MEASURES OF DISEQUILIBRIUM AS COMPONENTS OF LEADING INDICATORS INDEXES

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MEASURES OF DISEQUILIBRIUM
AS COMPONENTS OF LEADING INDICATOR INDEXES

by Joel Popkin*

The debate over the causes of business cycles has heated up again, as it does periodically. But the need to predict business cycle developments, regardless of their cause, has always attracted a significant body of researchers.

A long-lived approach to business cycle forecasting is to use leading indicators. The approach is one of two in widespread use throughout the world. The second method is the macroeconometric approach. Both are about the same age. Indicators first evolved in the 1920s under the leadership of Wesley Clair Mitchell (1927) at the National Bureau of Economic Research. Macroeconometric models go back to the work of Jan Tinbergen (1939) for the League of Nations.1

The macroeconometric approach gained acceptance, in part, because models were built in the framework of the National Income and Product Accounts (NIPA) around which Keynesian theory was implemented. The indicators evolved in a less structured environment in which the objective has been to understand the business cycle process in considerable detail. The approach has not been limited to the components of the NIPA. The search is broader. Two major additional areas of study have been intermediate output and financial markets.

In the indicator approach, the business cycle is defined by the selection of a set of time series (currently four in the U.S.) which are then aggregated into a coincident index of economic activity. This index provides a reference cycle against which to evaluate various candidate series for designation as leading and lagging indicators.

In macroeconometric models, the object has been to simultaneously predict the components of the GDP on both the income and product side in a formal Macroeconomic model structure (typically Keynesian), so that their aggregate tracks overall GDP.

Both methods need to incorporate variables that effect subsequent outcomes in order to have predictive ability. Macroeconometric models often employ expected values of variables that are directly impacted by monetary and fiscal policy, measures of anticipated private sector behaviour such as planned plant and equipment spending, and consumer sentiment measures. Additionally, lagged values of current variables are used to capture adjustment processes and to proxy for target variables such as desired inventory stocks. Some or all of these variables are treated as exogenous within the model structure.

Leading indicators play the same role as the macro model variable just described to identify information relevant to shaping the future path of the overall economy. Thus leading indicators usually comprise monetary policy and financial market variables and consumer expectation measures. Most other leading

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1 For a full accounting of the contributions of Tinbergen and others to macroeconometric model building, see Bodkin, et al, (1991).
indicators relate to the manufacturing and construction sectors. Of those, orders and construction contracts and housing starts, all of which reflect the early phases of production activities with long gestation periods, are well represented.

Thus indicators appear to fall into three main categories. Those that:

1. Reflect macro policy actions assumed to have future impact.
2. Measure expectations of producers and consumers about in their future behaviour.
3. Reflect substantive commitments, such as contracts and orders, that will affect future activity.

That these categories of indicators are assumed to, and many have been shown to impact the future, suggest they initially create a changed environment with different expectations. The difference between actual and anticipated behaviour initially creates a disequilibrium which prompts subsequent adjustment. This implies that the proximate cause of economic fluctuations is the emergence of a development that initially creates disequilibrium. That conclusion is consistent with both current major schools of equilibrium business cycle thought price stickiness and real business cycles. Those two schools differ in characterising the source of cycles i.e., what provides the “Frisch (1933) impulse” but both also focus on the path of propagation the impulse creates.2

Indicators focus primarily on revealing an understanding of propagation paths so they can be forecast. The indicator method is not directly concerned with specifying the source of the impulse. But that is not to say that indicators need not have a basis in economic theory. It would seem that the objective of indicators is to identify disequilibria and suggest the path that will ensue to correct them. Thus, the indicators can, and many do, bear relationships to economic theory.3

Some variables measure disequilibria directly. Others may contain unobserved components that are not in equilibrium vis-à-vis one another. For example, profits and inventories are both integral in the measurement of GDP, one from the final demand side, the other from the income side. But it is difficult, if not impossible, to capture from aggregate data on these components either in a given time period or in two adjacent time periods, the extent to which each may be in disequilibrium. Each of the two variables is the sum of components over the entire industrial economy. Each is an aggregate of inventory investment and profits over sectors that produce for intermediate as well as final demand.4 Profits may be in disequilibrium because an increase in a crude material price, destined to show up as an increase in final prices, has not completed its course. An overbuilding of inventories at retail stores may mask the need for a subsequent reduction not only at retail, but at wholesale and manufacturing stages as well.

