BOJ Reports & Research Papers

April 2013

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Abstract

One of the problems in economic assessments is the time lag between economic activities and publication for most economic indicators. In order to address this issue, anecdotal information obtained from companies is often used as supplement material. In recent years, the development and spread of information and communications technology has made it possible to obtain a wide range of information with shorter lags, and led to the emergence of a technique called "nowcasting" that uses this information to forecast currently unreleased data. This paper contains a brief explanation of nowcasting and then examines a method using Internet search data that has garnered so much attention in recent years and the potential to use it in economic assessments. The paper includes an analysis of service consumption (travel) before and after the Great East Japan Earthquake and finds that travel-related search data provides valuable information for the nowcasting of outlays for travel.

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[*]The authors would like to acknowledge the valuable comments received in the writing of this paper from Hibiki Ichiue, Ryo Kato, Koichiro Kamada, Kenichi Sakura, Junnosuke Shino, Tomohiro Sugo, Toshitaka Sekine, Koji Nakamura, Naoko Hara, Wataru Hirata, Eiji Maeda, Makoto Minegishi, Ichiro Muto, and the Bank of Japan staff. Any remaining mistakes are the responsibility of the authors themselves. All opinions and interpretations expressed in this paper are those of the authors and do not represent the public positions of the Bank of Japan or the Research and Statistics Department. This paper is an English translation based on the Japanese original.

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I. Nowcasting

It is crucial in the formulation and implementation of economic policy that authorities be able to quickly and accurately confirm current conditions. Economic indicators therefore provide the basic rationale upon which economic assessments are built. Official statistics and other economic indicators are designed carefully and compiled according to appropriate procedures to ensure high levels of reliability and suitability to analysis. A combination of economic indicators enables comprehensive, multifaceted monitoring of how the economy as a whole moves.

However, economic indicators have their limitations. First, they are not immediately available because time is always required for their compilation. For example, primary statistics like the *Family Income and Expenditure Survey* that collects reports from respondents and releases the results will require time for respondents to prepare data after the end of the survey period, and then time for the statisticians to tabulate the information. A derived statistic that is compiled from a combination of primary statistics must wait until the primary statistics become available before tabulation can begin, further extending the lag. For example, GDP provides the most comprehensive measure of current economic activity, but is derived by tabulating and processing large numbers of other statistics, which produces a long lag until its release, generally about a month and a half from the end of the quarter.[1] Second, there is the problem of the frequency with which data is released. Most statistics are released monthly, but GDP, which covers the economy as a whole, is only released quarterly.

Policy authorities have developed a number of techniques to try to overcome the limitations of economic indicators. Examples include analysis of financial market data (share prices, interest rates, commodities prices, etc.), which is available in almost real time, or anecdotal information collected from companies on the most up-to-date economic

[1]Conducting policy based on analysis using economic indicators has sometimes been compared to driving car while looking only at the rearview mirror.

movements.[2] Anecdotal information has the advantage of there being no time lags due to tabulation and processing. They also provide information on the thinking behind corporate behavior and where companies believe the economy is heading in the future, rather than just a snapshot of current economic conditions.[3] Nonetheless, there are some caveats about using the anecdotal information in assessing general macroeconomic trends: 1) the small size of the sample makes it difficult to determine whether it is justified to use information obtained from individual companies as a barometer of the macroeconomy as a whole; 2) the anecdotal information obtained from companies is ultimately only "real time respondent perceptions" and there is an unavoidable time lag involved in the formation of respondents' perceptions themselves; and 3) information on consumer spending, labor supply, and other household trends is indirect and only as seen from a corporate vantage point.

Nowcasting is a new and increasingly popular attempt to compensate for the time lag in economic indicators (the neologism is coined from "forecasting," which tries to anticipate the future, while "nowcasting" tries to measure the present). The technique involves the use of highly real-time information to "forecast" unreleased economic indicators. For example, while GDP statistics are only released once a quarter, it is possible to use statistics that are released monthly (the *Indices of Industrial Production*, *Family Income and Expenditure Survey*, etc.) to build a forecasting model and arrive at figures for the period half a month ahead of the release of GDP. It is also possible to quantitatively measure GDP, which is a quarterly figure, during the monthly interim laps.[4]

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[2]The Bank of Japan considers anecdotal information obtained from business contacts as quite valuable in monthly economic assessments, and a portion of such information gathered by the Bank branches is published as the "*Regional Economic Report*".

