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Recession risk: Labor market data and economic tipping points

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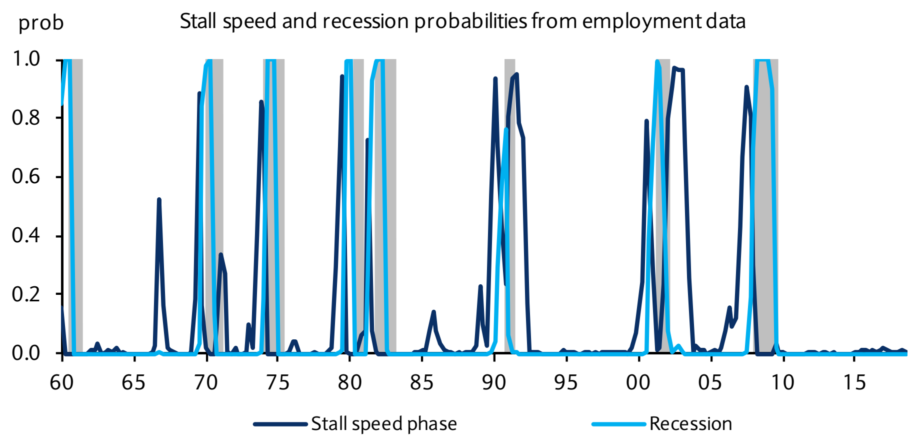
- **With the US economy only months away from setting the record for its longest expansion and a series of factors leading many, including ourselves, to forecast slower economic growth in 2019 and 2020, we believe it is time to update some of our research on estimating recession probabilities.**
- **Our preferred recession prediction model estimates the likelihood the US economy is in one of four states – rapid expansion, expansion, stall speed, and recession – and computes the probability that it will transition from one to the next. Identification of the stall state – when the economy is losing momentum and at risk of entering a recession – is the key component that helps understand recession risk.**
- **Evidence suggests that recession prediction models based on GDP or GDI likely suffer from misidentification due to the structural slowing in potential growth. We show that private employment as a share of the labor force can help overcome this problem and provide a clearer signal of recession risk. Replacing GDI with employment data to improve predictive capacity is a main thesis of this report.**
- **Our recession prediction models are flashing some warning signs, but are not signalling near-term risk that the economy will tip into recession. That said, we expect this to change gradually over our forecast horizon as economic activity slows and gains in employment moderate.**

FIGURE 1

Warning signals of a recession from labor market information remain low by historical standards



Note: Shading indicates NBER recessions. Estimated probabilities based on a regime switching framework where the state variable is growth in private employment as a share of the labor force. Source: Barclays Research

Introduction: It's that time again

With the US economy only months away from setting the record for its longest expansion and a series of factors leading many, including ourselves, to forecast slower economic growth in 2019 and 2020, we believe it is time to re-introduce – and improve – some of our research on estimating recession probabilities.[1] While we are not forecasting a near-term recession, our expectation that growth in economic activity should slow toward trend, if not fall modestly below it, communicates that we see some risk that the current expansion will end during our forecast horizon.

Our previous work on recession risks has proceeded on two tracks. The first is a probit-logit regression approach that allows the dependent variable to take on one of two values – expansion or recession – and uses one or more independent variables as regressors that are assumed to influence the result. The second strand is "regime switching" frameworks that assume the economy transitions between different stages of the business cycle, including a "stall speed" state that is akin to saying the economy has entered a "tipping point." The concept of stall speed is a key connector that complements our earlier probit-logit approach and identifies when the economy is losing momentum after being in expansion, which is equivalent to introducing a forecasting aspect to the regime switching models. Whereas some regime switching models are, at best, frameworks that help one assess where the economy is or where it has been, adding a stall speed state helps us to identify variables that predict recessions before they occur.

Since no single model has a fool-proof track record in terms of predicting recessions, we use a number of frameworks that incorporate different input data. That said, some of our previous research indicates that labor market data have high information content about the evolution of the business cycle and the economy's business cycle position.[2] This fits our belief that recession risks in the US stem from tipping points in the labor market, as opposed to external risk factors. This is because, in a large, relatively closed economy such as the US, healthy labor markets tend to generate sufficient income growth to keep households spending and the economy out of recession.

Our work proceeds as follows. We examine historical data to justify the inclusion of stall speed as a stage of the business cycle. We then estimate regime-switching models with four stages of the business cycle – rapid expansion, expansion, stall speed, and recession – and an indicator variable that helps identify these states. We estimate models using two separate indicators. The first uses gross domestic income (GDI), which prior research has identified as having superior stall speed identification than GDP. The second uses our preferred indicator, employment as a share of the labor force. We believe a structural shift to slower potential growth means GDI is no longer useful for predicting recessions, and a main point of this report is to improve our recession prediction framework by replacing GDI with labor market data.

Our preferred framework that uses labor market data to identify economic "tipping points" is flashing only a weak warning signal that the US economy is at risk of slipping into a near-term recession. We expect this to change gradually over the course of 2019 as growth in economic activity slows toward trend and gains in employment moderate.

[1] See *US Economics Research: Uncertainty shocks and recessionary risks*, 14 September 2011.

[2] For example, our state space framework that we use to jointly estimate the natural rate of unemployment, potential growth, and the natural rate of interest indicates that the labor market data are most useful in model identification. In order of importance, the employment rate and non-farm private employment have the highest correlation with innovations to the business cycle. This is consistent with findings in Fleischman, Charles A., and John M. Roberts, "From many series, one cycle: Improved estimates of the business cycle from a multivariate unobserved components model," *Finance and Economics Discussion Series* 2011-46, Federal Reserve, Washington, DC.

Stages of the business cycle

The term "business cycle" generally refers to the evolution of economic activity around a long-term trend. We show this stylistically in Figure 2, where the economy follows a boom-bust pattern over time, with expansions representing periods when actual output is rising and contractions designating periods when it is falling. The output gap is the difference between actual GDP and its long-run trend, normally expressed in percent of potential. Expansions generally lift the economy above potential, leading to positive output gaps, and contractions create negative output gaps. Hence, the concept of the business cycle generates two obvious phases of the economy: expansions and contractions, the latter of which is what we seek to predict.

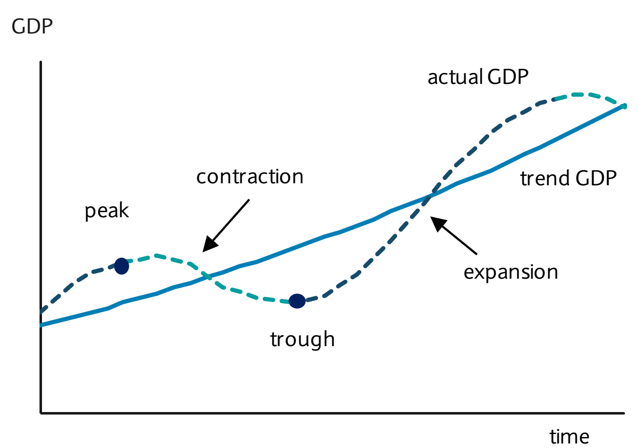
Two other useful concepts in Figure 2 are the peak and trough, which represent turning points in the economy, with expansions following the trough and recessions following the peak. These transitions suggest two possible additional phases of the business cycle, which we denote "rapid expansion" and "stall speed". The first of these is a period of rapid expansion that may occur at the conclusion of a recession. The second is when the economy is losing momentum as it transitions from expansion to recession. In the academic literature, these phases are often linked to the behavior of the durable goods sector, particularly to inventories. Stall phases are periods when the economy is expanding at a slower rate than before, which is usually most evident in durable goods expenditures and inventory investment that can eventually give way to outright declines if the economy tips into recession. In a rapid expansion phase, expenditures on durables and inventory investment quickly reverse direction as the recovery gains traction.

