A Primer on Short-Term Linkages between Key Economic Data Series

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IN THE UNITED STATES, ECONOMY WATCHERS ARE BLESSED (OR CURSED, DEPENDING ON ONE'S VIEWPOINT) WITH A PLETHORA OF DATA. TO THE CASUAL OR NEW OBSERVER OF THE ECONOMY, THE INFORMATION CONTENT OF THE MANY INDICATORS MAY BE UNCLEAR. MOREOVER, THE WAY EXPERIENCED ANALYSTS USE THE DATA TO EVALUATE THE ECONOMY MAY SEEM COUNTERINTUITIVE. TO THE NEWCOMER THE QUESTION OFTEN IS, WHY DO THOSE INTERESTED IN FUTURE ECONOMIC DEVELOPMENTS LOOK AT THESE NUMBERS? OR HOW DOES ONE USE THESE DATA SERIES? THERE MAY BE AS MANY ANSWERS AS THERE ARE ANALYSTS.

Why do analysts look at economic data? The simple answer is that investors and planners must look forward, and economic data help them forecast. If there is new information on the economy, on demand, on profit potential, or on prices, among other factors, then the underlying value of financial and real investments may shift, changing values, project projections, and plans.

The release of economic data can have an impact on the value of financial instruments and investment projects because it may change analysts' views of the strength or weakness of the economy. These views in turn may affect their forecasts for company or project earnings, general or specific prices, and interest rates. Because major decisions may depend on economic reports, market participants need to squeeze as much information as possible out of data so as to make intelligent decisions about financial holdings and investments.

There are a number of time horizons relevant to how market watchers evaluate economic data and use them for forecasting. The evaluation of various longer-run fundamentals often begins with examining short-run relationships among economic variables. This article focuses on these relationships—many of which involve lagged effects taking place over a few months or at least within a year and a half. Clarifying the source data linkages and the statistical linkages will help explain how and why financial markets track and react to economic data the way they do. Source data are series from one statistical agency used by another statistical agency to derive a new series (discussed below).

This article is a brief guide to some of the well-known short-term relationships between economic data series upon which many analysts focus. It explains how analysts use data in concurrent month forecasts and what some key relationships are, outlines the monthly calendar of economic releases, and, finally, reports on typical lags between various dependent and explanatory variables.

Concurrent Month Linkages—Source Data and Statistical Links

There are at least two basic approaches to linking two or more economic series over a short time horizon. Analysts try to use prior-released data to project later-released data for the same period. This practice is called "forecasting" concurrent data. Linkages between the earlier and later data sets may be based on common source data or on some statistical relationship.

Source Data. Source data are series used by a statistical agency (usually a government bureau such as the Commerce Department's Bureau of Economic Analysis [BEA]) to derive other economic statistical series. For example, the BEA uses average hourly earnings data from the Labor Department to help produce the wages-and-salaries component in personal income data; the BEA also uses residential construction outlays to help estimate the residential investment component of gross domestic product (GDP).

Analysts should be aware that analyzing source data to forecast concurrent data for the derived data series is less than straightforward because the statistical agencies typically make numerous adjustments to the source data at levels of detail not always accessible to the public. Adjustments may have been made for differences in definition, geographic coverage, or timing and obvious or subtle differences in economic concepts. Additionally, a subsequent data series may be based on more than one set of source data. Some examples follow.

The industrial production index has three principle components: manufacturing production, utilities production, and mining. For the initial release of the index, the Federal Reserve Board of Governors bases the manufacturing production component primarily on production worker hours in the manufacturing sector, available from the establishment survey in the employment report produced by the Bureau of Labor Statistics (BLS). The Federal Reserve Board uses this measure as its primary input for the initial estimate because so little hard data for actual production are available for the month about to be released. (For example, data on kilowatt hours of electricity used in production are not available until later in the month. For later revisions to the initial estimates of industrial production, the Federal Reserve Board incorporates these other types of data.) The production worker hours data become publicly available on the first Friday of each month following the reference month; the industrial production report for the same reference month is released around the fifteenth of the following month. Thus, on average, the production worker hours data are available about ten days prior to the production index release. Analysts use this data to judge the strength of the manufacturing sector in terms of estimated output. As a percentage of value added in 1994, production worker hours data underlay 29.1 percent of the initial estimate directly and 53.1 percent indirectly (for heavily judgmentally based series). These percentages, respectively, were 29.1 percent and 2.5 percent for the fourth month estimates.[1]

The evaluation of various longer-run fundamentals often begins with examining short-run relationships among economic variables.

Because production workers hours data are key inputs for initial estimates of industrial production, market analysts often attempt to forecast an upcoming release with a regression model based on production worker hours data, shown in Table 1.[2] This regression estimates manufacturing output as a function of production worker hours plus a constant over the 1980–97 period. Both output and hours are in monthly percentage change form. The percentage change in manufacturing output is estimated to be 0.631 times the percentage change in production worker hours plus a constant of 0.268. This simple model has reasonably good explanatory power with an adjusted R^2 of 0.5015 and with t-statistics for both explanatory variables statistically significant. (R^2 is the coefficient of determination, a statistical measure of the "explained" variation in the data as a percentage of the total variation in the data. Values for R^2 range from 0 to 1.00 so that, for a simple regression model with only one explanatory variable, all the data lie on the regression line when R^2 equals 1.00—that is, there are no unexplained

1. *These figures are unpublished estimates by Federal Reserve staff, October 1997.*
2. *This particular regression model is discussed in more detail in Rogers (1992). Importantly, one should note that the Federal Reserve Board estimates production with procedures for individual components. About 82 percent of the series is based on production worker hours, directly and indirectly, for the initial estimate. Even for these series, the Federal Reserve Board makes estimates using production factor coefficients (PFCs) based on more than just production hour data (see Board of Governors 1986, 33–128).*

   PFCs are used to estimate individual industrial production series, which are estimated over historical periods, taking into account trend and cyclical relationships between production and the hours input and adjusting the hours data to be representative of the month as a whole. This procedure is more complex than is represented by a simple production hours regression model, but market analysts have found this type of model to have some usefulness.

