of the data is a statistical survey whose reference unit is the commodity flow and therefore, all variables are referred to the imported commodities. Any commodity-related variable must be used carefully, according to the new statistical unit used in the Trade Register (the foreign trade operator). In particular, the code of the product-related economic activity (CPA) refers to the imported good (i.e. says which product is take into account) and not necessarily reflects the main economic activity of the importing enterprise, that can be found in the Enterprises Business Register.

The linking key adopted and the information extracted

The fiscal code has been chosen as key to link the two different business register, because this information is more reliable than the VAT code. In general, a one to one relationship occurs between the VAT and the fiscal code, except for the case of a change of location of the business headquarter of enterprises, as said above. Before linking the information of the two registers, the information of different VAT codes within the Trade Register that correspond to a single fiscal code in the Business Register must be added up.

A register's Tributary file joining together the code fiscal and the VAT code has been used to link the two registers.

The information of the two registers has therefore been linked using the fiscal code and merged to obtain a matrix of the quantities of imported products by main economic activities of the importing enterprises.

The information taken from the Foreign Trade Operator Business Register is:

- products imported by every economic operator according to the more disaggregated classification available, the Combined Nomenclature (CN8), in 1997;
- imports value of every operator for each item of CN8 in 1997;
- imports quantity of every operator for each item of CN8 in 1997.

The information taken from the Enterprises Business Register is only the enterprise main economic activity according to the Level 5 of the General Industrial Classification of Economic Activities (NACE Rev.1).

Coverage analysis

It is important to analyse the coverage of the final results in terms of trade values and quantities, as there are reasons to expect that a consistent number of records in both of the two registers do not match. Indeed, the two following different causes of loss of coverage can be highlighted:

1. the incomplete VAT codes present in the Trade register;
2. the different fields of interest of the two registers.

The coverage ratio of the results of the linkage in terms of values and quantities on national imports is high. In fact, in terms of values the coverage ratio of the data processing is 98,2 per cent on national imports values, in terms of quantity the rate is 98,1 per cent.

II.5.3 Residuals

II.5.3.1 Destination of wastes

A Use table for waste can be drawn – with some elaboration – from information on the treatment and recovery operations undergone by the various types of wastes. Indeed, knowledge of the way the waste is dealt with (landfill, incineration, recycling, etc.) is in general sufficient to determine the activity to which the waste is destined.

This kind of information is in general available in the APAT database deriving from MUD questionnaires (see the box in §II.4.3.1). Some waste flows, like for example Municipal waste, are very well known and it is possible to calculate how they are disposed of and where. Another example is given by packaging and packaging waste. The data set also provides overall knowledge on the operative treatment plants in Italy. Nevertheless, the analysis of this data set also shows that some further studies are also necessary, as difficulties are encountered on the attribution of some disposal and recovery operations codes, since the definitions of the various management operations are not always clear and unique.

II.5.3.2 Destination of other residuals

By definition, all air emissions flow to Nature, including those coming from landfills (unless recovered). Materials contained in wastewaters are in part held into the economic system by depuration systems, and destined to agricultural uses or landfilled. Estimates on these flows that can be considered as preliminary inputs for the Use table have been made in the framework of the Italian EW-MFB for 1997.

II.6 Estimation of missing items and "pre-balancing"

II.6.1 The importance of feedbacks and interaction between the various steps

The process foreseen for the final phases of the implementation of the PIOT framework can be stylised into the following two moments:

- utilisation of additional information from logic, scientific knowledge, commodity science, industry material balances and the like for the estimation of possible missing items and the preliminary reconciliation of resources and uses by commodity and of inputs and outputs by industry ("pre-balancing"); the purpose of this step is to obtain matrices ready for the mathematical balancing, in the sense that inputs and outputs are reconciled as far as possible by the application of the above mentioned *a priori* information pieces, which provide useful constraints on the dimensions of the flows relative to each other. A possible secondary output of this step will be an inventory of technical coefficients and physical constants, drawing from and integrating existing technological coefficients' databases, to be used in future MFA applications.
- Final derivation of the Material Integration tables and adaptation/application of the mathematical balancing procedures in use in NA, for the final balancing of the matrices.

It is not possible at this stage of the work to tell how well the data available on the Supply and the Uses of the different materials will match. It is likely, however, that a positive supply will be reported for some materials for which no uses are known, and also that for some other materials total Supply will exceed total known uses. In some other – less frequent – cases, the situation will be the opposite. The estimation of missing data will therefore be an important step. Since this estimation will partly be based on the material balance principle, applied by material or by activity, this estimation can be seen also as a pre-balancing of the tables, to be done before going to mathematical balancing. This pre-balancing should not be independent from the derivation of the Material Integration tables, as it should not be forgotten that

> "trying to derive symmetric input-output tables from supply and use table may reveal inconsistencies and weaknesses in the supply and use tables. In this respect there is therefore also a feedback from the symmetric input-output tables to the supply and use tables" (ESA 1995, §9.08, see, Eurostat, 1996a, p.209).