Data-based evidence of stall speeds

With these concepts in hand, we turn to the data to see if there is evidence in favour of these four stages of the business cycle. Using quarterly data on GDP, GDI, and industrial production (IP) from Q1 1959 to Q3 2018, we examine the quarterly annualized growth in each variable in the four quarters prior to NBER-defined recessions, the four quarters after the end of an NBER recession, and the remaining quarters outside NBER recessions.[3,4] Our

FIGURE 2

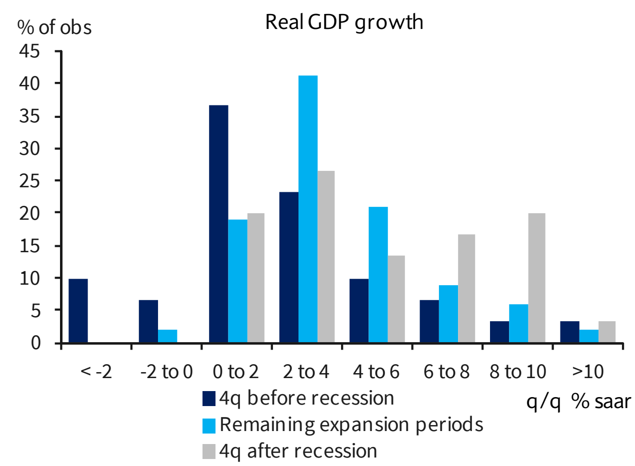
Stages of the business cycle



Source: Barclays Research

FIGURE 3

Distribution of real GDP growth across the business cycle



Source: BEA, Haver Analytics, Barclays Research

[3] Two exceptions are the recessions of 1980 and 1981-82. Since there were only four quarters between the two, we use the two quarters after the 1980 recession for the rapid recovery phase and the two quarters prior to the 1981-82 recession for the stall speed phase.

[4] The National Bureau of Economic Research (NBER) is the quasi-official arbiter of US recession dates. Recession dates are determined judgmentally by an internal Business Cycle Dating Committee, which makes its determination using a variety of indicators, including real GDP, incomes, employment, IP, and wholesale-retail sales. The committee seeks accuracy, not timeliness, so its determinations are often released after a recession has begun, or ended.

use of a four-quarter horizon before and after recessions is an arbitrary choice that is not informed by any structural framework. The histograms in Figures 3-5 report the results of this exercise, showing the percentage of observations that fall into each growth interval.

The results provide evidence in favor of four phases of the business cycle, including rapid expansion and stall. Beginning with the rapid expansion phase, each variable tends to accelerate in the quarters immediately following the end of a recession. This is particularly true for IP, which likely reflects inventory restocking.[5] Given that our dataset extends back to the 1950s, when manufactured goods accounted for a much larger share of activity, it is not entirely surprising that IP exhibits rapid expansion characteristics. That said, even though the US economy is now largely services oriented (manufacturing now accounts for a little more than 10% of total output and employment, compared with more than 25% in the 1950s), a small, yet volatile, goods sector is still consistent with a rapid expansion phase. In the four quarters following the financial crisis of 2008-09, IP grew at an average annualized rate of 7.2%, compared with 2.8% and 3.4% for real GDP and real GDI, respectively.

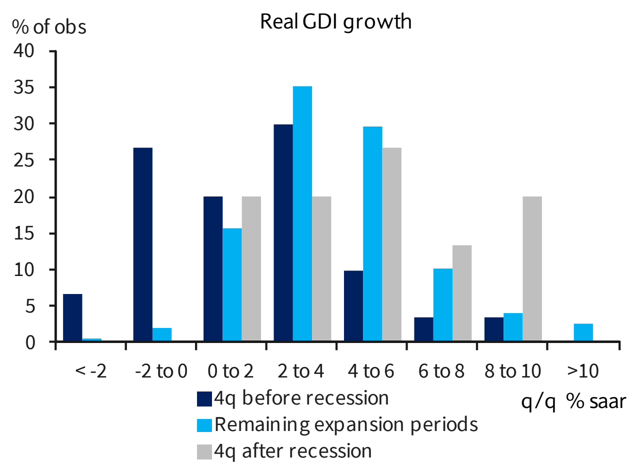
The data are also consistent with the concept of a stall speed phase. Outcomes in the four quarters prior to recessions are distributed to the left of outcomes in expansion periods (that is, expansionary periods that do not overlap with this rough definition of the stall phase). For example, the data indicate that GDP growth slows, on average, to somewhere between 0-2% prior to recessions, versus 2-4% in expansionary periods (Figure 4). This pattern is even more evident for real GDI (Figure 3), where growth outcomes in the four quarters prior to recessions are clearly distributed to the left of expansionary growth outcomes. The data suggest that slowdowns in the growth rate of GDI may be a superior leading indicator of economic turning points in GDP.[6] Finally, outcomes for IP also provide evidence of slower growth prior to recessions.

Identifying economic tipping points with macro data

To identify these economic tipping points, we need a framework that takes macroeconomic data as an input, provides a probabilistic assessment of the current state of the economy, and estimates the likelihood that it will move from one state to the next. The workhorse

FIGURE 4

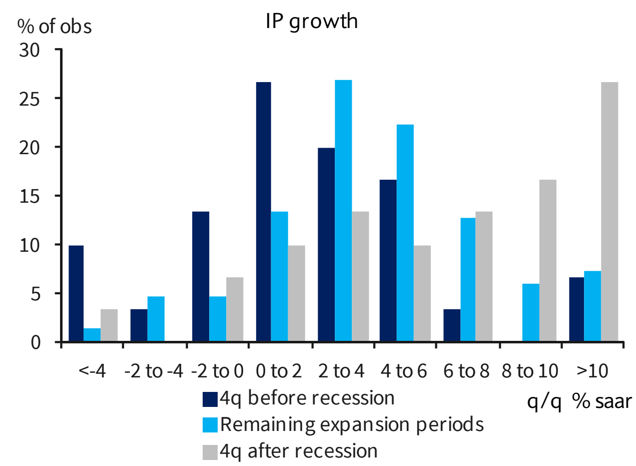
Distribution of real GDI growth across the business cycle



Source: BEA, Haver Analytics, Barclays Research

FIGURE 5

Distribution of real IP growth across the business cycle



Source: Federal Reserve, Haver Analytics, Barclays Research

[5] See Sichel, Dan, 1994, "Inventories and the three phases of the business cycle," *Journal of Business and Economic Statistics*, vol. 12, pp. 269-77.

[6] Other authors also find evidence in support of GDI as potentially a better indicator of stall speed than GDP. See Nalewaik, Jeremy, 2011, "Forecasting recessions using stall speeds," *Finance and Economics Discussion Series* No. 2011-24, Federal Reserve Board.

