



BANK OF JAPAN

Japan's FD-ID price indexes: Incorporating import prices



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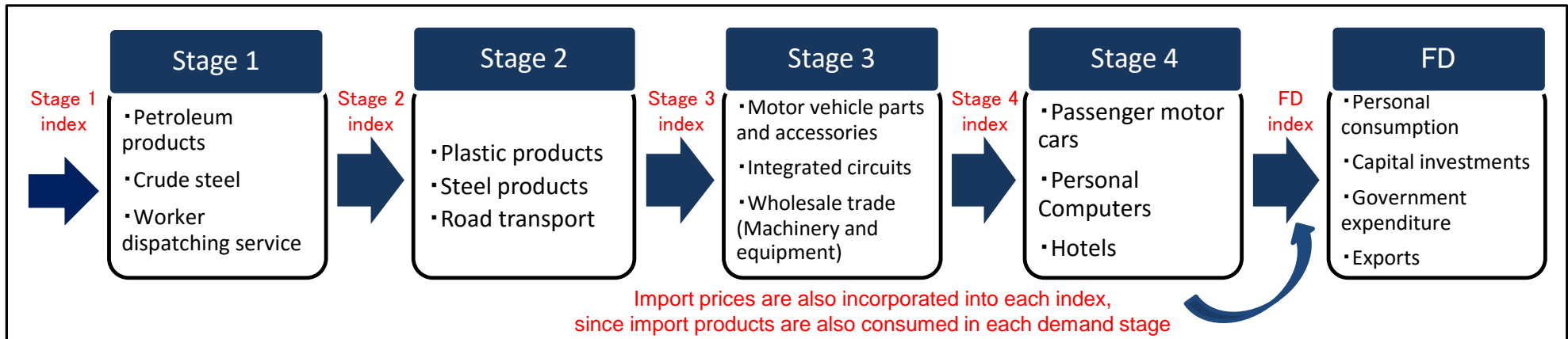
Overview of FD-ID price indexes

- ✓ The Final Demand-Intermediate Demand price indexes (FD-ID price indexes) are price index series by stage of demand that are comprised of the final demand index (FD index) and four intermediate demand indexes (ID indexes).
- ✓ By integrating prices of goods and services, and by dividing the intermediate stages in optimal manner in accordance with the Input-Output table, inflationary pressures in the entire Japanese economy can be tracked, including both goods and services sectors, and the process of price changes being transmitted from upstream to downstream stages in the production flow.

(1) Characteristics of the Japan's FD-ID price indexes

- (i) Express the production flow by the FD index and four ID indexes.
- (ii) Each index is an aggregate index of all goods and services as inputs to each stage, so it has the characteristics of input price index.
- (iii) Incorporate import price indexes as well as producer price indexes as input prices to each demand stage.

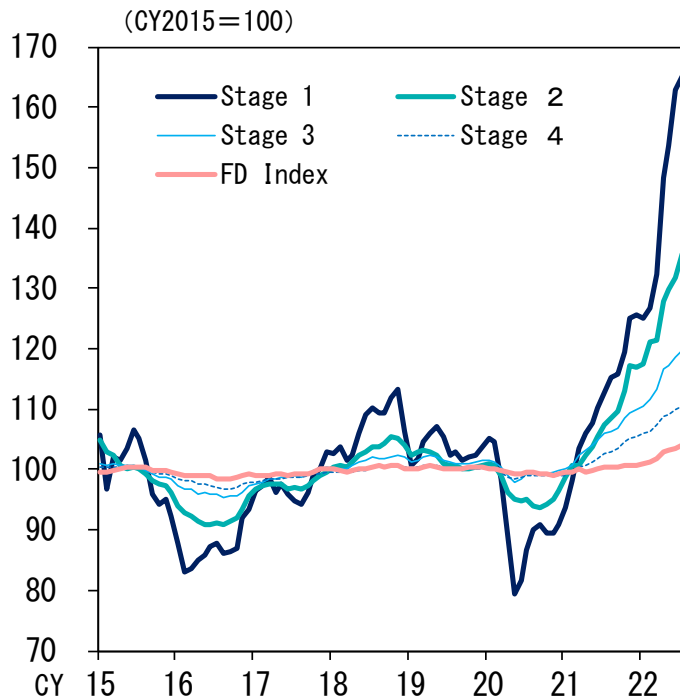
(2) Concept of the each index



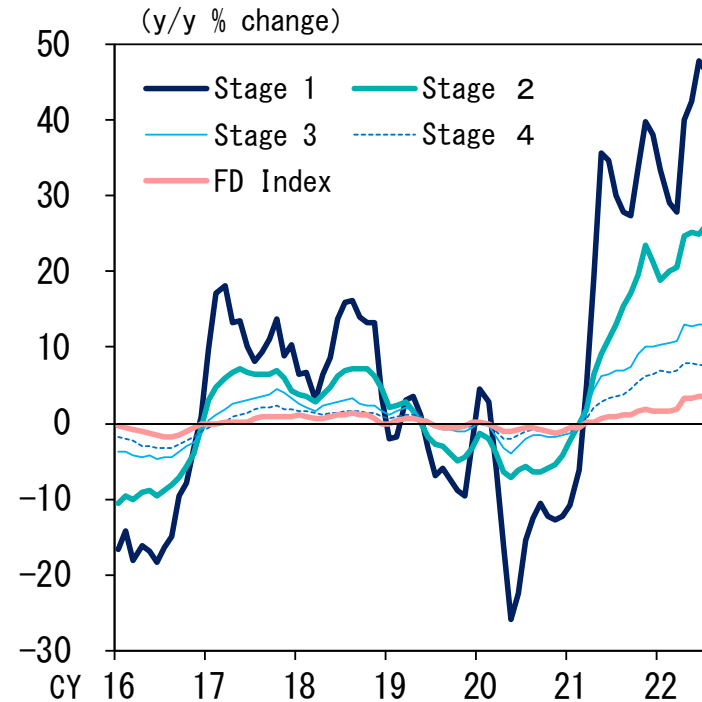
FD-ID price indexes

- ✓ Regarding the trends of the price indexes for Stages 1 to 4 of intermediate demand and the FD all commodities index (2015=100) for the period from 2021 onwards, the price index for Stage 1, which is the most upstream stage in the production flow, showed the largest rise, reflecting a rise in international commodity prices, among other factors. On the other hand, the price indexes for downstream stages and the FD index showed moderate rises, with the pace of rise becoming slower in more downstream stages.
- ✓ This indicates that the price shock in upstream stages have been absorbed through the production flow.

