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Methods and Practical Experiences in Compiling the IIP (Norbert Herbel)

Preliminary Remarks

This paper covers the essential aspects of compiling the Index of Industrial Production (IIP). The main focus lies on the discussion of practical elements, with special regard to the sectors in which productivity is relevant for describing the business cycle. The paper is accompanied by a PowerPoint file referring to all details of this paper.

The fundamentals are the "International Recommendations for the Index of Industrial Production 2010" of the United Nations Department of Economic and Social Affairs Statistics Division (Statistical papers Series F No. 107), where all aspects of the IIP are extensively described and where a lot of examples can be found.

For the calculation of the IIP, appropriate branch- and product classifications are necessary. According to the UN recommendations, the following presentation uses ISIC Rev. 4 as branch- and CPC Ver. 2 as product classifications.

1. National Accounts

Let us first have a look at the National Accounts (NA). The National Accounts is the main tool for assessing the economic situation of an economy. National Accounts are an indispensable set of tools for economic monitoring. They provide a comprehensive quantitative picture of economic development. National Accounts consist of domestic product calculation, input-output accounts, national wealth accounts, employment accounts, labour volume accounts, and financial accounts.

National Accounts are the basis for the Gross Domestic Product (GDP) which is internationally used as a central aggregate to measure economic performance. The GDP has proven useful especially for short-term economic analyses. The rate of change of the real

GDP is what is generally referred to as economic growth. The GDP provides the most important signal parameter to assess the current short-term economic situation.

National Accounts

GERMANY

Gross value added by industries

Industry	2011	2012	2013
current prices, Euro billion			
Agriculture, forestry and fishing	18.46	19.98	19.27
Industry, excluding construction	607.80	616.94	625.48
including: Manufacturing	529.79	534.36	535.18
Construction	109.18	111.32	115.80
Trade, transport, accommodation and food services	339.09	347.48	355.55
Information and communication	94.66	96.02	96.52
Financial and insurance services	101.47	94.42	98.55
Real estate activities	283.15	289.29	298.59
Business services	253.94	264.51	281.12
Public services, education, health	421.87	438.11	450.75
Other serivces	105.27	108.72	112.35
Total	2,334.89	2,386.79	2,453.98
price adjusted, chain-linked index (2005=100)			
Agriculture, forestry and fishing	93.98	95.51	95.32
Industry, excluding construction	112.82	112.32	112.32

Source: Federal Statistical Office Germany

2. Industrial Production Index

The most important sector of NA is the manufacturing industry. The Industrial Production Index (IIP) is used to describe the development of this sector and should represent the value added in real terms (GDP in National Accounts). With the rates of change of the IIP, it is possible to estimate the GDP at the current business cycle. Therefore, the aim of the IIP is to measure the real value added (by eliminating the inflationary price changes). In Germany, the value added is calculated with the annual Cost Structure Survey. This data source provides results approximately two years after the end of a reporting year – at the moment we obtained the data for 2011. From 2012 onwards, there is no information on value added available.

Here, the IIP is used as an estimator. It is assumed that there exists a constant relation between the value added and the gross production value of a branch – at least on the short-term. In this case, it is possible to use information from a monthly production survey for updating the value added up to the current edge.

National Accounts only provide data for the industry as a whole. The IIP is much more detailed – thus precise information about the current economic situation of branches results from IIP.

ISIC Rev.4

(International Standard Industrial Classification of All Economic Activities, Rev.4)

- A - Agriculture, forestry and fishing
- B - Mining and quarrying
- C - Manufacturing
- D - Electricity, gas, steam and air conditioning supply
- E - Water supply; sewerage, waste management and remediation activities
- F - Construction
- G - Wholesale and retail trade; repair of motor vehicles and motorcycles
- H - Transportation and storage
- I - Accommodation and food service activities
- J - Information and communication
- K - Financial and insurance activities
- L - Real estate activities
- M - Professional, scientific and technical activities
- N - Administrative and support service activities
- O - Public administration and defence; compulsory social security
- P - Education
- Q - Human health and social work activities
- R - Arts, entertainment and recreation
- S - Other service activities
- T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
- U - Activities of extraterritorial organizations and bodies

Analysing the current business cycle meanwhile is the most important task of the IIP.

3. IIP – from Output to Input…

Let us consider a simple number

86.5

At first, we notice the absence of any dimension (e.g. tons, square meters, pieces as physical measurement units, or Euro, Ruble, Dollar as value-based measurement unit, or a combination of both such as Euro/ton, Ruble/piece etc.) This means that the number above is dimensionless. Secondly, we observe the absence of any chronological assignment – is it a monthly-related number or a quarterly result? In our practical example, it is a monthly result, namely for December 2013.

To further assess this data, we need to know the corresponding reference value; in index calculation this is normally the monthly average of this variable in the base year, e.g. 2010=100. Now we know that the sample number shows that the result for this special month is 13.5 % below the level of the base year 2010.

Finally, it is important to know what the analysed number should represent. In our example, it is the IIP for the branch 2812 manufacture of fluid power equipment (according to the categories of ISIC Rev. 4).

ISIC Rev.4 code 2812

Structure

Hierarchy

- Section: C - Manufacturing
- Division: 28 - Manufacture of machinery and equipment n.e.c.
- Group: 281 - Manufacture of general-purpose machinery
- **Class: 2812 - Manufacture of fluid power equipment**

Explanatory note

This class includes:
- manufacture of hydraulic and pneumatic components (including hydraulic pumps, hydraulic motors, hydraulic and pneumatic cylinders, hydraulic and pneumatic valves, hydraulic and pneumatic hose and fittings)
- manufacture of air preparation equipment for use in pneumatic systems
- manufacture of fluid power systems
- manufacture of hydraulic transmission equipment

This class excludes:
- manufacture of compressors, see 2813
- manufacture of pumps and valves for non-fluid power applications, see 2813
- manufacture of mechanical transmission equipment, see 2814

Click here for complete correspondences for this code.

Now, a first diagnosis of the current economic situation for this branch is possible – in the reporting month of December 2013 the production of the class 2812 was 13.5 % below the average of the year 2010.

This seems to be not so positive – but we are interested in knowing whether the trend of this branch goes up or down – the fundamental question of business cycle statistics. For this purpose, we need two more comparable figures: the results for this branch in December 2012 (for the year-to-year comparison) and in November 2013 (for the month-to-month comparison).