Other variables are themselves directly capable of reflecting disequilibria because of their role as buffers in the production stream. Two good examples are unfilled orders and inventories of similar goods wherever held. When unfilled orders rise, cet. par., an increase in new orders relative to production is being buffered. Such a change in new orders relative to production could also be supplied through a decline in inventories of similar goods wherever held. In reality both may occur during a period of disequilibria.

2 For a description and analysis of both approaches, see Boehm (1990).
3 For an identification of some that do, see Popkin (1990).
4 The manufacturing sector is an important producer of intermediate output. The other major producers of intermediate output are service sectors, particularly business, financial and real estate services and the distribution networks that move goods and services along the production chain from producers to end users.
Disequilibria appear to occur most in manufacturing and in construction. Those sectors have characteristics that create disequilibria. It is necessary to hold inventories and to book unfilled orders, while orders are being produced. Some of those characteristics carry over into the wholesale and retail distribution sectors as finished manufactures move to final markets. Manufacturing is generally characterised by production and gestation lags.\(^5\) Perhaps all those structural aspects explain why manufacturing-sector-related variables comprise a substantial subset of leading indicators.\(^6\)

Whatever the reasons, the role of manufacturing in shaping economic fluctuations in the U.S. is clear from Chart 1. One distinguishing characteristic is that manufacturing output rises faster than total output during business cycle expansions and falls faster during contractions.

In the remainder of this paper, the focus will be on the manufacturing sector. The intention is to further develop an indicator that is both grounded in economic concepts and is useful in forecasting business cycle developments. To preview some conclusions:

1. Such an indicator exists.
2. Some of its components are used currently as indicators.
3. It is useful not only in predicting cyclical output patterns, but manufacturing sector prices as well.

Assume Diagram 1 depicts short run supply and demand developments in a market in the manufacturing sector. The supply curve represents production at various prices for a given level of industry capacity. The supply curve becomes quite inelastic as full capacity is reached. Two demand curves, each representing orders placed at various prices, are shown, an initial one and one reflecting an upward shift.

Initially, the market clearing price is in equilibrium. But assume it does not rise immediately in response to the increase in demand. The dotted line represents the extent to which demand now exceeds supply. When faced by this excess demand producers will initially backlog it resulting in a rise in unfilled orders, fill it from stocks causing a decline in finished goods inventories, or do both. Ultimately prices would adjust to the new, higher market clearing level.\(^7\) In so doing, new supply will come forth and the initial excess demand will be damped. The larger the disequilibrium, the greater is the rise in price needed to clear the market, for a given set of demand and supply curves. The more elastic the curves, the greater is the likelihood that the equilibrium will be reached with a large quantity adjustment. It is the quantity adjustment, of course, that ultimately alters the business cycle's path. But some price adjustment is likely as well. The more inelastic the supply and demand curves, the greater the portion of the adjustment that will be made by prices vis-à-vis quantities.

Of course, in time, capacity might increase shifting the supply curve rightward. The shift of supply represents a movement from one short-run situation to another, a gestation period long enough for capacity to be increased. This capacity augmentation would raise supply relative to demand and reduce, if not

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\(^5\) Gestation lags and their role in creating and propagating economic fluctuations received their first major articulation in the work of Kalecki (1935).

\(^6\) Another reason manufacturing sector indicators are numerous may be that the sector was among the first for which industrialized nations collected data.

\(^7\) The time that appears to be needed for this kind of price adjustment and others, such as those adjustments needed to equilibrate input and output prices, gives rise to the notion of "sticky-prices" in business cycle literature (see Boehm, 1990).
eliminate, the amount of price adjustment required. Thus, an increase in output would be facilitated, prolonging an expansion. The interplay of changes in the degrees of disequilibrium and in the underlying conditions of equilibrium create and govern cyclical movement.

