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Research and Statistics Department, Bank of Japan
TAKAHASHI Masato
KONDO Takuji
MUNAKATA Ko
OKUBO Tomohiro
IWASAKI Yuto

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Research and Statistics Department, Bank of Japan
TAKAHASHI Masato*
KONDO Takuji†
MUNAKATA Ko‡
OKUBO Tomohiro§
IWASAKI Yuto**

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Abstract

The Research and Statistics Department at the Bank of Japan compiles and publishes the Consumption Activity Index (CAI) to maintain a timely and accurate grasp of household consumption. This paper details revisions made to the compilation methodology of the CAI to improve its accuracy given recent changes in the consumption environment such as the expansion of e-commerce and the spread of the novel coronavirus (COVID-19). First, in addition to updating the weights on goods/services in accordance with the revision of the GDP statistics in December 2020, we replace the source statistics for items significantly impacted by COVID-19, such as food services and accommodations, to reflect the variations within each industry accurately. The revisions improve the performance of the CAI as measured by its correlation with and predictive power for household consumption in the *Annual Report of National Accounts*. Secondly, by incorporating "alternative data" based on credit card payments, we expand the range of online consumption captured by the CAI Plus, a supplementary index with the latitude to include newer goods/services, even where series of source statistics are short, in order to grasp shifts in consumption patterns promptly. COVID-19 has accelerated the expansion of online consumption, and digitalization is expected to entrench this shift in consumption from physical stores towards e-commerce in future. These trends point towards an increasing need to monitor the CAI Plus in addition to the original CAI going forward.

* Research and Statistics Department, Bank of Japan (E-mail: masato.takahashi@boj.or.jp)
† Research and Statistics Department, Bank of Japan (E-mail: takuji.kondou@boj.or.jp)
‡ Research and Statistics Department, Bank of Japan (currently at Financial System and Bank Examination Department; E-mail: kou.munakata@boj.or.jp)
§ Research and Statistics Department, Bank of Japan (E-mail: tomohiro.ookubo@boj.or.jp)
** Research and Statistics Department, Bank of Japan (currently at Monetary Affairs Department; E-mail: yuuto.iwasaki@boj.or.jp)
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1. Introduction

The Research and Statistics Department at the Bank of Japan compiles the Consumption Activity Index (CAI) to maintain a timely and accurate grasp of household consumption; the index is published as *Research Data* every month as shown in Chart 1.[1] Since the introduction of the CAI in 2016, we have steadily improved the index by attending to opinions and requests from outside users and incorporating newly available data (Nakamura *et al.* (2016a), Nakamura *et al.* (2016b), Kanafuji *et al.* (2018)). The revisions explained in this paper are in line with those past revisions.

Chart 1: The CAI Series Posted as "Research Data"

Index (CY 2011＝100, s.a.)	Background Data
Consumption Activity Index <Nominal, Real> Consumption Activity Index (travel balance adjusted) <Nominal, Real> Real Consumption Activity Index Plus Real Durable Goods Index Real Non-durable Goods Index Real Services Index	Nominal index, real index, deflator, and weights (as of April 2018)

While one of the purposes of the revisions this time is to make the CAI consistent with the revisions made to the *System of National Accounts* in Japan (hereafter the GDP statistics) in December 2020, we also update the CAI to capture shifts in consumption patterns due to the changes in the economic environment since the index was last revised. Specifically, the spread of COVID-19 since spring 2020 has caused an unprecedented decline in face-to-face services consumption on items such as restaurants and accommodations, generating large variations within sectors. Online consumption, however, had been expanding even before COVID-19, and the pandemic has driven an acceleration of this trend. Some of these changes are expected to be irreversible and to continue in future. Reflecting them properly in the CAI is, therefore, crucially important in terms of the index's accuracy for the relevant items and hence in its value as a reliable indicator of consumption movements.

The revisions can be categorized into the following two sets.[2] First are revisions to

[1] The *Research Data* are published on the Bank's website as part of its information provision regarding its research and analysis to users with interests in economic and financial developments. The CAI can be found at the following URL:
https://www.boj.or.jp/en/research/research_data/cai/index.htm/

[2] In addition to the revisions explained in the main text, we revise the method of seasonal adjustment used for the CAI. Please refer to the Appendix for the details of the revision.

weights and estimation methods in the CAI. In addition to updating the weights on goods/services to those as of CY 2015 in accordance with the revision of the GDP statistics in December 2020, we revise estimation methods for several items. Such items include "food services" and "accommodations," the sectors significantly influenced by the spread of COVID-19, for which we replace the source statistics with those based on the *Monthly Survey on Service Industries* to reflect variations within those sectors accurately. Second are revisions to the CAI Plus, incorporating alternative data based on credit card payments; these enable us to explicitly include online consumption of goods and to expand the range of online consumption for services.[3]

As a result of the first set of revisions above, the discrepancy between the original CAI series and consumption based on the *Annual Report of National Accounts* up to CY 2019 shrinks, and the correlation between these series improves. Moreover, the second set of revisions make both the CAI and the CAI Plus more useful by enabling proper real-time assessment of consumption activity including online consumption.

In section 2, we explain the revisions in more detail. In section 3, we examine the performance of the revised CAI and compare it with its performance prior to revision. Section 4 concludes, while highlighting some remaining challenges to be dealt with through future revisions.

2. Content of the revisions

2-1. Update of goods/services weights

We compile the CAI in two steps. The first step is to calculate the consumption indices by type (durable-goods, nondurable goods, and services), aggregating the component items ("automobiles," "household electrical appliances," etc.) in each consumption index using item-level weights (hereafter item weights) based on the *Input-Output Table*. In the second step, we aggregate the consumption indices calculated in step one using the appropriate weight for each consumption type (hereafter type weights) based on the domestic final consumption expenditure of households in the GDP statistics. We revise both item weights and type weights in accordance with the revisions made to the GDP statistics in December 2020, which include updating the benchmark year from 2011 to

[3] The CAI Plus is a supplementary index with greater latitude to incorporate newly available goods/services so as to grasp shifts in consumption patterns in a timely fashion. We include goods/services in the CAI Plus, but not in the original CAI, if the source statistics for those new items are available but short. For details, please refer to Nakamura *et al.* (2016a).

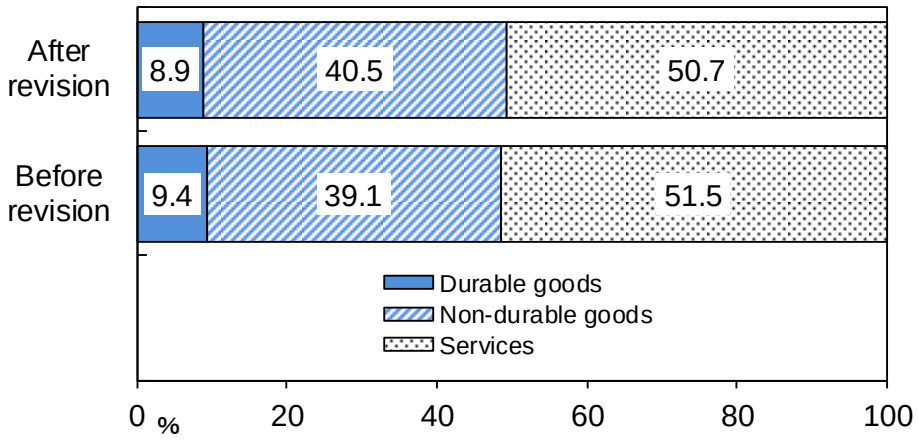
2015. We explain the content of the revisions in detail below.[4]

(1) Type weights

The benchmark year of the GDP statistics was changed from 2011 to 2015 at the time of the revision in December 2020. Accordingly, we update the type weights of the CAI from those for the CY 2011 figures, which followed the 2011-base GDP statistics, to the corresponding figures for CY 2015. At the same time, we update the benchmark year of the CAI from CY 2011 to CY 2015.

As a result of the revisions to the type weights, the weights on durable goods and services in the CAI shrink somewhat, while those on non-durable goods somewhat increase, as shown in Chart 2.

Chart 2: Type Weights in CAI



Sources: Bank of Japan, etc.

(2) Item weights

There are three main points of revision for the item weights.

First, we update the item weights of the CAI to reflect the shift in the base *Input-Output Table* from 2011 to 2015, so that the revision is consistent with the revision of the GDP statistics.

Secondly, we adjust the method used to calculate the weights on items related to travel so as to grasp more accurately travel-related consumption taking place through online travel

[4] We revise the weights of the CAI series only for the period starting CY 2015. As for the CAI series up to CY 2014, the type weights remain based on the CY 2011 figures from the 2011-base GDP statistics, and the item weights remain based on the CY 2011 figures from the 2011 *Input-Output Table*.

agencies (hereafter OTA)—that is, agencies without physical stores, which have rapidly expanded their market share in recent years. Before revision, as shown in Chart 3(1), the weight on "travel services" in the CAI was adjusted to include, in addition to the "package tour" component of "domestic final consumption expenditure of households" in the GDP statistics, some portion also of the weights on "accommodation service," "passenger transport by railway," and "passenger transport by air."[5] These extra weights were assigned to "travel services" to take into account the fees earned by travel agencies for travel other than package tours. However, the source statistics for "travel services" in the CAI are from the survey results for *Major Travel Agents' Revenue* released by the Japan Tourism Agency, whose respondents are primarily travel agencies with physical stores. Moreover, in recent years, OTA's share of sales has expanded rapidly while the sales of travel agencies with physical stores have weakened.[6] Thus, travel-related consumption in the CAI before revision may have been underestimated because the extra weights added to "travel services" amplify the weakness in sales at physical stores in a distortionary manner.