Production Index 2010=100

ISIC Rev. 4 - 2812 Manufacture of fluid power equipment

Reporting period	Index (original)	Change to previous year	Change to previous month
December 2013	86.5	-0.3%	-26.8%
November 2013	118.1		
December 2012	86.8		

However, these comparisons make little sense, either. On the one hand, the months differ with regard to the number of working days and on the other hand, December and November are influenced by different seasonal effects.

Here, we see the different number of working days:

Reporting period	Working days	Change to previous year	Change to previous month	Change to the average 1991-2013
December 2013	18.0	5.9%	-11.3%	-6.7%
Average December 1991-2013	19.3			
November 2013	20.3			-1.9%
Average November 1991-2013	20.7			
December 2012	17.0			-11.9%

The so-called “working-day adjustment” is usually applied together with the seasonal adjustment. It is a simple principle – if the reporting month has more working days than the long-term average, then the original index will be reduced; fewer working days lead to an increase of the original index. The original indices are converted to a special norm, e.g. the working days in the corresponding month of the base year or a long-term average (1991 to 2013 in our example). The working-day adjustment only makes sense if there is a close relation between the production process and the monthly working-days. This is not always the case, e.g. in special industries as production of cement or glass we observe continuous production.

After the working-day adjustment, the results can be used for the year-to-year comparison. We can now observe whether the IIP for the reporting month is above or below the last year level.

Production Index 2010=100

ISIC Rev. 4 - 2812 Manufacture of fluid power equipment

Reporting period	Index (working-day-adjusted)	Change to previous year	Change to previous month	Adjustment effect
Dezember 2013	89.1	-2.7%	-26.7%	3.0%
November 2013	121.5			2.9%
Dezember 2012	91.6			5.5%

Yet, we still do not know whether the current trend shows upward or downward tendencies. For the month-to-month comparison, we need a further data adjustment – the seasonal effects must to be removed from the series. Several methods may be applied; in Germany, we use Census X 12-ARIMA. Census X 12-ARIMA is an internationally wide-spread method which is applied in Germany as well as in several European countries and is accepted by Eurostat.

Finally, we obtain the table with comparable results and change rates that make economic sense:

Production Index 2010=100

ISIC Rev. 4 - 2812 Manufacture of fluid power equipment

Reporting period	Index (working-day- and seasonally adjusted)	Change to previous year	Change to previous month	Adjustment effect
Dezember 2013	107.3	-2.5%	-11.1%	24.0%
November 2013	120.7			2.2%
Dezember 2012	110.1			26.8%

In December, we find enormous seasonal effects; the original data are increased by approximately 25 %.

To compare the original data of the IIP, the working-day and seasonal influences must be eliminated. But how can these original data be calculated? The following section will focus on the calculation of the original data.

4. IIP – The Calculation of Original Indices

Before we deal with the calculation methods, we should have a look at the required classifications.

4.1. Branch- and Product Classifications

For the analysis of the economic development of a branch, we can use different economic variables, such as employment, new orders or turnover data. For the IIP, we use – as the name expresses it – the production. Which products can be used to describe a branch? This can be found e.g. in the (international) product classification CPC Ver. 2.

CPC Ver.2

(Central Product Classification, Ver.2)

- 0 - Agriculture, forestry and fishery products
- 1 - Ores and minerals; electricity, gas and water
- 2 - Food products, beverages and tobacco; textiles, apparel and leather products
- 3 - Other transportable goods, except metal products, machinery and equipment
- 4 - Metal products, machinery and equipment
- 5 - Constructions and construction services
- 6 - Distributive trade services; accommodation, food and beverage serving services; transport services; and electricity, gas and water distribution services
- 7 - Financial and related services; real estate services; and rental and leasing services
- 8 - Business and production services
- 9 - Community, social and personal services

In correspondence tables we can see which products of CPC are assigned to the branches of ISIC Rev. 4. In our special case 2812, we find the following groups of products (online via https://unstats.un.org/unsd/cr/registry/regso.asp?Ci=67):

Correspondence between ISIC Rev.4 and CPC Ver.2

The following table shows the links between the selected classifications. In case of a partial link, the detail column specifies the portion of the second classification. An icon in the last column signifies comments, such as changes after the original publication. Clicking on the codes of either classification links to the definition of that particular category.

2510 records found

ISIC Rev.4	CPC Ver.2	Part	Detail	
2812	43211			
	43219			
	43251			
	88762			

We see that production data for the subclasses 43211, 43219, 43251 and 88762, the lowest stage of CPC, are needed. By clicking on the individual subclasses, we get the detailed description of the products.

CPC Ver.2 code 43211

Structure Notes

Hierarchy

- Section: 4 - Metal products, machinery and equipment
- Division: 43 - General-purpose machinery
- Group: 432 - Pumps, compressors, hydraulic and pneumatic power engines, and valves, and parts thereof
- Class: 4321 - Hydraulic and pneumatic power engines and motors
- **Subclass: 43211 - Linear acting (cylinders) hydraulic and pneumatic power engines and motors**

CPC Ver.2 code 43219

Structure Notes

Hierarchy

- Section: 4 - Metal products, machinery and equipment
- Division: 43 - General-purpose machinery
- Group: 432 - Pumps, compressors, hydraulic and pneumatic power engines, and valves, and parts thereof
- Class: 4321 - Hydraulic and pneumatic power engines and motors
- **Subclass: 43219 - Other hydraulic and pneumatic power engines and motors**

CPC Ver.2 code 43251

Structure Notes

Hierarchy

- Section: 4 - Metal products, machinery and equipment
- Division: 43 - General-purpose machinery
- Group: 432 - Pumps, compressors, hydraulic and pneumatic power engines, and valves, and parts thereof
- Class: 4325 - Parts for the goods of classes 4321 to 4324
- **Subclass: 43251 - Parts for the goods of subclasses 43211 and 43219; parts of reaction engines other than turbo-jets**

