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Economics Group

Special Commentary

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Modeling Dynamic Adjustment Due to Economic Frictions: Decision Making in an Evolving World

"The art of economics consists in looking not merely at the immediate but at the longer effects of any act or policy; it consists in tracing the consequences of that policy not merely for one group but for all groups."
Henry Hazlitt

Executive Summary

Christina Romer once said, "There's a joke in economics about the drunk who loses his keys in the street but only looks for them under the light posts. When asked why, he says, 'because that's where the light is.'" Hazlitt's statement and Romer's (insightful) joke shed light on issues related to the limits of conventional econometric tools and hence the opportunity to improve decision making.

First, for instance, the total effect of a policy change is typically distributed over a prolonged period and we should not estimate, nor expect, the impact of a policy change to appear for just one period. Second, a policy change may produce heterogeneous effects among the markets (sectors) of an economy. More broadly, sometimes the effect of a policy change in one country may spill over into other economies (countries). In addition, a policy change may produce short- and long-run effects, which may be different from one another. A third point we want to stress is that the effect of a policy change on markets (raising the Fed funds target rate, for example) may be different during different time periods because relationships between economic/financial variables evolve over time. The fourth and final point we want to highlight in this report is that the frictionless assumption (finding keys only under the light post) could pose serious issues for effective decision making and evaluation.

We provide a guide to modeling the change in economic variables that allow for the existence of economic frictions.

In our previous research, we have discussed issues related to the frictionless assumption in the dynamic adjustment process and how to quantify frictions.[1] This third installment provides a guide to modeling the change in economic variables that allow for the existence of economic frictions for effective decision making. In particular, we estimate the effect of a policy change on a sector (market) and then determine whether the effect is heterogeneous for multiple markets. In effect, we describe how to search beyond the "light posts."

To anticipate our results, in our first case study we estimate the effect of a one percentage point increase in employment growth on key labor market indicators. One result we find is that the largest effect was noted for the unemployment rate (a drop of 0.2 percentage points). Second, the change in the fed funds rates produced a heterogeneous effect for multiple markets, ranging from the largest change of 0.12 percentage points in the PCE deflator to no meaningful change in the S&P 500 and the growth rate of housing starts. Third, the effect of a change in interest rates was different during different time periods, which suggests that past benchmarks of policy effectiveness need to be re-evaluated. Finally, our econometric analysis found that the conventional relationship between GDP growth and the unemployment rate (Okun's Law) is not stable—therefore, the relationship cannot be utilized as a guide (without further investigation).

[1] The first part of the series, "Frictionless Models in a World Full of Frictions" and the second part "Quantifying Frictions: Long-run Average a Useful Guide for Future?," are available upon request.

For decision makers in an ever evolving world, one must go beyond the light posts to search for "keys" (reliable results) to effective decision making.

Estimating the Distributed Effect of a Policy Change: Impulse Response Functions

How might we estimate the effect of a change in the fed funds rate on different sectors of the economy, for example—the labor, housing and output markets? To answer this question, we turn to the vector autoregression (VAR) modeling methodology.[2] The beauty of VARs is that they are simple statistical representations of economic systems, as they rely only on the variables that comprise the system and a few lagged values of those variables. In addition, VARs can be "shocked" to show how all the variables respond to a change in one of the other variables. The way the variables respond over time to a change in the "shocked" variable are called impulse response functions.[3]

Furthermore, we can approximate the total effect of a change in the funds rate on the other real variables of interest, where the impact may be distributed over a prolonged period of time. Therefore, we estimate the effect of a change in the fed funds rate in the current month on the unemployment rate, inflation, output and the housing market over the next 12 months.

In sum, an increase in the employment growth rate affects other key elements of the labor market.