Indeed, the aggregation of flows by activity provides additional constraints that can help completing or ameliorating the picture. Therefore it is important to stress that the estimation of missing items and the derivation of the Material Integration table should not be looked at as self-contained and separate steps, but rather as interacting ones, with continuous feedbacks. Not even the final mathematical balancing can be considered as a completely separate step: the setting the admissible variation of each flow's estimate from the initial one, will require that the knowledge acquired from the previous steps be used; the way the starting values have been obtained must therefore be kept in mind until the end of the construction process of the tables.

II.6.2 Additional information from logic, scientific knowledge, commodity science, industry material balances and use of technical coefficients and physical constants for estimation of missing items and pre-balancing

Given the incomplete coverage of the economic activities provided by the information sources described in the previous chapters, it will be necessary to integrate in our study of material flows inside the economy the a-priori quali-quantitative information provided by the natural sciences and by the knowledge of production technologies. Indeed, there are many exact and necessary relationships between different inputs, between inputs and outputs, and between different outputs,

whose knowledge can be exploited to determine aggregates that would otherwise remain unknown. One important condition for using this knowledge is that the total quantity of products available for domestic use is known, so that the problem is in most case reduced to that of determining its destination. For this, the use of qualitative information is often sufficient, as the use of certain products is exclusive of some activity. One example in this line is that of building materials, which are used, by definition, in construction works.

The first tool that science makes available is the same that is at the basis of the very possibility of balancing the tables: the law of matter conservation, or 1st law of thermodynamics. Materials are never destroyed or created, but always transformed, and this gives the mass balance principle: the total outputs of a well-defined system are equal to the total inputs minus the change in stocks. This means that whatever comes into a system is either accumulated into the system itself or given back to the surrounding environment, and if no input flow exists, outputs can derive only from the reduction of stocks accumulated in the past. In a formula: $I=O+\Delta S$. This formula can be applied to whatever subsystem or process whose material balance is incomplete, in order to find an unknown quantity, provided the other two are known with reasonable certainty.

Moreover, this is also valid for the individual chemical elements entering the processes and reactions. Knowledge on chemical composition of materials and elements' weights can therefore also be used in connection with it, e.g. to calculate the weight of the oxygen demanded for burning a given quantity of methane.

Of course, if there is uncertainty attached to the known quantities, this is transferred to the one derived this way, which must be made smaller if a subtracted quantity is made bigger and vice versa.

An example of the use of technical coefficients for the calculation of otherwise unknown quantities of flowing materials is that of the CORINAIR system of air emission estimation, which provides official figures on countries' emissions for use in the international arena. The following two sub-paragraphs provide two further examples of possible knowledge inputs to pre-balancing.

II.6.2.1 The Technology Database of EPIS

The European Environmental Pressure Information System (EPIS)[20] is an attempt to put into practice the idea that knowledge on the technologies used in the economy should systematically be exploited in order to calculate the pressures on the natural environment generated in the production and use of goods and services.

The Technology Database (TD) has been developed at the Institute for Technology Assessment and Systems Analysis of the Research Centre Karlsruhe as part of the so-called PRODCOM module of EPIS; it provides a complete technical description of a number of industrial production processes, identified by their main products, to which the appropriate PRODCOM codes are attached. Unitary factors quantified in physical units are given for the inputs (including energy) and outputs (including Residuals) involved in these processes, expressing the quantities that is necessary to use or co-produce in order to obtain one unit of main product; in other words, the TD gives the whole material/energy balance of the production process from which the product considered arises, expressed in terms of units (of energy input, of wastewater, and so on) per product unit[21].

One important feature is that these coefficients derive directly from knowledge of the production techniques. The coverage of products and activities provided, however, is quite limited, as can be

[20] See, among others, Bombana et al. (1997)

[21] In at least one case, however, the factors are expressed per unit of an important input, from which many co-products stem at once.

seen from the table, reported below from the final report to Eurostat of the Research Centre Karlsruhe.

A warning that should be kept in mind when considering the possibilities of application of the TD and similar coefficients' databases for our purposes is the fact that in some cases the production process described for a given product is not the one in use in Italy. The TD factors are indeed often explicitly related to the technologies in use in a specific country and calculated on the basis of that country's data. Even if the resulting product as such is exactly the same, however, technologies of production might be country-specific. This is the case, for instance, in glass production and primary non ferrous metal production. Another example is that of pulp paper production, for which the only process described in the TD is the Kraft process, which is not relevant for Italy; the use of PRODCOM data on paper production along with the factors given by the TD for this product could then be misleading[22].