The analysis of Diagram 1 suggests that finished goods inventories, unfilled orders and capacity, along with flow demand, as represented by new orders, need to be combined to measure the magnitude of shifts in the point of equilibrium and the degree of disequilibrium that exists. Those, in turn, may be helpful in predicting movements in prices and quantities in manufacturing. If so, they will be useful as well in predicting the overall business cycle.

Such a measure has been constructed and tested for a while. It is called, for want of a better term, the demand-supply ratio (D/S). The numerator is the sum of unfilled orders at the beginning of a period and new orders received during the period. The denominator is the sum of finished goods inventories and one-half of goods-in-process inventories at the beginning of a period and capacity to produce during the period. All variables are measured in nominal dollars because roughly similar prices are in both the numerator and denominator and cancel out. Since capacity is a quantity index, it is converted to nominal dollars through multiplication by a price index for the output the capacity produces.

The ratio can be calculated monthly since the data are published with that frequency. The ratio is calculated in this paper for the manufacturing sector as a whole and for the set of industries within manufacturing that produce materials and supplies. The data on inventories and new and unfilled orders are compiled by the U.S. Census Bureau. Capacity indexes are those of the Federal Reserve Board. The price indexes for transforming the capacity indexes to nominal dollars are those of the Bureau of Labour Statistics.

The results are shown in Charts 2 and 3. In each, the series are plotted on a grid that shows official U.S. business cycle peaks and troughs. There is a clear tendency for both indexes to lead at the six cyclical peaks depicted. The only exception for both indexes is their lag at the 1973 peak. Price controls were in effect at that peak and were taken off in the spring of 1974. These events may have influenced the behaviour of the D/S indexes. Output probably was stronger than it would have been in the absence of controls, so manufacturing production continued to expand while the rest of the economy weakened.

For troughs, the results are mixed. The ratio for materials and supplies appears to coincide with the reference cycle trough more often than the ratio for the total manufacturing, but neither seems to give a leading signal that a recession has ended.

Chart 4 combines the data on Charts 2 and 3 in one graph. From it, the greater volatility of the materials and supplies ratio is evident. The total manufacturing ratio is quite volatile as well. It would probably be less so if materials and supplies were subtracted from it. (There are currently some technical obstacles to so doing). Nonetheless, the behaviour of both series suggests that disequilibria exist and change rapidly in the manufacturing sector. The ratios give loud, clear and fairly early evidence the economy is headed toward a recession. And while the ratios do not anticipate troughs, they have usually given clear signals that expansions are underway.

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8 Used internally by Joel Popkin since the early 1990s, it was first noted and analyzed in a column in the Washington Post by John M. Berry (1994).

9 There is considerable evidence that the processes that end expansions differ from those that cause upturns at troughs. Many think separate indicators are needed for expansions and contractions.
Charts 5 and 6 show the relationship between the D/S ratios and the prices of the relevant outputs.\textsuperscript{10} The price indexes are plotted as 6-month percentage changes. Peaks in the D/S ratios usually lead peaks in the rate of change of prices.\textsuperscript{11} Until the two most recent recessions, 6-month span price increases for total manufacturing, shown in Chart 5, have usually peaked at, or after business cycle troughs. Thus, the lead of the D/S ratio over peak rates of price increase was particularly long. In terms of the disequilibrium in Diagram 1, this suggests the adjustment to move back to equilibrium occurs initially in quantities, and only later in prices. Such behaviour is consistent with the “sticky-prices” view of economic fluctuations. More recently, the lead of D/S appears to have shortened, perhaps suggesting that increasing competitiveness is speeding the adjustment processes.

For the materials and supplies sector, shown in Chart 6, the picture is somewhat different, though the recent trends are similar. Prices peak sooner for materials and supplies than for overall manufacturing. They slow and/or decline at, and most recently before, business cycle peaks. This suggests prices of “upstream” goods are not as sticky as those of “downstream,” finished goods.