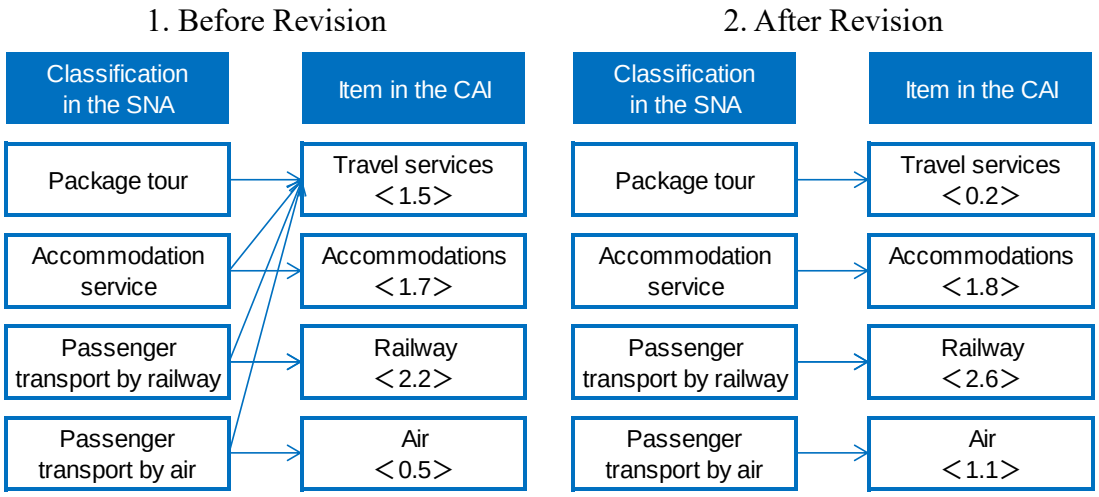
We therefore revise the weight on "travel services" so that it no longer includes the extra weights for "accommodations," "railway," and "air." In other words, the revised weights on "travel services," "accommodations," "railway," and "air" are identical to the corresponding items in the GDP statistics, as shown in Chart 3(2). Because the source statistics for "accommodations," "railway," and "air" in the CAI are the sales figures for accommodations (to be explained later), the number of railway passengers, and the number of airplane passengers, respectively, those items conceptually include travel services reserved through OTA.[7] The travel-related items as a whole in the CAI after revision, therefore, better capture the impact of the increased share of OTA.

[5] Because the weights on the 88 categories (divided by purpose) that make up the "domestic final consumption expenditure of households" in the GDP statistics are not publicly available, the CAI employs weights estimated using other statistics including the *Input-Output Table*. For details, please refer to the Appendix of Kanafuji *et. al.* (2018).

[6] See Japan Association of Travel Agents (2019) for the share of OTA.

[7] Strictly speaking, the source statistics for both "railway" and "air" in the CAI come from the corresponding figures in the *Indices of Tertiary Industry Activity*, whose source statistics are the numbers of railway/airplane passengers.

Chart 3: Weights on Travel-Related Items in the CAI



Note: The arrows indicate the correspondence between the classifications in the *System of National Accounts* (SNA) and the relevant item in the CAI. The classification in the SNA refers to the 88-purpose classification of domestic final consumption expenditure of households in the SNA. Figures in angular brackets show the weights on each item in the CAI.

Sources: Cabinet Office; Bank of Japan, etc.

The third point of revision for the item weights relates to the weights on "game software" and "digital contents delivery services," which we correct in order to adjust for the oversensitivity of the CAI to the impact of movements in these items before revision. There are no items that directly correspond to these in the *Input-Output Table*. Therefore, when the CAI was last revised in 2018, the weights adopted for these two items were, respectively, those on "computer programming and miscellaneous software services" and "internet based services" –namely, the respective upper categories containing each of these items in the *Input-Output Table*. The assumption behind this calculation method was that developments in "game software" and "digital contents delivery services" would basically follow those in their respective upper categories. However, the evidence to date suggests that this assumption does not hold: sales of game software exhibit a rather different trend from sales of "software excluding games" due to idiosyncratic factors such as releases of new games; meanwhile, the prevalence of digital delivery of various contents in recent years means that these are also likely to follow a different path from other internet-based services. We therefore no longer use the weights of the upper categories as they are but instead multiply them by the respective shares of each item within the category to obtain the estimated item weight.[8] After the revision, the CAI

[8] Specifically, to calculate the weight on "game software," we multiply the weight on "computer programming and miscellaneous software services" in the *Input-Output Table* by the sales share of "game software" among "software products" based on the *Current Survey of Selected Services*

incorporates the two items using more accurate weights.

Chart 4 shows the new item weights after the revisions explained so far. For durable goods, the weight on "automobiles" increases somewhat relative to the weight on "household electrical appliances." For non-durable goods, the weight on "food and beverages" increases, while that on "fuel" declines. As for services, the item "care services" has a larger weight partly because of Japan's aging demographic.[9] In addition, the weight on "travel services" declines while those on "railway" and "air" increase as a result of the change in the weight calculation method for those items described above.

Industries. As for the item "digital contents delivery services," we multiply the weight on "internet-based services" in the *Input-Output Table* by the sales share of "digital contents delivery services" among the "internet-related services industry" based on the same survey. The sales shares of both items are those for CY 2015.

[9] In accordance with the re-benchmarking of the *Indices of Tertiary Industry Activity* from CY 2011 to CY 2015, the source statistics for "care services" in the CAI are changed from "care services" to "social welfare," the latter including not only care services but also other social welfare services. Because the weight on "care services" before revision is based on only "nursing care" in the *Input-Output Table*, we revise it by adding the weight on "social insurance and social welfare" to that of "nursing care," thus ensuring that the weight after revision is consistent with the expanded coverage of the source statistics. The increase in the weight of "care services" after revision is partly due to this change.

Chart 4: Item Weights in the CAI

Item	Before revision		After revision	
Durable goods	9.4	—	8.9	—
Automobiles	3.6	<38.1>	4.1	<46.6>
Household electrical appliances	5.8	<61.9>	4.7	<53.4>
Non-durable goods	39.1	—	40.5	—
Food and beverages	18.6	<47.6>	19.6	<48.4>
Clothes	4.3	<10.9>	4.9	<12.0>
Fuel	3.5	< 8.8>	2.7	< 6.8>
Drugs, cosmetics, etc.	5.5	<14.1>	6.5	<16.1>
Electricity	2.1	< 5.3>	2.2	< 5.4>
Gas	1.2	< 3.1>	1.1	< 2.6>
Water	0.8	< 2.1>	0.8	< 1.9>
Newspapers	0.3	< 0.7>	0.4	< 0.9>
Books and magazines	0.4	< 0.9>	0.3	< 0.8>
Game software	0.4	< 1.1>	0.2	< 0.6>
Tobacco	2.1	< 5.2>	1.9	< 4.6>
Services	51.5	—	50.7	—
Food services	12.1	<23.4>	11.3	<22.3>
Travel services	1.5	< 3.0>	0.2	< 0.4>
Medical and other health care services	5.1	<10.0>	5.0	< 9.9>
Care services	0.4	< 0.7>	1.8	< 3.6>
Communications	6.1	<11.8>	5.2	<10.2>
Railway	2.2	< 4.3>	2.6	< 5.1>
Bus	0.9	< 1.7>	0.8	< 1.7>
Taxi	1.3	< 2.6>	1.1	< 2.1>
Air	0.5	< 1.1>	1.1	< 2.1>
Postal services	0.1	< 0.2>	0.1	< 0.2>
Services for amusement and hobbies	4.7	< 9.2>	4.8	< 9.5>
Accommodations	1.7	< 3.3>	1.8	< 3.5>
Supplementary tutorial schools	1.7	< 3.4>	1.3	< 2.6>
Ceremonial occasions	1.9	< 3.7>	1.4	< 2.7>
Public broadcasting	0.4	< 0.8>	0.4	< 0.7>
Automobile parking	1.1	< 2.2>	1.3	< 2.5>
Financial services	1.6	< 3.1>	1.8	< 3.6>
Life insurance	5.7	<11.0>	6.0	<11.8>
Non-life insurance	0.6	< 1.1>	1.2	< 2.3>
Automobile maintenance	1.8	< 3.4>	1.6	< 3.2>

Note: Figures in angular brackets show the weights within each category. Non-durable goods include goods classified as "semi-durable goods" in the GDP statistics. Services exclude imputed rent.
Sources: Bank of Japan, etc.

2-2. Revision of estimation methodology for items in the original CAI

The spread of COVID-19 has caused unprecedented declines in consumption, especially face-to-face services consumption, and given rise to large variations within affected sectors. We change the source statistics for related items in the CAI so that the index reflects movements in those sectors more precisely. In addition, because the predictive power of extrapolation for travel balances (i.e., inbound and outbound consumption) has worsened since the start of the pandemic, we update the method of extrapolation. Furthermore, we change the source statistics for items such as "food and beverages" and "clothes" to alleviate monthly fluctuations, and revise the method of estimating "tobacco" and "life insurance," where problems have been recognized for some time.