(1) FD-ID price indexes



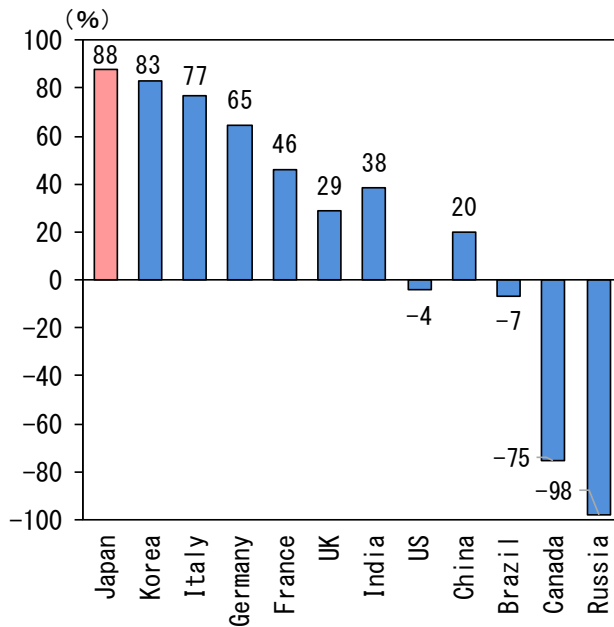
(2) year-on-year changes



FD-ID price indexes by domestics and imports

- ✓ In Japan, industries depend on imports for most of the raw materials needed for their production, and imports also play an important role in each stage of demand. Therefore, in order to examine the inflationary trend and the transmission process of price changes, it is important to take into consideration the effects of not only domestic prices but also import prices on price changes in each stage of demand.
- ✓ The price changes in Stage 1 are attributable almost entirely to the price volatility of import goods. This may imply that price changes in Stage 1 are caused by such factors as international commodity prices, overseas economic conditions, and foreign exchange volatility, rather than by the domestic supply demand factor.

▽ Dependence on imported energy

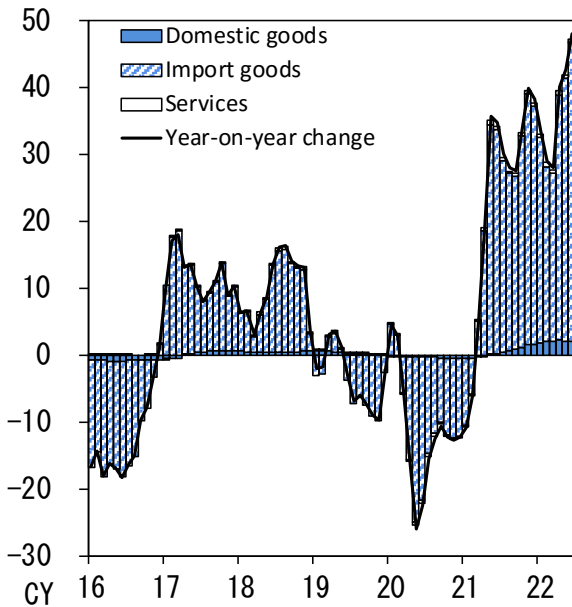


Note: Including nuclear power (2019).