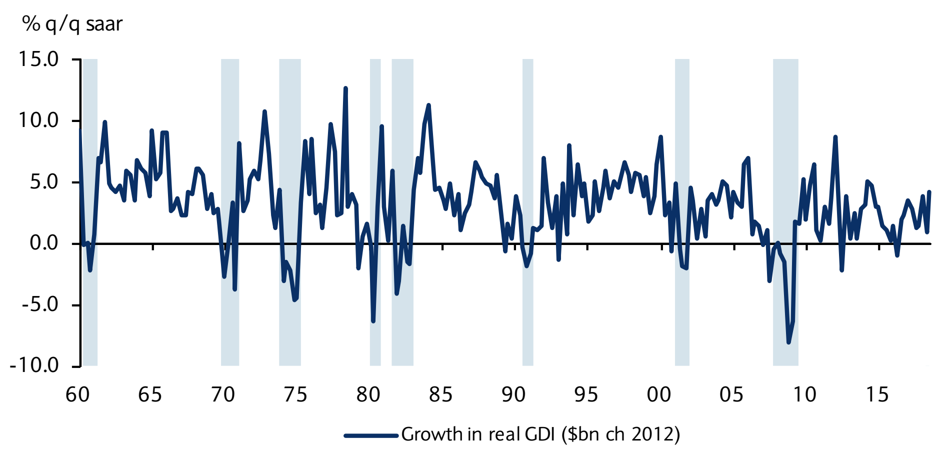
model for this type of analysis is called a “regime switching” framework.[7] This allows us to define various phases – or regimes – of a business cycle between which the US economy will transition and allows for sufficient flexibility to incorporate multiple regimes (rather than just a binary outcome of recession or expansion). The model uses historical data on economic indicators to characterize the distribution of data in each stage of the cycle and employs probabilistic techniques (specifically, Bayesian inference) to estimate the likelihood that the economy was in a particular state at any given time. To inform these inferences, the model also estimates transition probabilities. Simply stated, the model attempts to identify a probability that the economy is in each of the included states and to estimate the probability that it will transition into another state from that point.

Our workhorse is a basic univariate regime switching model that includes the multiple states of the world between which the economy can transition. To help it disentangle these multiple states, we impose certain identifying restrictions that reduce the number of variables that we need to estimate. In particular, we do not allow the economy to move from either rapid expansion or expansion directly into recession. These restrictions effectively force the economy to transition through the stall speed state before entering recession. That said, once in the stall speed state, we allow the economy to re-accelerate back into expansion, though we do not allow transitions from stall speed to rapid expansion. These assumptions allow for the possibility of a mid-cycle slowdown, which, ultimately, proves non-recessionary in nature. Once in the recession phase, we do not allow the economy to transition back into the stall phase, which helps preserve the notion of the stall as a tipping point when the economy slows from expansion to contraction.

Finally, since one purpose of the exercise is to compare estimated outcomes to actual instances of NBER-defined recessions, we use the actual behavior of each indicator during NBER-defined recessions to calibrate both its distribution and transition probabilities during the recession phase. For example, if our model were to use real GDP as an indicator, we would tell it that the average growth rate of real GDP during a recessions is -1.7% q/q saar (as in NBER recessions) and that the probability of remaining in a recession next quarter is 73% (based on the average length of NBER recessions).[8]

FIGURE 6

Annualized growth rate in US real gross domestic income



Note: Based on quarterly data from Q3 1959 to Q3 2018. Source: BEA, Haver Analytics, Barclays Research

[7] See Davig, Troy, 2008, “Detecting recessions in the great moderation: A real-time analysis,” Federal Reserve Bank of Kansas City’s Economic Review; Hamilton, James, 1989, “A new approach to the economic analysis of nonstationary time series and the business cycle,” *Econometrica* 57: 357-84; Hamilton, James, 1990, “Analysis of time series subject to changes in regime,” *Journal of Econometrics* 45: 39-70; Kim, Chang-Jin, and Charles Nelson, 1999, “Has the US economy become more stable? A Bayesian approach based on a Markov-switching model of the business cycle.” *Review of Economics and Statistics*, 81, 68–616; Nalewaik, Jeremy, 2011, “Forecasting recessions using stall speeds,” Finance and Economics Discussion Series, 2011-24, Federal Reserve Board, Washington D.C.

[8] The US has had eight recessions spanning 30 quarters since Q3 1959. This implies 100*((30/8)-1)/(30-8) = 73.3% is the probability that the US economy remains in recession next quarter if it is in recession this quarter.

Estimating stall speed with GDI: Structural shifts lead to misidentification

Since academic research has concluded that GDI is more useful than GDP in identifying a stall speed state, we first estimate the model using the quarterly annualized change in US real GDI. While GDP and GDI are conceptually identical, measured values differ in practice. Although both are equally comprehensive, research has concluded there is information in GDI that is useful in identifying stages of the business cycle. In particular, measures of wages and salaries used in GDI are calculated using data from state and federal employment insurance records, which constitute a near-census of employment income. These comprehensive data may help GDI do a better job of capturing turning points than GDP, which is pieced together using various measures informed by sampling techniques. Indeed, there is some evidence to suggest that GDI falls sooner, if not more than, GDP in recessions.[9] Hence, we focus our attention on estimating the framework using GDI and provide details of the model estimate using GDP in an appendix.

Before getting to the results, we provide some initial clarification of how to interpret our outputs. Regime switching estimation generates two types of probabilities: filtered and smoothed. Differences between these are based on the information used to form the estimation of the current state. The procedure uses the entire time series of data from Q3 1959 to Q3 2018 to estimate the mean of the indicator in each of the states and a common variance that applies to all states. We show these in Figures 7 and 8. The estimated transition probabilities, shown in Figure 9, then describe the probability of transitioning from each state to another in the subsequent period. Given this information, the filtered probabilities (Figure 10) represent a prediction of the current state of the economy in each period given the prior history of real GDI up to the present. Hence, unlike the transition probabilities, these filtered probabilities use historical data to help inform an expectation of the current state – much akin to what one does when forming a forecast based on available information about a set of economic variables.

In contrast to these filtered probabilities, the smoothed probabilities in each period are "two-sided" in the sense that they are also informed by information from subsequent outcomes using the entire data set. In other words, smoothed probabilities use information from the past

FIGURE 7

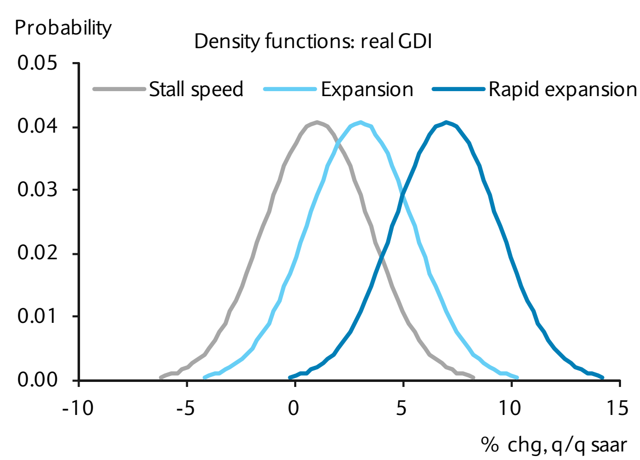
Estimated parameters for GDP, GDI, and employment as a share of the labor force

Parameter estimates: Mean growth rate (μ) and common variance (σ^2) (final data, 1959 Q3 - 2018 Q4)				
	Rapid expansion	Expansion	Stall speed	variance
	μ_1	μ_2	μ_3	σ^2
Real GDP	7.87	3.17	1.10	5.04
std. error	(0.58)	(0.31)	(1.08)	(0.60)
Real GDI	8.22	4.11	1.57	3.76
std. error	(0.73)	(0.33)	(0.44)	(0.46)
Employment to labor force	3.07	1.17	-1.52	1.34
std. error	(0.54)	(0.15)	(0.25)	(0.08)

Note: The mean rate of growth during recessions was calibrated from actual data based on NBER dating. Source: Barclays Research

FIGURE 8

Regime probability distributions using real GDI



Source: Barclays Research

[9] See Grimm, Bruce, 2005, "Alternative measures of U.S. economic activity in business cycles and dating," BEA Working Paper, 2005–05 and Nalewaik, Jeremy, 2012, "Estimating probabilities of recession in real time using GDP and GDI," *Journal of Money, Credit and Banking*, vol. 44, No. 1, 235-53. Data revisions over time, however, have reduced the differences between GDP and GDI, including the degree to which each declines in economic downturns.

and future to help inform the model's assessment about the present state. While this may be useful as a look-back device to identify where the economy was at any given time, in retrospect, based on all available information, it is less relevant for forecasting. Since our goal is to forecast recession probabilities, the filtered probabilities are more appropriate.