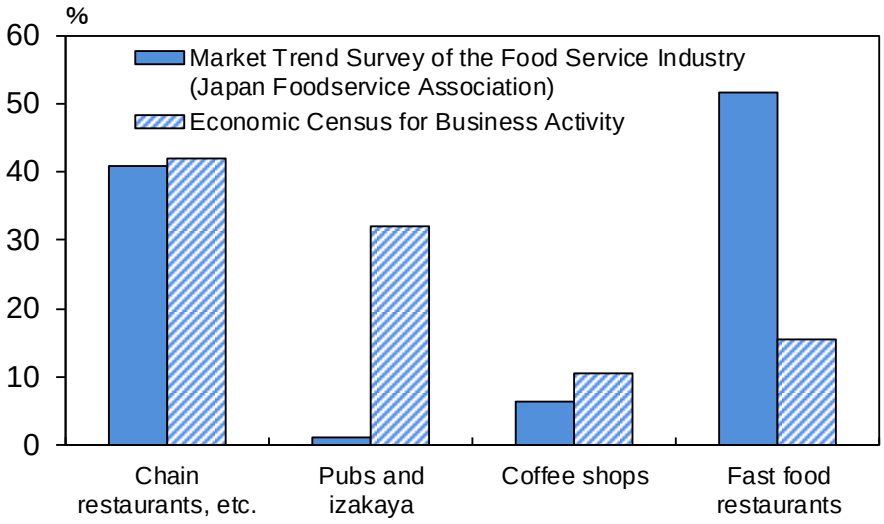
(1) Revision of source statistics for "food services"

The item "food services" in the CAI before revision employs the *Market Trend Survey of the Food Services Industry* published by the Japan Foodservice Association (hereafter the JFSA Survey). In contrast, the GDP statistics employ the *Monthly Survey on Service Industries* (hereafter the Monthly Survey) for food services.[10] The movements of the two statistics have diverged, especially since the outbreak of COVID-19.

The difference between the two statistics is presumably due to compositional differences in the categories of food services included as well as differences in enterprise sizes. The share of pubs and *izakaya* (Japanese pubs) is smaller in the JFSA Survey compared to the *Economic Census*, while the share of fast food restaurants is larger. Since the *Economic Census* provides the population from which the Monthly Survey is drawn, the composition of the two is presumed to be similar. Furthermore, whereas the JFSA Survey sample comprises primarily large enterprises, the Monthly Survey includes small enterprises and so reflects sales movements for both large and small enterprises.

[10] At the last revision of CAI in 2018, the idea of incorporating the Monthly Survey into the CAI items was considered from the perspective of consistency with the GDP statistics; however, the proposal was not adopted, partly because the shortness of the series meant that seasonal adjustments were not stable. In this regard, the larger accumulation of data to date has improved the stability of seasonal adjustments.

Chart 5: Shares of Food Services Industry by Category

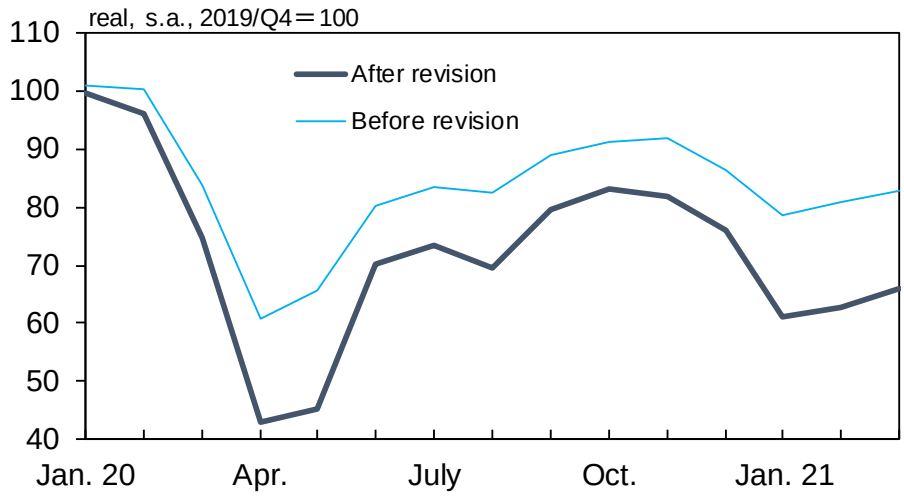


Note: "Chain restaurants, etc." include dinner restaurants. Figures for "Economic Census for Business Activity" are calculated using the category classification according to the Japan Foodservice Association. Figures for "Market Trend Survey of the Food Service Industry" are calculated based on the number of outlets and those for "Economic Census for Business Activity" on the number of establishments.
Sources: Ministry of Internal Affairs and Communications; Japan Foodservice Association, "Market Trend Survey of the Food Service Industry."

When heterogeneity by category and size is not large, such differences do not significantly affect movements in "food services" as a whole. However, the spread of COVID-19 and the resultant public health measures have put especially severe downward pressure on vendors that primarily operate at night, such as pubs, *izakaya*, and dinner restaurants. By contrast, sales at fast food restaurants have been relatively solid, taking advantage of the increased demand for takeaways. As a result, since the onset of the spread of COVID-19, sales recorded in the JFSA Survey are much stronger than those in the Monthly Survey. Because of this difference, shown in Chart 6, we revise the source statistics for "food services" by replacing figures from the JFSA Survey with the sum of sales for "eating and drinking places" and "food take out and delivery services" from the Monthly Survey.[11] As mentioned above, because the GDP statistics employ the Monthly Survey as source statistics for food services, the current revision of the source statistics for the CAI is expected to enhance the correlation between the CAI and the *Annual Report of National Accounts*.

[11] Because the time series for the Monthly Survey with its current survey framework are publicly available only for the period since January 2013, we use the series before revision for the period up to and including December 2012. The same applies to "accommodations" explained below.

Chart 6: Revision of "Food Services"



Sources: Bank of Japan, etc.

Note that the results of the Monthly Survey are released with a lag of two months from when the survey was conducted, at around the end of the month, which is after the release of the corresponding JFSA Survey. Thus, the figure for the latest month needs to be extrapolated. For the extrapolation, we employ a weighted average of the category-level sales based on the JFSA Survey using sales shares by category in the 2015 *Economic Census* as weights. We have confirmed that the extrapolation method performs well in terms of its predictive power.

(2) Revision of the source statistics for "accommodations"

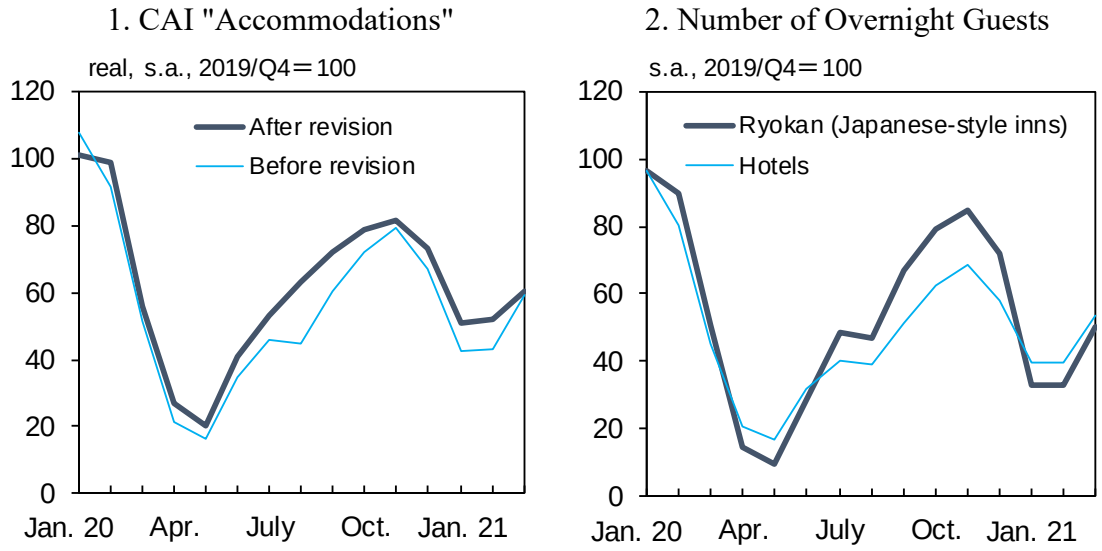
For the item "accommodations" in the CAI, we switch source statistics from the *Statistical Survey on Overnight Travel* (hereafter the SSOT) to accommodation sales in the Monthly Survey, which are the figures employed in the GDP statistics.[12] As stated above, because the figures for the Monthly Survey for the latest month are not available at the point when we compile the CAI for that month, we extrapolate the data using statistics including the SSOT.

This switching of the source statistics for "accommodations" also accounts better for the impact of COVID-19. Specifically, because the SSOT tracks movement in the number of overnight guests, it does not reflect changes in unit price. By contrast, because the

[12] Strictly speaking, the SSOT provides the source statistics for the accommodation figures in the *Indices of Tertiary Industry Activity*, which in turn are used as source statistics for "accommodations" in the CAI.

Monthly Survey follows movement in accommodation sales, its ups and downs reflect not only changes in numbers of guests but also changes in unit price. With this difference in mind, a comparison of the CAI series "accommodations" before and after revision (see Chart 7(1)) shows the post-revision series to be stronger during the period from summer to winter 2020 when the "Go To Travel" campaign was supporting the sector. The difference between the two series is consistent with the more marked recovery of Ryokan (Japanese-style inns), where unit price per night is higher, relative to hotels, as shown in Chart 7(2). These observations demonstrate the importance of accounting properly for changes in unit price.

Chart 7: Revision of "Accommodations"



Sources: Japan Tourism Agency; Bank of Japan, etc.