TABLE 1 A Simple Model for Forecasting IP with Production Worker Hours

Regression using OLS
Dependent variable: FRB industrial output, manufacturing, percent change
Explanatory variable: Production worker hours, percent change
1980M1–97M10

Variable	Coefficient	Standard Error	*t*-statistic	Significance
Constant	0.267801	0.380935E-01	7.03011	0.000
Production Worker Hours, Percent Change	0.631322	0.430306E-01	14.6715	0.000

Equation Summary

Number of Observations	=	214	R^2 (adjusted)	=	0.5015
Sum of Squared Residuals	=	65.6672	Standard Error of Regression	=	0.556553
R^2	=	0.5038	Durbin-Watson	=	2.36697

variations in the data. Adjusted R^2 is a measure that takes into account how many explanatory variables are used in the regression model.) Based on its moderately high adjusted R^2, the regression confirms that a percentage change in manufacturing production worker hours is useful for forecasting manufacturing output for the current month.

Statistical Relationships. A second way that analysts may make forecasts—short-term or long-term—is by linking different data series that have relatively dependable statistical relationships. Two data series may have a common near-term link either to each other or to separate variables even though statistical agencies do not use one series to produce the other. An example of such a concurrent-month—or same-reference-month—statistical relationship is using producer price index (PPI) data, released earlier in the month, to project the consumer price index (CPI), even though the BLS derives these indexes independently.

Another example involving short-term linkages of data for concurrent forecasting is using the purchasing managers index to predict the later-released industrial production index.[3] Even though the former index is not used to produce the latter, there is a statistical relationship between the direction and magnitude of movement in the purchasing managers index and the industrial production index on a concurrent month basis. The National Association for Purchasing Management (NAPM) releases a survey of manufacturers in its association on the first business day of each month following the reference month. This release is timed so that manufacturing sector data are available on average about two or three days before the employment situation data on production worker hours. This early release date for manufacturing sector data makes this release a very important one for profit-driven analysts, who are motivated to determine whether it contains any significant information that will help them assess the strength of the economy before the employment report is released.

The purchasing managers survey release contains a composite index, the components of the composite index, and a number of indexes not included in the composite. The composite index is based on subcomponents for production, new orders, employment, inventories, and vendor performance. To predict the release of industrial production later in the month—but prior to the release of the employment situation—analysts typically regress the percentage change in industrial production against the NAPM composite diffusion index. This diffusion index measures not levels of activity but percentages of respondents indicating an increase, decrease, or no change in activity. NAPM's diffusion index is the percentage of respondents indicating an increase in activity plus half the percentage indicating no change. Hence, the level of these diffusion indexes is associated with percentage changes in corresponding government data series based on actual dollar values or output level. For this article's statistical comparison, the Federal Reserve Board's manufacturing output index in monthly percent changes is regressed against the NAPM's production diffusion index level. This regression model, shown in Table 2, estimates that the percentage change in manufacturing output is equal to 0.055 times the NAPM production index plus a constant of –2.758. The explanatory power of this model, with an adjusted R^2 of 0.2991, is lower than the production worker hours model (Table 1), but analysts use this type of model because the NAPM data are released prior to the production worker hours data and the NAPM data's explanatory power is significant.

Statistical relationships can be expanded beyond the current month when one variable "explains" a second

TABLE 2 A Simple Model for Forecasting IP with the NAPM Production Index

Regression using OLS
Dependent variable: FRB industrial output, manufacturing, percent change
Explanatory variable: NAPM production diffusion index level
1980M1–97M10

Variable	Coefficient	Standard Error	*t*-statistic	Significance
Constant	–2.75805	0.315984	–8.72845	0.000
NAPM Production Index	0.554479E-01	0.578480E-02	9.58510	0.000

Equation Summary

Number of Observations	=	214	R^2 (adjusted)	=	0.2991
Sum of Squared Residuals	=	92.3292	Standard Error of Regression	=	0.659936
R^2	=	0.3023	Durbin-Watson	=	2.21014

series over an extended time horizon (even if only for a few months). One series in a base time period typically has some known economic impact on another series in a subsequent time period. For example, changes in housing permits over time lead to changes in housing construction outlays.

In summary, short-term analysis of data can involve concurrent forecasting using either source data or well-known statistical relationships among explanatory variables. The use of independent variables can be expanded beyond current period analysis to longer-term forecasting.

Monthly Releases and Concurrent Linkages

Analysts' abilities to predict economic strengths as much in advance as possible depend on the fact that there is a regular cycle to economic news releases. Federal government statistical agencies typically give dates for economic news releases for a given year during the latter part of the previous year. The relative order of each release during the calendar month has changed little over the years. For example, the U.S. Department of Labor generally releases the employment situation report on the first Friday of each month. Industrial production is usually released by the Federal Reserve Board of Governors around midmonth, and GDP estimates typically are released during the last week of each month. Other government—and private-sector—release dates are also generally known well in advance and have followed much the same sequence relative to each other for years. For example, the PPI always precedes the CPI, usually by about three days. Table 3 gives a typical schedule of key economic releases over a monthly release cycle.