The filtered state probabilities using GDI, reported in Figure 10, show evidence of rapid expansions following recessions, particularly in the first half of the sample, as well as evidence of late-cycle acceleration in activity in 2000 and 2006. The latter two episodes may relate to bubbles in asset and housing markets during these periods. Importantly, the model estimates using GDI also identify stall phases with high probability in advance of all the recessions in our time sample, including the onset of the global financial crisis in 2008. It also points to a high likelihood that the US is in a stall phase and that it has been in such a phase for much of the current expansion. When the US economy is in stall, the transition probabilities indicate that it is twice as likely to slip into recession in the next quarter as re-accelerate back to expansion. While this does not eliminate false positives, where the stall reflects a mid-cycle slowdown rather than recession, the transition probabilities confirm previous literature that suggests that GDI contains considerable information about turning points in the cycle. Based on these results, it would seem that GDI would be an appropriate state variable to forecast stall speeds and risk of recession.

FIGURE 9

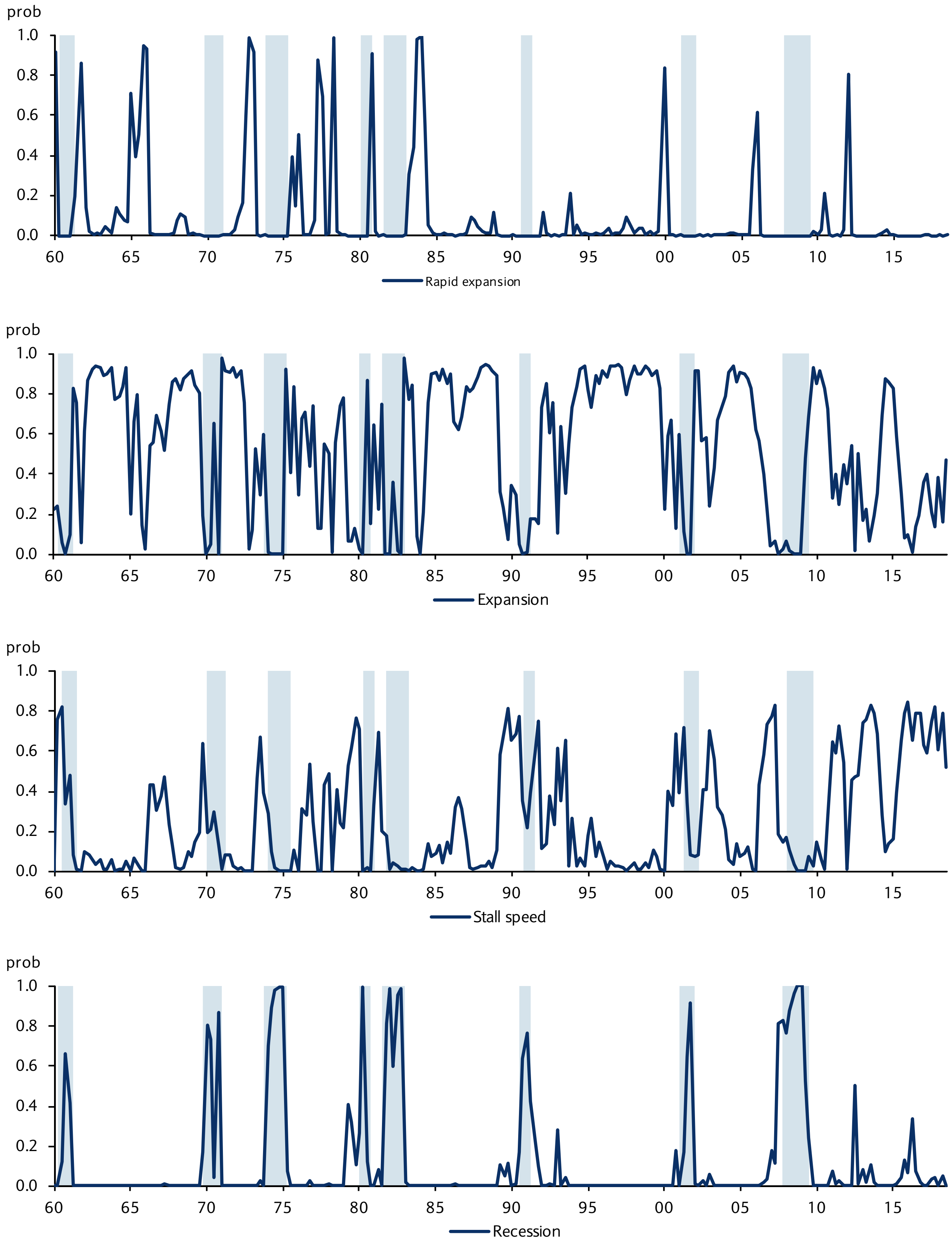
Transition probabilities using GDI data

State space transition possibilities (from, to)				Transition probabilities using GDI data (%)			
Pr(rapid expansion, rapid expansion)	Pr(rapid expansion, expansion)	Pr(rapid expansion, stall)	Pr(rapid expansion, recession)	53.8	25.8	20.4	0.0
Pr(expansion, rapid expansion)	Pr(expansion, expansion)	Pr(expansion, stall)	Pr(expansion, recession)	11.0	83.8	5.2	0.0
Pr(stall, rapid expansion)	Pr(stall, expansion)	Pr(stall, stall)	Pr(stall, recession)	0.0	8.6	77.8	13.6
Pr(recession, rapid expansion)	Pr(recession, expansion)	Pr(recession, stall)	Pr(recession, recession)	0.0	26.7	0.0	73.3

Source: Barclays Research

FIGURE 10

Estimated probabilities using GDI data Q3 1959 to Q3 2018



Source: Barclays Research

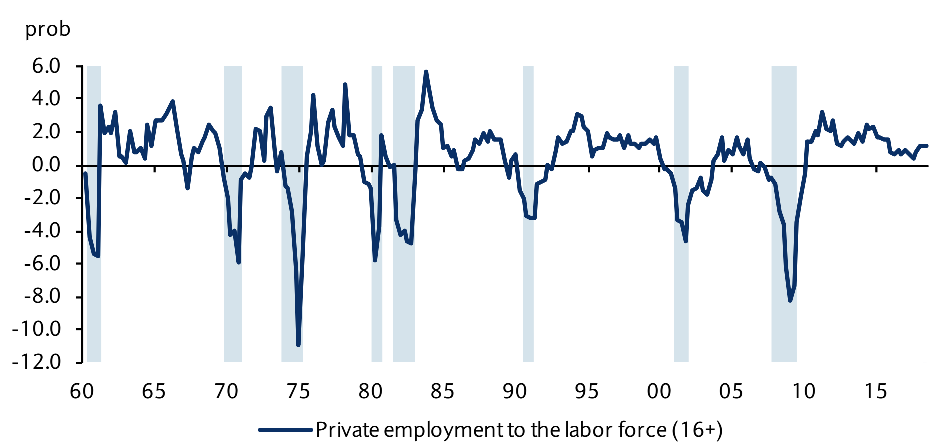
That said, we believe that GDI suffers from a critical flaw that will reduce its usefulness in forecasting future economic tipping points. The structural shift in the US economy toward slower potential growth, which became more apparent following the financial crisis, is likely to lead to misidentification. For example, the mean growth rate of real GDI during expansion and stall speed periods are 4.1% q/q saar and 1.6%, respectively, based on our 1959-2018 sample. The sharp deceleration in potential – from rates exceeding 4% in the late 1990s to about 2% at present, according to the CBO – means that expansionary behavior for the US economy today is akin to stall speed behavior in the past. This observation likely helps explain why the filtered probabilities in Figure 10 place the US economy in stall speed for virtually the entire recovery. The likelihood of stall compared with expansion seems unreasonably high to our eye. If so, forward-looking estimates of stall speed and recession extracted from changes in GDI may be less accurate now than they have been in the past.