(3) Revision of the extrapolation method for travel balances

As a part of the CAI series, we compile and release the CAI (travel balance adjusted), which excludes inbound tourism consumption and includes outbound tourism consumption in order to capture consumption by Japanese citizens.[13] For the adjustment of travel demand, we employ the travel balance from the *Balance of Payments* (hereafter BoP). When the figure from the BoP for the latest month was not available, before the current revision, we extrapolated the data using the month-on-month rates of change for the numbers of inbound/outbound visitors released by the Japan National Tourism

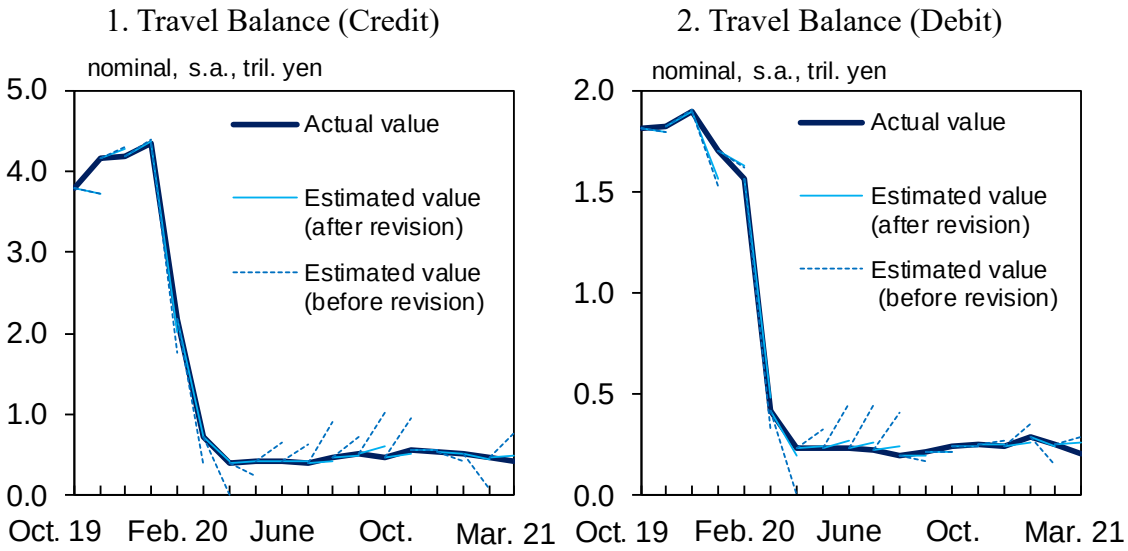
[13] The CAI (travel balance adjusted) is conceptually consistent with the "consumption of households" in GDP. We therefore use the "consumption of households" in the *Annual Report of National Accounts* as a benchmark to evaluate the performance of the CAI (travel balance adjusted) in section 3.

Organization (JNTO).

Chart 8 shows that the figures obtained by the extrapolation method above have tended to diverge significantly from their actual values since the spring of 2020. The reason for the divergence is that, given there have been almost no inbound/outbound visitors due to the spread of COVID-19, most of the recent travel balance has been ascribed to international students, etc., counted as "personal/education-related" in the BoP, which do not move in line with the number of inbound/outbound visitors.

After revision, therefore, we use a new extrapolated figure that is the sum of two terms. One term is the travel balance for international students, etc., which is assumed to be the same as the latest figure. The other term is the travel balance for tourists and business visitors, which is extrapolated using month-on-month rates of change for the numbers of inbound/outbound visitors in the same way as the CAI before revision. The extrapolated figures after revision are almost identical to the actual values for the travel balance, suggesting a significant improvement in the performance of the extrapolation.

Chart 8: Performance of the New Extrapolation Method for the Travel Balance



Note: To evaluate the performance of the estimation accuracy, real-time data for the travel balance are used.
Source: Ministry of Finance and Bank of Japan.

(4) Revision of items such as "food and beverages" and "clothes"

The source statistics for the nominal series of "food and beverages," "clothes," and "drugs, cosmetics, etc." include the sales of corresponding goods at department stores and supermarkets in the *Current Survey of Commerce* (CSC). Since the last revision in 2018,

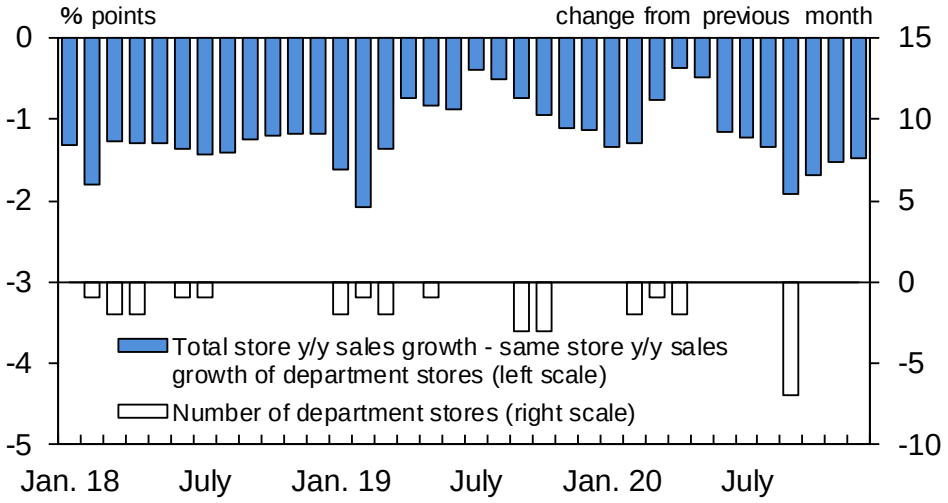
the CAI has employed figures based on all department store and supermarket establishments on the assumption that these figures track macro consumption well.[14] However, store closings, especially of department stores in countryside areas, have recently become more frequent, increasing fluctuation in the sales of all establishments and generally complicating the overall picture of the consumption trend, as shown in Chart 9.

With this background in mind, we computed the consumption figures for the CAI non-durable goods in two ways, one using sales of all establishments for "food and beverages," "clothes," and "drugs, cosmetics, etc." and the other using adjusted figures for the same items. We then compared the performance of the two series by computing the correlations between each and the corresponding series in the *Annual Report of National Accounts*, which comprise the sums of the consumption of semi-durable goods and non-durable goods. The comparison confirms that switching to the adjusted figures, which exclude monthly fluctuations due to stores closing, has no negative impact on performance for department stores, but significantly worsens performance for supermarkets. We therefore replace the sales of all establishments with the adjusted figures for department stores, while we continue using the sales of all establishments for supermarkets.[15]

[14] The CSC releases time series data for sales of all establishments as well as a set of adjusted figures. The adjusted figures track only the sales of establishments which have reported sales data without interruption since the same month in the previous year. In contrast, the sales of all establishments also reflect changes in the number of establishments due to opening/closing of stores.

[15] The CAI series "drugs, cosmetics, etc." before revision used the sales of "others" from the CSC, which comprised total sales of department stores and supermarkets excluding "food and beverages" and "clothes". To improve the accuracy of the CAI after revision, we made a partial change to how the figures for "drugs, cosmetics, etc." are calculated. Specifically, we exclude "household electric appliances" sold by department stores and supermarkets (actually included under "others" in the CSC) from the CAI figures for "drugs, cosmetics, etc." and include them instead under "household electric appliances." Moreover, because the figures for "restaurants and cafés" included under "others" in the CSC are not conceptually compatible with the CAI figures for "drugs, cosmetics, etc.," we exclude the contribution of "restaurants and cafés" from the CAI numbers.

Chart 9: Comparison of sales of all enterprises and adjusted figures for department stores



Source: Ministry of Economy, Trade and Industry.

(5) Revision of "tobacco"

Before revision, the CAI "tobacco" series primarily employed the sales of cigarettes compiled by the Tobacco Institute of Japan (TIJ) as source statistics.[16] In the current revision, we change the method for calculating the CAI "tobacco" figures to account for sales of heat-not-burn (HNB) tobacco, given that there has been a shift in demand from cigarettes to HNB tobacco in recent years.[17] Specifically, we add the sales of HNB tobacco published by the TIJ to the sales of cigarettes from the second quarter of 2020.[18] Up to and including the first quarter of 2020, when sales figures for HNB tobacco were not available from the TIJ, we estimate the sales of HNB tobacco using investor relations information from major tobacco companies.

The comparison between the CAI figures for "tobacco" before and after revision in Chart

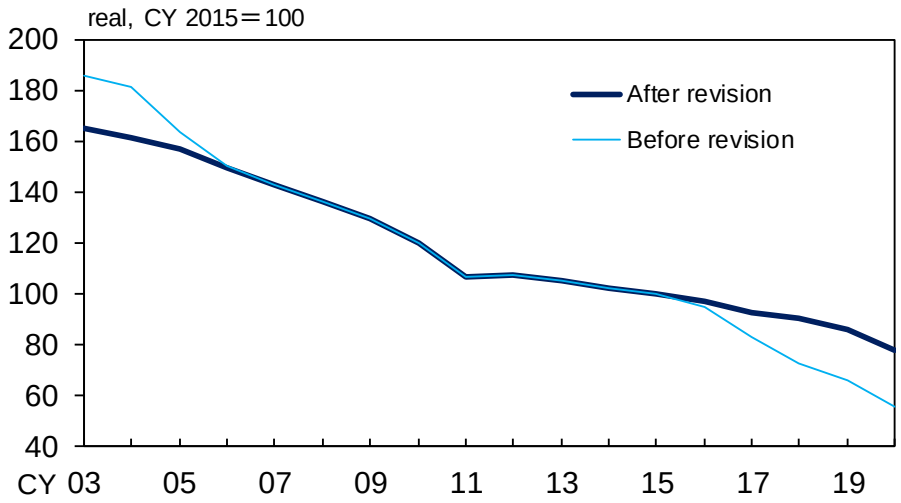
[16] Since April 2020, because monthly figures of the sales of cigarettes have been no longer available, to estimate the more recent data, CAI has used "tobacco" in the *Indices of Industrial Shipments* published by Ministry of Economy, Trade, and Industry.

[17] Before revision, for the period up to and including March 2006, when monthly figures for the sales of cigarettes were not available, the month-on-month rates of change for "tobacco" in the *Indices of Industrial Shipments* were used to extrapolate the CAI "tobacco" backwards. After revision, we instead employ the sales figures for cigarettes for each fiscal year, which we divide into monthly figures using the *Indices of Industrial Shipments*.

[18] Because the frequency of the sales of HNB tobacco are quarterly, and the latest figures are published with a lag of about two months, we need to divide the quarterly figures into monthly figures and extrapolate the series to estimate the values for the latest months. For those estimates, we use the "tobacco" series in the *Indices of Industrial Shipments*.

