Methodological Details

To estimate our Tech-Pulse Index, we follow the methodology developed by Stock and Watson (1988, 1989). This approach filters out the idiosyncratic noise from each coincident indicator to obtain the best estimate of the common comovements of all indicators. This common trend is our estimate of the coincident index of tech-sector activity and serves as our Tech-Pulse Index.

More formally, let Δx_{it} be the growth rate of indicator i at time t. Here, $i = 1,\ldots,5$ indexes: the employment, industrial production, shipments, consumption, and investment series. Let Δc_t be the growth rate of the unobserved coincident index of tech-sector activity that we will estimate. We assume that

$$\Delta x_{it} = \beta_i + \sum_{j=1}^{p} \phi_{ij} \Delta x_{it-j} + \gamma_i \Delta c_t + \varepsilon_{it} \ . \tag{1}$$

Hence, the growth rate of each indicator is assumed to be a weighted sum of its own p past values; an indicator-specific random effect, ε_{it}; and the growth rate of the common factor Δc_t that we will estimate. In our application, we choose $p = 3$. It turns out, however, that our results do not depend on the particular model specification and are robust for almost all of the specifications we estimated.

To distill the common factor, we make an assumption about its behavior.

We assume that it follows

$$\Delta c_t = \delta_i + \sum_{j=1}^{2} \theta_j \Delta c_{t-j} + v_t \ , \tag{2}$$

where v_t is again a random shock and is assumed to have a unit variance.

Equations 1 and 2 are also known as a state-space model representation, in which the observed indicators, x_{it}, are determined by an unobserved state variable, c_t. We assume that the random disturbances, ε_{it} and v_t, are independently normally distributed.

The estimated trend growth rate of c_t in this model is a weighted average of the average growth rates of the indicator variables. The specific weights, also known as the cumulative dynamic multipliers, are a complex function of the estimated parameters of the model. These multipliers can be normalized to calculate the share that the average growth rate of each indicator contributes to the trend in c_t. We report these estimated shares in the table. Because the trend growth rate of the index is a weighted average of the growth rates of the indicator variables, it is not advisable to compare it with the growth rates of other variables.

We estimate the model using maximum likelihood and the Kalman filter. Estimation is conducted using the software developed by Clayton-Matthews (2001) and based on Stock and Watson (1989) and Clayton-Matthews and Stock (1998-99). The table presents the means and standard deviations of the five coincident indicators and the coincident index, as well as the growth rate share and the number of estimation lags for each coincident indicator. An important virtue of this method is that it allows us to combine data that are observed at different frequencies. That is, whereas all other variables are reported monthly, data on investment are released only every quarter.

It is worth noting that we do not prefilter the coincident indicators. As shown in the table, certain coincident indicators, such as shipments and personal consumption expenditures, are quite volatile at monthly frequencies, a pattern that leads to a volatile Tech-Pulse Index. However, we do not consider this to be a practical problem (in principle, the Kalman filter should be able to distinguish the idiosyncratic noise from the common trend) but rather an indication of the inherent volatility of tech-sector activity. By choosing $p = 3$ in equation 1, we have already allowed the model to capture sizable fluctuations specific to each indicator.

Summary Statistics for Estimation of the Tech-Pulse Index

	Annualized Growth Rate			Model	
	Frequency	Mean (Percent)	Standard Deviation (Percent)	Share (Percent)	Number of Lags (p)
Coincident indicator					
Employment	Monthly	3.2	8.4	17.2	3
Industrial production	Monthly	21.3	23.4	7.3	3
Shipments	Monthly	19.2	40.8	58.8	3
Investment (real)	Quarterly	16.0	14.3	13.9	3
Consumption (real)	Monthly	95.2	259.7	2.9	3
Tech-Pulse Index (real)	Monthly	17.97	19.12	100.0	

Sources: Authors' calculations; U.S. Department of Commerce, Bureau of Economic Analysis; U.S. Department of Labor, Bureau of Labor Statistics; Board of Governors of the Federal Reserve System.

Note: The model is estimated from October 1970 to March 2003.