A clearer signal: Employment growth and stall speed

If problems using real GDI to identify business cycle phases and recession risks relate to slowing in trend growth, then there are several potential remedies. One potential solution is to expand the regime-switching framework to include more than one input variable. For example, academic research has often added variables such as the unemployment rate, the yield curve slope, industrial production, or the ISM manufacturing index alongside GDI in a multivariate setting. While this may improve model estimates, we believe it is unlikely to overcome the essential problem of a significant slowing in trend growth, as many variables that could be used in such a setting may suffer from the same flaw. A second potential solution would be to relax the assumption that the mean growth rates of the economy in the four stages of the business cycle are constant across time. In other words, the framework we use in this paper assumes the general characteristics of the economy are identical across business cycles. Although this may be a reasonable assumption over short sample periods, the analysis in the previous section suggests it may be unreasonable over longer samples. Hence, an approach that allows the mean growth rates to vary across expansions could help account for structural shifts in the economy.[10] We think this route has value, albeit at the cost of increasing the complexity of the analysis.

FIGURE 11

Growth in private employment as a share of the labor force



Note: Growth rate (% chg, q/q saar) in the ratio of private employment to the four quarter average of the civilian labor force (16y and up). Shading equals NBER recession. Source: BLS, Haver Analytics, Barclays Research

[10] See Eo, Yunjong and Chang-Jin Kim, 2016, "Markov-switching models with evolving regime-specific parameters: Are postwar booms or recessions all alike?" *The Review of Economics and Statistics*, vol. 98, no. 5, pp. 940-949.

A third solution, which we undertake in this report, is to use a different input variable that does not suffer from the same flaw. For this purpose, we use the level of private employment (from the payroll survey) scaled by the four-quarter average in the level of the labor force (from the household survey). We use the quarterly annualized change in this series as our indicator.[11] This choice is motivated by our understanding of the sources of fluctuations in potential GDP growth, which include the effects of population aging and demographics on potential employment. In prior decades, the influx of the baby boom generation to the workforce put upward pressure on labor force growth and, in turn, growth rates in potential employment and GDP. The structural shift toward higher rates of participation among women that started in the 1970s had similar effects. By normalizing employment by the size of the labor force, we hope to correct for factors that may have caused potential employment growth to change, thereby improving model identification. The idea of this correction is that if stronger labor force growth boosts potential employment growth, then expansions will likely come with more employment growth than otherwise, and vice versa. Hence, we should obtain a more reliable signal about the cyclical position of the economy from the degree that growth in private employment exceeds (or falls short of) growth in the labor force.[12,13] The employment data also have the advantage of being more timely than GDI and correlated with wage and salary income, which is believed to help GDI capture turning points better. As we would expect, the growth rate in this normalized employment series (Figure 11) shows no visible shift through our sample period, with somewhat less volatility from 1985 onward (consistent with the diminished frequency of NBER-defined recessions).

Filtered probability estimates from this model are shown in Figures 13 and 14. Estimates using the employment data are consistent with the GDI (and GDP) estimates in that the frequency of rapid expansions drops substantially from 1985 onward. Nevertheless, the

FIGURE 12

Transition probabilities using employment data

State space transition possibilities (from, to)				Transition probabilities using employment as a share of the labor force (%)			
Pr(rapid expansion, rapid expansion)	Pr(rapid expansion, expansion)	Pr(rapid expansion, stall)	Pr(rapid expansion, recession)	47.7	52.3	0.0	0.0
Pr(expansion, rapid expansion)	Pr(expansion, expansion)	Pr(expansion, stall)	Pr(expansion, recession)	4.8	89.7	5.5	0.0
Pr(stall, rapid expansion)	Pr(stall, expansion)	Pr(stall, stall)	Pr(stall, recession)	0.0	7.9	70.2	21.9
Pr(recession, rapid expansion)	Pr(recession, expansion)	Pr(recession, stall)	Pr(recession, recession)	2.6	24.1	0.0	73.3

Source: Barclays Research

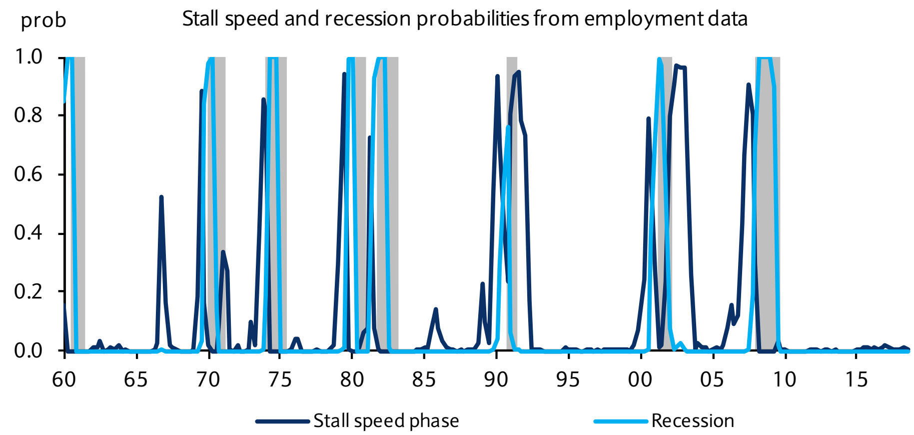
[11] We use a four-quarter average to smooth through some of the variation in estimates of the labor force.

[12] The labor market data we use comes from different surveys, with private nonfarm payroll data coming from the Current Employment Statistics Survey (the "establishment report") and the labor force coming from the Current Population Survey (the "household survey"). Among other differences, the establishment report contains some dual-job holders since it counts the number of employees on payrolls but does not account for those who may hold more than one job. Total employment in the household survey is generally larger than in the establishment report since it includes both wage and salary workers and self-employed ones. The household survey has a relatively small sample size of 60,000 households and, as a result, can sometimes send a more volatile signal than the payroll data in the establishment report, which is why we take the employment data from the latter and the labor force data from the former. While there are differences between the two surveys, they tend to track together over long periods. See Bowler, Mary and Teresa Morisi. "*Understanding the employment measures from the CPS and CES survey*," *Monthly Labor Review*, February 2006.

[13] This normalization may not be complete because the slowdown in potential is also related to weaker productivity growth. Our hope is that scaling employment by the size of the labor force is sufficient to capture this influence, since the trends in these two variables should be determined mainly by population growth and demographics. This contrasts to trend GDI and GDP, which should both be directly affected by trend productivity.

FIGURE 13

Estimated probabilities for stall speed and NBER recessions using employment data



Source: Barclays Research

employment data identify two periods, following the 1990-91 recession and following the financial crisis, that could be associated with rapid expansion (though the filtered probabilities do not rise above 50% in either occasion).