What series are used to project subsequently released concurrent month data? And what are the basic relationships between the released and the projected series? Table 4 lists the primary linkages for concurrent month forecasting according to when key data series are first made public. Series in the left-hand column are released to the public prior to those in the right-hand column. Table 5 shows the primary source data specifically for GDP components. Financial markets track economic series in the sequence that they are released publicly. The key reports shown in Tables 4 and 5 and linkages from those reports to later-released data are discussed below.

The Purchasing Managers Report. Several individual series from the monthly report by the National Association of Purchasing Managers are used to predict other, later-released economic data. Although the most notable instance is the use of the purchasing managers production index to predict the industrial production index produced by the Federal Reserve, discussed earlier, there are others. Some analysts use the NAPM composite index rather than the production index as the explanatory variable. Other series are used to a lesser degree because the statistical relationship is less reliable. The NAPM employment index is used to predict BLS data for nonfarm payroll employment—or, more specifically, for the manufacturing employment component of the establishment employment report. The NAPM prices paid index is often correlated with the BLS producer price index. The NAPM new orders index has a small predictive capability for the Census Bureau's new factory orders. Finally, the Conference Board uses the NAPM vendor performance index as source data directly

3. For more detailed discussion of these types of models, see Rogers (1988, 1992, 1994, and 1998), Harris (1991), and Harris and Vega (1996).

TABLE 3 Monthly Release Schedule for October 1997

Release Date	Indicator	Reference Period
October		
1	Construction expenditures	August
1	Purchasing managers index, NAPM	September
1	Conference Board's composite indicators	August
2	Manufacturers shipments, inventories, and orders	August
2	Initial unemployment claims	September 25
3	Employment situation	September
6	Auto sales, AAMA	September
8	Wholesale trade	August
9	Initial unemployment claims	October 4
10	Producer price index	September
14	Atlanta Fed manufacturing survey	September
14	Richmond Fed manufacturing survey	September
15	Advance monthly retail sales	September
16	Consumer price index	September
16	Initial unemployment claims	October 11
16	Philadelphia Fed manufacturing survey	October
16	Business inventories and sales	August
17	Housing starts and permits	September
17	Industrial production and capacity utilization rate	September
21	U.S. international trade in goods and services	August
23	Initial unemployment claims	October 18
28	Employment cost index	Third Quarter
29	Advance report on durable goods	September
30	New one-family house sales	September
30	Initial unemployment claims	October 25
31	GDP	Third Quarter
November		
3	Personal income, outlays, and saving	September
3	Purchasing managers index, NAPM	October

for that component in the Conference Board's index of leading indicators.

The Employment Situation Report. The employment situation report, released the first Friday of each month after the reference month, contains four major sets of data series used for concurrent month forecasting. The report's primary importance stems from the fact that it is the first major release each month with comprehensive coverage of all major sectors of the economy; the report provides key data on the strength of the manufacturing and consumer sectors. As already discussed, the manufacturing production worker hours index is used by the Federal Reserve Board to estimate the first release figure for manufacturing output. Second, the BEA uses nonfarm payroll data on employees, the average workweek, and average hourly earnings to estimate the private-sector portion of wage and salary disbursements in the personal income report. Next, the manufacturing average workweek is one of the components of the Conference Board's composite index of leading indicators. Finally, the series for nonfarm payroll employment is part of the Conference Board composite index of current indicators.

American Automobile Manufacturers Association (AAMA). The AAMA, formerly known as the Motor Vehicle Manufacturers Association, produces data on unit sales for autos and light trucks. The BEA uses these data to estimate portions of GDP components—notably durables personal consumption expenditures, producers durable equipment, and government consumption expenditures and gross investment. These components reflect purchases or leases of light motor vehicles.

Chain Store Sales—LJR Redbook. Several private firms produce reports on weekly or monthly chain store sales. The most widely known is the weekly series produced by the New York investment firm of Lynch, Johnson, and Ryan, published in their Redbook report. (This report was previously called the Johnson

TABLE 4 Indicators for "Forecasting" within the Monthly Cycle

Precursor/Explanatory Series and Producing Agency	Series Being "Forecast" and Producing Agency
Purchasing Managers' Report, NAPM	
(a) composite or production index	(a) industrial production, FRB
(b) employment index	(b) manufacturing employment, BLS
(c) prices paid index	(c) producer price index, BLS
(d) inventory index	(d) manufacturers inventories, Census
Employment Report, BLS	
(a) aggregate production hours in manufacturing[a]	(a) industrial production, FRB
(b) average hourly earnings, payroll employment, average workweek[a]	(b) wage and salary disbursements in personal income report, BEA
(c) average manufacturing workweek[a]	(c) component of index of leading indicators, Conference Board
(d) nonfarm payroll employment[a]	(d) component of index of current indicators, Conference Board
Unit New Auto Sales, AAMA	
(a) auto and light truck sales[a]	(a) durables PCEs in personal income report, BEA
LJR Redbook	
(a) chain store sales	(a) department store sales in retail sales report, Census
Retail Sales, Census	
(a) retail sales[a]	(a) durables and nondurables PCEs in personal income report, BEA
Producer Price Indexes, BLS	
(a) consumer product components	(a) goods components in CPI, BLS
Manufacturers' Shipments, Inventories, and Orders, Census	
(a) nondefense capital goods shipments[a]	(a) producers' durable equipment in GDP, BEA
(b) manufacturers inventories[a]	(b) change in inventories, manufacturers, in GDP, BEA
Monthly Business Inventories, Census	
(a) business inventories[a]	(a) inventory change in GDP, BEA
Monthly International Trade, Census and BEA	
(a) goods and services exports and imports[a]	(a) net exports in GDP, BEA
Construction Outlays, Census	
(a) residential outlays[a]	(a) residential investment in GDP, BEA
(b) nonresidential outlays[a]	(b) nonresidential structures in GDP, BEA
(c) public outlays[a]	(c) structures component in government purchases in GDP, BEA