CPC Ver.2 code 88762

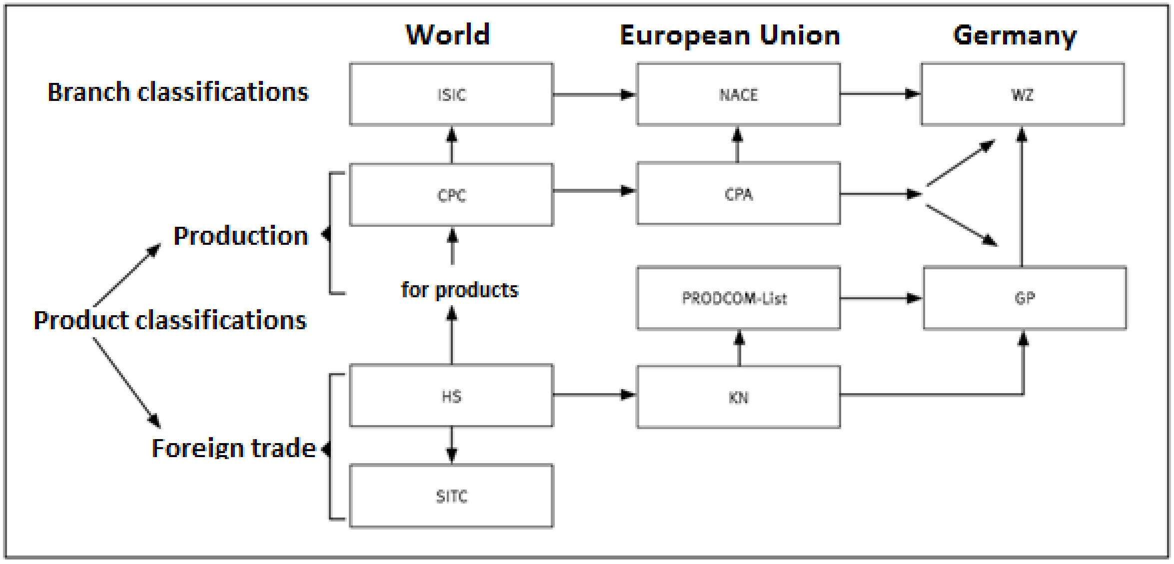
Structure Notes

Hierarchy

- Section: 8 - Business and production services
- Division: 88 - Manufacturing services on physical inputs owned by others
- Group: 887 - Fabricated metal product, machinery and equipment manufacturing services
- Class: 8876 - General-purpose machinery manufacturing services
- **Subclass: 88762 - Fluid power equipment manufacturing services**

If we look at the European classifications, we find that the branch classification NACE Rev. 2 is almost identical with ISIC Rev. 4; only in a few cases some 4-digit branches of NACE are combined under one 4-digit ISIC-branch. The German branch classification WZ 2008 is fully identical with NACE Rev. 2 at the 4-digit-level.

International system of economic classifications



WZ 2008 Kode	WZ 2008 - Description (n.e.c. = not elsewhere classified)	ISIC Rev. 4
28	**Manufacture of machinery and equipment n.e.c.**	
28.1	**Manufacture of general-purpose machinery**	
28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	2811
28.11.0	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	
28.12	Manufacture of fluid power equipment	2812
28.12.0	Manufacture of fluid power equipment	
28.13	Manufacture of other pumps and compressors	2813*
28.13.0	Manufacture of other pumps and compressors	
28.14	Manufacture of other taps and valves	2813*
28.14.0	Manufacture of other taps and valves	

The corresponding product classification to CPC is – at the European level – the CPA 2008 (Statistical Classification of Products by Activity).

28.12 CPA class, categories and subcategories

28.12	Fluid power equipment
28.12.1	Fluid power equipment, except parts
28.12.11	Linear acting hydraulic and pneumatic motors (cylinders)
28.12.12	Rotating hydraulic and pneumatic motors
28.12.13	Hydraulic pumps
28.12.14	Hydraulic and pneumatic valves
28.12.15	Hydraulic assemblies
28.12.16	Hydraulic systems
28.12.2	Parts of fluid power equipment
28.12.20	Parts of fluid power equipment
28.12.9	Sub-contracted operations as part of manufacturing of fluid power equipment
28.12.99	Sub-contracted operations as part of manufacturing of fluid power equipment

While CPC describes the branch 2812 with four types of products, CPA provides eight kinds of products for characterizing the branch.

Much more detailed information can be obtained by using the European product classification PRODCOM. The term comes from the French "PRODuction COMmunautaire" (Community Production) for mining, quarrying and manufacturing: sections B and C of the Statistical Classification of Economy Activity in the European Union (NACE 2). Here we find that 14 different product series (6-digit items) are assigned to the branch 2812.

It is recommended to choose product series at a rather disaggregated level to avoid Paasche-effects in the index calculation (see section “the second stage of index calculation”).

METADATA
PRODCOM List 2013

Detail

- 28.12 Manufacture of fluid power equipment
  - 28.12.11 Linear acting hydraulic and pneumatic motors (cylinders)
  - 28.12.12 Rotating hydraulic and pneumatic motors
  - 28.12.13 Hydraulic pumps
  - 28.12.14 Hydraulic and pneumatic valves
  - 28.12.15 Hydraulic assemblies
  - 28.12.16 Hydraulic systems
  - 28.12.20 Parts of fluid power equipment

- 28.12 Manufacture of fluid power equipment
  - 28.12.11 Linear acting hydraulic and pneumatic motors (cylinders)
    - 28.12.11.30 Hydraulic cylinders Detail
    - 28.12.11.80 Pneumatic linear acting actuators (including cylinders) Detail
  - 28.12.12 Rotating hydraulic and pneumatic motors
    - 28.12.12.00 Rotating hydraulic and pneumatic motors Detail
  - 28.12.13 Hydraulic pumps
    - 28.12.13.20 Hydraulic pumps (radial piston) Detail
    - 28.12.13.50 Hydraulic pumps (gear) Detail
    - 28.12.13.80 Hydraulic pumps (vane) Detail
  - 28.12.14 Hydraulic and pneumatic valves
    - 28.12.14.20 Pneumatic filters, regulators and lubricators Detail
    - 28.12.14.50 Valves for the control of oleohydraulic power transmission for pipes, boiler shells, tanks, vats and the like Detail
    - 28.12.14.80 Valves for the control of pneumatic power transmission for pipes, boiler shells, tanks, vats and the like Detail
  - 28.12.15 Hydraulic assemblies
    - 28.12.15.30 Hydraulic pumps (axial piston) Detail
    - 28.12.15.80 Hydraulic pumps (excluding axial, radial, gear, vane) Detail
  - 28.12.16 Hydraulic systems
    - 28.12.16.30 Hydraulic systems (power packs with actuators) Detail
    - 28.12.16.80 Hydraulic systems (power packs) (excluding actuators) Detail
  - 28.12.20 Parts of fluid power equipment
    - 28.12.20.00 Parts of fluid power equipment Detail

4.2. *Production Data as Source of the IIP-Calculation*

Which unit should we use for measuring the production? First, the IIP-Manual of the UNSD gives us hints for the appropriate units. In the mentioned branch 2812, the use of output values is recommended; the product quality is important and therefore pure quantity units (pieces or tons etc.) are not adequate.