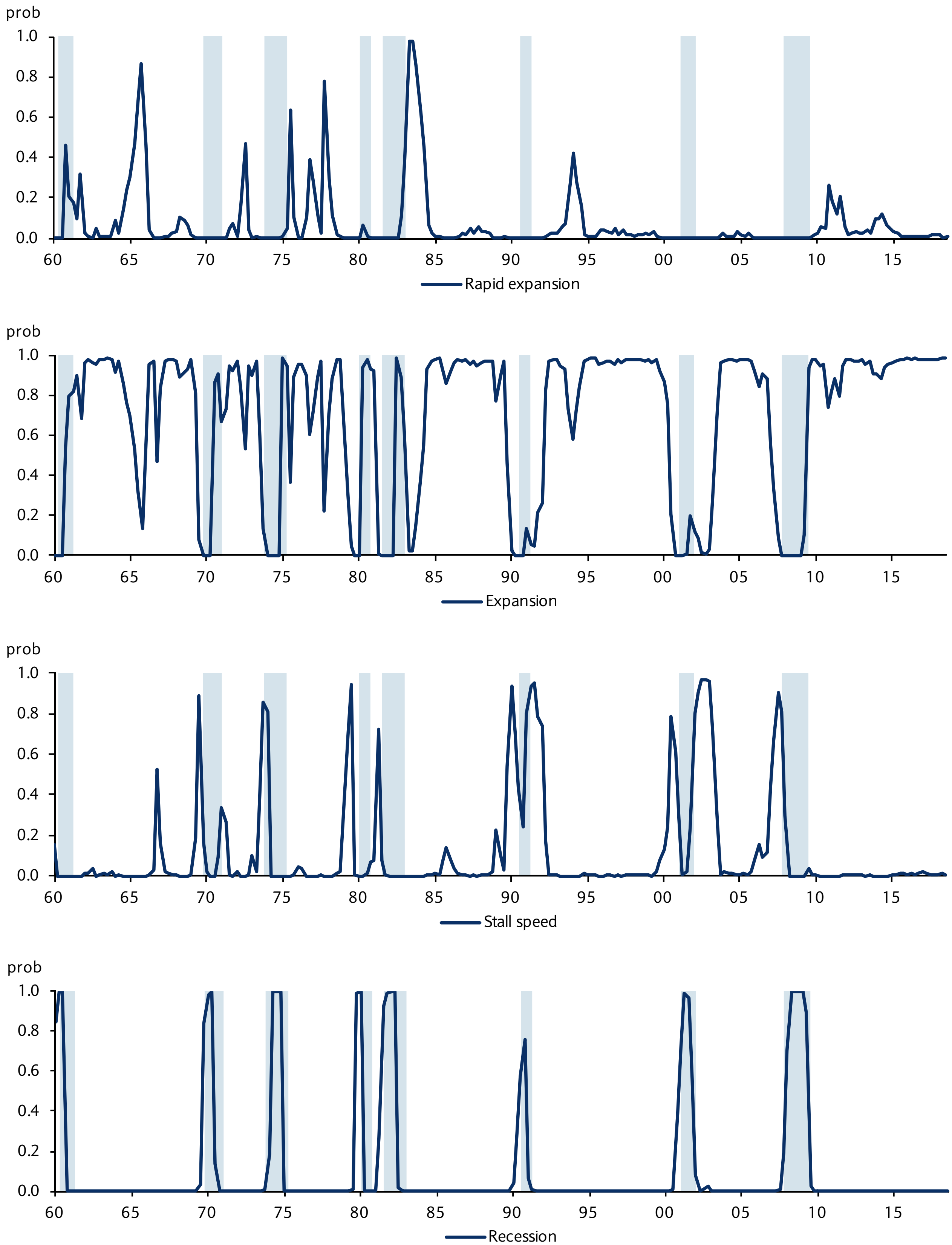
The performance of the model is particularly good in identifying stall speeds in advance of recessions across the entire time sample. In each of the last seven NBER-defined recessions, the estimated probability that the economy was in stall speed rose from near-zero levels to about 80% or better. When the estimated probability of stall speed rose above 30% in each of these cases, the US economy was in an NBER recession three quarters later on average, with a range of two to four quarters. Only once, in 1966, did the probability the economy was in stall speed rise above 30% without falling into recession shortly thereafter. The model also pointed to risk of double-dip recessions during the "jobless recoveries" following the recessions in the early 1990s and 2000s.

The transition probabilities also suggest the employment data send few false signals. As shown in Figure 12, when the US economy is in stall speed in the current quarter, it is likely to reside there next quarter with a 70% probability. If it transitions out of stall speed, it is about three times as likely to move into recession as expansion (22% to 8%, respectively). This is somewhat better performance than the GDI-based estimates, where transitioning from stall speed to recession was twice as likely as reverting to expansion.

This evidence from employment data, in our opinion, suggests that employment data send a strong signal of recessionary risks. We believe this likely reflects the fact that the US is a relatively closed economy that is heavily dependent on services production and consumption. With private consumption accounting for about 70% of output, recessions are most likely to occur when labor markets weaken and households move into precautionary saving mode. Identifying when labor markets are weakening seems to be an important indicator of a stall and, ultimately, is a good forecast variable to predict recessions. At present, labor market data are providing only a weak warning signal that the US economy is at risk of slipping into a near-term recession. We expect this to change gradually as economic activity slows toward trend and employment gains moderate. We will continue to monitor employment data to evaluate whether there has been a meaningful shift in recessionary risks.

FIGURE 14

Estimated probabilities using private employment as a share of the labor force Q3 1959 to Q3 2018



Source: Barclays Research

Appendix A: Estimating stall speed with GDP

We estimate the four-state regime switching model using the quarterly annualized change in US real GDP. Similar to the results from calibration with real GDI, the estimated probabilities based on GDP data in Figure A.3 indicate that the US economy has spent almost no time in rapid expansion since the mid-1980s. This could be a result of several factors, including a decline in the relative weight of the goods sector, the “Great Moderation,” or the slowing in potential growth.

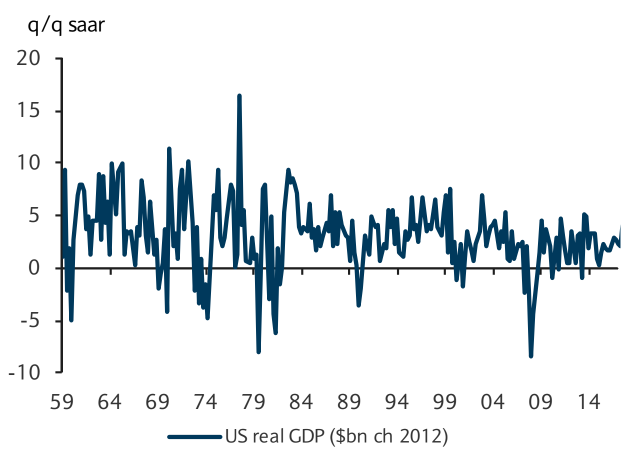
The transition probabilities in the model estimated with GDP are consistent with few observations. If the economy is identified as being in rapid expansion, it remains in that state next period with 64% probability. If the economy transitions out of this state, it is twice as likely to move to expansion as stall speed. Once in expansion, the economy is expected to remain there with a high probability next quarter (94.0%), which is likely driven by the five long post-war expansions in our sample period. Finally, when in stall, the GDP data point to almost no likelihood of transitioning back to expansion and, instead, indicate the economy will be in recession with a 36% chance next period.

As noted in the body of this report, we see the slowdown in trend growth as leading to the potential for model error in state identification. That said, this seems to be less of a problem with GDP than GDI. The GDP data generally seem to identify expansion and recession well even though the average rate of growth in the economy has slowed. The GDP data identify the economy as remaining in an expansion phase for much of the last four expansions, with little to no probability of rapid expansion. The exception is the 2001 recession, for which GDP data provided only a modest signal; the signal from GDP pointed to only a 40% chance of being in recession and only after the NBER estimated that the recession had begun.