What Would the Reaction Be to a Change? Within a Market Case

Our first application focuses on just one sector, which is the labor market. We estimate the effect of a one percentage point increase in employment growth on the unemployment rate, labor force participation rate and growth rate of average hourly earnings.[4] This example is a simple one, as it only shows the effect for the labor market and not for other markets. In the next case, we include more sectors in the model. The increase in employment growth is associated with a reduction in the unemployment rate, with the largest drop appearing during the second month, a drop of 0.2 percentage points (Figure 1). The rise in employment growth boosts the growth rate in labor force participation by 0.09 percentage points in the first month, and that is the largest change in the participation rate (Figure 2). So, there is some evidence for the view that employment gains will tend to raise participation rates. Average hourly earnings show a negative growth rate (with the largest drop of 0.1 percentage points for the first month) in response to the employment growth increase (Figure 3). The drop in the earnings growth rate may suggest that a rise in employment growth rate boosts participation rates, which put downward pressure on earnings growth. Typically during the first year of job expansions, workers with less experience and training reenter the job market.

In sum, an increase in the employment growth rate affects other key elements of the labor market and the largest response to the employment growth change is noted for the unemployment rate. In addition, the total effect of an increase in employment on the unemployment rate is 0.97 percentage points (sum of total declines in the unemployment rate over the 12-month period), 0.38 percentage points for the labor force participation rate and 0.51 percentage points for the average hourly earnings series. This indicates that the total impact on the unemployment rate is more than the combined effect of the labor force and earnings series, another way of saying there is a heterogeneous effect. Therefore, decision makers should estimate the possible impact of a change in one variable on each of the variables of interest because the impact could be heterogeneous for different variables, and most assume the same adjustment process to any exogenous change would be uniform across markets.

[2] See Christopher Sims, "Macroeconomics and Reality," *Econometrica*, Vol 48 (1980), p.1-48.
[3] For a broader explanation of these techniques and a number of applications, see Silvia, Iqbal et al. (2014). *Economic and Business Forecasting*. Wiley.
[4] All shocks in this study last for one month.

Figure 1

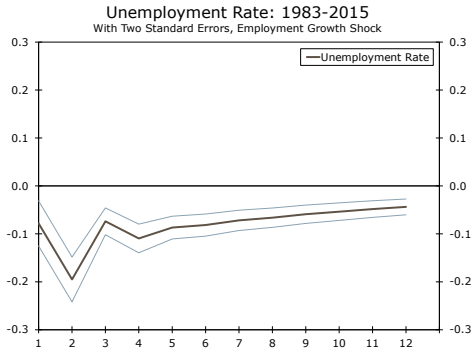


Figure 2

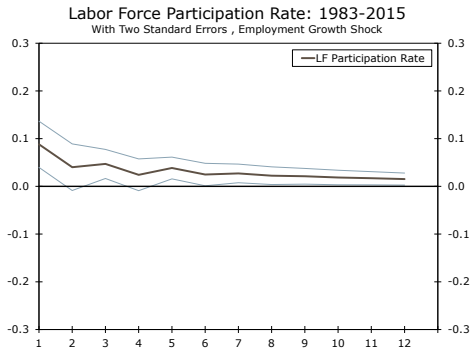
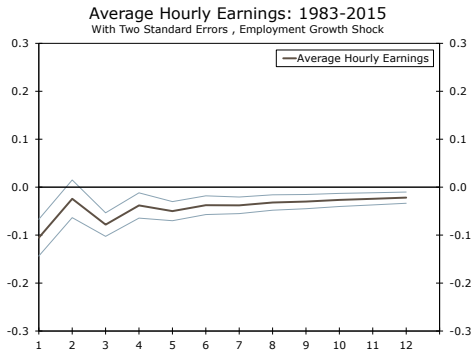


Figure 3



Source: U.S. Department of Labor and Wells Fargo Securities, LLC

Does a Change in the Fed Funds Rate Matter? Heterogeneous Reaction Among Markets

What is the likely effect of a fed funds rate hike on the major sectors of the economy?

An economy is comprised of many major sectors, and reactions to a policy change may differ in timing and size for different markets. Here we build a model that includes information from the six major sectors of the U.S. economy. The six sectors are interest rate/credit markets (Fed funds target rate as proxy), prices/inflation (PCE deflator), labor market (unemployment rate), financial/equity market (S&P 500 index), housing sector (housing starts) and output (industrial production).