10 indicates that, due to the declining trend in the number of smokers, consumption of tobacco has been decreasing in both series, but the pace of decrease for the series after revision is milder than that before revision. This observation suggests that the pace of decrease before revision was overestimated due to the shrinking market share of cigarettes.

Chart 10: Revision of "tobacco"



Sources: Bank of Japan, etc.

(6) Revision of "life insurance"

As pointed out by Nakamura *et al.* (2016b), the CAI figures for the latest months for "life insurance", which were estimated by extrapolation, tended to suffer from large revisions when they were replaced by actual values.[19] In addition, the "life insurance" series in the *Indices of Tertiary Industry Activity*, which provided the source statistics for the CAI "life insurance" figures before revision, is conceptually different from the corresponding series in the GDP statistics. Specifically, while the series in the *Indices of Tertiary Industry Activity* describes the developments in insurance premiums, the series in the GDP statistics basically captures the margin, that is, the difference between the insurance premiums paid to insurance companies by households and the insurance claims that the companies pay out.[20]

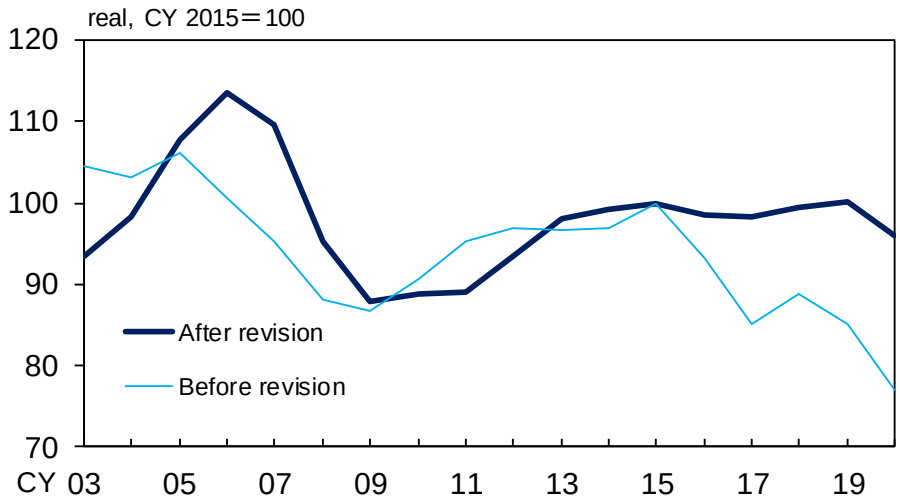
[19] The series "life insurance" in the *Indices of Tertiary Industry Activity* are based on the data of insurance premium that life insurance companies receive from households, for which actual data are reflected to the indices two months after the release of CAI. This implies that extrapolation is required for latest months, though, as pointed out by Nakamura *et al.* (2016b), accurate extrapolation is extremely difficult due to irregular fluctuations of insurance premium.

[20] More precisely, output of life insurance in the GDP statistics is estimated using the following equation:

output = premiums – claims incurred + net investment income – net increase in reserves

We revise "life insurance" in the CAI so that the estimation of the series follows that of the GDP statistics. Specifically, we stop using the series "life insurance" in the *Indices of Tertiary Industry Activity* as the source statistics for the CAI "life insurance" figures. We instead estimate a series that approximates the output of life insurance in the GDP statistics, following the estimation methodology explained by Fujiwara (2014) and employing a variety of data resources for each fiscal year, including the *Summary of Life Insurance Business* published by the Life Insurance Association of Japan and the financial statements of life insurance companies.[21] The CAI series "life insurance" after revision, shown in Chart 11, exhibits rather different trend behavior from the series before revision, which covered only insurance premiums. As we mention later, the revision of "life insurance" in the CAI contributes significantly to improvement in the correlation between the CAI and the *Annual Report of National Accounts*, especially for services consumption.

Chart 11: Revision of "life insurance"



Sources: Bank of Japan, etc.

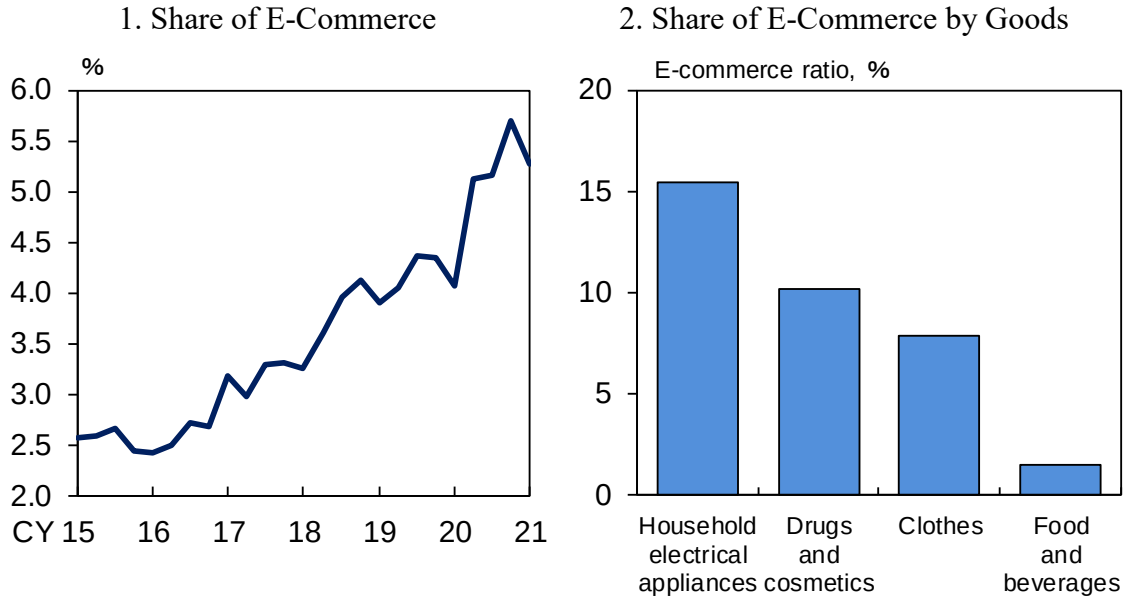
For details, please refer to Yamazaki (2016).

[21] Because we estimate the output of life insurance using data for each fiscal year, we need to divide the data into monthly figures to make it compatible with the CAI. To do this, we divide the data by smoothing the annual data, assuming that changes in the output of life insurance are smooth. For the latest period, for which data are not available, we extrapolate the figures by using the linear trend based on the data for the past three years.

2-3. Revision of CAI Plus to capture digitalization of economy

In this revision, we explicitly incorporate online consumption into the CAI Plus, an index that supplements the CAI series. Chart 12 shows how the share of consumption taking place online (e-commerce) has exhibited a clear upward trend in recent years. Especially after the spread of COVID-19, the number of households purchasing online has clearly increased, a development that has begun to extend to the elderly population, most of whom did not use e-commerce before.[22] In this regard, it is increasingly important to capture online consumption in order to understand consumption in Japan properly.

Chart 12: Online Consumption



Note: Figures are calculated using "expenditure on goods and services ordered over the Internet" in the Survey of Household Economy and "consumption expenditure" in the Family Income and Expenditure Survey. Figures for the e-commerce ratio by goods are for CY 2016.
Source: Ministry of Internal Affairs and Communications.

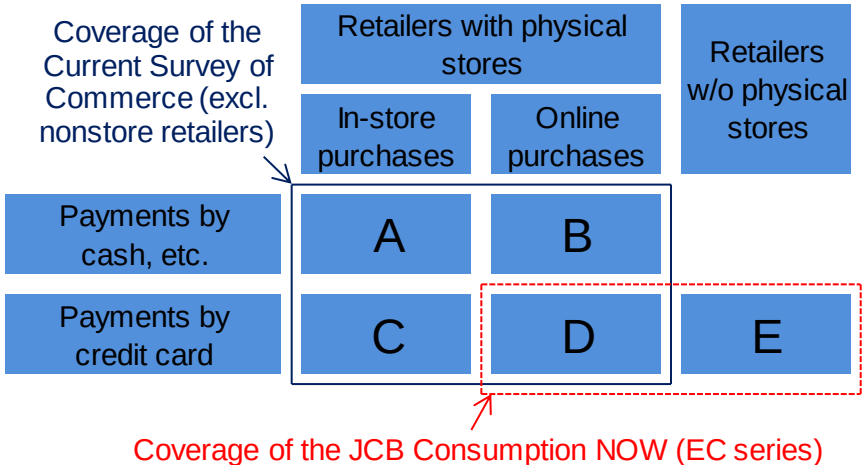
Up until recent years, because there were no adequate source statistics capturing online consumption with monthly frequency and by item of goods/services, we did not explicitly incorporate online consumption. However, consumption data compiled based on credit card payments have recently become available, making it easier to capture online consumption, which is largely paid for using credit cards. The current revision introduces *JCB Consumption Now*, one of the consumption indices based on credit card payments, to expand the range of online consumption captured by the CAI Plus. We explain the details regarding particular goods and services below.

[22] Please refer to BOX 4 of the Outlook for Economic Activity and Prices (Outlook Report) of the Bank of Japan, January 2021.

(1) Incorporating online consumption of goods

Among the CAI series for goods, source statistics for items including "household electrical appliances," "food and beverages," and "clothes" are drawn from the *Current Survey of Commerce* (CSC) published by Ministry of Economy, Trade and Industry. As described in Chart 13, the CAI series for these items before revision include "B+D," online sales by enterprises with physical stores, but not E, online sales of enterprises without physical stores.[23] This is because, for those enterprises without physical stores, classified as "non-store retailers" in the CSC, data for sales by item are not publicly available.