Instead, our critique of GDP is that despite its comprehensiveness, it does not seem to contain information that helps with stall speed identification, particularly compared with GDI (Figure A.4). In advance of the last three recessions, the estimated probability of stall speed based on GDP rose to about 20%, with the weakest identification occurring prior to the 2001 recession. These results are overturned to some degree if we use the output from a two-sided filter. With that, GDP data more clearly identify stall speeds prior to most recessions since 1960, though they do not signal much evidence of a stall speed during the 2001 recession. In addition, as mentioned in the body of this report, the two-sided filter

FIGURE A.1

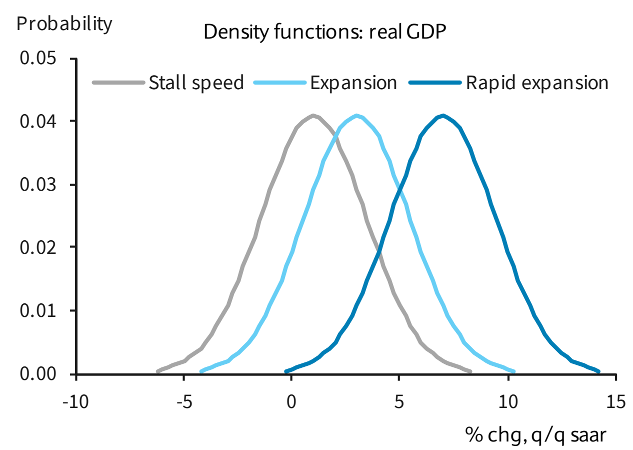
US real GDP growth: Q3 1959 to Q3 2018



Source: BEA, Haver Analytics, Barclays Research

FIGURE A.2

Regime probability distributions using real GDP



Note: The mean rate of growth in the rapid expansion, expansion, and stall speed phases was estimated as 7.87%, 3.17%, and 1.10%, respectively. The common variance was 5.04%. Source: Barclays Research uses information from before and after any particular date to estimate the likely state of the economy. While this is useful for understanding where the economy was at any giving point with hindsight, it is not consistent with identifying recession risk given available information. On this basis, we see problems with using GDP data as a candidate variable for identifying stages of the business cycle.

FIGURE A.3

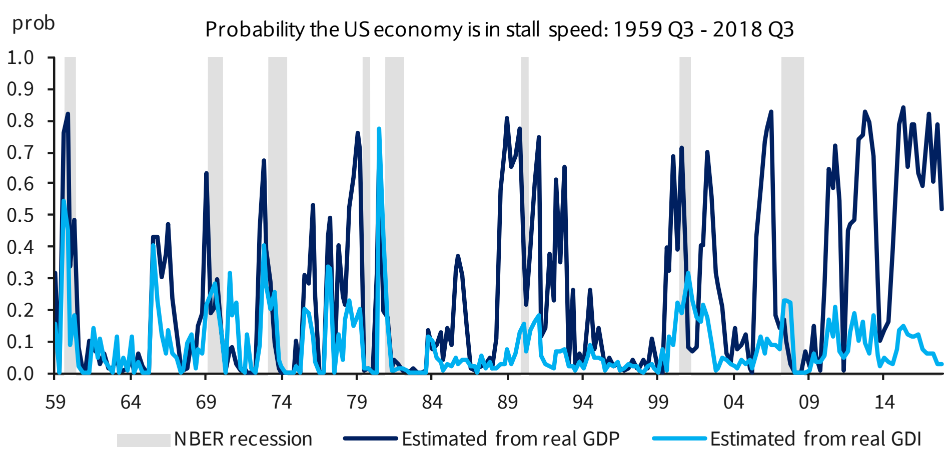
Transition probabilities using GDI data

State space transition possibilities (from, to)				Transition probabilities using GDI data (%)			
Pr(rapid expansion, rapid expansion)	Pr(rapid expansion, expansion)	Pr(rapid expansion, stall)	Pr(rapid expansion, recession)	53.8	25.8	20.4	0.0
Pr(expansion, rapid expansion)	Pr(expansion, expansion)	Pr(expansion, stall)	Pr(expansion, recession)	11.0	83.8	5.2	0.0
Pr(stall, rapid expansion)	Pr(stall, expansion)	Pr(stall, stall)	Pr(stall, recession)	0.0	8.6	77.8	13.6
Pr(recession, rapid expansion)	Pr(recession, expansion)	Pr(recession, stall)	Pr(recession, recession)	0.0	26.7	0.0	73.3

Source: Barclays Research

FIGURE A.4

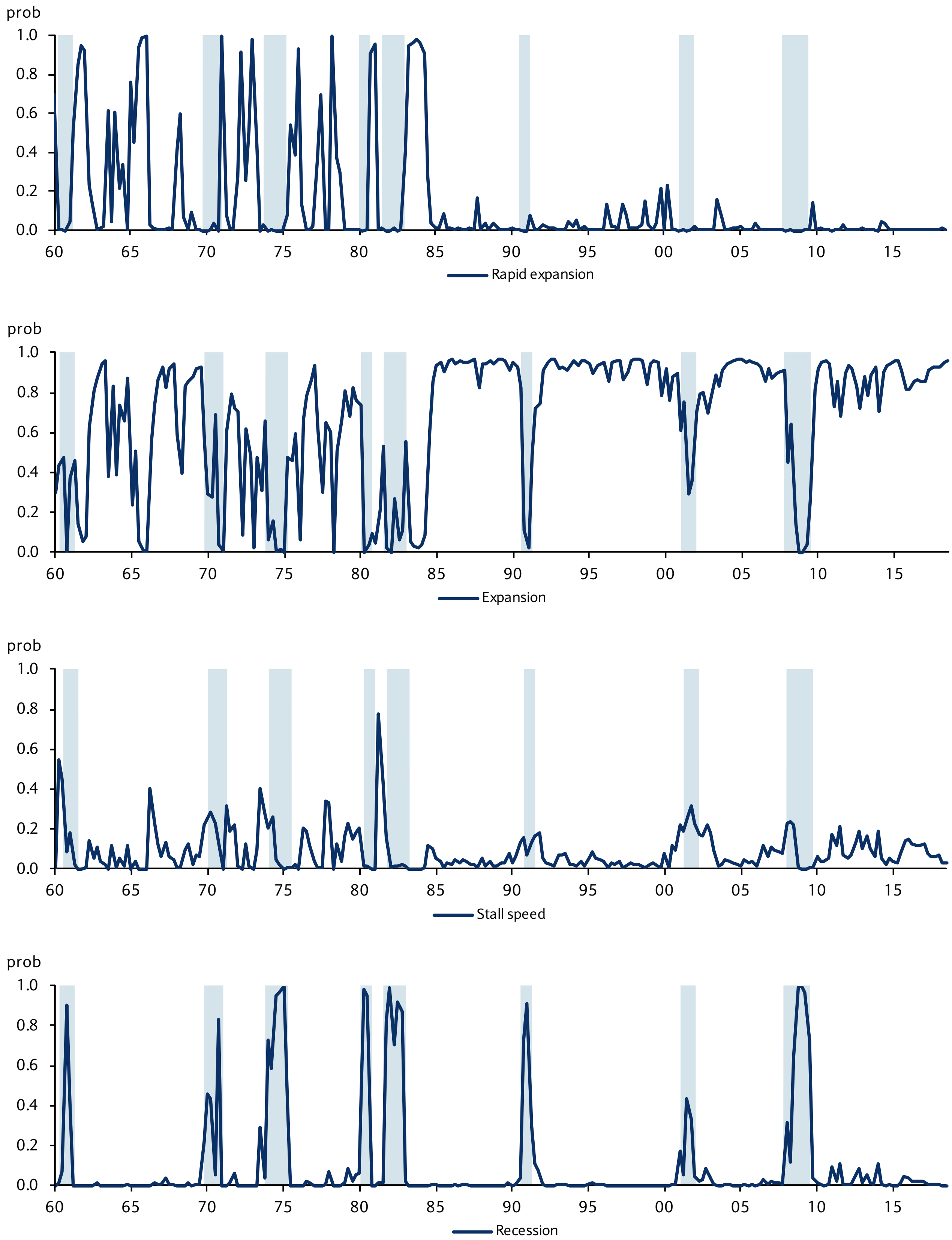
Estimated stall speed probabilities using real GDP and GDI