ISIC class	Description	Explanatory notes	Products or product groups	Preferred method	Alternate method	Other methods
2812	**Manufacture of fluid power equipment**	This class includes: - manufacture of hydraulic and pneumatic components (including hydraulic pumps, hydraulic motors, hydraulic and pneumatic cylinders, hydraulic and pneumatic valves.	- Hydraulic and pneumatic components (including hydraulic pumps, hydraulic motors, hydraulic and pneumatic cylinders, hydraulic and pneumatic valves, hydraulic and pneumatic hose and fittings) - Fluid power systems - Hydraulic transmission equipment	**Deflated indicator** Value of output deflated by appropriate quality adjusted PPI	**Volume indicator (output-based)** Quantity (count) of products produced, by product	**Volume indicator (input-based)** Number of hours worked adjusted for changes in productivity

Second, we have to decide whether all product series related to a branch should be taken into account or only a selection of products. In many countries detailed production statistics only exist on a yearly basis (in the EU obligatory for the PRODCOM-Statistics)

If products are used for updating the IIP, it is normally a selection of representative products. This basket of products must be analysed from time to time to detect whether it is still representative for the economic situation of the special branch. Due to technical progresses products disappear from the market and new products become relevant, e.g. the difference between a modern LCD or LED-TV and a conventional CRT-TV is substantial.

In Germany, we have a monthly survey (for the units with 50 employees onwards) of the total production (according to the 8-digit product classification). In this case, the basket of products is always complete; new products can in each case be reported under the term "other products in this product group n.e.c. (=not elsewhere classified)". If the product classification is revised from time to time, it is possible to create new statistical reporting items, perhaps even a new branch is needed to indicate changing economic circumstances.

If production values are applied for updating series, appropriate producer's prices must be available. In Germany, those price indices exist for nearly all industrial products. The price indices should only measure the inflationary price movement - that means, changes in product quality over time have to be removed. This is a very difficult problem for the "designers" of the producer's price indices and it is worth to be discussed in a separate workshop.

4.3. *The First Stage of the Index Calculation – Value Indices for Products*

Comparing the production values of the current month (reporting month t) of the particular products with their (monthly) average values in the base year (0) will lead to the value indices.

$$\text{Value Index } \frac{\sum p_t q_t}{\sum p_0 q_0} * 100$$

The prices included in the value indices are the current prices of the sold production; the producer's price indices (PPI) on the other hand only contain the price movements caused by the pure inflation.

We know two types of price indices:

$$\text{Price Index (Laspeyres) LaPI } \frac{\sum P_t q_0}{\sum P_0 q_0} * 100 \quad \text{(quality changes taken into account)}$$

$$\text{Price Index (Paasche) PaPI } \frac{\sum P_t q_t}{\sum P_0 q_t} * 100 \quad \text{(quality changes taken into account)}$$

For the designer of the price indices it is difficult to calculate Paasche indices because they provide no information about the current weighting structure. Therefore, only Laspeyres price indices are available for deflation, with the following consequence:

Value Index/Price Index (Laspeyres) ≈ Volume Index (Paasche)

$$\frac{\sum p_t q_t}{\sum p_0 q_0} / \frac{\sum P_t q_0}{\sum P_0 q_0} * 100 = \frac{\sum p_t^* q_t}{\sum p_t^* q_0} * 100$$

The producer's price indices are of the type Laspeyres – for this reason the results of deflating the value indices are volume indices of type Paasche.

Only by using a Paasche price index we get an appropriate Laspeyres volume index:

Value Index/Price Index (Paasche) ≈ Volume Index (Laspeyres)

$$\frac{\sum p_t q_t}{\sum p_0 q_0} / \frac{\sum P_t q_t}{\sum P_0 q_t} * 100 = \frac{\sum p_0^* q_t}{\sum p_0^* q_0} * 100$$

Yet, for a short-term the price movements signalled by the Laspeyres price indices are sufficient for using them as deflators for the production values.

Therefore, we need production values and the matching producer's price indices.

The production values can be of two different types:

a) Production intended for sale
b) Value of output sold (sold production)

Version a) meets most closely the aim of measuring the production as soon as possible, immediately when the production process is finished. Those parts of the production which cannot be sold yet go on stock. On the other hand, this way of measuring the production is rather difficult because the value of the production must be known before the sale takes place. Therefore – as far as I know – this way of production measurement is only applied in Germany. The advantage of this method is a possible positive time-lag to the turnover statistics.

Measuring the value of output sold (sold production) is much easier because here invoice amounts can be used (as they are contained in the turnover statistics).

4.4. The Second Stage of the Index calculation – IIP for Branches

We assume for simplicity that we have calculated volume indices for all n products assigned to a branch (V_t^i , i=1,…,n).Also available are the production values in the base year for each product (W_0^i , i=1,…,n). We can thereby calculate the share of the value of each product in relation to the value of all products relating to the particular branch ($g_i = W_0^i / \sum_1^n W_0^i$).

These g_i are the individual weights (product weights) for aggregating the individual volume indices to the branch index k (k=1,…,m).

$$I_t^k = \sum_{i=1}^{n} g_i * V_t^i$$

That means that the individual branch is exclusively described by the development of the gross production.

As explained in the previous section, the volume indices for the several product series are of the type Paasche. But the more disaggregated the updating series for a branch is, the more the Laspeyres-effect (price relations of the base period) will influence the branch index.

4.5. The Third Stage of the Index Calculation – IIP for the Whole Industry

Finally, the several branch indices have to be concentrated to higher aggregates of the branch classification – up to the index for the total manufacturing industry. As a rule, the contribution of the individual branch to the total result should correspond with its own economic contribution to the whole value added of the manufacturing industry. The own economic performance of the branch is represented by the gross value-added at factor cost (the information needed can normally be derived from the results of cost structure surveys).