[3]Even economic indicators like the *Tankan* (Short-Term Economic Survey of Enterprises in Japan) and *Indices of Industrial Production* contain information on how companies perceive the economic outlook.

[4]Research continues on analytical techniques for the nowcasting of GDP, with economists at national central banks playing a key role. A number of methods have been developed to deal with questions like: 1) the kinds of methods that should be used when the object to be forecast and the data used to forecast it have different frequencies; 2) what methods should be used to contract information when there are large numbers of series; and 3) how to handle differences in the timings of release for monthly indicators (for details see Bańbura et al. (2010), etc.).

Recent research also attempts to use nowcasting for monthly economic indicators. Traditionally, real time data has been limited to share prices and other financial market data. Recent advances in information and communications technology, however, are making it possible to use POS data, which records sales information, Internet search history data, and text data from the day-to-day communications on blogs and Twitter, etc. This is known as "big data".[5] Indeed, considerable progress has already been made on the use of Internet-based data constellations in business. In addition to analyzing text data from blogs and the like and using it in marketing, there are also services that use the results to forecast product demand and share prices. Among research institutes, Massachusetts Institute of Technology (MIT) in the United States collects data on merchandise prices from Internet retailers around the world on a daily basis in a project to investigate companies' pricing behavior and the mechanisms by which prices propagate.[6]

Inspired by this trend, universities, research institutes, and policy authorities have begun to analyze the utility of data on Internet search results in nowcasting, particularly of indicators related to household trends (Chart 1).[7] One example is an analysis of search data published in the June 2011 Quarterly Bulletin of the Bank of England, the central bank for the UK. According to this analysis, use of the data improved the precision of unemployment-rate and housing-price forecasts in the UK, and search data trends should therefore be watched closely in future economic assessments. Much prior research focuses on unemployment rates or selected goods and services, but Schmidt and Vosen (2011) finds that search data is useful in forecasting overall consumer spending as well.

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[5]There is no standard definition of "big data," but it is generally used to refer to data constellations with the following characteristics: 1) volume so large that it is only processable thanks to recent advances in information and communications technology; 2) may contain text data and images that are not necessarily standardized; 3) highly real time in nature.

[6]For further information on the MIT project, see http://bpp.mit.edu. Additionally, the more prevalent use of big data is not limited to the realm of economic policy. For example, the U.S. government made an announcement, in March 2012, to allocate budget for technological development for exploiting big data for application in such areas as environment, education and defense.

[7]There are many examples of research into search data-based nowcasting by central bank staff. In addition to the Bank of England study described above (McLarren and Shanbhogue [2011]), studies have been done by the Banco de España (Artola and Galán [2012]), Banca d'Italia (D'Amuri and Marcucci [2009]), and Bank of Israel (Suhoy [2010]).

Chart 1: Nowcasting Using Search Data

	Analyzed data (Country)	Estimation method and result
Choi and Varian(2011)	Motor Vehicles and Parts, Travels, etc. (United States)	Simple seasonal AR models that include relevant Google Trends variables tend to outperform models that exclude such variables.
Askitas and Zimmermann（2009）	Unemployment rate (Germany)	Search data of the web pages of career support had a statistically significant explanatory power.
McLaren and Shanbhogue(2011)	Unemployment, Housing prices (United Kingdom)	Adding results of relevant online searches to the forecasting model of housing prices and the number of the unemployed improves performance.
Kholodilin, et.al.(2009)	Private consumption (United States)	In forecasting private consumption, the model that incorporates search data outperforms the model that uses survey-based indicators of consumer confidence, especially for the period of from 2008 onward that includes the financial crisis.
Schmidt and Vosen(2011)	Private consumption (United States)	The model that incorporates search data outperforms the model that uses survey-based indicators of consumer confidence. Even where variables such as income, interest rates, and share prices are added as explanatory variables, search data still contributes to the improvement of the forecasting performance.