Source: Japan Atomic Energy Relations Organization

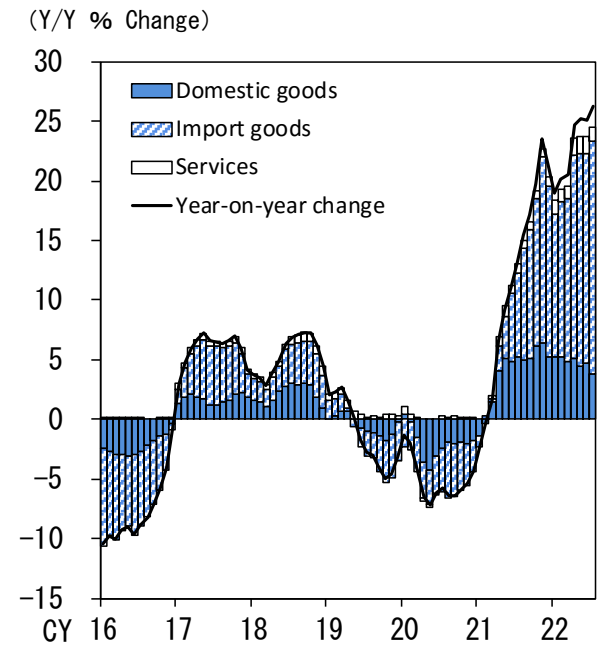
▽ Decomposition of Year-on-Year Changes

(1) Stage 1



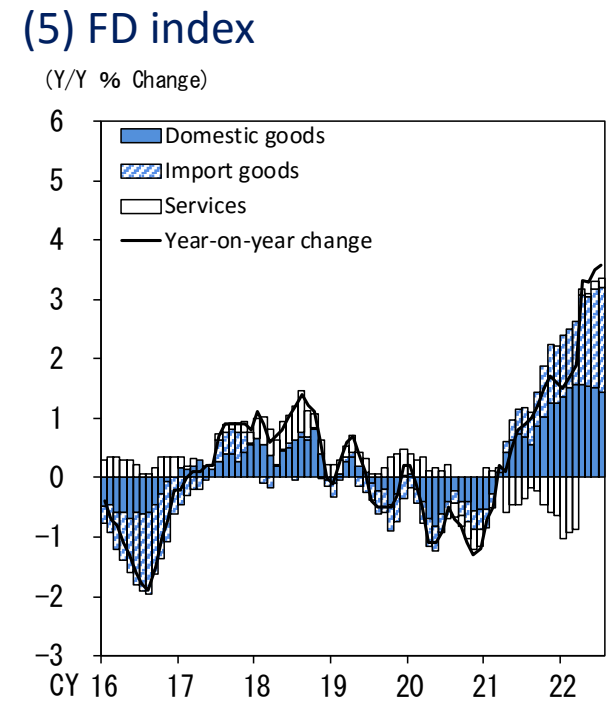
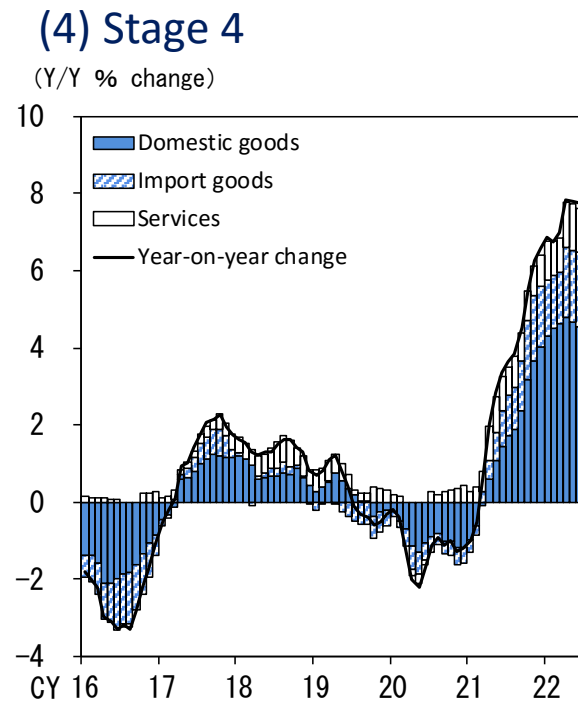
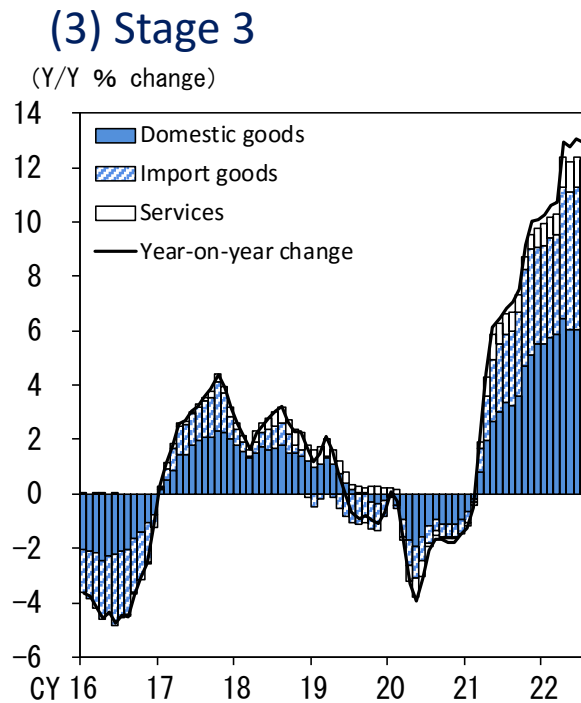
Note: The total of each decomposition and year-on-year changes after 2020 does not exactly match up because these are separately linked to data before Dec-2019.

(2) Stage 2



FD-ID price indexes by domestics and imports

- ✓ However, in more downstream stages (Stages 2 and 3) in the production flow, the contribution of prices of import goods becomes smaller while the contribution of domestic goods becomes larger.
- ✓ In Stage 4 and FD, not only is the contribution of domestic goods large, but also the contribution of services, which is unremarkable in upstream stages, becomes clearly visible.
- ✓ The results of these breakdown indicate that price changes for import goods, which represent an exogenous factor, are important for Japan in upstream stages of intermediate demand in the production flow but that the price changes are absorbed stage by stage as the production process moves on.



Note: The total of each decomposition and year-on-year changes after 2020 does not exactly match up because these are separately linked 5 to data before Dec-2019.

Scope of the FD-ID Price Indexes

- ✓ The FD-ID price indexes cover both of goods and services transactions, including transactions not only in domestics (domestically produced goods and services) but also in imports.
- ✓ If we look at the scope of the FD-ID price indexes in reference to the I-O table, we see that those indexes are distinctive in that goods and services sectors are classified by stage of demand in the flow of production (column sectors of the I-O table), rather than by type of goods and services (row sectors of the I-O table).

▽ Scope of the FD-ID price indexes

(i) Including Goods and Services

(ii) Including Domestics and Imports

(iii) Classified by the stage of demand in the flow of production (column sectors of the I-O table)

Commodity type (row sector)	Production sector	Demand sector (column sector)															
		Intermediate demand												Final demand			
		Stage 1			Stage 2			Stage 3			Stage 4			PC	CI	Gov	Exp
		2	3	9	1	4	10	5	7	8	6	11	12				
Goods	1																
	2																
	3																
	4																
	5																
	6																
Services	7																
	8																
	9																
	10																
	11																
	12																
Imports																	

PC : Personal Consumption
 CI : Capital Investment
 Gov : Government expenditure
 Exp : Exports

Legend:

- Stage 1: Light blue background
- Stage 2: Grid pattern background
- Stage 3: Medium blue background
- Stage 4: Dark blue background
- Final demand: Dark blue background

Stage Assignments: Overview

- ✓ In order to divide intermediate demand into four stages, the value of inputs to goods and services sectors is used based on the I-O table (2015 base).
- ✓ Each domestic sector is classified into four stages using cut off variables ($X=70$, $Y=65$, and $Z=60$).
- ✓ The cut off variables are determined through three processes ; (1) provisional assignment of sectors to stages, (2) additional optimization, (3) judgment-based adjustment (For more details, please refer to Appendix 2-5).

▽ Dividing intermediate demand into four stages using cut off variables

- Stage 4 is the closest to final demand, namely the most downstream stage of intermediate demand. Stage 4 is preceded by Stage 3 ,Stage 2, Stage 1 in that order , with Stage 1 as the most upstream stage of intermediate demand.

Stage 4 : Sector in which $X\%$ or more of the value of output is sold to final demand.

Stage 3 : Sector in which $Y\%$ or more of the value of output is sold to final demand or Stage 4 and which are not included in stage 4.

Stage 2 : Sector in which $Z\%$ or more of the value of output is sold to final demand, Stage 4 or Stage 3 and which are not included in Stage 3 or Stage 4.