Chart 13: Coverage of Online Consumption



The current revision incorporates the part of online consumption not covered by the CAI before revision into the CAI Plus, by employing the "EC" series, which record only online consumption, from *JCB Consumption Now*. We note that the series in *JCB Consumption Now* are demand-side indices, because they are compiled based on payment data for credit card holders.[24] Before the current revision, the CAI did not incorporate existing demand-side statistics due to the large fluctuations caused by the small sample size. Incorporating

[23] In addition, the CSC may fail to capture those sales labelled "D" in Chart 13 if (a) establishments focusing on online stores are not sampled in the *Survey of Commerce* (or *Economic Census* for some periods, including the latest period since March 2020), which provides the population from which the CSC is sampled; (b) respondents to the CSC do not include sales through online stores; or (c) establishments not classified as retailers according to the industry classification sell products to consumers online. By contrast, the "EC" series in *JCB Consumption Now* covers part "D" explicitly.

[24] *JCB Consumption Now* is compiled based on the purchase histories of about 1 million users randomly sampled from holders of JCB cards. *JCB Consumption Now* publishes two series: IM (intensive margin) series that capture changes in the consumption of credit card holders; and IM+EM (extensive margin) series that include changes in the number of card holders. The current revision of the CAI Plus employs the IM+EM series.

the *JCB Consumption Now* data is deemed helpful in this regard, because the large sample size of *JCB Consumption Now* (about 1 million users) reduces the likelihood of fluctuations resulting from sample noise. However, we need to pay attention to the concern that movements in the *JCB Consumption Now* data may be sensitive to shifts in payment methods, for example from cash to credit cards triggered by the spread of COVID-19, which are irrelevant to the consumption expenditure that the index is designed to track.

The items for which we incorporate online consumption are "household electrical appliances," "food and beverages," "clothes," and "drugs, cosmetics, etc.," for which, as shown above in Chart 12(2), the share of e-commerce is relatively high and *JCB Consumption Now* provides item-level "EC" series. We explain how we incorporate the *JCB Consumption Now* data, taking "household electrical appliances" as an example. We obtain the series incorporating online consumption shown in Chart 14(2) by taking a weighted average of (a) the CAI series "household electrical appliances" that excludes online consumption (also shown in Chart 14(2)) and (b) the "EC (machinery and equipment)" series from *JCB Consumption Now*. For the weight, we adopt the share of online consumption in consumption expenditure for the corresponding item, which we estimate using the *Survey of Household Economy*, etc.[25,26] Because the time series in *JCB Consumption Now* start in April 2015, we can incorporate online consumption only after that date; for the series up to and including March 2015, we extrapolate backwards using the month-on-month rates of change for the series before revision.

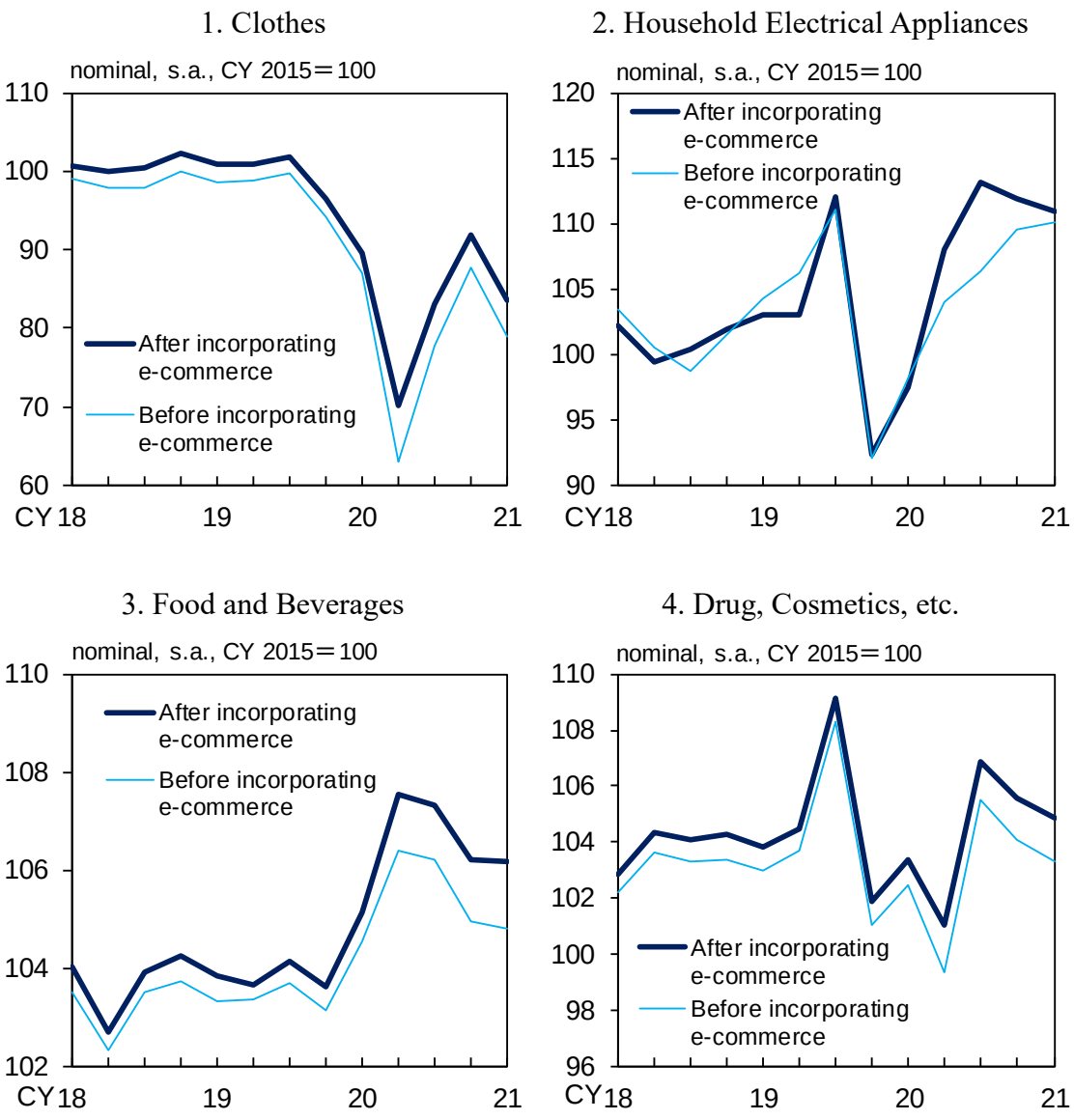
Chart 14 compares the series with and without online consumption for the four items "household electrical appliances," "food and beverages," "clothes," and "drugs, cosmetics, etc." For all four items, the series that explicitly incorporate online consumption are stronger than those without—as expected, given the increase in e-commerce's share of

[25] The online share of consumption for each item is obtained by dividing online purchases of the item in the *Survey of Household Economy* during CY 2016 by overall expenditure on the item in the *Family Income and Expenditure Survey* during CY 2016. Before taking the weighted average, both series are standardized so that their averages over CY 2016 equal 100.

[26] For online purchases through websites offering products in a variety of categories (multi-category e-commerce websites), even if the product purchased could be naturally classified into one of the four items, "household electrical appliances," "food and beverages," "clothes," or "drugs, cosmetics, etc.," the purchases are not included in the item-level series in *JCB Consumption Now*. However, the share of e-commerce, which we use to aggregate the series based on the CSC and the "EC" series in *JCB Consumption Now*, is estimated using demand-side statistics and so includes purchases through multi-category e-commerce websites among e-commerce purchases. This means that, if the rates of change in the purchases of each item through multi-category e-commerce websites are similar to the rates of change in the purchases of those same items through single-category e-commerce websites (included in the item-level data in *JCB Consumption Now*), then the CAI Plus effectively captures purchases through multi-category e-commerce websites.

consumption after the onset of the pandemic. The four series incorporating online consumption are included only in the supplementary CAI Plus, and not the CAI, due to the shortness of the time series and the concern that they may be affected by shifts in payment methods.

Chart 14: Developments of consumption by item with and without online consumption

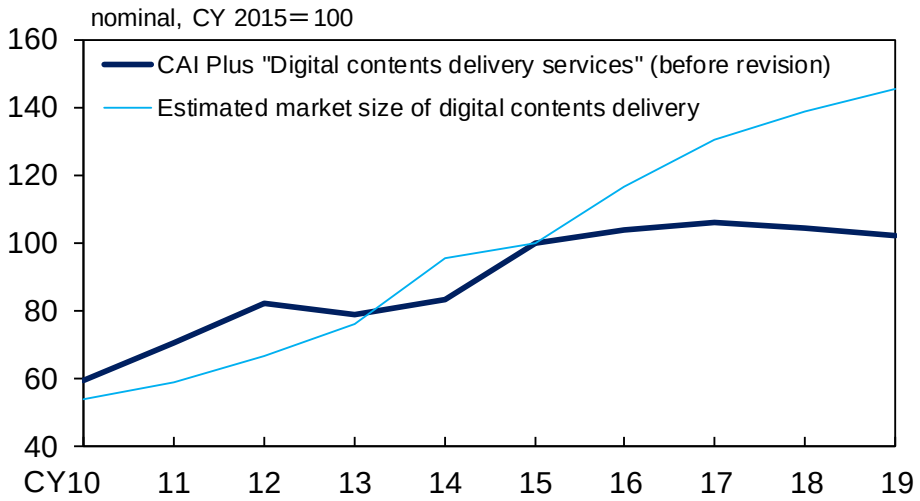


Sources: Bank of Japan, etc.