[a] Source data for forecast series

Note: FRB indicates Federal Reserve Board of Governors; BLS indicates Bureau of Labor Statistics; BEA indicates Bureau of Economic Analysis.

TABLE 5 Principal Source Data for GDP: Availability for the Advance GDP Release

GDP Component and Monthly Series	Months Available
Personal Consumption Expenditures	
Retail sales	3
Unit auto and truck sales	3
Nonresidential Fixed Investment	
Unit auto and truck sales	3
Value of construction put in place	2
Manufacturers' shipments of machinery and equipment	2
Exports and imports of machinery and equipment	2
Residential Investment	
Value of construction put in place	2
Housing starts	3
Change in Business Inventories	
Manufacturing and trade inventories	2
Unit auto inventories	3
Net Exports of Goods and Services	
Merchandise exports and imports	2
Government Consumption Expenditures and Gross Investment	
Federal outlays	2
Value of construction put in place by state and local government	2
GDP Prices	
CPI	3
PPI	3
Nonpetroleum merchandise export and import price indexes	3
Values and quantities of petroleum imports	2

Redbook, named after the individual who started the report.) The LJR chain-store data are compiled from public reports from major chain stores in the United States. The weekly data, which are released on Tuesday afternoons, are not source data for any government statistics on retail sales. But analysts take an interest in the LJR Redbook data because they are available prior to the Commerce Department's retail sales report, are somewhat indicative of the strength of consumer spending, and have moderate predictive power for the narrowly defined department store series within the retail sales report.

The Retail Sales Report. Commerce's report on retail sales is released around midmonth following the reference month. The Census data on retail sales are used by the BEA to produce estimates for portions of personal consumption expenditures, which are part of GDP. The retail sales data are also used in the "disposition of income" portion of the Personal Income report, which is released the next business day after GDP estimates. Markets look at the retail sales data because they are a major indicator of consumer strength and they precede the personal consumption numbers by about two weeks. However, retail sales do not cover services and as such are only source data for durables and nondurables portions of personal consumption expenditures (PCEs). (In 1997, durables and nondurables PCEs were 12.0 percent and 29.0 percent, respectively, of total nominal PCEs. The BEA uses AAMA data for motor vehicle consumption because those numbers are more reliable than the Census survey–based data for retail sales. The AAMA data essentially cover all sales as tallied by the auto manufacturers themselves.)

Producer Price Index. The producer price index is released midmonth following the reference month. It precedes the CPI report by about three days, and analysts use the PPI numbers to project the CPI release figures. PPI data are not source data for CPI data; the data sets are derived from two independent surveys. The predictive power of PPI data for CPI numbers is only moderately strong, as suggested by standard regression statistics (see Rogers 1988). There are some notable definitional differences between the PPI for finished goods and the all-urban CPI. For example, the PPI does not cover services but does cover capital equipment; about half of the CPI component weight is services, but the CPI does not cover capital equipment. Also, even for components that are very similar for the PPI and CPI, such as food and energy, the rate at which prices at the producer level pass through to the consumer level varies by component.

Manufacturers Inventories, Orders, and Sales. This report, produced by the Census Bureau, contains source data for two components of GDP. The manufacturers inventories data from the monthly Census report form the backbone of the manufacturers component of inventory investment within GDP. However, the relationship is not as tight as might be expected because the BEA must make substantial adjustments in the Census data to convert them to the proper form for National Income and Product Accounts (NIPA).[4]

The monthly manufacturers report also provides source data for a second GDP component: producers durable equipment. Analysts focus on data for nondefense capital goods equipment shipments within the orders report as a barometer of future spending on producers durable equipment. But the relationship of nominal shipments of nondefense capital goods shipments with nominal producers durable equipment investment is not as tight as might be expected. The relationship is not one-for-one for two primary reasons: not all capital equipment produced in the United States is sold to domestic users, and U.S. businesses obtain capital equipment not only from domestic producers but also from those overseas. Therefore, in the manufacturers inventories, orders, and sales report, exports of capital equipment are subtracted from domestic equipment investment—that is, producers durable equipment and imports of capital equipment are added, but the latter are not part of (domestic) shipments of nondefense capital goods as measured in the Census report.

Monthly Business Inventories. The business inventories report is a later-published, broad report on overall business inventories. It includes the earlier-released manufacturers inventories plus data for merchant wholesale inventories and retail inventories. These data are source data for nonfarm inventory investment within the GDP accounts. As with the manufacturers data, there are a number of adjustments made by the BEA in converting the wholesale and retail series to their NIPA equivalents.