One interesting thing we learn from the TD thanks to the completeness of its material balances, is that joint production is quite a frequent phenomenon. Indeed, there often are, next to the main output of a production process and to its unwanted residues, useful by-products which are also marketed. Also this should be considered when applying coefficients for calculating inputs from known outputs, since a duplication of inputs could follow from product being at the same time the main output of a process and the by-product of another process.

[22] See also Tudini (ed.), 2001, p.49.

Coefficients present in the Technology Database of EPIS

NACE	NACE/PRODCOM description	INPUT COEFFICIENTS					OUTPUT COEFFICIENTS																														Countries
PRODCOM		Raw materials PROD-COM	Operating sustances PROD-COM	Energy demand	Process water	Cooling water	Product	By-products	Air emissions	Process water	Cooling water	Process wastes name*) EWC	CO_2	SO_2	NO_X	NH_3	NMV	N_2O	CH_4	SPM	Chl. comp.	PAH	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Solvents	BOD	COD	Tot P	Tot N	
101	Mining of hard coal			#	#	0	#	#	#	#	0	#	0	0	0	0	0	0	–	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0		T
102	Mining and agglomeration of lignite			#	–	0	#	0			0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0		T
151	Production and processing of meat																																				
	Slaughtering of cattle	#	–	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
	Production and preserving of meat - beef and sausage production	#	–	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	–	–	T
154	Mnf of vegetable and animal oils																																				
	Production of crude vegetable oil by extraction (e.g. soya-bean oil)	#	#	#	–	#	#	#	0	–	#	0	0	0	0	0	0	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	–	#	v	–	T
	Refinery of crude vegetable oil (e.g. soya.bean oil)	#	#	–	–	–	#	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	#	–	–	T
155	Manufacture of dairy products																																				
	Production of cheese suitable for slicing	#	0	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
156	Mnf of grain mill prod, starches																																				
	Production of potato starch	#	0	#	#	0	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
	Production of wheat starch	#	0	#	#	0	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
1583	Mnf of sugar	#	0	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
1592	Mnf of ethanol	#	0	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
1593	Mnf of wine	#	0	0	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
15961000	Beer	#	0	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
171	Prep and spinning of textile fibres																																				
	Wool washing	#	#	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
191	Tanning and dressing of leather	#	#	#	#	0	#	#	0	#	0	#	0	0	0	0	0	0		0	0	0	0	0	0	#	#	0	0	0	0		#	#	#	#	T
2111	Manufacture of pulp	#	#	#	#	#	#	#	#	#	#	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
231	Manufacture of coke oven products	#	0	#	#	–	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	0	0	0	0	0	0	0	0	0	0	#	#	#	#	T
232	Mnf of refined petroleum products	#	0	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	–	#	#	#	#	#	#	~	#	#	#	#	#	#	T
24131111	Chlorine	#	#	#	#	#	#	#	#	#	#	0	0	0	0	0	0	0	0	#	0	0	0	0	0	0	0	#	0	0	0	0	#	#	–	–	T
24131413	Hydrogen Chloride (direct synthesis)																																				
	Chlorine and hydrogen	#	–	–	–	–	#	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	T
	NaCl and sulphuric acid	#	–	#	–	–	#	#	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	T
24131433	Sulphuric acid																																				
	From sulphur	#	–	#	#	#	#	0	#	–	–	–	0	#	–	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
	Spent acid	#	–	#	–	–	#	0	–	#	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	T
24151050	Nitric acid	#	#	#	#	#	#	#	#	–	#	–	0	0	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
24151075	Ammonium, water free	#	–	#	#	–	#	#	#	#	–	0	#	#	#	#	0	#	0	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
24153013	Urea, > 45 % by weight of nitrogen on dry weight of anhydrous product	#	#	#	–	–	#	#	#	#	#	0	0	0	0	#	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24121150	Titanium dioxide	#	0	#	0	0	#	#	#	#	0	#	0	#	#	0	#	0	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
24131525	Sodium-hydroxide, solid (same as chlorine except water evapomtion)	#	#	#	#	#	#	#	#	–	#	#	0	0	0	0	0	0	0	0	#	0	0	0	0	0	0	0	#	0	0	0	0	#	#	~		T
24133310	Di-sodium carbonate, dust	#	#	#	#	#	#	0	#	#	#	#	0	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
24141130	Ethylene	#	–	#	#	–	#	#	#	–	–	–	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24141140	Propylene	#	–	#	–	#	#	#	#	–	–	0	#	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24141165	1, 3-Butadiene	#	#	#	–	#	#	#	#	–	–	–	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24141223	Benzene	#	–	#	–	#	#	#	#	–	–	–	0	#	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24146373	Ethylenoxide	#	#	#	–	–	#	#	#	#	–	–	#	0	#	0	#	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24146111	Formaldehyde (BAYER process)	#	#	#	#	#	#	#	#	#	#	–	0	#	#	#	#	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24141250	Styrene	#	#	#	#	–	#	#	#	–	–	–	0	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24141371	Vinylchlorid	#	–	#	#	#	#	#	#	#	#	#	0	0	#	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T