Value added at factor cost can be calculated from the sum of:

i) turnover
ii) capitalised production
iii) other operating income,

minus the sum of:

i) purchases of goods and services
ii) other taxes on products which are linked to turnover but not deductable
iii) duties and taxes linked to production, plus or minus changes in stocks.

The value-added shares are the so-called branch weights

$$va_k = VA_0^k / \sum_{k=1}^{m} VA_0^k$$

With these value-added weights va_k the individual branch indices I_t^k are aggregated

$$IIP_t = \sum_{k=1}^{m} va_i * I_t^k$$

4.6. Chain Linking and New Products

The traditional principle of IIP is the calculation following the Laspeyres concept. That means that the structure of a selected base year is kept unchanged for a longer period, for the updating elements g_i as well as for the branch weights va_k. The less dynamically the national economy develops, the longer it is justified to maintain these structures. The international rule is the update of the weights every five years (in the years ending with 0 or 5).

To cope with more dynamic structures, the weights can be updated annually. In this way, it is possible to change the representative basket of goods from year to year.

This leads to the method of the "chain-linked" Laspeyres-Index, where the individual rates of change (each related to individually updated base periods) $\frac{\sum p_0 q_1}{\sum p_0 q_0}, \frac{\sum p_1 q_2}{\sum p_1 q_1}, \ldots, \frac{\sum p_{t-1} q_t}{\sum p_{t-1} q_{t-1}}$ are strung together.

Period	Individual Laspeyres-Indices (Example)												Chained Laspeyres-Index	
	2000		2001		2002		2003		2004		2005		Referenzjahr 2005=100	
	Index	Rate of change to previous year	Index	Rate of change to previous year	Index	Rate of change to previous year	Index	Rate of change to previous year	Index	Rate of change to previous year	Index	Rate of change to previous year	Index	Rate of change to previous year
2000	100.0												100.0	
2001	102.5	2.5%	100.0										102.5	2.5%
2002			103.4	3.4%	100.0								106.0	3.4%
2003					104.0	4.0%	100.0						110.2	4.0%
2004							100.7	0.7%	100.0				111.0	0.7%
2005									98.1	-1.9%	100.0		108.9	-1.9%
2006											103.0	3.0%	112.2	3.0%

The advantage of this method is that in each new base year the basket of products can be updated for the structure as well as for the composition. Hence, it is rather easy to extend the list of selected products to new products and to eliminate meanwhile unimportant products.

Our own experiences in Germany lead to the result that an annual updating of weights should be carried out from the lowest level (product weights) onwards and not only for the (value-added based) branch weights (as it is normally suggested in index manuals).

4.7. Laspeyres, Paasche and Fisher – How Do These Indices Fit Together?

We need price- and volume-indices of the type Laspeyres as well as from the type Paasche

$$\text{LaPI} = \frac{\sum p_t q_0}{\sum p_0 q_0} \qquad \text{LaQI} = \frac{\sum p_0 q_t}{\sum p_0 q_0} \qquad \text{PaPI} = \frac{\sum p_t q_t}{\sum p_0 q_t} \qquad \text{PaQI} = \frac{\sum p_t q_t}{\sum p_t q_0}$$

The geometric average of Laspeyres- and Paasche-Index is called Fisher-Index (after Irving Fisher).

$$\text{FPI} = \sqrt[2]{\text{LaPI} * \text{PaPI}} = \sqrt[2]{\frac{\sum p_t q_0}{\sum p_0 q_0}\frac{\sum p_t q_t}{\sum p_0 q_t}}$$

$$\text{FQI} = \sqrt[2]{\text{LaQI} * \text{PaQI}} = \sqrt[2]{\frac{\sum p_0 q_t}{\sum p_0 q_0}\frac{\sum p_t q_t}{\sum p_t q_0}}$$

If the price change is measured by a Fisher-Price-Index and the quantity growth by a Fisher-Quantity-Index, the change measured by a value-index $\frac{\sum p_t q_t}{\sum p_0 q_0}$ can be split into a price component and a quantity component.

The total growth (1+μ) can be split into a price-related change (1+π) and a quantity-related change (1+ρ)

$$\frac{\sum p_t q_t}{\sum p_0 q_0} = (1+\mu) = (1+\pi)\ (1+\rho)$$

$$\frac{\sum p_t q_t}{\sum p_0 q_0} = (1+\mu) = (1+\pi)\ (1+\rho) = \sqrt[2]{\frac{\sum p_t q_0}{\sum p_0 q_0}\frac{\sum p_t q_t}{\sum p_0 q_t}}\ \sqrt[2]{\frac{\sum p_0 q_t}{\sum p_0 q_0}\frac{\sum p_t q_t}{\sum p_t q_0}}$$

Since Paasche-indices are normally not available, Fisher-indices do not play a significant role. In addition, it is not easy to economically interpret and understand the price or quantity movements described by the Fisher-method.

Special recommendation referring to this topic:
Chain Fisher Volume Index Methodology, by Michel Chevalier from Statistics Canada
http://www.statcan.gc.ca/pub/13-604-m/13-604-m2003042-eng.pdf
Including the amusing example of the wine-and-cheese-economy

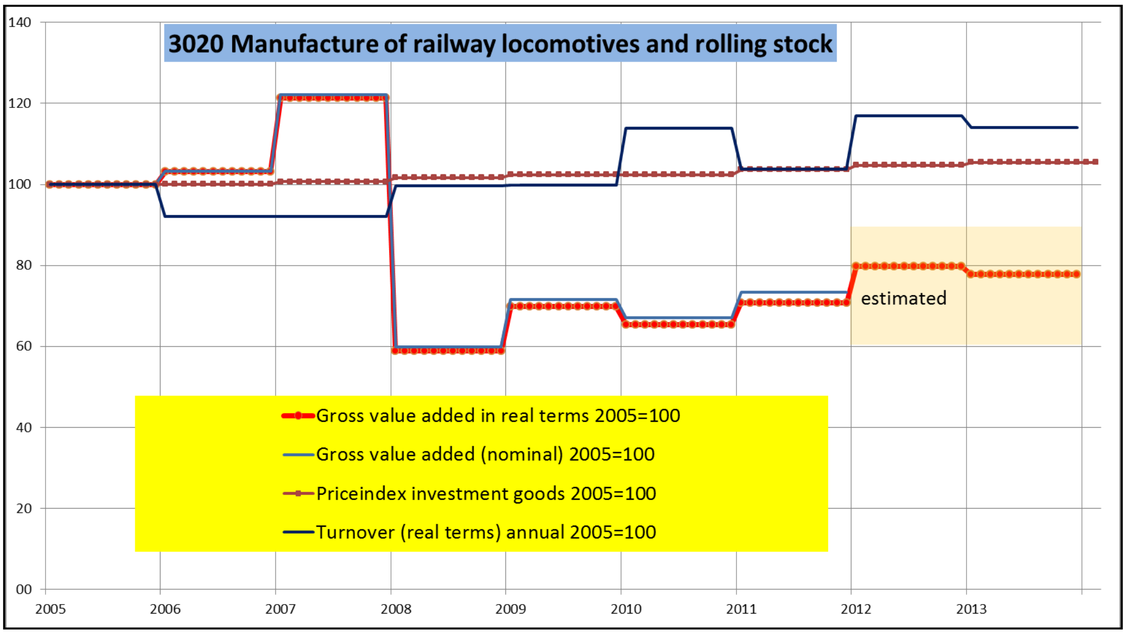
5. Special Case – Updating the IIP with Hours Worked