II. Search Data-based Nowcasting of Service Consumption

This paper focuses on service consumption as the subject of its nowcasting. It is generally anticipated that there will be a close correlation between household consumption activities and Internet use. For example, when preparing for a trip overseas, members of a household may search for relevant international travel information, or when going out to eat may search for restaurant information. It is increasingly the norm that relevant information is searched on the Internet prior to consumption. Therefore, when business conditions improve and people have more desire to consume, it is highly likely that there will be an increase in Internet searches for relevant items, and a simultaneous increase in actual spending. Therefore, access to information on the numbers of searches related to travel or dining may enable a quantitative measure of current consumption trends.[8]

[8] Among the issues in the measurement of consumer spending trends are: 1) the inability to immediately measure the impact of the diversification of sales channels (Internet sales and the like) in statistics that are based on conventional distribution structures (retail sales values, etc.); and 2) the significant number of fields, particularly in service consumption, for which there are no surveys of short-term trends in existing statistics. The *Family Income and Expenditure Survey* and similar statistical surveys that question households directly about actual consumption behavior avoid these issues, but in practice, constraints on sample size may result in large short-term swings that make it difficult to determine if a change is transient or secular. Search data has the potential to provide valuable supplementary information on these points as well. In addition, search data enables the use of virtually all of the keyword series searched by users, making immediately available time series data on new goods and services for which there are no statistics in existence (in official

More than a month and a half is required for the release of statistics related to service consumption, meaning that there are large potential benefits to search data-based nowcasting. For example, after the Great East Japan Earthquake more than two months was required for the release of the *Current Survey of Selected Service Industries* and outlays for travel for March 2011, the month in which the earthquake occurred. By contrast, search data is available virtually without a lag (Chart 2).[9] The remainder of this paper contains a concrete example of search data-based nowcasting focusing on travel among the service consumption items experiencing large fluctuations immediately after the Great East Japan Earthquake (see the box for details).

This analysis uses data provided by *Google Trends*, a web service that tabulates Google search results. This is time-series data indicating the frequency with which a particular word or phrase was searched on Google. Weekly data beginning January 2004 is available free of charge.[10] In addition to offering data on the any words and phrases designated by users, the service also contains data on categories like "Shopping" or "Entertainment" classified according to Google standards for the search terms. Data can be accessed on a regional basis (in Japan, on a prefectural basis). In addition to Google, other search sites such as "Yahoo! Japan" and "goo" also provide data on searches through their sites in Japan.

The data used in this analysis is from the "Travel" category on *Google Trends* and consists of 21 series of data that are available for the entire period beginning January 2004 (Chart 3).[11] The search data was processed for use in the analysis, as follows. First, to

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statistics, several years are required from the time a good or service begins to spread until it is included in survey items).

[9] For March 2011, the period analyzed in this paper, data was published three days later. Currently, data is updated virtually in real time.

[10] To be more precise, with a view to making levels comparable across data, a share of a respective term to total searches within a predefined region (country, prefecture, etc.) is derived as an index, whose cumulative rate of change beginning with the starting point of the data is provided. For details on data, see, for instance, Choi and Varian (2011).

[11] Series used in estimates are shadowed in gray. "Agritourism," "Vineyard and Wine Tourism," and "Museums" were excluded from the estimates because data was not available for the entire period beginning January 2004 at the time this paper was written.

provide for consistency in data frequency with outlays for travel, which is a monthly statistics, search data, which is furnished on a weekly basis, were converted to monthly dates by allocating the first and last weeks of each month according to numbers of days. Then, obtained monthly data were seasonally adjusted using X-12-ARIMA before taking changes from the previous period in the logarithmic scale.