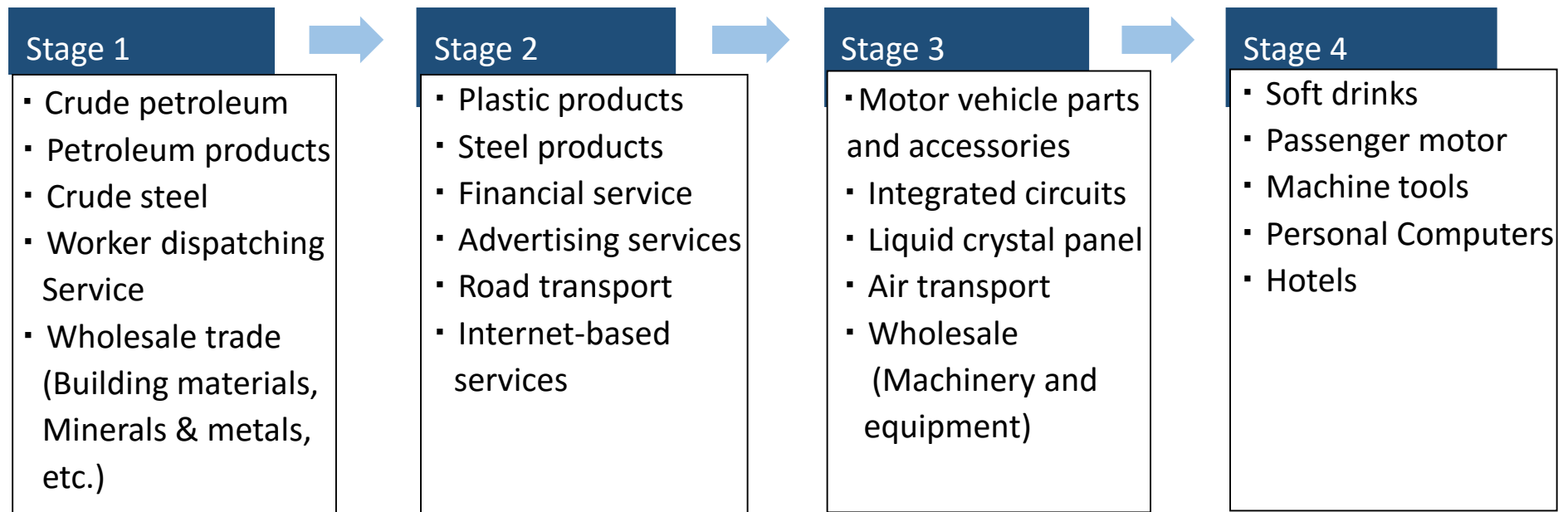
Stage 1 : Sectors which do not meet either of the above definitions.

- The values “X”, “Y” and “Z” in the above chart are cut-off variables used to determine boundaries between the stage.
- Finally, $X=70$, $Y=65$, and $Z=60$ are selected in the Japan’s FD-ID structure based on the 2015 I-O table. 7

Stage Assignments: Major Sectors

- ✓ As a result of stage assignments, each sector (good and service) is classified in each stage.
- ✓ Major sectors below show that these are appropriately classified in accordance with the flow of production, which can capture the supply chain structure.

▽ Assignment of Goods and Services Sectors to Stages: Major Sectors

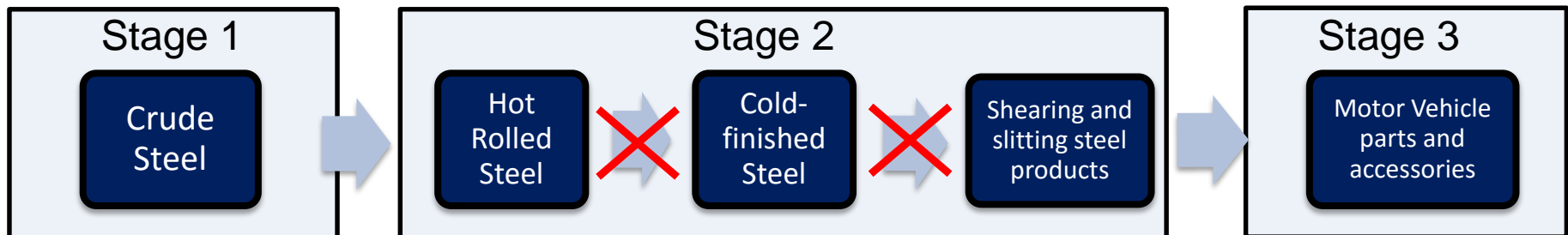


Calculation of weights for FD-ID Price Index

- ✓ The value of inputs to goods and services sectors (the 2015 I-O table) is also used in the calculation of weights.
- ✓ For the ID indexes, the value of internal flow is excluded from the weight calculation in order to avoid the “multiple counting problem” (For “multiple counting problem,” please refer to Appendix 1).
- This is not the case with imports because imports are not produced in the domestic production flow and thus never counted multiple times.

▽ Effects of exclusion for the internal flow (Example)

- In the Stage 2, There are “hot rolled steel”, “cold-finished steel”, “Shearing and slitting steel products”.
- If we calculate the indexes without any adjustments, weights of these indexes become large. As a result, the effects of prices of steel products tend to be overrepresented.



⇒ Avoid the “multiple counting problem” by excluding the weights of trade within the same stage

Matching of Price Data (Commodity-level indexes)

- ✓ Commodity-level indexes of PPI, IPI (Import Price Index), EPI (Export Price Index), and SPPI that correspond to the row sectors in the I-O table are used as price.
- ✓ The CPI is also used in the case of services for personal consumption (B to C transaction) since Japan's SPPI only covers B to B transaction.

▽ Number of Commodities Used for FD-ID price indexes

Number of Commodities	Intermediate Demand				FD (including exports)	FD+ID
	Stage 1	Stage 2	Stage 3	Stage 4		
PPI	559	396	437	523	459	743
IPI	205	199	202	203	169	256
EPI	0	0	0	0	207	207
SPPI	108	82	117	143	54	151
CPI	38	41	31	8	126	126
Total	910	718	787	877	1,015	1,483

Note: As of 2015

Coverage of the FD-ID Price Indexes

- ✓ If there is no appropriate price index, these weights are considered zero and excluded in the FD-ID price indexes.
- ✓ However, the coverage of the FD-ID price indexes as a whole is approximately 70 percent, which is generally sufficient level for an aggregation price index based on producer prices that integrates price of goods and services.