Coefficients present in the technology database of EPIS - *continued*

NACE	NACE/PRODCOM description	INPUT COEFFICIENTS					OUTPUT COEFFICIENTS																															Countries
PRODCOM		Raw materials PROD-COM	Operating sustances PROD-COM	Energy demand	Process water	Cooling water	Product	By-pro-ducts	Air emissi ons	Process water	Cooling water	Process wastes* EWC	CO_2	SO_2	NO_X	NH_3	NMV	N_2O	CH_4	SPM	Chl. comp.	PAH	Ag	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sol-vents	BOD	COD	Tot P	Tot N	
2416	Mnf of polyethylen																																					
	HDPE	#	#	#	–	–	#	#	#	–	–	#	0	0	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
	LDPE	#	#	#	–	–	#	#	#	–	–	#	0	0	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
24143385	Adipic acid	#	#	#	#	–	#	#	#	–	–	0	0	0	#	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
2416513	Mnf. of polypropy lene	#	#	#	–	–	#	#	#	–	–	0	0	0	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	T
2613	Mnf. of hollow glass	#	#	#	0	0	#	#	#	#	0	#	#	#	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	#	0	0	0	0	0	T
262	Manufacture of ceramic goods																																					
	Tableware and kitc henware	#	#	#	#	0	#	0	#	#	0	0	#	#	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
	Ceramic sinks etc. of china p.	#	#	#	#	0	#	0	#	0	0	#	#	#	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
264	Mnf of bricks etc. in baked clay	#	#	#	0	0	#	#	#	0	0	0	#	#	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
26510	Manufacture of cement	#	#	#	0	0	#	#	#	0	0	#	–	#	#	0	0	0	0	#	#	0	0	#	#	0	0	#	#	#	#	0	0	0	0	0	T
271020	Liquid non alloy steel, for casting																																					
	Blast furnace process	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	0	0	#	#	#	0	0	#	#	#	#	#	#	#	#	0	0	#	0	#	T
	Electric arc furnace process	#	#	#	0	0	#	#	#	0	0	#	#	#	#	0	0	0	0	#	#	0	0	#	#	#	#	#	#	#	#	0	0	0	0	0	T
	Basic oxygen furnace process	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	0	0	0	#	#	#	0	#	#	#	#	#	–	#	#	0	0	0	0	0	T
27106010	Concrete reinforcing bars																																					
27220	Manufacture of steel tubes																																					
	Hot rolling	#	#	#	#	#	#	#	#	#	#	#	0	0	0	0	#	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
27210	Manufacture of cast iron tubes																																					
	Blast furnace process	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	0	#	#	#	#	0	0	#	#	#	#	#	#	#	#	0	0	#	0	#	T
2731-4	Cold drawing, rolling & forming																																				T	
	Cold rolling	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	#	0	0	#	#	0	0	0	0	0	#	0	0	#	0	0	0	0	0	0	T
	Cold rolling, electrol. coating	#	#	#	#	0	#	#	#	#	0	#	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
27351200	Ferro-chromium	#	0	#	–	–	#	#	#	#	#	#	0	#	0	0	0	0	0	0	0	0	0	0	0	#	0	0	#	0	#	0	0	0	0	0	T
27351300	Ferro-nickel	#	–	#	0	0	#	#	#	0	0	#	0	#	#	0	0	0	0	0	#	0	0	0	0	0	0	0	#	0	0	0	0	0	0	0	T
27352013	Ferro-silicon	#	#	#	0	0	#	#	#	0	0	#	0	#	0	0	0	0	0	#	0	0	0	0	0	#	0	0	0	#	#	0	0	0	0	0	T
27421130	Aluminium in raw form	#	#	#	#	0	#	#	#	#	0	#	#	#	#	0	0	0	0	#	0	#	0	0	#	0	0	0	#	0	#	0	0	0	0	0	T
27421155	Secondary aluminium																																					
	Refiner	#	#	#	0	–	#	#	#	0	–	#	#	0	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
	Remelter	#	#	#	0	0	#	#	#	0	0	#	#	0	#	0	0	0	0	#	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
27421200	Aluminiumoxide	#	#	#	#	–	#	#	#	#	–	#	#	#	#	#	0	#	#	#	0	0	0	0	0	0	0	0	0	0	0	0	#	#	0	0	T
274313–19	Lead																																					
	Primary lead	#	#	#	0	0	#	#	#	0	0	#	0	#	0	0	0	0	0	#	0	0	0	#	#		#	#	0	#	#	0	0	0	0	0	T
	Secondary lead	#	–	#	0	–	#	#	#	–	–	#	0	#	0	0	0	0	0	#	0	0	0	#	#	0	#	#	0	#	#	0	0	0	0	0	T
2743123–5	Zinc	#	–	#	–	–	#	#	#	–	#	#	0	#	0	0	0	0	0	#	0	0	0	#	#	0	0	#	0	#	#	0	0	0	0	#	T
274411–26	Copper	#	#	#	#	–	#	#	#	#	–	#	#	#	#	0	#	0	0	#	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	T
40101051	Conventional thermal electricity– CHP plants/fossil fuels, biomasss or wastes	#	#	0	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	0	#	#	#	#	T, AU, S, SF, ES
40101052	Conventional thermal electricity– non CHP plants/Fossil fuels, biomass or wastes	#	#	0	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#		#	#		#	#	#	#	#	#	#	#	0	#	#	#	#	T, AU, S, SF, ES
40301030	Heat-Heating plants/fossil fuels, biomass or waste, sold to third parties	#	#	0	#	0	#	#	#	0	0	#	#	#	#	#	#	#	#		#	#		#	#	#	#	#	#	#	#	0	0	0	0	0	T, AU, S, SF, ES
40301070	Heat-CHP plants/Combined Heat and Power plants	#	#	0	#	0	#	#	#	0	0	#	#	#	#	#	#	#	#		#	#		#	#	#	#	#	#	#	#	0	#	#	#	#	T, AU, S, SF, ES