(2) Expansion of coverage of online consumption for services

Even before the current revision, the CAI Plus captured the consumption of various contents delivery services such as music and movies through the item "digital contents delivery services." However, as shown in Chart 15, the series has remained almost flat since around 2015, which is not consistent with the expanding market volume of digital contents delivery services suggested by industry statistics. This discrepancy suggests that, for some reason, sales of digital contents delivery services in the *Current Survey of Selected Service Industries*, the source statistics for the item in the CAI Plus before revision, may be underestimated.[27]

Chart 15: Developments in digital contents delivery services



Note: Figures for the estimated market size of digital contents delivery are the estimated market size of digital contents (excluding advertisements) distributed via computers or mobile phones.
Sources: Bank of Japan; Digital Content Association of Japan, etc.

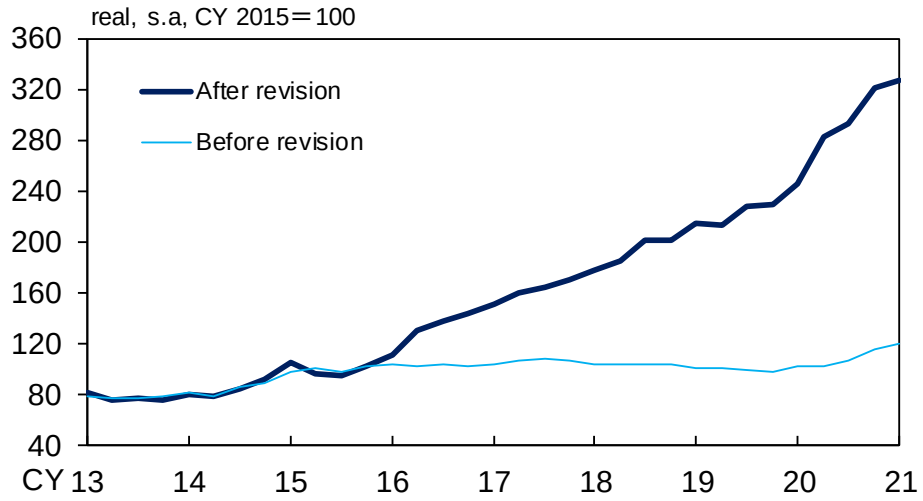
We replace the source statistics for the item "digital contents delivery services" in the CAI Plus with "contents delivery services" from *JCB Consumption Now* so that the item captures consumption better.[28] As stated above, *JCB Consumption Now* comprises

[27] A possible source of the discrepancy is inadequate representation of new enterprises in the *Economic Census*, which provides the population for the *Current Survey of Selected Service Industries*, as newcomers are playing an important role in the rapidly expanding market of digital contents delivery services. For markets where existing enterprises have a declining market share due to competition from new entrants, supply-side statistics, including the *Current Survey of Selected Service Industries*, may underestimate market volume if they are slow to incorporate newcomers.

[28] In the current revision, we also change the price index used to convert the nominal "digital contents delivery services" series into real terms, from "internet based services" in the *Services Producer Price Index*, utilized before revision, to "charges for web content" in the *Consumer Price Index*, utilized afterwards. Because the series "contents delivery services" in *JCB Consumption Now* are available only since April 2015 and the series "charges for web content" in the *Consumer Price Index* are

demand-side indices based on information from credit card payments. For markets such as digital contents delivery services in which market volume rapidly expands with the entry of new enterprises, demand-side statistics may well provide a more accurate estimate of market volume than supply-side statistics such as the *Current Survey of Selected Service Industries*. In fact, Chart 16 shows the "digital contents delivery services" series in the CAI Plus after revision exhibiting a remarkable increase in recent years, from which we judge that the series after revision captures the expansion of the market better than the series before revision.

Chart 16: Revision of "digital contents delivery services"



Sources: Bank of Japan, etc.

3. Performance of the CAI after revision

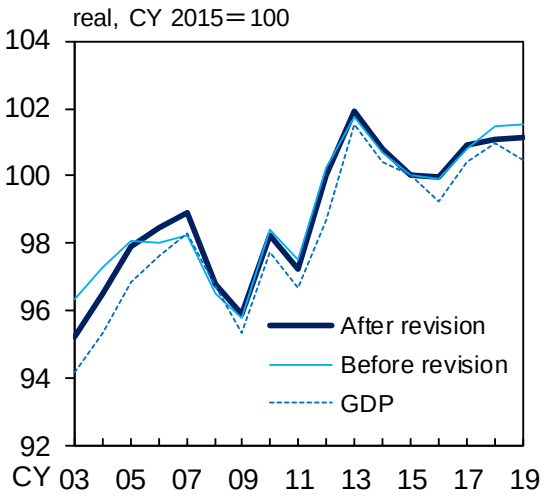
This section examines the performance of the CAI after the revisions explained in the previous section by comparison with its performance before revision.

First, as was done for the previous revisions of the CAI, we calculate the correlation between the original CAI (travel balance adjusted) series with the "consumption of households excluding imputed rent" in the *Annual Report of National Accounts* (ARNA), which are generally regarded as the series that capture consumption most comprehensively. As shown in Chart 17, the index after revision boasts higher correlation coefficients in terms of both level and year-on-year rates of change than the index before revision. In addition, in terms of the power of the CAI to predict the ARNA, the index after revision shows smaller errors than the index before revision.

available only since January 2010, we estimate the data for periods of unavailability by extrapolating backwards using the series before revision.

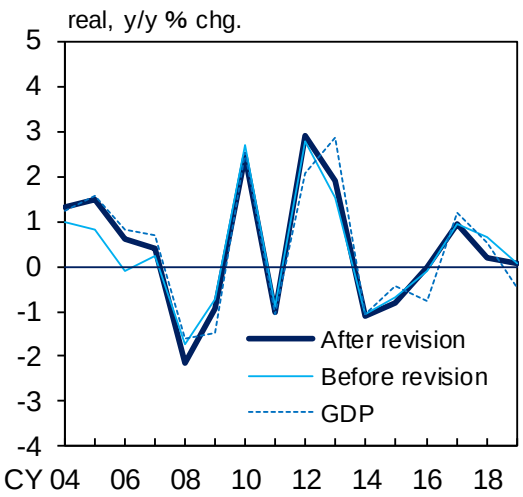
Chart 17: Performance of the CAI (travel balance adjusted) before and after revision

1. Level



	Before revision	After revision
Correlation	0.95	0.99
RMSE	0.75	0.62
MAE	0.97	0.72

2. Year-on-Year Change



	Before revision	After revision
Correlation	0.91	0.94
RMSE	0.48	0.38
MAE	0.59	0.47

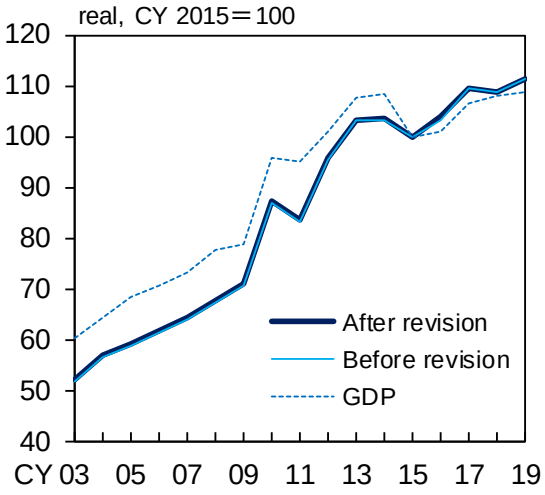
Notes: 1. "GDP" refers to the consumption of households (excluding imputed rent) in the GDP statistics.
2. Correlation, RMSE (Root Mean Squared Error), and MAE (Mean Absolute Error) are calculated in relation to GDP. Sample periods are CY 2003-2019 for the left chart and CY 2004-2019 for the right chart.

Sources: Cabinet Office; Bank of Japan, etc.

Comparisons of correlation coefficients and predictive power by type of consumption, shown in Chart 18, also confirm that the index after revision mostly performs better. Especially for services, the improvement in the performance of the CAI after revision in terms of both correlation coefficients and predictive power is notable, because of the revision of items such as "food services," "accommodations," and "life insurance," as well as the change in item weights.

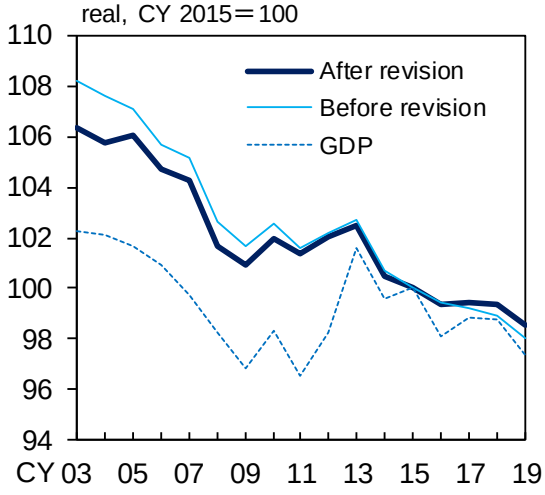
Chart 18: Performance of CAI by type before and after revision

1. Durable Goods



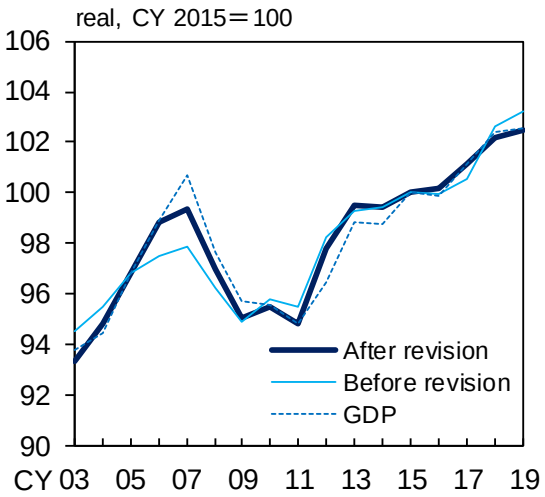
	Before revision	After revision
Correlation	0.98	0.99
RMSE	6.35	6.13
MAE	7.26	6.96