Troughs in rates of price change for total manufactured goods usually lag business cycle troughs and troughs in the D/S ratio. Troughs in materials and supplies' price changes occur sooner than those for manufacturing prices, sometime being reached during, rather than after recessions. Again this is consistent with the peak analysis that suggested such prices adjust more quickly than manufacturing as a whole.

Early-stage prices would probably behave even more responsively if they were measured by a more precise index, one covering only the subset of materials and supplies that are the outputs of those manufacturing sectors that are the first processors of raw materials. Research suggests the movement of prices of those primary manufactures leads the changes of other materials and supplies, i.e., semi-manufactures. Prices of semi-manufactures, in turn, lead those of finished manufactures. Part of the reason lies in the fact that output cycles increase in amplitude as one goes upstream from final demand and finished goods to primary manufactures.\textsuperscript{12} Given this increase in amplitude, the earlier and greater amplitude of the response of prices is to be expected.

This process is consistent with the implication that the earlier the stage of process, the greater the amplitude in the fluctuation in output. The primary manufactures stage could be expected to provide the earliest indication of a change in the manufacturing climate and the signal would be likely to be robust.

Conclusions

The development, and subsequent adjustment, of disequilibrium is a major factor in the propagation of economic fluctuations. A useful set of leading indicators should include variables that are sensitive to and mirror disequilibria. These include inventories by stage of fabrication as well as by stage of process, new and unfilled orders and prices of inputs relative to outputs.

\textsuperscript{10} The price indexes are for so called "core" goods, thus excluding prices of food and energy. The industries that produce them are not excluded from the D/S ratios, but are industries for which the Census Bureau does not collect unfilled-orders data because the lag between new orders and shipments is so short.

\textsuperscript{11} It must be kept in mind that D/S is measured each time period while price changes are calculated over a 6-month period a period generally found long enough to reduce the noise in the series. This method contributes to the finding of a price lag.

\textsuperscript{12} For a model describing this process, see Popkin (1984).
In this paper, a measure incorporating some of these variables has been presented. That it was derived from the economic model of a market shocked into disequilibrium, suggests that leading indicators can be rooted in fairly rigorous economic theory. They should not be characterised, as they sometimes are, as measurement without theory.

Variables that measure disequilibria are most obvious in manufacturing (and construction). But they probably exist elsewhere; certainly trade inventories reflect disequilibria.

Disequilibria imply a difference between two or more variables. Therefore, those who compile sets of leading indicators should consider examining relevant ratios. This approach was found useful in constructing the indicator that is the focus of this paper. But certainly other ratios, such as inventories to sales and unfilled orders to shipments should be explored.

Many early-lead disequilibrium variables are likely to be found in sectors producing intermediate output. Because of that, it is awkward, if not difficult, to introduce them into macroeconometric models built around the national accounts. It is easier and more straightforward to develop indicators as an independent forecasting system. In countries where leading, coincident and lagging indicators are produced, this is the strategy that is followed.

Finally, some data improvements seem called for. It would appear useful to develop manufacturing sector data disaggregated into three sectors: (1) primary manufacturing the first processors of raw materials; (2) finished manufacturers the last processors of manufactured goods; and (3) semi-manufacturers all processors that do not fall into primary or finished. And most data provides are aware of the need to measure more behavioural variables in non-manufacturing. For indicators, perhaps, that effort should centre on intermediate, non-manufacturing output.

References


Chart 2: Manufacturing Demand/Supply Ratio
(Feb. 1967 = 100)
Chart 4: Manufacturing and Materials & Supplies Demand/Supply Ratios

(Oct. 1967=100)

- P: Manufacturing
- T: Materials & Supplies

Yearly Data:
- 1959 - 1995
Chart 5: Manufacturing Demand/Supply Ratio vs Core Finished Goods PPI

Percent Change

Level of Ratio

Manufacturing D/S Ratio (right scale)

Core Finished Goods PPI, 6 month percent changes It AR (left scale)
Chart 6: Materials & Supplies D/S Ratio vs Core Intermediate PPI