*) Waste specification to be given by their actual names and EWC

Coefficients: # produced; 0 not relevant; - no information available

II.6.2.2 APAT Sector Studies

The Italian National Agency for Environmental Protection and Technical Services (APAT, formerly ANPA) has produced several sector studies in order to validate and integrate the estimates it produces of the waste generated in Italy by the various economic activities, starting from specific analyses of the main processes. Let consider here to some of the publications containing these studies.

The following activities are covered in ANPA, 1999b:

- Manufacture of food products and beverages (NACE division 15)
- Manufacture of textiles (NACE division 17)
- Tanning and dressing of leather (NACE group 19.1)
- Manufacture of refined petroleum (NACE group 23.2)
- Manufacture of other inorganic basic chemicals (NACE class 24.13)
- Manufacture of other organic basic chemicals (NACE class 24.14)
- Manufacture of plastics in primary forms (NACE class 24.16)
- Manufacture of basic metals (NACE division 27)
- Production and distribution of electricity (NACE group 40.1).

Most of these studies are based on the reconstruction of the material balance of the activities, and may immediately supply information inputs for the integration of the Use table. Even when this is not the case, flow charts and descriptions of the production processes, as well as lists of their inputs and outputs – though without a quantification of the respective proportions – are provided, so that the studies can be at least be used as a starting point for the reconstruction of the material balance.

Another publication specifically deals with the chain of production activities that serve the motor vehicles industry, providing information (tough not material balances), in addition to some already present in the list above, on the following activities (ANPA, 2002a):

- Manufacture of dyes and pigments (NACE class 24.12)
- Manufacture of synthetic rubber in primary forms (NACE class 24.17)
- Manufacture of paints, varnishes and similar coatings, printing ink and mastics (NACE group 24.3)
- Manufacture of rubber tyres and tubes (NACE class 25.11)
- Manufacture of other rubber products (NACE class 25.13)
- Manufacture of plastic plates, sheets, tubes and profiles (NACE class 25.21)
- Manufacture of flat glass (NACE class 26.11)
- Shaping and processing of flat glass (NACE class 26.12)
- Manufacture of hollow glass (NACE class 26.13)
- Pressing and stamping of steel (ATECO categories 28.40.2 and 28.40.3)
- Manufacture of bearings, gears, gearing and driving elements (NACE class 29.14)
- Manufacture of motor vehicles, trailers and semi-trailers (NACE division 34)

For a minority of these activities, however, the information is said to be insufficient, and as far as the step of production of components is concerned "it is not clearly foreseeable with mass balances or estimates, due to the multiplicity of technologies involved" (p. 79).