Chart 2: Release Schedule of Statistics after the Great East Japan Earthquake (March 2011)

Great East Japan Earthquake	
Search data ←**Three days later**	March
←20 days later	
New passenger-car registrations	
Economy Watchers Survey	
←30 days later	April
Sales in food service industry	
Indices of Industrial Production, Current Survey of Commerce, etc	
←60 days later	
Current Survey of Selected Service Industries	
Major Travel Agents' Revenue	May
←70 days later	
Quarterly Estimate of GDP : January-March 2011	

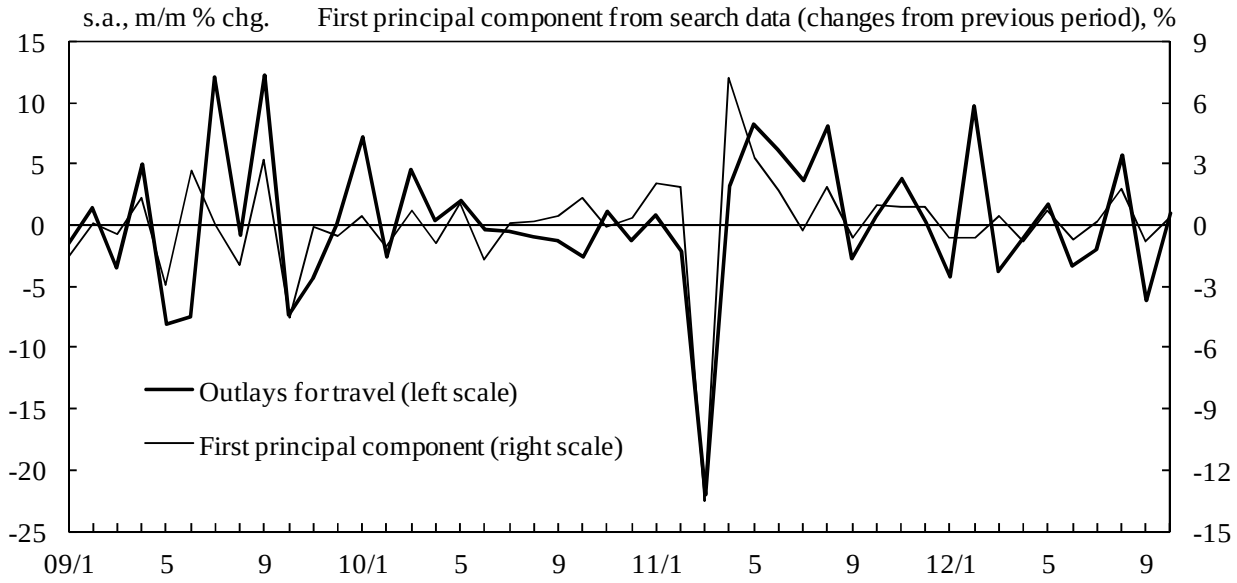
Chart 3: Breakdown of the "Travel" Category in Search Data and Series Used

Travel	Specialty Travel	Agritourism
		Ecotourism
		Vineyards & Wine Tourism
		Sightseeing Tours
		Adventure Travel
	Bus & Rail	
	Hotels & accommodations	
	Car Rental & Taxi Services	
	Tourist Destinations	Theme Parks
		Beach & Islands
		Lakes & Rivers
		Regional Parks & Gardens
		Mountain & Ski Resorts
		Historical Sites & Buildings
		Zoos-Aquariums-Preserves
		Museums
	Air Travel	Recreational Aviation
		Airport Parking & Transportation
	Cruises & Charters	
	Carpooling & Ridesharing	
	Travel Guides & Travelogues	
	Luggage & Travel Accessories	
	Travel Agencies & Servises	Vacation Offers
		Tourist Boards & Visitor Centers

This analysis builds on findings of existing studies and uses 21 series of search data related to travel, which is contracted with a principal component analysis before being input to a forecasting model.[12] Comparing the derived first principal component with changes of outlays for travel from the previous month (both seasonally adjusted with X-12-ARIMA; Chart 4) indicates that there is some degree of similarity in the direction of change, although the size of change differs across periods. Both also coincide in capturing the sudden and steep decline after the Great East Japan Earthquake, and the sharp recovery that followed.

[12]The reason for reducing the number of series used in estimates is because variances of the estimates in the model increases and forecasting precision declines when there are more than necessary number of parameters to be estimated. As another example of the use of search data-based series contracted with principal component analysis to perform nowcasting of consumer spending, see Kholodilin et al. (2009).