During mid-summer 2015, most commentators expected that the Federal Open Market Committee (FOMC) would raise the target for the fed funds rate in the near future. An important question for analysts is what is the likely effect of a fed funds rate hike on the major sectors of the economy? Using a dataset spanning 1983-2015, we estimate the effect of a one percentage point increase in the fed funds rate on the remaining five major sectors of the economy.[5] The hike in the fed funds rate is not associated with a drop in inflation, at least for the first couple of months (Figure 4). However, the PCE deflator shows non-positive numbers for the remaining months of our study. One major reason for the positive relationship with the PCE deflator is that the FOMC usually raises the fed fund target rate during expansions (later part of the recovery/expansion cycle) and that phase of the business cycle is usually experiencing rising inflation. An increase in the fed funds rate is also associated with falling unemployment (Figure 5). This result is not surprising given that the FOMC typically raises rates during expansions, and the unemployment

[5] We utilize growth rates of the PCE deflator, the S&P 500 index, housing starts and industrial production in our econometric models. Typically, growth rates (differenced form) of many variables are stationary. In addition, level form may be non-stationary and econometric results using a non-stationary dataset could produce un-reliable (spurious) results.

rate also tends to fall during those same expansions. Similarly, a fed funds rate hike is associated with an increase in industrial production because the FOMC is generally raising rates when the economy is getting stronger (Figure 6).

Figure 4

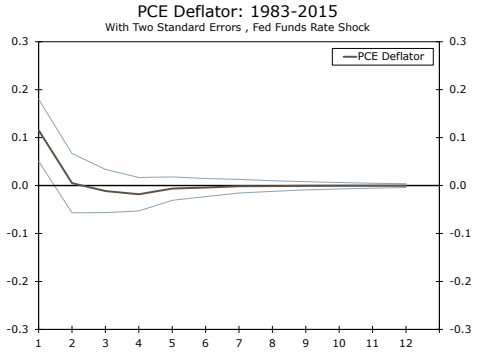


Figure 5

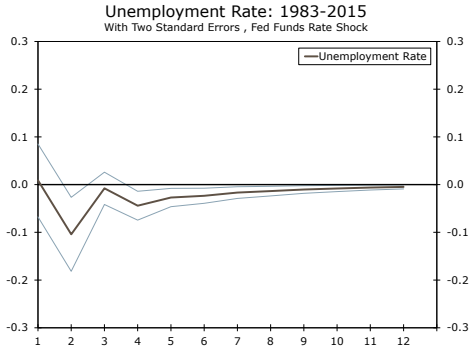


Figure 6

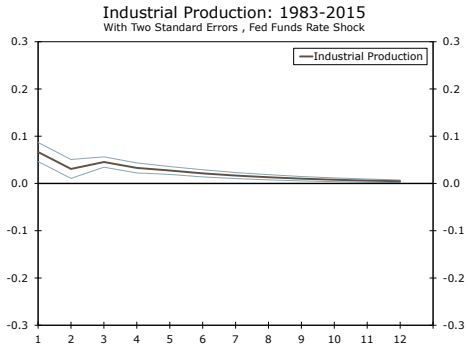


Figure 7

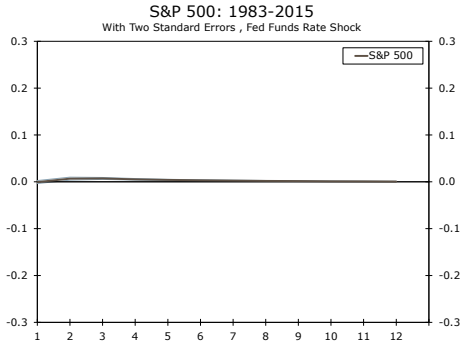
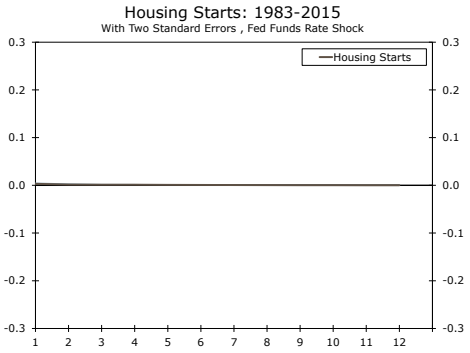


Figure 8



Overall, a fed funds rate hike produces a heterogeneous effect among different markets.