In some branches, it is rather difficult to measure the monthly production by using pieces or tons or production values. These are mainly those branches where the production process normally lasts more than one month (e.g. shipbuilding). In those cases, a period-adequate updating variable must be used which enables us to estimate the production progress in the respective month. The IIP-Manual suggests the survey of hours worked for these sectors.

ISIC class	Description	Explanatory notes	Products or product groups	Preferred method	Alternate method	Other methods
3011	**Building of ships and floating structures**	This class includes the building of ships, except vessels for sports or recreation, and the construction of floating structures.	- Passenger vessels, ferry boats, cargo ships, tankers, tugs - Warships - Fishing boats and fish-processing factory vessels - Floating docks, pontoons, coffer-dams, floating landing stages, buoys	**Volume indicator (input-based)** Number of hours worked adjusted for changes in productivity	**Volume indicator (input-based)** Number of persons employed adjusted for changes in productivity	**Deflated indicator** Value of raw material consumption (major materials) used in production deflated by appropriate quality adjusted PPI
3020	**Manufacture of railway locomotives and rolling stock**	This class includes: - manufacture of electric, diesel, steam and other rail locomotives - manufacture of self-propelled railway or tramway coaches, vans and trucks, maintenance or service vehicles	- Electric, diesel, steam and other rail locomotives - Railway or tramway rolling stock - specialized parts (bogies, axles and wheels, brakes and parts of brakes; etc)	**Volume indicator (input-based)** Number of hours worked adjusted for changes in productivity	**Volume indicator (input-based)** Number of persons employed adjusted for changes in productivity	**Deflated indicator** Value of raw material consumption (major materials) used in production deflated by appropriate quality adjusted PPI
3030	**Manufacture of air and spacecraft and related machinery**	This class includes: - manufacture of airplanes for the transport of goods or passengers, for use by the defence forces, for sport or other purposes - manufacture of helicopters	- Airplanes for the transport of goods or passengers, for use by the defence forces, for sport or other purposes - Helicopters - Spacecraft and launch vehicles, satellites, planetary probes, orbital stations, shuttles	**Volume indicator (input-based)** Number of hours worked adjusted for changes in productivity	**Volume indicator (input-based)** Number of persons employed adjusted for changes in productivity	**Deflated indicator** Value of raw material consumption (major materials) used in production deflated by appropriate quality adjusted PPI

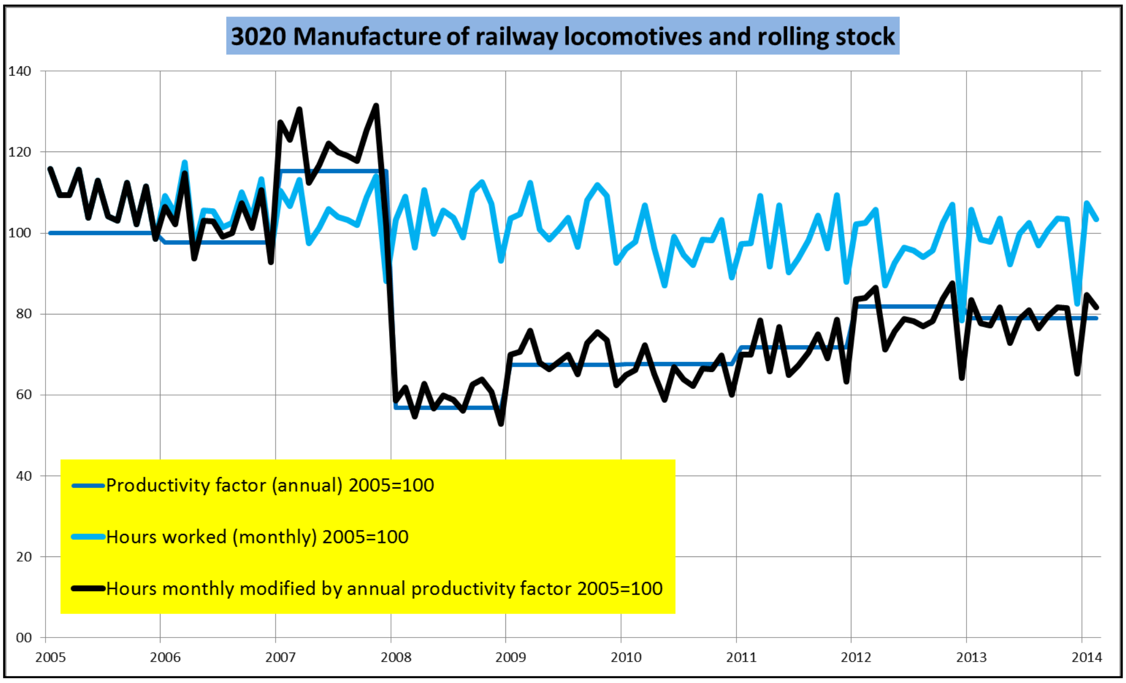
The relation "output per hour worked" is not constant over time; the influence of technological factors such as improved machinery equipment and optimized labour organization tend to increase this relation (technical influence). On the other hand, the state of the business cycle also determines the productivity – in the economic downswing e.g. the production processes will be decelerated (if possible) and the relation "output per hour worked" will decrease (economic influence).