▽ Coverage of the FD-ID price indexes

	Intermediate Demand				FD (including exports)	FD+ID
	Stage 1	Stage 2	Stage 3	Stage 4		
The value of transactions covered by indexes/ The total value of transactions	88%	79%	86%	87%	63%	72%

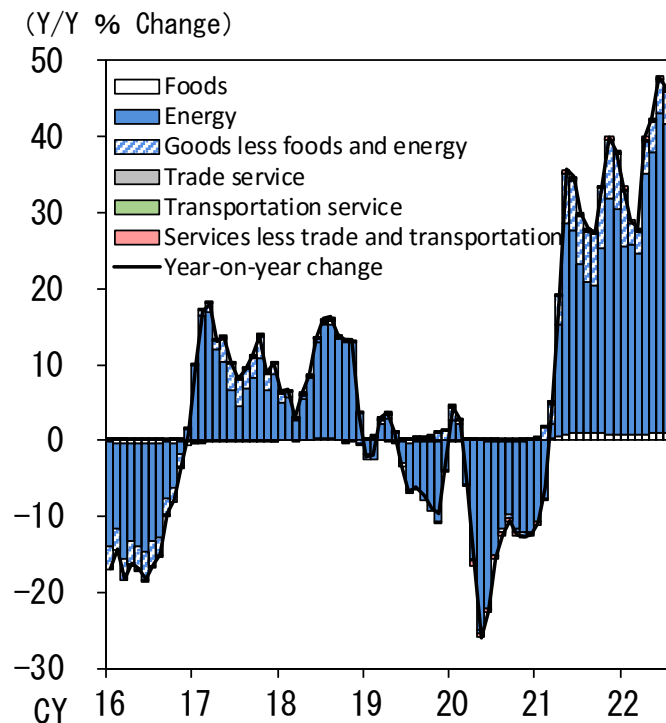
Note: As of 2015

FD-ID price indexes by goods and services

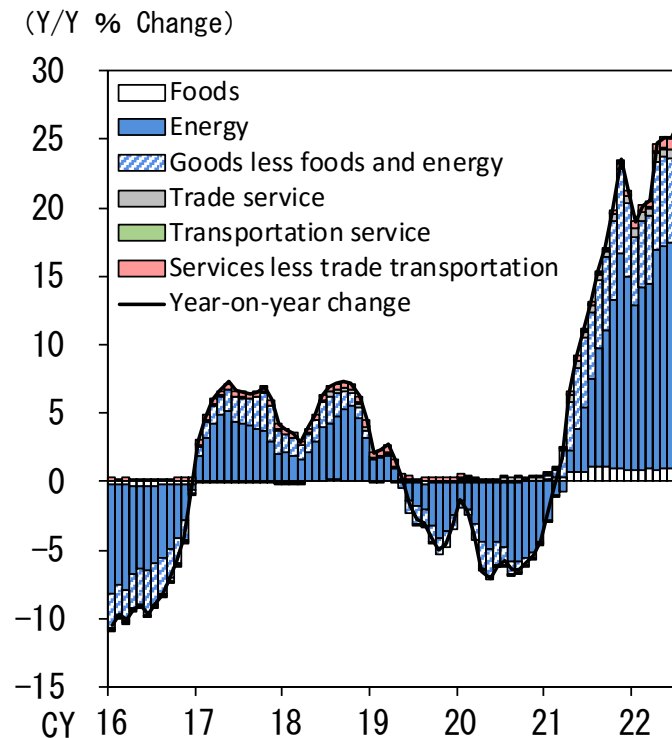
- ✓ In addition to the FD-ID price indexes by domestics and imports, those by goods and services are also beneficial for capturing inflationary pressures especially when energy prices are rising/falling greatly.
- ✓ Looking at decomposition of contributions by type of goods/services to year-on-year changes, although energy made the greatest contributions in upstream stages, such as Stages 1 and 2, its effects declined in downstream stages, such as Stage 4.

Decomposition of Year-on-Year Changes

(1) Stage 1



(2) Stage 2

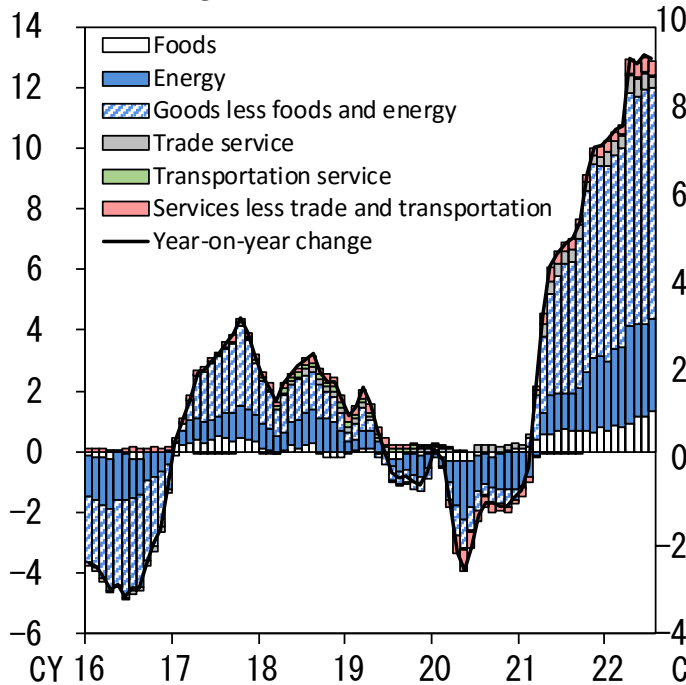


FD-ID price indexes by goods and services

✓ On the other hand, services made progressively larger contributions during the production flow, with the contributions becoming larger in downstream stages, including Stage 4 and the FD (final demand) stage.

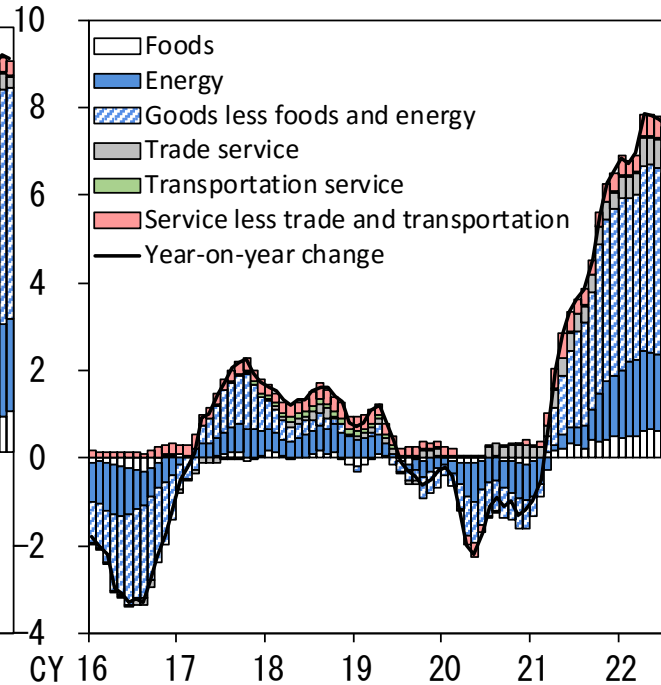
(3) Stage 3

(Y/Y % change)