Source: U.S. Department of Commerce, U.S. Department of Labor, IHS Global Insight, Federal Reserve Board and Wells Fargo Securities, LLC

The change in the fed funds rate does not produce a meaningful effect on S&P 500 returns (Figure 7) and on housing starts (Figure 8). The changes in both sectors are approximately zero for all 12 months. Overall, a fed funds rate hike produces a heterogeneous effect among different markets, ranging from the largest change of plus 0.12 percentage points for the PCE deflator to no change at all for the S&P 500 and housing starts.

Is It All About the Base? Lucas Critique

For effective decision making, we must make sure that the results/conclusions are consistent between sub-samples, which is the essence of the so-called Lucas Critique.[6] Put differently, the implied conclusion should not change with a change in the sample period base (starting or ending point of the sample). To test the robustness of our results, we estimate the effect of the fed funds rate hike on the five major sectors using the 1983-2005 period. We choose an ending point in 2005 because it is approximately in the middle of the previous expansion. Results are reported in Figures 9 through 13. We do note a change in the magnitude for the PCE deflator (Figure 9) and the unemployment rate (Figure 10). The largest change was for the PCE deflator, which jumped 0.19 percentage points from 0.12 percentage points based on the 1983-2015 period. The 1983-2005 period showed the largest drop in unemployment (0.17 percentage points) compared to a drop of 0.10 percentage points for the 1983-2015 period. The response of industrial production was stronger in the first several months for the 1983-2005 period compared to the 1983-2015 period (Figure 11). The overall conclusions, however, are similar for both time periods. The response of inflation, the labor market and output sectors to a fed funds rate hike are meaningful, although the growth rate of housing starts and S&P 500 returns did not show a noticeable effect in response to the fed funds rate hike (Figures 12 and 13).

Our conclusions still hold, which may fulfill the Lucas Critique requirement for a policy recommendation.

In addition, we conduct another analysis using the 1983-2008 time span. The logic behind this sub-sample is that the ending points of our previous two analyses were in expansions and ending the sample period in 2008 gives us an opportunity to estimate the effect of a change in the fed funds rate on the variables during a recession. As the impulse response functions (IRFs) are linear, the interpretation can be done for a drop in the fed funds rate by changing the sign of the estimated coefficient. For example, a one percentage point increase in the fed funds rate is associated with a 0.12 percentage point increase in the PCE deflator growth rate. We can also interpret that a one percentage point drop in the fed funds rate would reduce PCE inflation by 0.12 percentage point. Therefore, we can interpret the 1983-2008 period results for a drop in the fed funds rates as, typically, the FOMC reduces the target for the fed funds rate to combat recessions. Results are shown in the Appendix of this report. The conclusions from the other two samples were valid for this time period as well.

Therefore, there is no change in the conclusions using three different sample-periods, which suggests that our results are robust. Furthermore, we end our sample for both expansionary and contractionary phases of a business cycle, and our conclusions still hold, which may fulfill the Lucas Critique requirement for a policy recommendation.

[6] Lucas, Robert (1976). Econometric Policy Evaluation: A Critique. ***Carnegie-Rochester Conference Series on Public Policy 1.***