The productivity factor is defined as "deflated value-added per hour worked on a yearly basis". Value-added – in Germany resulting from the cost structure survey – is at the moment only available for the year 2011. Hence, we need estimates as forecast values until the current end of the series. To this end, we use the year-to-year changes of the (deflated) turnover.



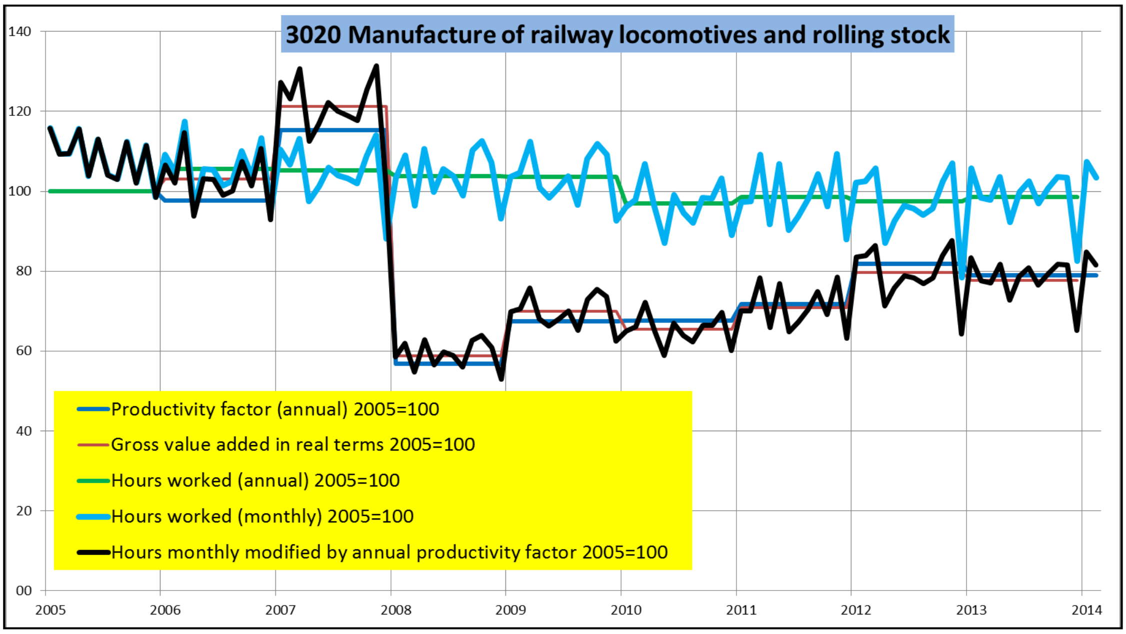
Deflation needs appropriate producer's price indices. For the classes 3011, 3020 and 3030 we cannot find any price indices – this is understandable because ships, rail vehicles and airplanes are individually designed and customized, so the calculation of a price index is quite impossible.

The construction of a price index is the easier to design as products are more homogeneous and more comparable over time. A possible method could be the estimation of the price movement by employing information from the material input; but in this case, detailed information about product-based input-output-relation would be necessary. In Germany, we decided to use the producer's price index for investment goods as deflator – a simple but sufficient method.



To compile the IIP, the indices of hours worked are multiplied with the annual productivity factor. The sub-annual movement of the series is determined by the hours worked, from year to year the productivity changes have an influence.

Regarding the index construction, a long-term smoothing of the productivity factors can be quite appropriate; but this will cause – if new data from value added are taken into account – that revisions will occur not only for the period in which turnover is replaced by value added but in addition for periods lying far more in the past.



It is recommended to agree with National Accounts experts upon the productivity factor used at the current end of the series.

6. Missing Values – Increasing the Quality of the Preliminary IIP

Sometimes we have to face the problem that in the reporting month, for some updating series no data are available. Either the production was really zero or by the deadline of the report the information was not known. In the latter case, estimates have to be included in the index calculation.

In Germany, we have the following practice: The reporting units send their questionnaires to the Statistical Office at fixed dates. If in one of the items in the questionnaire the value "zero" is found, it is assumed that no production existed with regard to this item.

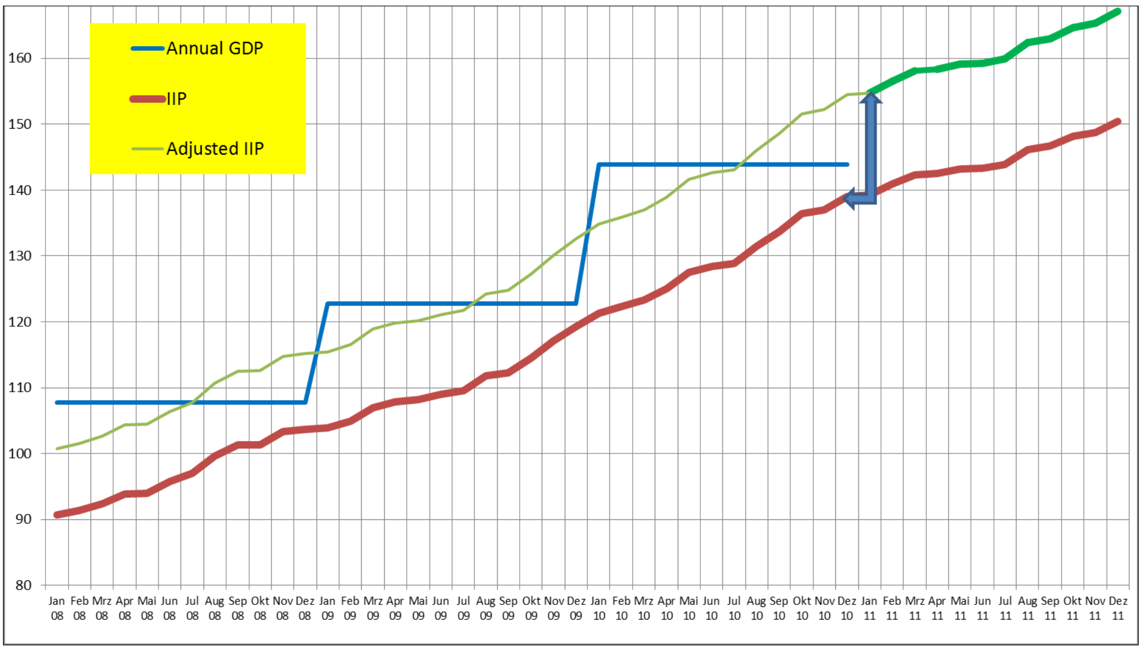
If the whole questionnaire is missing, the missing information is replaced by the report of the previous month. The (preliminary) IIP contains – to a certain degree – data from the previous month. As the main part of the updating series refer to production values, it is possible to calculate the share of these previous monthly results compared to the total production value used for the IIP-calculation. With these shares, we can improve the data quality of the preliminary IIP, as the following example shows.