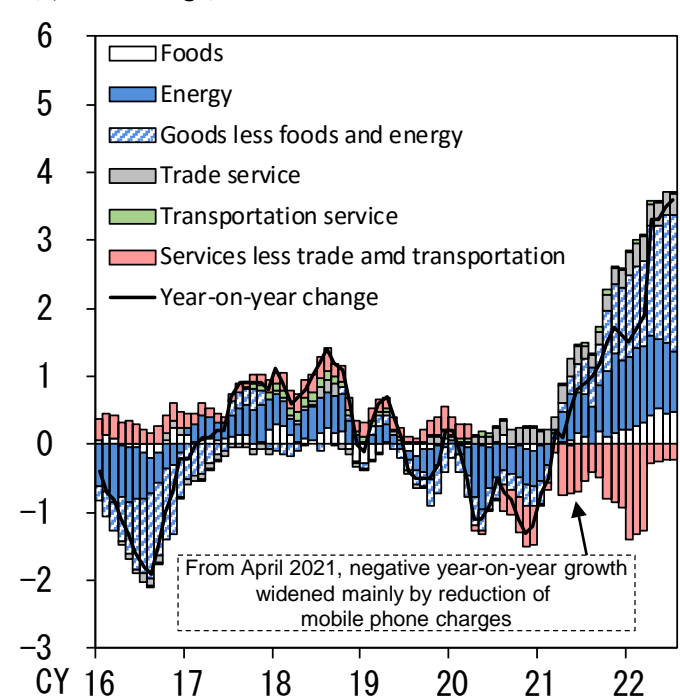
(4) Stage 4

(Y/Y % change)



(5) FD indexes

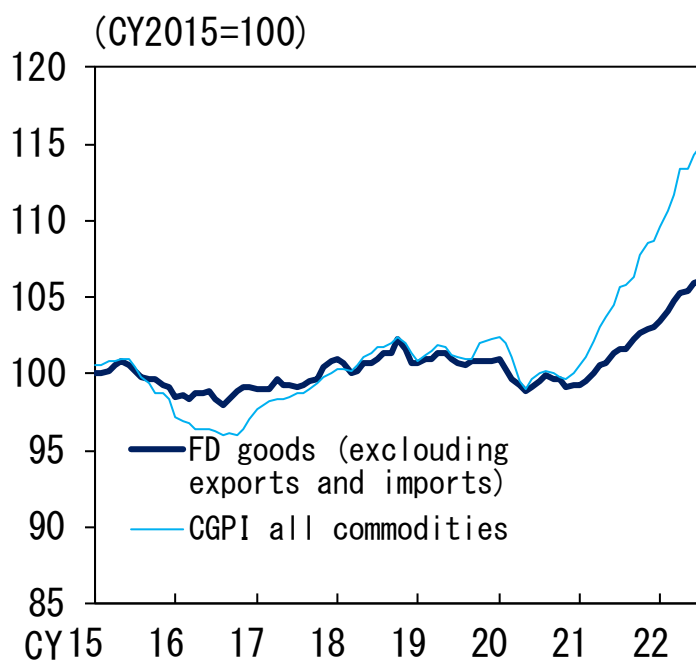
(Y/Y % Change)



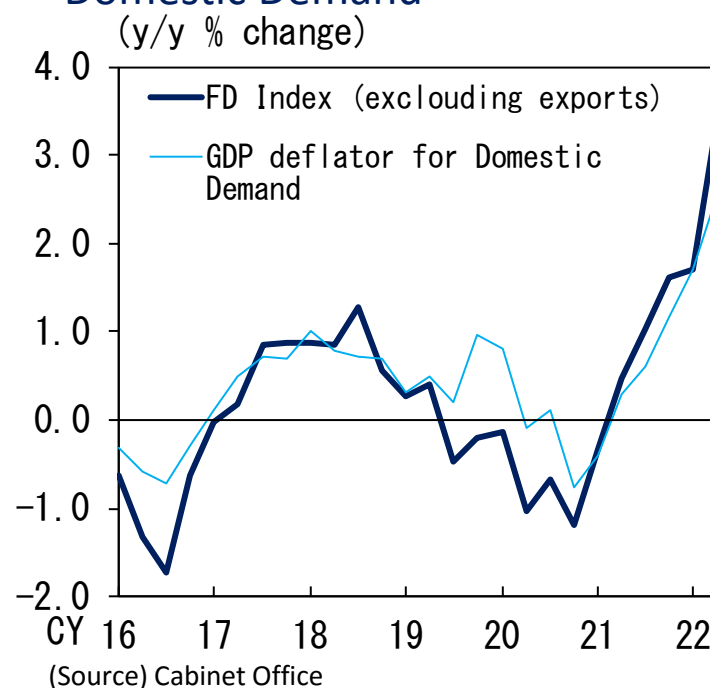
Comparison of the FD-ID price indexes with existing price indexes

- ✓ The FD index (domestic goods) is less volatile than the CGPI all commodities index, particularly when the energy price is falling/rising. CGPI all commodities index significantly overstates price changes for energy because it has “multiple counting problem” (For more details, please refer to Appendix 1). FD index is considered more appropriate as an aggregate price index that represents the macro-level supply-demand condition in the stage of final demand in Japan because it covers goods and services in the final demand.
- ✓ The FD index (excluding exports) has the scope closest to a scope of the deflator for domestic demand and two indicators follow mostly similar trends.