Chart 4: Outlays for Travel and Search Data



Sources: Japan Tourism Agency, "Major Travel Agents' Revenue";
Google, "Google Trends."

To quantitatively measure the relationship between search data and actual outlays for travel, month-on-month changes of outlays for travel were regressed against the first principal component derived from the search data. This found that search data had a certain level of explanatory power for outlays for travel and confirmed that there was a statistically significant positive correlation between search data and changes in outlays for travel (Chart 5).[13] It should be noted, however, that there are significant differences in coefficients of determination before and after the earthquake, and the large shock from the earthquake significantly impacted performance of the estimation.

[13]The maximum number of principal components, including explanatory variables, was set at six in light of the findings in Marcellino and Schumacher (2010), an attempt at GDP nowcasting using a similar technique. Factors 1-6 were individually studied on the basis of information criteria. The result found that the second principal component and below did not have significant coefficients, and the first principal component-only model had the smallest AIC.

Chart 5: Nowcasting of Search Data and Outlays for Travel from the Economy Watchers Survey

	Constant	Economy Watchers Survey (Travel, transportation)	First principal component from search data	S.E. of regression	Adj.R^2
Period prior to the Great East Japan Earthquake (January 2004 to February 2011)	-0.11 (-0.29)		0.61** (2.93)	3.37	0.08
	-0.14 (-0.37)	0.27** (2.47)		3.42	0.06
	-0.12 (-0.32)	0.22** (2.03)	0.53** (2.56)	3.31	0.11
Entire period (January 2004 to September 2012)	-0.08 (-0.22)		1.13*** (6.83)	3.74	0.31
	-0.07 (-0.19)	0.45*** (7.32)		3.65	0.34
	-0.07 (-0.20)	0.31*** (4.54)	0.70*** (3.91)	3.42	0.42

Estimation formula: Outlays for travel (month-on-month changes)
$= \alpha + \beta$ First principal component of search data
$+ \gamma$ Economy Watchers Survey (changes from previous month) $+ \varepsilon$

Note: t values in parentheses. ** Indicates significant difference from zero at a level of 5%; *** at a level of 1%.

Sources: Cabinet Office, "Economy Watchers Survey"; Japan Tourism Agency, “Major Travel Agents’ Revenue"; Google, "Google Trends."

For comparison, estimation results from a model using the *Economy Watchers Survey*[14] (Cabinet Office) are presented. Among many economic indicators, the *Economy Watchers Survey* has one of the shortest lags between the timing of the survey and the release of the result. It also exhibits a high degree of linkage with business cycles. It is therefore one of the closely watched metrics in the assessment of current conditions. The analysis finds that both before and after the earthquake, the model using search data was roughly an equivalent fit with the model using the *Economy Watchers Survey*.

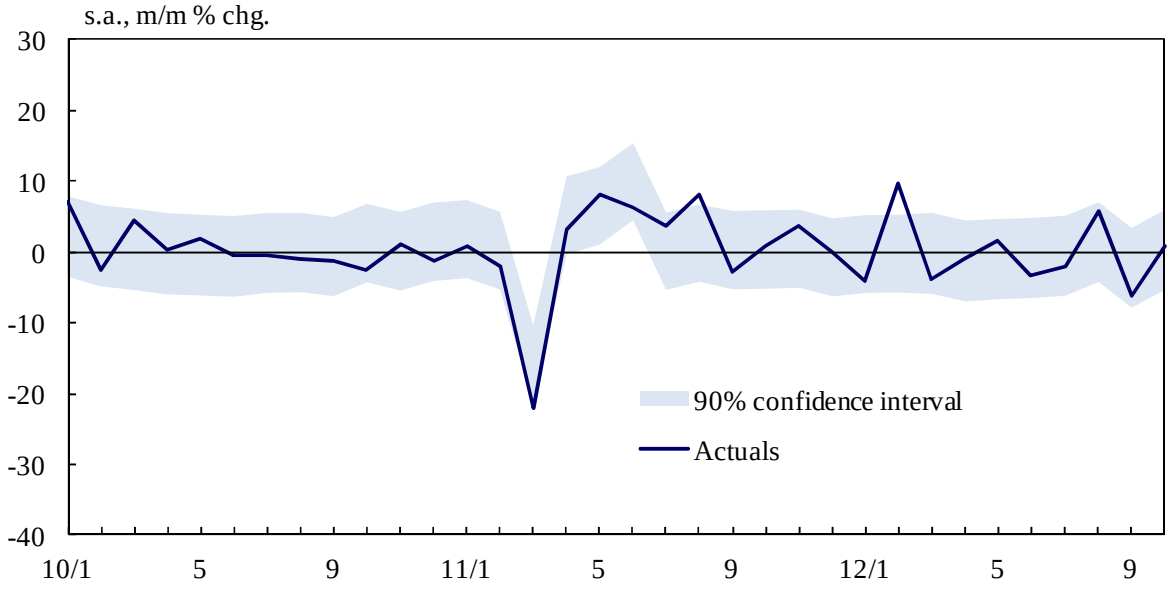
When both search data and the *Economy Watchers Survey* are used, data from both is significant, and the overall fit improves compared to the use of either one on its own.