Figure 9

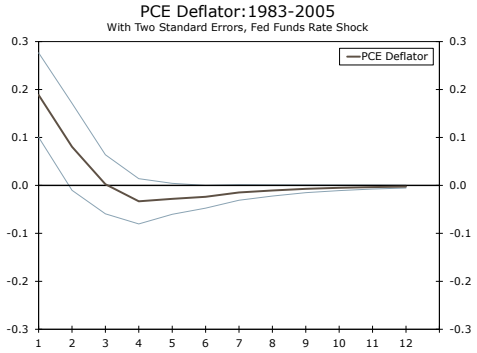


Figure 10

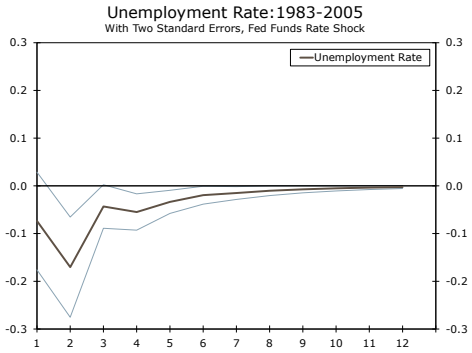


Figure 11

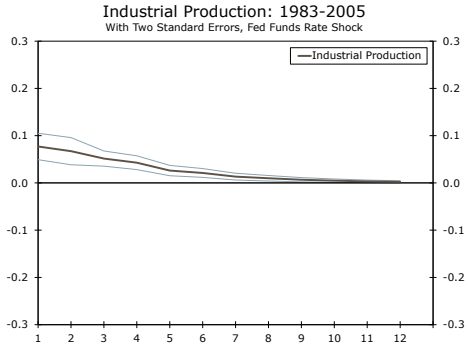


Figure 12

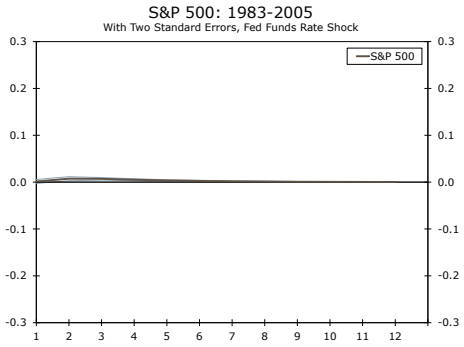
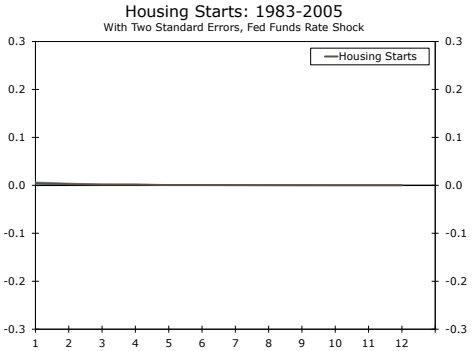


Figure 13



Source: U.S. Department of Commerce, U.S. Department of Labor, IHS Global Insight, Federal Reserve Board and Wells Fargo Securities, LLC

Does the Base Period Matter for the Labor Market Analysis?

We also test the robustness of the analysis focusing on the labor market by estimating the effect of a one percentage point increase in employment growth on the unemployment rate, labor force participation rate and average hourly earnings using the 1983-2005 sub-sample. Results are shown in Figures 14-16 and lead to similar conclusions as those drawn from the 1983-2015:M4 period. A shock to employment growth leads to a decline in the unemployment rate, a pickup in labor force participation and a slight decline in average hourly earnings. In addition, we rerun our model using the 1983-2008 period to see if our conclusions hold when ending in a recessionary period and we find this is true, see Appendix for results.

It is important to note that, although the results in both case studies are consistent among these sub-samples, this does not necessarily mean they will hold in all cases/sub-samples. Therefore, before we make policy recommendation, we should test and re-confirm our results using different samples/sub-sample periods.

Figure 14

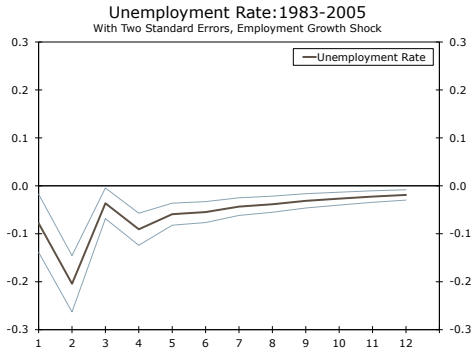


Figure 15

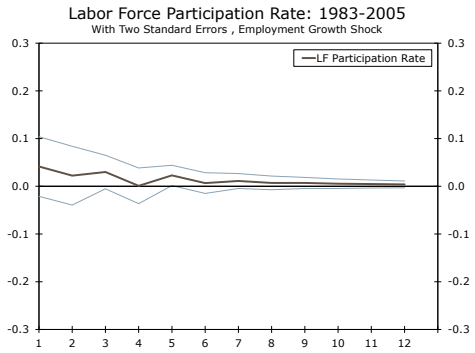
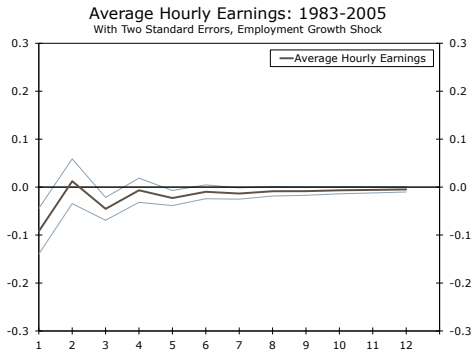