(1) FD indexes and CGPI All Commodities Index



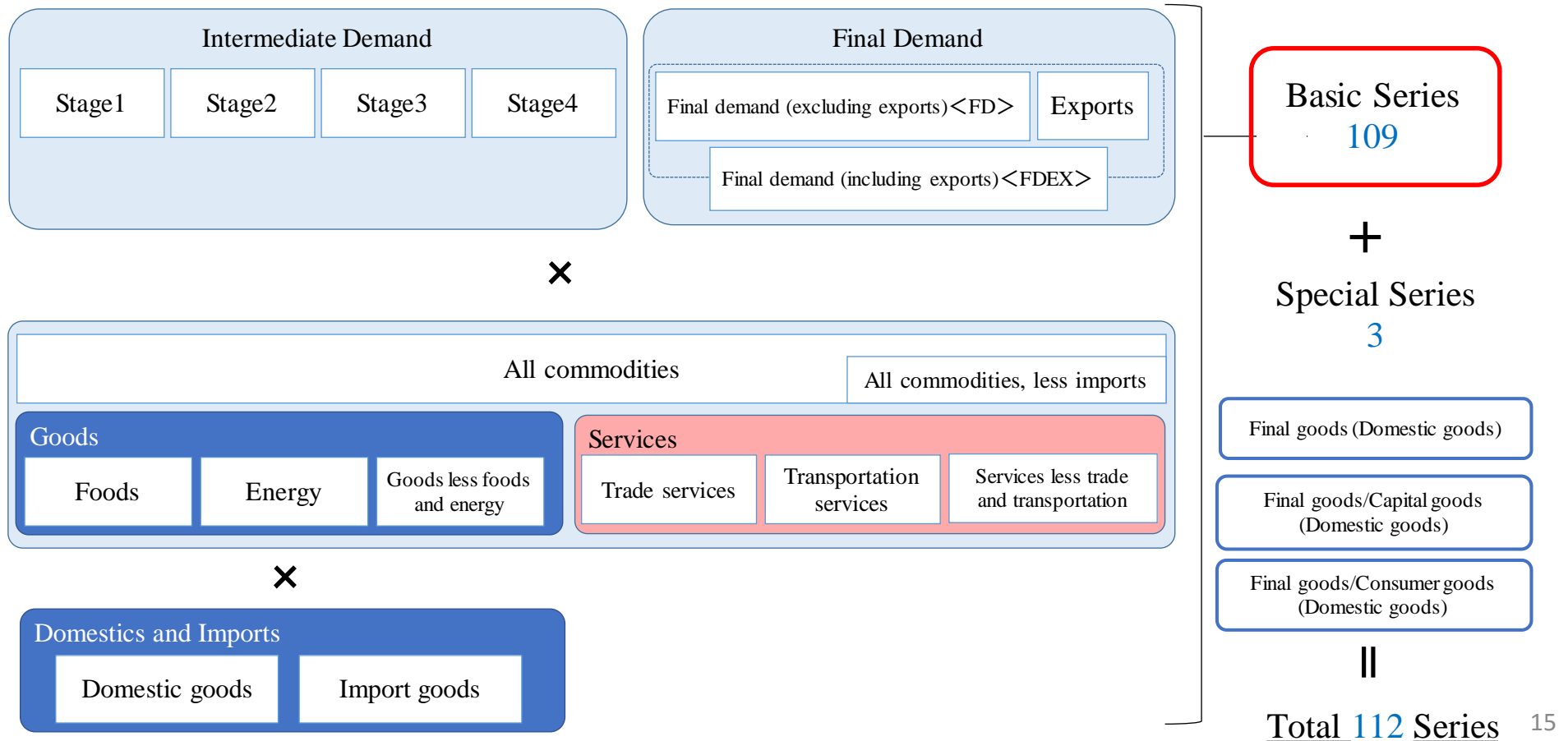
(2) FD Indexes and GDP Deflator for Domestic Demand



Index series of the FD-ID Price Indexes

- ✓ In order to meet many kinds of analysis, **109 indexes** classified (i) **by type of goods/services** and (ii) **by domestics/imports** with respect to each of the ID indexes for Stage 1 to Stage 4 and the FD index are published on a monthly basis.
- ✓ Three other special indexes, the FD goods indexes published within our old structure, are also continued.

▽ Index series of the FD-ID price indexes



Publication of the FD-ID price indexes


- ✓ FD-ID price indexes are published monthly for the data since Jan-2015.
- ✓ In principle, figures are released on the Bank of Japan's website on the 20th business day of the month following the reference month.

▽ Publication of the indexes

Frequency of compilation	Monthly
Time of release	In principle, the date of release is the 20 th business day of the following month.
Starting time of date	Starting time of data for the basic series : January 2015

Data / Notes

In principle, figures are released at 2:00 p.m. JST on the 20th business day (two days after the release of Services Producer Price Index) of the month following the reference month. The indexes are revised along with the corrections of data used as price data (CGPI and SPPI).

Date	Detail	Data
Jul. 28, 2022	June 2022	 [XLSX 76KB]

<https://www.boj.or.jp/en/statistics/pi/fdid/index.htm/>

Conclusion

- ✓ The FD-ID price indexes can track inflationary pressures in the entire Japanese economy, including both goods and services sectors, and the process of price changes being transmitted from upstream to downstream stages in the production flow.
- ✓ Japan's FD-ID price indexes incorporate import prices because industries depend on imports for most of the raw materials needed for their production. It is important to take into consideration the effects of not only domestic prices but also import prices on price changes in each stage of demand.
- ✓ The Bank of Japan publishes 112 price indexes by domestics and imports, and by goods and services so that analysts can choose their appropriate indexes that meet their analysis purposes.

Appendix: Detailed information of Japan's FD-ID price indexes

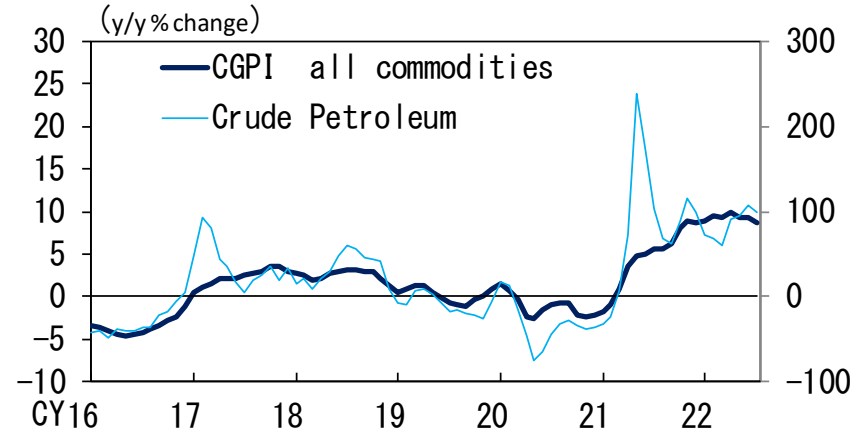
✓ Purpose: Improving a utility as an economic indicator

➤ The index for all commodities (CGPI, SPPI), headline for PPI is compiled by aggregating commodities in different stages of demand through weighted-averaging by gross trade value.

▽ Problems of the index for all commodities

- ① Overall inflationary pressures in the entire economy cannot be tracked because the indexes for goods and services are separately constructed and published.
- ② The effects of price changes in upstream stages in the production flow are exaggerated because the PPI is aggregated as the “all commodities index” in which prices of commodities in different demand stages are aggregated through weight-averaging by gross trade value. (“Multiple Counting Problem”)

▽ CGPI All Commodities Index and IPI Crude Petroleum



↑ Price volatility in upstream stages and their influences on downstream stages are aggregated to a single index.