Monthly International Trade. Monthly international trade data, jointly produced by the Census Bureau and the BEA, are source data for goods and services exports and imports in the GDP accounts as well as in the balance of payments accounts. There are a notable number of coverage and timing differences between the monthly series and the balance of payments series and, in turn, the GDP series. One coverage difference is that the customs data that go into Census data are based on the geographic authority of U.S. Customs, which includes U.S. territories. Data that include U.S. territories are appropriate for balance of payments data but are not appropriate for GDP accounts within NIPA since GDP is defined by national borders exclusive of territories.

Short-term analysis of data can involve concurrent forecasting using either source data or well-known statistical relationships among explanatory variables.

Monthly Construction Outlays. Monthly construction outlays data, or construction spending data, produced by the Census Bureau, are key source data for various structures components within GDP. Monthly construction spending data serve as a measure of production in the construction sector. Data on private residential outlays are source data for GDP's residential investment component; nonresidential outlays, for nonresidential investment; and public construction outlays, for structures components within government consumption expenditures and gross investment. The statistical relationship between these series is moderately strong, based on regression analysis, because the monthly outlay series source data are not the only source data used for GDP structures components. Additional source data includes for example, a quarterly survey used to estimate spending on additions and

4. The National Income and Product Accounts, produced by the BEA, are broad "double-entry" accounts that track economic activity in the United States. With double-entry accounts, for every expenditure series there is a corresponding income account; the NIPA accounts attempt to follow economists' definition that spending generates an equal amount of income. For GDP estimates based on expenditures (such as personal consumption and investment, among others), there are GDP estimates based on personal income, corporate profits, and other income components.

alterations, which are part of the GDP residential investment series, and a subcomponent for brokerage commissions.

Key Source Data for GDP. Analysts project GDP ahead of its official release because it is viewed as a summary measure of overall economic performance. Tracking various releases for source data is important for developing an estimate for current-quarter GDP as the release months of the quarter progress. Most of the key series of GDP source data are listed in Table 5, which pulls together many of the series listed by separate reports. A more complete listing is available from the U.S. Commerce Department (1996).

One key difference between estimating GDP from earlier-released source data and using source data to estimate other monthly series is that one or more months of data are missing for some component series when the first release for GDP is made to the public. Quarterly GDP is revised each month for two months after the initial release. The first release is referred to as "advance;" the second, as "preliminary;" and third, as "revised." Table 5 shows how many months of data are available for each source data series when GDP is initially released for a given quarter. The BEA also uses additional unpublished data that may not be available to the public. In addition, some source data may not be available at all for the early estimates of current-quarter GDP and become available only by the time of the annual revisions during the subsequent year. In these cases the services components are projected for the current quarter since they are derived from private-sector annual surveys.

One series in a base time period typically has some known economic impact on another series in a subsequent time period.

When the BEA releases the advance estimate for GDP, it also publishes its assumptions for missing months of data for monthly source data that are public. This table, titled "Summary of Major Data Assumptions for Advance Estimates," is published in the *Survey of Current Business* with the advance GDP report. Comparing subsequent releases of missing monthly data with the BEA's assumptions provides some clue toward the direction of later revisions to current-quarter GDP. However, because monthly source data are only one part of the estimation procedure, differences between BEA assumptions and subsequent releases provide only part of the explanation for subsequent revisions to GDP estimates.

Behavioral Links between Data Series

Analysts use economic data to forecast other economic series by observing various behavioral links. That is, one type of economic activity appears to have an impact on another type of economic activity, and often with a lag. For example, a rise in factory orders is believed to lead to an increase in industrial production. Although a detailed explanation of econometric models for various sectors in the economy is beyond the scope of this article, a brief discussion of some basic behavioral linkages between economic data series and what type of lagged impact one variable has on the other will round out this primer on data series.

The Consumer—Income and Expenditures. An income-expenditure flow analysis of the consumer sector is relatively straightforward. Income is the "driver" behind consumer spending, although other factors play a role. Additional fundamentals include changes in employment and wealth, changes in interest rates, and changes in prices. Nonetheless, a key to understanding the consumer income-expenditure flow is to examine what determines—in simple terms—consumer income. Aggregate consumer income, in a definitional sense, is based on the product of the number of workers, the average number of hours worked, and the average wage. The data series that correspond to these concepts are nonfarm payroll employment, the nonfarm average workweek, and average hourly earnings. All of these series are part of the employment situation report produced by the BLS and form the backbone of the BEA's estimates of the wage and salary disbursement portion of personal income. Analysts track these series in part so that they can gauge the strength of consumers' ability to spend.

As the flow diagram in Chart 1 shows, an increase in either employment, the average workweek, or average hourly earnings leads to an increase in personal income, and, in turn, an increase in personal consumption. Of course, this flow assumes that all other factors are held constant as the factors in the behavioral flow change. Clearly, other factors come into play in determining consumer spending, but in this simplified model these outside factors have no impact on explaining changes in consumer spending. Similarly, as the article discusses other behavioral flows between economic data series, for variables not discussed, the assumption of ceteris paribus is made.