[14]The *Economy Watchers Survey* is a questionnaire survey that focuses on sectors and jobs considered to be sensitive to economic trends, for example, sales floor managers at department stores and workers at theme parks. The survey is performed at the end of each month and published at the beginning of the following month. The analysis in this paper uses the current conditions DI for the travel and transportation sectors.

Search data is obtained from consumers (purchasers of services), and may therefore contain information not well captured by the *Economy Watchers Survey*, which focuses on companies (providers of services). This is presumably why the use of both sets of data improves the fit of the model.

Next, we used a model that took the search data and the *Economy Watchers Survey* as explanatory variables and performed consecutive (in other words, real time) nowcasting based on information available at specific points in time during the January 2010 to October 2012 period and compared estimated outlays for travel against actuals (Chart 6). The estimate began in January 2004, the first date for which search data is available, and used data obtainable through the first part of the month following the month for which nowcasting was performed, seeking estimates and confidence intervals at each juncture. For example, nowcasting for March 2011 was estimated using data available through early April of that year.[15]

Chart 6: Estimates and Actuals of Outlays for Travel



Sources: Cabinet Office, "Economy Watchers Survey"; Japan Tourism Agency, "Major Travel Agents' Revenue"; Google, "Google Trends."

[15]However, we did not, strictly speaking, use only the search data available at each point in time: 1) full-period (January 2004 to October 2012) data was used when performing seasonal adjustments, and 2) there were a number of revisions and reclassifications in the past, but categories as at October 2012 were used.

The estimate results indicate that, as early as the beginning of April, it was possible to assess to a considerable degree the decline in March outlays for travel after the earthquake, rather than waiting for the official release of outlays for travel in mid-May. Similarly, the results also capture the subsequent recovery relatively early on, including the pace of monthly recoveries.[16]

It should be noted, however, that compared to forecasting performance at the time of the earthquake, the model does not have a high degree of explanatory power at ordinary times when there are no significant shocks, even if both search data and the *Economy Watchers Survey* are used. For example, the 90% confidence interval for October 2012 amounts to 11.3% or between month-on-month changes of +5.9% to -5.3% (the actual value was +0.9%). Search data 1) contains bias in the form of the age, income, and other aspects of the sample because the survey is limited to Internet users; and 2) may experience increases in search numbers for reasons that are unrelated to increases in consumption, for example scandals or accidents (there may, indeed, be factors that can actually cause consumption to decline). This noise exists both during ordinary times and during times of emergency, and the low explanatory power of the model during ordinary times is presumably because of the impediment that noise poses to forecasting.

Nonetheless, when search data is used, even during major shocks like the earthquake, actuals are not significantly different from confidence intervals, nor are their sizes. Search data can be considered useful as a means of quantitatively capturing the impact of a significant, unexpected shock, at least to some extent. Kholodilin et al. (2009) also reports that search data has higher performance during times of distress (for example, the collapse of Lehman Brothers) than during ordinary times. Given the nature of search data we believe, at least at the current point in time, it is appropriately treated as a tool for nowcasting particularly during times of emergency. Search data by its nature is appropriately positioned as a complement to economic indicators in improving the overall performance of economic assessments.