	Total production value		Value taken over from previous month		Reported value in the reporting month	
t	150 000		15 000		135 000	
	100%	Δ=	10%	1-Δ=	90%	
	IIP		**IIP**		**IIP**	
t-1	103.4		103.4		103.4	
t	123.0	1.190	103.4	1.000	**X**	
t	**125.2**	1.211	125.2	1.211	125.2	1.211
	adjusted					
	preliminary IIP	X=	(IndexTotal(t)-IndexTotal(t-1)*Δ)/(1-Δ)			
		X=	125.2			
rate of change reported data=			1.211			

10% of the production values result from the previous month. The IIP of the previous month (103.4) is defined as completed (100 % incoming reports are assumed). The (preliminary) IIP for the reporting month is calculated as a start with 123.0 – the rate of change to the previous month (+19.0 %) is by 10 % caused by the IIP-level of the previous month (104.4) and by 90 % by the (unknown) level of the reported cases (X). The index for X can easily be calculated by applying the formula and thus the change rate of the reported cases can be estimated this way. This rate is applied to the (preliminary) IIP and increases the data quality at the current end (it is assumed that the rate of change of the reported cases is more or less valid for the missing results (= data from the previous month in the current index calculation)). In Germany, we have significantly improved the accuracy of the preliminary IIP by using this estimation method.

7. Benchmarking

Here, the question is raised whether the IIP should be adjusted to the level of GDP (for the manufacturing sector). Such a practice will cause a level-shift of the current IIP (see diagram).



At the current end we must use the monthly rates of change of the (original) IIP for the updating of the adjusted IIP.

In Germany we do not apply this kind of adjustment. The status of the business cycle is the most interesting fact; here, the observed rates of change are independent from the level of the series. GDP is often revised over time and available comparatively late – adjusting the IIP would lead to several revisions of the index numbers in the past.

8. Production Survey – Sample Survey or Total Survey with Cut-Off?

If the population is too high to conduct a monthly production inquiry, a representative selection of reporting units has to be made. The statistical theory normally proposes a sample survey. However, a sample survey needs to include new reporting units from time to time and to release other units (rotation). This is correct from the theoretical point of view – however practical aspects should be taken into account, too. The (new) reporting unit needs several periods to convert the internal production data for the statistical requirements. As a result, less significant data will be observed at the beginning. At the time the unit is able to supply valid data, it will be rotated from the sample and for the next new unit similar problems will come up.

For this reason, the monthly business cycle statistics in Germany are conducted with a fixed threshold; only those companies with 50 employees or more are obliged to deliver monthly data such as production, employment, hours worked, turnover and new orders. This leads to a rather stable situation regarding the reporting units and therefore valid comparisons are possible also for longer terms.

Appendix – Guidelines for the IIP methods

(UN Department of Economic and Social Affairs Statistics Division)
International Recommendations for the Index of Industrial Production 2010

Scope, frequency, sources and methods of the IIP

Scope of industrial production indices
The Index of Industrial Production to be compiled for activities in ISIC Rev. 4 Sections B, C, D and E, i.e. Mining and quarrying; Manufacturing; Electricity, gas steam and air-conditioning supply; as well as Water supply, sewerage, waste management and remediation activities.

Compilation frequency
It is recommended that the IIP be compiled monthly, so that turning points in economic development can be identified at the earliest possible point in time.

Sources and methods

Method to compile volume measures for the IIP
In general, the deflation process with the use of an appropriate price index is recommended.

Deflator to be used to compile volume measures from value data
The Producer Price Index (PPI) is recommended as the price index to be used by countries when current price values are deflated to compile volume measures of output for the IIP.

Level at which to apply deflator
It is recommended that the deflator be applied to the value data at the lowest level possible, but not higher than the ISIC class (4-digit) level in order to obtain a volume estimate for use in the compilation of the IIP. The detailed PPI used for deflation should be defined as closely as possible (in terms of scope, valuation and timing) to the respective product groups for which it is being used as a deflator

Variables to be used to approximate industrial production for the IIP
In general, measures of output (value of output, physical quantity of output) are preferred over input (labor and materials consumed) measures. (See para. 4.54)
Index compilation

Type of index formula to be used
The Laspeyres-type index formula is recommended to compile the IIP

Missing data
Missing data are to be estimated using imputation techniques or an administrative data replacement strategy so that the data matrix is complete.

Data adjustments – quality change
Quality changes should be incorporated into the calculation of the IIP either via the use of the price index when deflation methods are employed, or by adjusting input data when volume extrapolation methods are used.

Weighting variable – product and product group level of the index
Value of output is recommended as the weight variable to compile the IIP at the product and product group levels of the index.

Weighting variable – industry level of the index
Gross value added at basic prices data is recommended as the weight variable to compile the IIP for the different levels of the ISIC structure.

Frequency of weight update – product group level of the index
Product group weights should be updated at least every 5 years.

Frequency of weight update – industry level of the index
Industry level weights of the IIP should be updated annually.

Chain linking of the IIP on weight change
The chain linking method should be used when weights are updated, i.e. the new series should be linked to the old series to produce a continuous series.

Aggregation of the IIP
Aggregation from basic data items (products or product groups) should be done directly to industries, without an intermediate step of calculating indexes for establishments. Aggregations to higher level industries should be done in steps, in the case of ISIC through each level of ISIC, using the existing ISIC structure, i.e. index numbers at the ISIC class (4-digit) level should be aggregated first to the ISIC group (3-digit) level, then to the ISIC division (2-digit) level and finally section (1-digit) level.

Data adjustments – seasonal adjustment
Seasonal adjustment should be applied to the IIP data at the lowest level of aggregation for which reliable estimates can be obtained and in every period the IIP is calculated.

Benchmarking of IIP data
Benchmarking of the IIP should be considered to reconcile high-frequency with low-frequency series, as well as other sources, like the annual national accounts.

Quality review
A quality review of the IIP should be undertaken every four or five years, or more frequently if significant new data sources become available.