Manufacturing and the Inventory Cycle. Income and expenditures flows play a more complex role in the manufacturing sector in what is traditionally called an inventory cycle. Essentially, changes in consumer spending affect actual and desired inventory levels; when desired inventory levels differ from actual levels, manufacturers, wholesalers, and retailers make necessary adjustments to bring the two together. These actions, in

CHART 1 Behavioral Flow for Consumer Spending

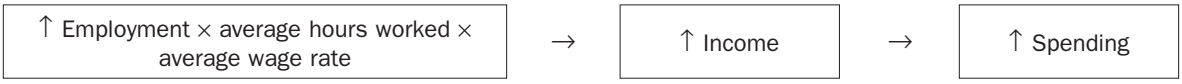
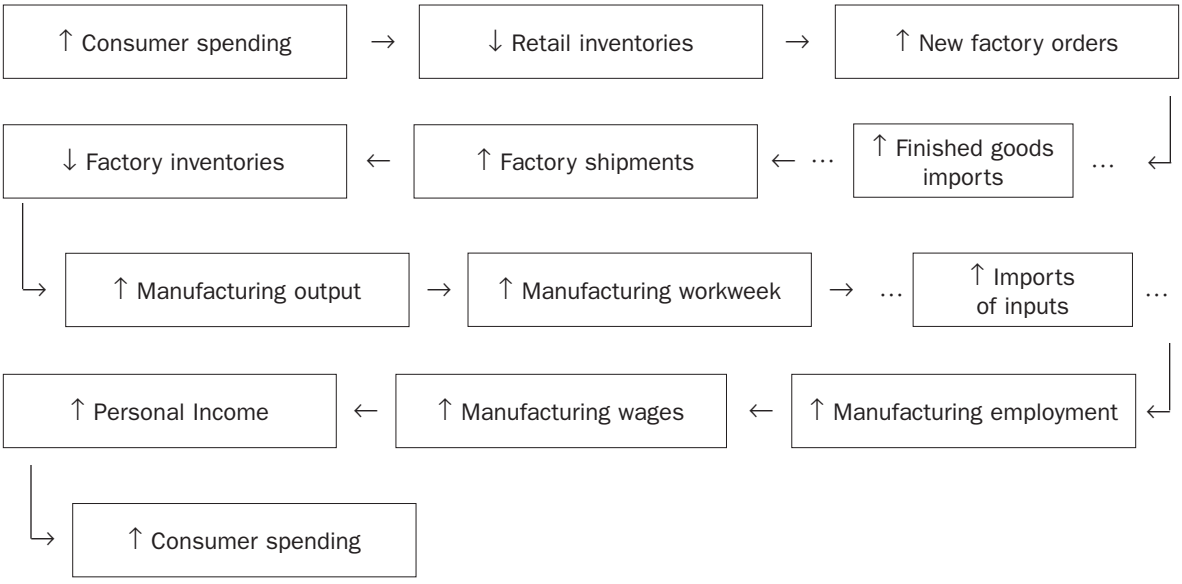


CHART 2 Behavioral Flow for Manufacturing



turn, affect consumer income and spending. Essentially, the consumer plays a key role in the inventory cycle.

The flow diagram in Chart 2 illustrates this cycle. At the beginning of the cycle, if retail sales to consumers are unexpectedly strong, retail inventories will decline below desired levels. Retailers will then place new orders with domestic producers or order additional imports. Domestic producers respond by increasing shipments, which in turn cause manufacturers' inventories to drop below desired levels. This drop in turn boosts manufacturing output. Initially, manufacturers merely increase the average workweek, but when demand is sufficiently strong they hire additional workers. Average hourly earnings may rise in order to attract the additional workers. As personal income rises, the cycle is renewed because this income gain can fuel additional consumer spending.

Table 6 lists the data series that analysts track to follow this cycle. The left-hand column shows the generalized economic concepts in the behavioral flow for manufacturing while the right-hand column indicates the specific data series that correspond to the economic concept.

Analysts are interested in determining the average length of time it takes for a change in one variable to affect a second variable. But a complicating factor in estimating some of these average lag lengths is that the direction of causality is not always consistent, especially for sales series and inventory data. During a business cycle, businesses may do a better job of anticipating sales at some times than at others; inventory changes may anticipate sales changes and vice versa. This reciprocity reduces the likelihood that measures of average lag length are statistically meaningful for these data series. For other data series, the causal relationships may be more consistent so that average lag lengths can be estimated. For example, housing starts essentially always precede housing outlays, and changes in durables factory orders precede changes in durables production.

For manufacturing sector analysis, it is useful, for a couple of reasons, to segment the discussion between durable goods and nondurable goods. First, durable goods, especially heavy capital equipment, tend to have longer production cycles than nondurables, and durables output is more cyclically sensitive. Changes in durables and nondurables share of output over the business cycle would affect the reliability of estimates of various lag coefficients (such as orders to production) if estimated using data that were not disaggregated between durables and nondurables. Second, differences in methodologies for nondurables orders affect lag estimates.

TABLE 6
Behavioral Flow for Manufacturing: Economic Concepts and Corresponding Data Series

Economic Concept	Data Series
Consumer spending	Retail sales, Census Personal consumption expenditures, BEA Unit new motor vehicle sales, AAMA and BEA Chain store sales, LJR
Retail inventories	Retail inventories, Census
New factory orders	Manufacturers new orders, Census
Factory shipments	Manufacturers shipments, Census
Factory inventories	Manufacturers inventories, Census
Imports	Imports of goods and services, BEA and Census
Manufacturing output	Industrial production index, Federal Reserve Board Manufacturing surveys: NAPM, Chicago Purchasing Managers, Atlanta Fed, Kansas City Fed, Philadelphia Fed, and Richmond Fed
Manufacturing workweek	Average workweek, manufacturing, BLS
Manufacturing employment	Nonfarm payroll employment, manufacturing, BLS
Manufacturing wage	Average hourly earnings, manufacturing, BLS
Personal income	Personal income, BEA

Table 7 shows the average (mean) lags, estimated by the Almon distributed lag technique, between various manufacturing sector indicators for durables. The mean lag between changes in new factory orders for durables (real) and industrial production for durables manufactured goods in all durables industries is 2.3 months;[5] the lag from production to shipment is relatively short—only 1.654 months. Lags would vary if they were estimated on an industry-by-industry basis. For example, the orders-to-production mean lag would be much longer for the aircraft industry than for the lumber industry. Estimates of lag length also vary depending on the model and lag structure chosen (see Greene 1993, 519–25).