The results for waste generation of some other studies are contained in ANPA, 2002b, referring to the following additional activities:

- Manufacture of pulp, paper and paperboard (NACE group 21.1)
- Treatment and coating of metals (NACE class 28.51)
- Manufacture of ceramic tiles and flags (NACE group 26.3)

An important feature that the studies considered here share with the Technology Database is that, besides products and activities, they introduce a further dimension in the analysis, that of processes, whose relation with the former two needs clarification case by case (on this, see also Bombana et al., 1997).

II.7 Derivation of the Material Integration tables and final balancing

II.7.1 Total flows

After compiling detailed and as far as possible complete Supply and Use Tables, also with the help of the estimation of missing items and pre-balancing, it will be possible to derive the Material Integration tables. This will require combining the information contained in those tables, as well as additional data elaborations.

II.7.1.1 A summary picture

The following table represents in broad terms the structure of the table – the same as that of the German PIOT – and the expected relationship between the PSUTs and the PIOT:

<table>
<tr><th></th><th>Production activities</th><th>Households non-durable</th><th>Useful Stocks</th><th>Landfills</th><th>Nature</th><th>Rest of the World</th></tr>
<tr><td>Production activities</td><td>USE TABLE
Products
(plus ad hoc elaborations for Residuals flowing into production activities)</td><td colspan="2" rowspan="2">USE TABLE
Products</td><td rowspan="4">Ad hoc elaborations on the waste database and on the SUPPLY and USE TABLES Residuals</td><td rowspan="3">SUPPLY TABLE Residuals</td><td>USE TABLE
(Exports)</td></tr>
<tr><td>Households non-durable</td><td>ad hoc elaborations for Residuals flowing into production activities</td><td></td></tr>
<tr><td>Useful Stocks</td><td>ad hoc elaborations for Residuals from Stocks flowing into production activities</td><td></td><td></td><td></td></tr>
<tr><td>Landfills</td><td></td><td></td><td></td><td></td><td>SUPPLY TABLE Residuals</td><td></td></tr>
<tr><td>Nature</td><td>USE TABLE
Natural Resources</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rest of the World</td><td>SUPPLY TABLE
(Imports of similar products)</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

As can be seen, the relationship is not a very complex one. The most complicated case is that of Residuals used for production or otherwise dealt with by economic activities, which will require the *ad hoc* elaborations discussed in §II.7.1.4.

The explicit inclusion in this figure of a row and column entitled to Households has the purpose of highlighting a specific feature of the PIOT, i.e. that of allowing to see how Households, after receiving Products (which is all that is shown in a MIOT), transform them into Residuals – precisely, the non-durables part of their purchases has to come out of the economic system as waste, wastewater or air emissions.

II.7.1.2 Flows of Natural Resources

By definition all flows of Natural Resources have Natural stocks as source and economic activities as users. The data on these flow to be included in the Material Integration table can be found in the corresponding part of the Use table.

II.7.1.3 Flows of Products

Products flow within the domestic economy (intermediate and final uses), between this and the Rest of the World (imports and exports) and from the domestic economy to the natural environment (dissipative uses and losses, according to EW-MFB terminology; even though in the SEEA these flows are considered as of Residuals, we consider it necessary to classify them as Products even when they leave the economy, as otherwise the identity total supply = total uses would not hold for them).

To the extent that Products are the output of a single activity each, the Supply table is important only as key for the aggregation of the Products in the homogeneous branches, and the description of the use of Products (by production activities, households and useful stocks) can be derived from the Use matrix alone. The intermediate flows block coincides with the matrix of flows of Products to production activities but for the flows of Residuals used in production activities, especially waste, discussed in the following.

II.7.1.4 Flows of Residuals

II.7.1.4.1 Managed waste flows

As far as the data are concerned, a deeper analysis of waste flows is necessary to tell at the same time where they come from and where they flow to, since some kinds of waste can be generated by several activities and/or used by several others. In particular, a specific study has to be carried out for the economic activities of NACE divisions 37 (recovery and treatment for recycling), 27 (production of metals and their alloys) and 90 (disposal of solid waste, and wastewater). Indeed, a great part of the raw materials used in these activities or otherwise flowing into them is waste. From the MUD dataset (see §II.4.3.1) it is possible to calculate the quantity of waste reintroduced in the economic cycle. From the dataset both the amount of waste coming from other activities and the waste generated by these activities can be calculated.

As far as the representation of managed waste (and managed Residual in general) flows in a PIOT is concerned, the fact that they are not Products in SNA's sense, yet they are used by economic activities, requires that the representation issue be specifically dealt with.

Attention must be paid first of all to the fact that two different kinds of material flows going into waste management activities can be distinguished:

- flows of materials that are the "working object" of the activity (the waste collected);
- additional flows of materials that are necessary for carrying out the activity's operations (e.g. the fuel consumed by the lorries).