Source: Barclays Research

FIGURE A.5

Estimated probabilities using real GDP data Q3 1959 to Q3 2018



Source: Barclays Research

Appendix B: Probit models of recession

An alternative to the regime switching framework specified above is a probit model, which is a type of non-linear regression model that is often used when the dependent variable outcomes are binary – that is, “0 or 1”, which in this case denotes expansion or contraction. For example, if we wanted to estimate the probability that the economy would fall into recession in three months’ time, the basic framework would be:

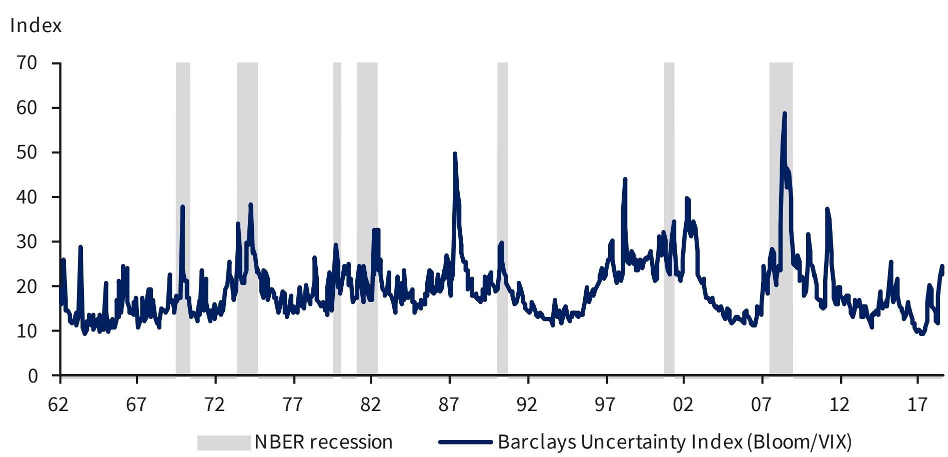
$$\text{Prob}[Recession_{t+3}|Data\ as\ of\ time\ t] = \Phi\ [\alpha + \beta(X_t)],$$

where Φ is the standard normal cumulative distribution function, α is a constant, and X_t is any other explanatory variable that may have information about the likelihood that the economy is in recession. Common variables include the yield curve spread and the Chicago Fed National Activity Index. The latter is frequently used since it is a weighted average of 85 indicators of US economic activity covering four broad categories of data (production and income; employment, unemployment and hours; personal consumption and housing; and sales, orders and inventories), where the relative weights of the inputs are estimated by principal components analysis. Factor analysis is often an efficient process to capture common co-movement from a set of underlying variables that is, by construction, orthogonal. Not surprisingly, the labor market inputs in the National Activity Index carry high factor loadings, consistent with our findings that such data are information-rich for understanding the business cycle.

To these variables, we often add an index of uncertainty. We begin with a series from Bloom[14] that computes the daily volatility of the S&P 500 going back to 1967 and then splice that index to the VIX starting in 1990. The resulting “uncertainty index” is shown in Figure B.1. Recently, it has risen from historically low levels because of the uncertainty created by fading fiscal stimulus in the US and concerns over global growth, among other factors. Previous spikes in uncertainty following the global financial crisis coincided with the European debt crisis, the political difficulties associated with raising the US debt ceiling, and the S&P downgrade of US sovereign debt. A message from the data, however, is that although uncertainty does rise when the economy is already in a recession, it can also spike in the midst of an expansion and not necessarily trigger a recession. For example, uncertainty occasionally spikes because of financial events, such as the 1987 stock market crash and 1997 Asian financial crisis. Neither episode, however, led to a recession. Uncertainty also remained elevated after the 2001 recession because of the tech collapse, fears of deflation, and geopolitical uncertainty following September 11, yet did not lead to a double-dip recession.

FIGURE B.1

The US confronts an uncertainty shock of modest size



Source: CBOE, Nick Bloom, Barclays Research

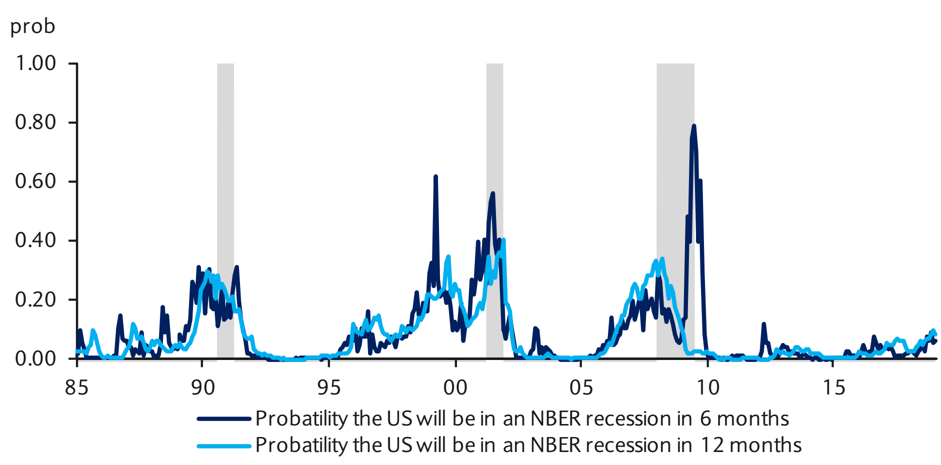
[14] Bloom, Nick, 2007, “The impact of uncertainty shocks,” *Econometrica* 77(3), 623-685.

The 1s10s spread is the most valuable indicator in predicting recessions and, according to estimates from the model, is about 25 times more important when assessing the likelihood of a recession compared with the uncertainty index. These estimates underscore our earlier point: although uncertainty is a powerful force in shaping the outlook, it is often insufficient on its own to tip the economy into a recession. Even though the Fed has pushed its policy rate higher recently and is gradually reducing its securities holdings, Figure B.2 shows that the model is currently flashing only a weak warning signal – despite the flattening in the yield curve and rise in uncertainty – that the economy will be in a recession in the coming year. The Chicago Fed National Activity Index, which is likely reflecting the impulse from fiscal stimulus and has been in positive territory in ten of the last eleven months, is providing offset against negative signals from financial markets. That said, both indicators of recession have edged higher and stand near 10%.

The probit model output in Figure B.2 highlights some of the advantages and disadvantages of probit frameworks. On one hand, the model does indicate rising recession risk in advance of the last three recessions, though we would argue it sent a false recessionary signal in the late 1990s, likely due to the increased financial market stresses and the sharp flattening of the yield curve. In addition, recession probabilities never rose much above 40% prior to each recessionary episode, in contrast to the estimated probabilities in the regime switching framework, which indicated the economy was slipping further into stall speed with virtual certainty. The difference in model performance is likely due to the richness of the regime switching framework, which estimates quarter-to-quarter transition probabilities and does not assume a uniform lag between changes in state variables and incidence of recession across time. By imposing a fixed lag length, the probit model implicitly assumes a regular structure between state variables and recession.

FIGURE B.2

Forward-looking warning signals of a recession have edged higher, but remain low by historical standards



Note: Probit regression with the dependent variable equal to a binary recession outcome and independent variables equal to the 1s10s US Treasury spread, the Chicago Fed National Activity Index, and an uncertainty index.
Source: Barclays Research

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