As a result, the effects of commodities whose price volatility are great, such as crude petroleum, tend to be overestimated.

➤ We assign commodity-level indexes of CGPI and SPPI to the stage of final demand and the four stages of intermediate demand in an optimal manner in accordance with the production flow in the IO table and aggregate commodity-level indexes in a way that eliminates multiple counting.

⇒ FD-ID price indexes make it possible to measure [inflationary pressures in the entire Japanese economy, including both goods and services sectors](#), and [the process of price changes being transmitted from upstream to downstream stages in the production flow](#).

Stage Assignments : Searching cut-off variables (Appendix 2)

- ✓ More specifically , the maximization of the value of net forward flow is pursued through the following three stage : (1) provisional assignment of sectors to stages, (2) additional optimization, (3) judgment-based adjustment.

(1) Provisional assignment

- ✓ First, the four stage of intermediate demand are defined as follows.
 - Stage 4 is the closest to final demand, namely the most downstream stage of intermediate demand. Stage 4 is preceded by Stage 3 ,Stage 2, Stage 1 in that order , with Stage 1 as the most upstream stage of intermediate demand.

Stage 4 : Sector in which X% or more of the value of output is sold to final demand.

Stage 3 : Sector in which Y% or more of the value of output is sold to final demand or Stage 4 and which are not included in stage 4.

Stage 2 : Sector in which Z% or more of the value of output is sold to final demand, Stage 4 or Stage 3 and which are not included in Stage 3 or Stage 4.

Stage 1 : Sectors which do not meet either of the above definitions.

- ✓ The values “X”, “Y” and “Z” in the above chart are cut-off variables used to determine boundaries between the stage.
- ✓ Regarding cut-off variables, a grid search is conducted in increments of 5 points within the preset search range of $50 \leq X, Y, Z \leq 90$, with 729 combinations of the values of cut-off variables (X, Y, and Z) set up. From among those combinations, the one that achieves the greatest possible consistency with the production flow in the I-O table is searched.

Stage Assignments : Criteria for evaluating the cut-off Variables

- ✓ It is necessary to use some criteria for conducting comprehensive evaluation as to whether the assignment of sectors to stages is consistent with the production flow in the IO table. For the FD-ID price indexes the Bank uses an indicator called "net forward flow (NFF)".
- ✓ More specifically, NFF is defined as the value obtained by subtracting the total value of inter sector transactions that flow from downstream to upstream demand stages (back flow) from the total value of inter-sector transactions that flow from upstream to downstream demand stages (forward flow).

Net forward flow (NFF)

= total value of inter-sector transactions that flow from upstream to downstream demand stages (forward flow)
 – total value of inter-sector transactions that flow from downstream to upstream demand stages (back flow)

		Demand Sector				
		Stage 1	Stage 2	Stage 3	Stage 4	FD
Production Sector	Stage 1	A	B	C	D	E
	Stage 2	F	G	H	I	J
	Stage 3	K	L	M	N	O
	Stage 4	P	Q	R	S	T

Forward Flow

–

Back Flow

= Net Forward Flow (NFF)

- ✓ As a result of the calculation of the value of NFF, around 10 cases are selected as candidates from among the 729 provisional assignment cases. In this process, in addition to the top five cases in terms of the value of NFF, the top five cases in terms of the value of forward flow (ranked within the top 20 or so in terms of the value of NFF) are selected as candidates for optimizing the provisional assignment.

Stage Assignments: Determination of Cut-off Variable

- ✓ We conduct the additional optimization and judgment-based adjustments.

(2) Additional optimization

- ✓ With respect to each candidate case selected through the provisional assignment, sectors of goods and services are moved, one by one, from their original stages under the provisional assignment to new stages, and the impact on NFF is measured. By repeatedly implementing this procedure, assignment cases that achieve a marginal improvement of NFF below a certain threshold are identified. From among assignment cases selected through this additional optimization procedure, those which are ranked high in terms of the value of NFF are adopted as final candidates.

(3) Judgment-based adjustments

- ✓ With respect to the final candidate cases selected through additional optimization, adjustments are made based on judgments. For example, sectors where the upstream/downstream relationship in the production flow is clear but the respective stages are assigned in reverse should be corrected (e.g., the relationship between hot rolled steel and cold rolled steel in the production flow of steel products). Meanwhile, sectors for which the export ratio is high tend to be assigned to Stage 4, but even among those sectors, the ones whose commodities are mostly intermediate goods in nature should be transferred to a different stage on condition that the value of NFF increases (e.g., iron scrap).

⇒ As a result of the optimization procedures described in (1) to (3), the values of the cut-off variables were fixed at: $X=70$, $Y=65$, and $Z=60$.

Stage Assignments: Evaluation for Stage Assignments

- ✓ As for the shares of inter-stage transactions regarding the ID indexes calculated as a result of the optimization, forward flow accounts for 84.5 percent of the overall output value, while the share of back flow is only 4.3 percent. On the whole, our assessment is that the Japanese FD-ID price indexes can capture net forward production flow accurately.
- ✓ The share of internal flow, which represents trade within the same stage, is 11.2 percent. Internal flow is excluded from the final calculation of aggregation weights in order to avoid the multiple counting problem. However, our findings show that even if internal flow is excluded, around 90 percent of the overall value of transactions is covered.





▽ Shares of Transactions between Stages of Demand

(%)

		Demand Sector				
		Stage 1	Stage 2	Stage 3	Stage 4	FD
Production Sector	Stage 1	2.4	5.1	1.4	2.2	2.5
	Stage 2	1.5	4.3	4.6	6.4	6.0
	Stage 3	0.7	0.8	2.9	6.4	9.2
	Stage 4	0.3	0.5	0.4	1.6	40.6

(%)

Forward Flow			Back Flow	Internal Flow
	Next Stage	Skip		
84.5	56.8	27.7	4.3	11.2

-  Next Stage: The percent of total shipments sold by sectors to sectors classified in the next forward stage of production
-  Skip: The percent of total shipments sold by sectors to sectors classified in forward stages of production other than to the next stage
-  Back Flow: The percent of total shipments sold by sectors to sectors classified in earlier stages of production
-  Internal Flow: The percent of total shipments sold by sectors to sectors classified within the same stage of production

Note: These are calculated based on domestic transactions.

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