2. Non-durable Goods



	Before revision	After revision
Correlation	0.72	0.74
RMSE	3.19	2.69
MAE	3.86	3.16

3. Services



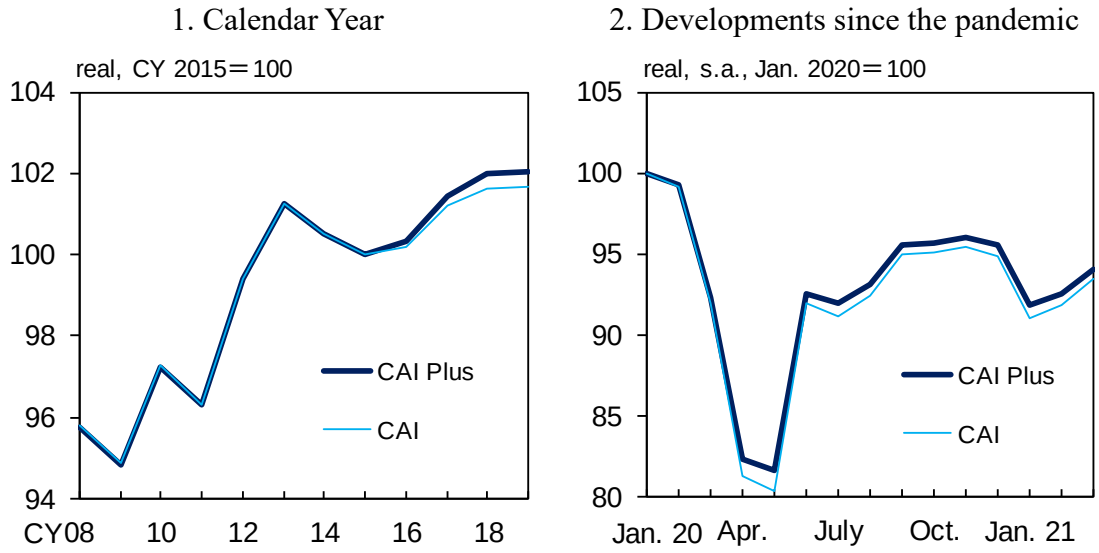
	Before revision	After revision
Correlation	0.92	0.98
RMSE	0.80	0.40
MAE	1.06	0.58

Notes: 1. "GDP" in the bottom left chart excludes imputed rent.
2. Correlation, RMSE (Root Mean Squared Error), and MAE (Mean Absolute Error) are calculated in relation to GDP. Sample periods are CY 2003-2019.

Sources: Cabinet Office; Bank of Japan, etc.

Finally, we compare the CAI Plus, with its expanded coverage of online consumption, with the original CAI. Comparing the two time series in Chart 19 reveals that (a) the CAI Plus is stronger than the CAI even through 2019, before the spread of COVID-19, and (b) since 2020, during the pandemic, the relative strength of the CAI Plus is even more pronounced and the difference between the two series larger.

Chart 19: Comparison between the CAI and CAI Plus



Sources: Bank of Japan, etc.

4. Conclusion and challenges left for future revisions

This paper explains the contents of the revision of the CAI motivated by recent changes in consumption patterns such as the expansion of e-commerce and the impact of COVID-19. First, after updating the weights on goods/services to make them consistent with the revision of the GDP statistics in December 2020, we also revise estimation methods for several items. Such items include "food services" and "accommodations," the sectors significantly influenced by the spread of COVID-19, for which we replace the source statistics with those based on the *Monthly Survey on Service Industries* to reflect variations within those sectors accurately. These revisions result in improved performance of the CAI in terms of its correlations with and predictive power for the consumption of households reported in the *Annual Report of National Accounts* for the period up to CY 2019. [29] Secondly, by incorporating *JCB Consumption Now*, a newly available

[29] Due to the unprecedented nature of the changes in consumption patterns exhibited during CY 2020 as a result of COVID-19, there is some uncertainty over whether the performance of the CAI for CY 2020, as measured by the index's correlation with and predictive power for household consumption in the *Annual Report of National Accounts* (ARNA), will remain comparable to that for the period up to

consumption index based on information on credit card payments, we expand the range of online consumption captured by the CAI Plus. While COVID-19 triggered an acceleration in the increase in online consumption, the shift from physical stores to e-commerce is expected to become further entrenched in future, against the background of ongoing digitalization. Thus, we need to monitor the CAI Plus in addition to the original CAI more carefully.

Among the current revisions, the incorporation of online consumption and the use of the *Monthly Survey on Service Industries* as source statistics were considered in the previous revision (Nakamura *et al.* (2016b) and Kanafuji *et al.* (2018)), but these revisions were not made at that time due to limitations of the source statistics and the shortness of the relevant time series. In future, as the availability of official statistics and opportunities to make use of alternative data evolve, we will need to continue revising the compilation methodology of the CAI to capture consumption movements more accurately. In this regard, even after the current revision, the CAI items cover only about 70 percent of the services consumption excluding imputed rent recorded in the GDP statistics; this is not yet a level with which we can be satisfied. Several items in the GDP statistics, for example, "housing rent," "education," and "other services," have relatively large weights but are not covered by the CAI due to limited availability in the source statistics.[30] Expanding the coverage of services, especially for these items, is an important challenge to further improve the performance of the CAI in future.

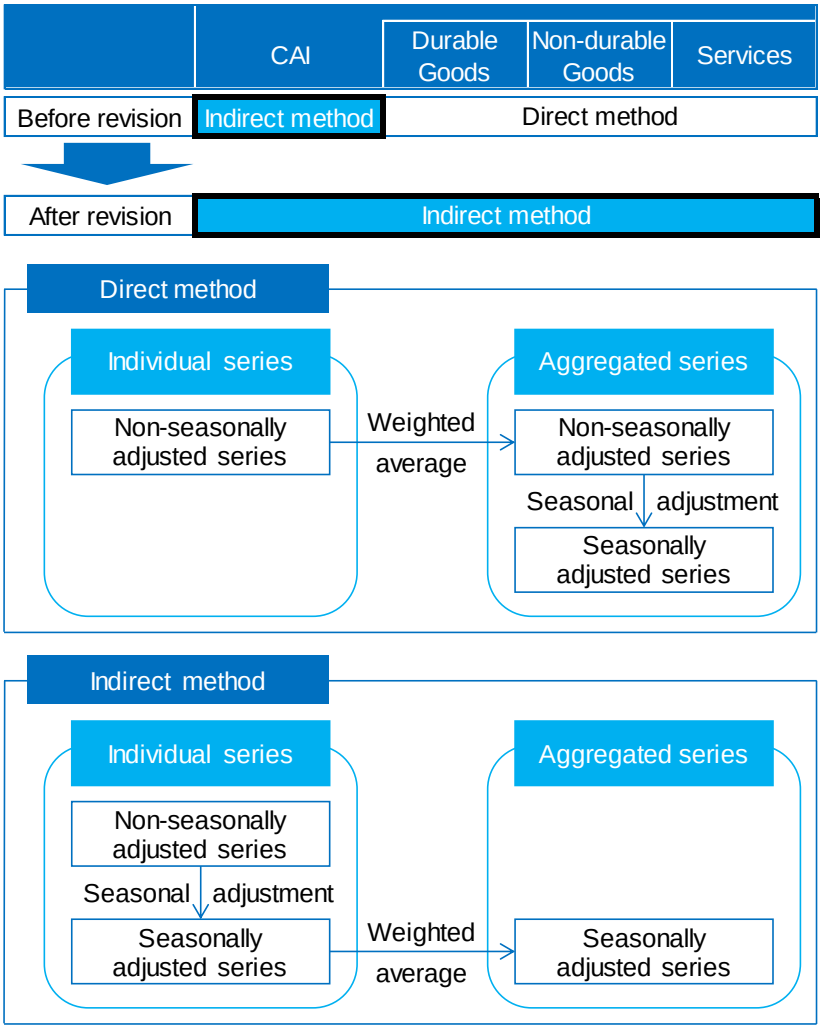
CY 2019. In order to verify this issue, we need to wait until December 2021 when the ARNA figures for CY 2020 are scheduled to be published.

[30] Strictly speaking, some items including "ceremonial occasions" among "other services" have already been captured by the CAI.

Appendix: revision of seasonal adjustment method

If non-seasonally adjusted series for both individual components and the aggregate are available, there are generally two ways to obtain seasonally adjusted aggregate series: the direct method, which applies seasonal adjustment to the aggregated series; and the indirect method, which aggregates seasonally adjusted individual series. Before revision, the CAI aggregated seasonally adjusted series by type, i.e. durable goods, non-durable goods, and services, while the series for each type were obtained by applying seasonal adjustment after aggregating item-level series. Thus, as illustrated in the Appendix Chart, the seasonal adjustment method for the series for each type was based on the direct method, while the aggregate series were obtained using a method that combined aspects of both direct and indirect methods. The method adopted for the CAI before revision is consistent with that used by the Cabinet Office to calculate *Quarterly Estimates of GDP*. However, during periods in which household consumption was hit by large shocks, such as the consumption tax hikes and the spread of COVID-19, the direct method used to calculate seasonally adjusted series for each type may be problematic. Specifically, in the direct method, individual item movements that should be regarded as idiosyncratic fluctuations when seasonal adjustment is applied to the individual series, may be misunderstood as seasonal fluctuations if several series are aggregated and seasonally adjusted. To allay such concerns, we adopt the indirect method for the type-level series in the current revision, which allows us to obtain the seasonally adjusted series for durable goods, nondurable goods, and services, by aggregating seasonally adjusted series for individual items.

Appendix Chart: Seasonal Adjustment Methodology for the CAI



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