Flows of the first kind are not paid for, and do not constitute a cost of production as intermediate inputs in SNA's sense. Therefore, coherence with the MIOT would require that only the second kind of flows be included in the intermediate flows part of the Material Integration Table.

Nevertheless, these Residuals, especially waste, physically flow from one activity to the other and need therefore be recorded somewhere in the PIOT in order to keep the balance between inputs and outputs.

A reference for solving the problem is provided by the fact that the above distinction between two different kinds of flows is in practice applied in NA to many activities which produce services. This is the case of transport, trade and repair activities. For instance a car repair activity does not have the cars coming in and out of the business premises as inputs nor as outputs. Almost all goods sold to final and intermediate users go through trade and transport, but this notwithstanding the same goods are recorded as if directly delivered to the users by the producing activity, even if the traders pay for them and the transporters move them around, as the output of these activities is given by their margins only, and not by the whole value of the good to the purchaser[23]. If we were to apply rigidly this rule, then we should attribute to the activity generating the waste all the outputs to the environment and/or the increases of landfill stock generated by their disposal, while the waste management activity would only have the second kind of materials as inputs.

This kind of treatment would have the merit of showing the structure of the material inputs to waste management in a way fully comparable to that of the MIOT, as only items to which a production cost corresponds would be included in this activity's column. However, it would hide the specific role of waste management in material cycles, and in particular the fact that some wastes are heavily transformed in waste management activities. Showing this is of primary importance for an accounting in physical terms that aims at being meaningful from an environmental perspective. For example, it would not be very informative if we attributed the air emissions that correspond to the incineration of some waste to the activity that generates the waste, because we would thus mix these air emissions with the ones directly generated by the activity itself. The generation of the air emissions due to incineration would in fact appear as a direct consequence of a productive process who in reality directly generates waste, while only a decision taken in the waste management activity makes a waste that can *a priori* be treated in several different ways end up in the atmosphere. Therefore we deem it important to distinguish the waste that is not transformed – even if it is brought to a landfill by an economic unit different from the one that generates it – from the waste that is actually transformed in the waste management activities, i.e. transformed to a sufficient extent for the output of its management to be considered a physically different material from the initial waste. Therefore, we will aim at further distinguishing the first kind of flow in two parts, the one transformed by the "waste management services" which will be shown as going through this activity, and the non-transformed one, which will be recorded directly in the "controlled landfills" column, consistently with the general treatment of transport and trade in the IO framework of NA.

Moreover, it can be observed that the taking in charge of waste is the very service that waste management activities sell to the other activities, as the unusual relationship between the flow of money and that of matter proves: contrary to what happens in all other cases, matter flows in the same direction as money[24]. This suggests that the treatment which most guarantees comparability with the MIOT is one where the transformed waste is recorded as negative material output in the row of waste management, rather than as a positive input in its column, where it would bias the representation of the structure of the current material inputs of the activity. This solution therefore allows not only to see that the waste goes through the waste management sector but also to maintain

[23] If this was not the case, we would not have a IOT, but rather two input columns and two output rows, with several duplications in each of them.

[24] Custody services could seem to be another exception, but it can be said that no material flow takes place in that case, as the goods usually go back to the unit that pays for the service.

the meaning of the intermediate flows matrix as the material counterpart of current production costs[25].

Waste going to non-controlled landfills, even if dealt by waste management activities, is an output to the Natural environment.

II.7.1.4.2 Other Residuals

Most of the Residuals flow to Nature. The supply table tells which activities are directly responsible for air emissions. Emissions to water are like managed waste when going to depuration. The materials contained into waters that are not collected but discharged directly into the environment, as well as other non-managed waste will have to be calculated as difference between total and managed quantities.

Residuals other than waste that flow within the domestic economy are of minor importance, except for the case of farmyard manure, which goes from animal farming to agriculture and is spread to the soil. Manure is not always delivered free of charge, however, but often paid for, as it is a valuable input for agriculture. It is therefore correct to deal with it as with a product. This flow thus will appear as intermediate input from animal farming to agriculture and then from agriculture to the soil.

The same kind of reasoning as for waste should be applied to the other possible cases of use by some activity of the Residuals generated by some other, when no positive price is paid for the material by the activity that uses it.

II.7.2 Nature in the PIOT

The German PIOT deals with Nature using the categories of National Accounts that apply to it. As NA has not been developed to deal with Nature, however, there just seems to be one category for it: "Non produced natural assets". This implies compressing all information on flows from and to Nature into a row and a column. Of course more detailed information is contained in the Supply and Use tables. However, it might be difficult for the non-specialist, to perceive from this table the importance of the environmental pressures connected to the use of Nature as Resource provider and as sink for emissions, and to figure the new analyses on the interaction of the economic and natural systems that the PIOT makes possible. The Danish PIOT does not have SUTs, but includes in the PIOT more detailed information on the type of Residuals which flow into the environment.