For nondurables, data methodology for orders has an interesting impact on lag estimates. The Census Bureau's monthly estimates for new orders are defined as current-month shipments plus current-month unfilled orders minus prior-month unfilled orders (see Rogers 1994, 145). This formula works reasonably well for industries with unfilled orders. However, most nondurables industries report no unfilled orders—for December 1997 only 25.5 percent of the dollar value of new orders for nondurables was for industries that report unfilled orders. For industries with no unfilled orders, Census uses shipments data for new orders—that is, new orders are assumed to equal the available shipments numbers and to represent post-production activity. Official data indicate that most nondurables production takes place during the same month as the shipments/new orders. Table 8, which reports on the regression output of nominal shipments regressed against contemporaneous nominal new orders and a constant, shows the high correlation (an adjusted R^2 of 0.9378) between nondurables new orders and nondurables shipments.

Construction Sector Linkages. Just as there are inventory cycle effects in manufacturing, there are similar linkages in the construction sector (see Table 9). An unexpected increase in housing sales leads to a drop in houses for sale as well as in the months' supply of houses for sale. Houses for sale and months' supply are the housing sector's equivalent of manufacturers' inventories data and of the inventories-to-sales ratio. If hous-

TABLE 7 Manufacturing Indicators: Lags between Key Series

Estimation technique: Almon distributed lag
Observation period: 1970M1–97M9

Series and Predecessor Series	Mean Lag (Months)	Standard Error of Mean Lag	Adjusted R^2 of Equation	Lag Specification (Order, Lag Length, Endpoint Constraint)
Industrial production, durables/ Durables orders, real	2.342	Undefined	0.401	2, 12, None
Durables shipments, real/ Industrial production, durables	1.654	Undefined	0.309	3, 9, None

TABLE 8
High Correlation between Same-Month Nondurables New Orders and Shipments

Regression: Dependent variable is
nondurables, shipments, nominal, percent change
1970M1–97M9

Variable	Coefficient	Standard Error	*t*-statistic	Significance
Constant	0.320391E-01	0.192568E-01	1.66378	0.097
New Orders, Nominal, Percent Change	0.940697	0.132951E-01	70.7552	0.000

Equation Summary

Number of Observations	=	333	R^2 (adjusted)	=	0.9378
Sum of Squared Residuals	=	34.8928	Standard Error of Regression	=	0.324679
R^2	=	0.9380	Durbin-Watson	=	2.92446

ing stocks decline below desired levels, then builders take out housing permits, initiate housing starts, and work toward completing houses by making construction outlays (spending), as Chart 3 demonstrates. As in manufacturing, this cycle can differ when production is based on expectations of changes in the business cycle. For example, housing stocks may be built up in anticipation of housing sales rather than housing being replenished after a rise in sales. There clearly are times that the direction of causality among some of the inventory-sales-permits-starts linkages reverses, reducing the statistical reliability of these relationships.

Table 10 shows that the average lag (using the Almon distributed lag estimation technique) between changes in housing permits and housing starts is very short—only 1.026 months. The average lag from changes in starts to changes in construction outlays is 4.032 months.

Price Sector Linkages. To some degree there are linkages in prices in various sectors of the economy

5. Because output for durables and nondurables is in real (inflation-adjusted) terms, it is appropriate that the orders and shipments data be converted from current dollars to real dollars. Durables and nondurables orders and shipments data were deflated using BLS data for producer price indexes for durables manufactured goods and nondurables manufactured goods, respectively.

Durables industries include lumber and products, furniture, and fixtures; clay, glass, and stone products; primary metals, fabricated metal products, industrial and commercial machinery, and computer equipment, electrical machinery, transportation equipment, instruments, and miscellaneous manufactures. Nondurables industries include foods, tobacco products, apparel products, paper and paper products, printing and publishing, chemical and products, petroleum products, rubber and miscellaneous plastics products, and leather and leather products.

TABLE 9
Behavioral Flow for Construction: Economic Concepts and Corresponding Data Series

Economic Concept	Data Series
Housing sales	New single-family housing sales, Census Existing single-family housing sales, National Association of Realtors (NAR)
Houses for sale, ratio stocks/sales	Months supply, new single-family houses, Census Months supply, existing single-family houses, NAR
Housing permits	Housing permits, Census
Housing starts	Housing starts, Census
Residential construction spending	Residential construction outlays, Census

TABLE 10 Construction Indicators: Lags between Key Series

Estimation technique: Almon distributed lag
Observation period: 1970M1–97M9

Series and Predecessor Series	Mean Lag (Months)	Standard Error of Mean Lag	Adjusted R^2 of Equation	Lag Specification (Order, Lag Length, Endpoint Constraint)
Housing starts/ Housing permits	1.026	Undefined (Lag signs switch)	0.389	3, 6, None
Residential construction outlays, 1992$/Housing starts	4.032	0.450	0.537	2, 15, None