[16]Performing the same nowcasting using only data from the *Economy Watchers Survey* or using only search data indicates that both were able to forecast the decline in March 2011 due to the earthquake, but understate its magnitude.

III. Challenges Going Forward

This paper began with a brief explanation of nowcasting and then presented an attempt to evaluate service consumption with a particular focus on travel sales immediately after the Great East Japan Earthquake, using the nowcasting method based on search data. The analysis finds that search data has a unique forecasting ability when nowcasting travel sales. This analysis was limited to travel sales, but search data has a broad range of application and could potentially be used for the consumption of goods, and even in areas other than consumption.

We must underscore that attempts such as this to use search data in economic assessments are still in the early stage of development and at the current point in time lack a degree of forecasting precision. There are still many hurdles that must be cleared before it is of practical use in economic assessment, for instance questions of statistical analysis (how to extract significant information from the enormous volume of data available) and issues in systems development (how to build databases that make maximum use of the real time nature of the data).

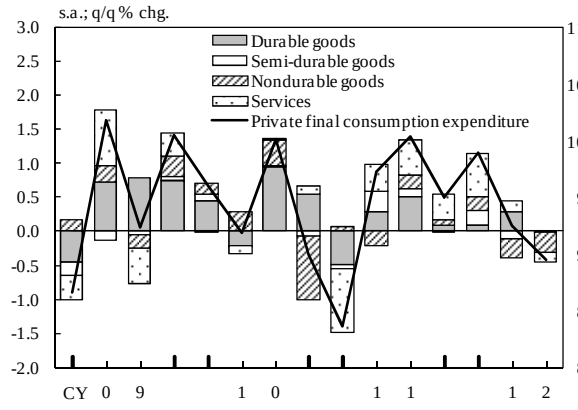
More precise nowcasting may be made possible in the field of economic forecasting, by drawing on the increased use of text data or other non-standardized data in addition to search data. We anticipate continuing progress in attempts to use big data in decision-making in many different fields. It is hoped that the field of economic assessment will also see developments in systems and analytical techniques.

Box: Service Consumption Trends after the Earthquake

Consumption trends after the Great East Japan Earthquake of March 2011 show a large decline because of a worsening of household sentiment in reaction to concerns about Japan's economic prospects, the nuclear power plant accident, and other uncertain factors. Looking at consumption by category of expenditure for the first half of 2011 when the earthquake had impacts, the declines were largest for durable goods and services. Durable goods consumption declined significantly as a result of such specific factors as the payback in demand (for television sets and other consumer electronics) after the surge in demand prior to the termination of the "Eco-Point" system for consumer electronics in December 2010, and supply constraints (for automobiles and the like) because of supply chain disruption. However, the negative contribution of service consumption was even greater.

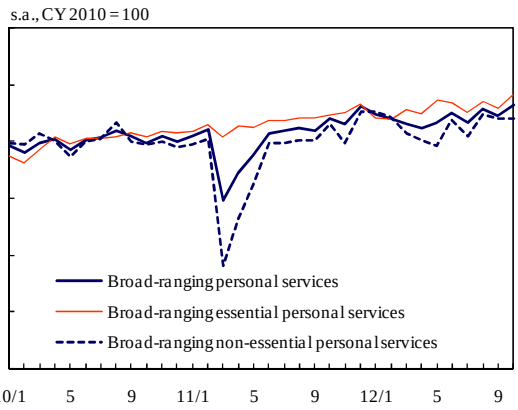
Examining the index of tertiary industry activity (broadly-defined personal services), which represents total production for service industries, to achieve a more detailed view of service consumption trends after the earthquake (Box Chart 2), one can see a significant decline during March, when the earthquake occurred, and then a modest recovery beginning April. The breakdown for March when the decline occurred shows that "essential personal services" like health care spending and rent remained in flat territory, while "non-essential personal services" like travel and dining experienced significant declines, representing an impact from the earthquake.

(Box: Chart 1)



Source: Cabinet Office, "National Accounts."

(Box: Chart 2)



Source: Ministry of Economy, Trade and Industry, "Indices of Tertiary Industry Activity."

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