We deem it interesting to include some information on which are the natural "activities" that supply resources and receive residuals in the PIOT properly said. In particular, both the flows of Resources from Nature and the flows of Residuals to Nature can be aggregated according to the natural body they come from or go to. This is the way prof. Nebbia deals with Nature in his table, by dividing it into Soil, Water, Air, and Natural Stocks. We will adopt this approach, making sure to apply it consistently with the concept of "Non produced natural assets" - i.e. that the natural bodies define a complete and exhaustive partition of these assets - for the reason that it allows to show in the same table how the flows regarding the individual natural bodies are not in a balance, partly because of the accumulation of materials in the economy, partly because something taken from a body is returned to another, reducing the availability of the Resources of the former and changing the composition of the latter (the most immediate example is that of fossil fuels transformed into air pollutants).

[25] The j-th cell of the waste management row thus contains the balance between the waste absorbed for transformation by activity j and waste given by the same activity to waste management for transformation; by adding to the absolute value of this balance the quantity sent to landfills, it will be possible to see how much more waste activity j generates than uses.

II.7.3 Sub-tables

The Material Integration tables are potentially as many as the ways in which the materials can be classified. The most relevant classifications referred to so far are by origin of the material (domestic or foreign) and by type of material (Natural Resources, Products, Residuals). These are the classifications used e.g. in the German PIOT system, and by using them it is possible to provide interesting details that are hidden in the most aggregate Materials Integration table, the one that refers to total flows, including all flows irrespective of the origin and type of materials.

As far as the origin is concerned, this total flows matrix can be split – as usual in NA – into the matrices of domestic and import flows. This split concerns only Products, but for some minor import/export flows of Residuals. It is clearly sufficient to determine one of these two component, since, given the totals, the other component must be equal to the difference. The component we aim at constructing is that of import flows. Nevertheless, to the extent that information total and domestic flows can be estimated independently, the additional information that their estimates incorporate should also be exploited for better balancing. E.g., surveys on the use of products give the total quantities used, while statistics on sales of domestic production and imports give figures independently obtained for domestic and imported quantities. The constraint given by the fact that the sum of the latter two items must be equal to the former total should be implemented in the balancing procedures, so that an adjustment of the less reliable figure can follow.

Among the tables by type of material, those referring to Residuals allow to see how these are used by the recycling or waste management industries, and finally disposed of into the natural environment. However, it is not possible to see from these tables e.g. how much of the Residual matter used by recycling is actually transformed into Products.

Indeed, a feature of these two types of partial tables is that, taken individually, they are not balanced (i.e. the row-totals do not equal the corresponding column-totals also for activities and not just for stocks), as the outputs of one of them are often inputs of another. E.g. something that comes in as a product in an activity does not appear in the Residuals table that contains the waste derived from it, so that the column of that activity has a lower total than the corresponding row.

One distinguishing feature of PIOTs, however, should be exactly that of showing how the materials are transformed into one another. One possible exercise that would add further value to the data in the derivation of Material Integration tables, is that of applying not just a "direct" classification of materials but also an "indirect" one, i.e. of constructing tables whose scope is defined by an homogeneous physical nature of the materials at a certain stage of the economic cycle (say, at the entry in the economic system), and which track the fate of those materials (say, all biomasses) through the subsequent stages of their usage and transformation, until they become Residuals. Thus, we would not just be able to tell separately, e.g., how biomasses are formed in agriculture from Natural Resources, and how Residuals are given back to Nature or recycled, but also how biomasses are transformed into Residuals after becoming Products of the food industry and non-durable consumption goods used by households. The embryo of one such exercise can be seen in the construction of material balances by kind of raw material, tried in the EW-MFB of Italy, 1997.

II.7.4 Mathematical balancing

The last step in the implementation of the PIOT framework will be the mathematical balancing of the tables, integrated and organised as described in the previous chapters and paragraphs.

The mathematical procedure to be used is the Stone-Champernowne-Meade one, based on least squares, which will be adapted for the specific needs of the PIOT.

As far as the Material Integration Table is concerned, it is mainly production activities and households' non-durables consumption that are interested by the procedure, as the other "activities" featuring in the table represent the Rest of the World and man-made and natural stocks, whose accumulation/depletion reported in the table is typically not null. However, it must be kept in mind that the overall unbalance of natural stocks (not present in monetary tables) must be equal in absolute terms, and have different sign, to the overall unbalance of manmade stocks and foreign trade. This unbalance expresses the net direct result on Nature, in terms of changes in material stocks, of all economic activities carried out by the domestic activities. The analysis of its composition between air, waters and soil, will also provide interesting information.

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