TABLE 11 Inflation Indicators: Lags between Key Series

Estimation technique: Almon distributed lag
Observation period: 1970M1–97M9

Series and Predecessor Series	Mean Lag (Months)	Standard Error of Mean Lag	Adjusted R^2 of Equation	Lag Specification (Order, Lag Length, Endpoint Constraint)
CPI, total/ PPI, finished goods	1.573	0.144	0.621	3, 6, None
PPI, finished goods/ PPI, intermediate products	0.100	0.105	0.561	2, 4, None
PPI, intermediate products/ PPI, crude materials	5.056	0.460	0.347	4, 12, None

CHART 3 Behavioral Flow for Construction

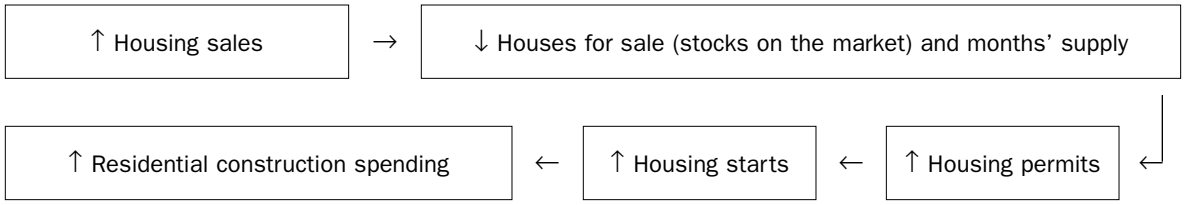
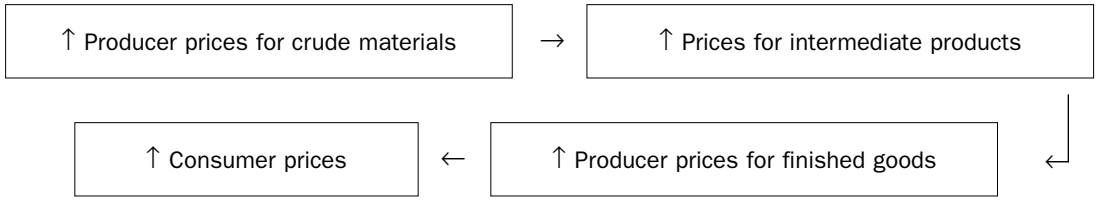


CHART 4 Behavioral Flow for Prices



Note: The individual units in the chart are the names of indexes produced by the BLS. However, producer prices for crude materials refers not only to the index published by the BLS but also to series by the Commodity Research Bureau (CRB) and the *Journal of Commerce* and the prices paid diffusion index from the NAPM.

through cost pass-through. The cost for crude materials may be passed through to costs for intermediate goods, for producer prices for finished goods, and on to the consumer (see Chart 4).

The relationship between the PPI for finished goods and the CPI should be measured using the CPI for goods only (that is, excluding services, since the PPI for finished goods has no services other than electricity from public utilities). In addition, the length of pass-through from the PPI for finished goods to the CPI is rather short, with most of the impact taking place within the current and following months. Finally, the relationship between any two price series above is not particularly strong because there is a great deal of volatility in the data, more so for producer prices for crude materials than for finished goods. Crude materials prices and diffusion indexes provide many false signals of building price pressures at the consumer level. However, rising crude and intermediate prices are generally precursors of an increase in consumer price inflation.

Table 11 shows a very short lag time from changes in producer prices for finished goods and consumer prices—only 1.573 months. Movement in prices for finished goods and intermediate goods is essentially coincident, with an estimated lag of 0.100 month. The apparent pass-through of changes in crude materials prices to intermediate products is somewhat longer, with an estimated mean lag of 5.056 months.

Summary

This article is a primer on some of the key short-term economic relationships among data series upon which economic analysts focus. Certainly, market participants closely watch the calendar of economic releases and, as each release is made, enter the new information into their calculations—with either formal models or with judgment—regarding the strength of the economy. The article, though it touches only on selected data relationships, should clarify how analysts carry information from one economic release into their view of the strength of other economic indicators.

REFERENCES

BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM. 1986. *Industrial Production: With a Description of the Methodology*. Washington, D.C.

GREENE, WILLIAM H. 1993. *Econometric Analysis*. 2d ed. Englewood Cliffs, N.J.: Prentice Hall.

HARRIS, ETHAN S. 1991. "Tracking the Economy with the Purchasing Managers' Index." Federal Reserve Bank of New York *Quarterly Review* 16 (Autumn): 61–69.

HARRIS, ETHAN S., AND CLARA VEGA. 1996. "What Do Chain Store Sales Tell Us about Consumer Spending?" Federal Reserve Bank of New York *Economic Policy Review* 2 (October): 15–35.

ROGERS, R. MARK. 1988. "Improving Monthly Models for Economic Indicators: The Example of an Improved CPI Model." Federal Reserve Bank of Atlanta *Economic Review* 73 (September/October): 34–50.

———. 1992. "Forecasting Industrial Production: Purchasing Managers' versus Production-Worker Hours Data." Federal Reserve Bank of Atlanta *Economic Review* 77 (January/February): 25–36.

———. 1994. *Handbook of Key Economic Indicators.* Burr Ridge, Ill.: Irwin Professional Publishing.

———. 1998. *Handbook of Key Economic Indicators.* 2d ed. Burr Ridge, Ill.: McGraw-Hill Professional Publishing.

U.S. DEPARTMENT OF COMMERCE. 1996. "Updated Summary Methodologies." *Survey of Current Business* (August): 81–103.