Figure 16



Source: U.S. Department of Labor and Wells Fargo Securities, LLC

Is Okun's Law Still Valid? Searching Beyond the Light Posts

Unfortunately, some decision makers utilize economic/financial heuristic guideline benchmarks without reconfirming the validity of these theories with the data. In our view, they are searching for "keys under the light posts." Economies evolve over time, and the relationships between variables also evolve. Therefore, for effective decision making, it is crucial to retest/reconfirm the underlying relationship suggested by a theory before using that theory as a guide. In other words, search beyond the light posts to find the "keys." One important application could be Okun's Law, which suggests a relationship between GDP growth and the unemployment rate.[7] That is, a boost

Economies evolve over time, and the relationships between variables also evolve.

[7] **Okun, Arthur M. (1962). Potential GNP: Its Measurement and Significance. American Statistical Association, Proceedings of the Business and Economic Section, pp. 98-104.**

in GDP growth would help to reduce the unemployment rate. In our view, before decision makers utilize Okun's Law as a guide, they must test the causal relationship. What is the direction of the relationship? Is GDP growth causing (leading) unemployment or vice versa?[8] The Granger causality test is a useful tool to determine causal relationships between variables of interest. Results based on the Granger causality test are reported in Table 1. The GDP growth rate Granger-causes the unemployment rate using the 1983-2015:Q1 dataset (Table 1, Box A). That is, GDP growth is a useful predictor for the unemployment rate. However, the unemployment rate is not a useful predictor for GDP growth in our sample period.

Before we jump to a conclusion, we need to test the robustness of the results.

Before we jump to a conclusion, we need to test the robustness of the results. We rerun the Granger causality analysis between GDP growth and the unemployment rate using the 1983-2007:Q3 period (pre-Great recession era, results in Table 1, Box B). We find a two-way Granger causality relationship, which implies GDP growth is Granger-causing the unemployment rate and the unemployment rate is also Granger-causing GDP growth. Certainly a different result than the one based on the 1983-2015:Q1 period (Table 1, Box A). These two different results lead us to two different conclusions for the different samples and raises questions about the reliability of Okun's Law over time.

Table 1

	Time Period	Testing the Causal Relationship: The Granger Causality Test		
		Regressor	Dependent variable	
			Unemployment Rate	Real GDP
A	1983-2015:Q1	Unemployment Rate	NA	0.34
		Real GDP Growth	0.00*	NA
B	1983-2007:Q3	Unemployment Rate	NA	0.07***
		Real GDP Growth	0.00*	NA
C	1990-2015:Q1	Unemployment Rate	NA	0.78
		Real GDP Growth	0.00*	NA
D	1990-2007:Q3	Unemployment Rate	NA	0.23
		Real GDP Growth	0.00*	NA
E	2000-2015:Q1	Unemployment Rate	NA	0.27
		Real GDP Growth	0.00*	NA
F	2009:Q3-2015:Q1	Unemployment Rate	NA	0.68
		Real GDP Growth	0.79	NA

* Significant at 1 percent, ** Significant at 5 percent, *** Significant at 10 percent

Source: Wells Fargo Securities, LLC

To retest our results, we run another analysis using the 1990-2015:Q1 period. We utilize this alternate sample period because the last three economic recoveries are considered "jobless" recoveries and that may have posed a structural break in the unemployment rate/GDP growth relationship. Therefore, testing the relationship between the two variables using the post-1990s period would be crucial for effective decision making. The results (Table 1, Box C) suggest that GDP growth Granger-causes unemployment, but that unemployment does not Granger causes GDP growth. We also run the Granger causality test using 1990-2007:Q3 (pre-Great Recession era) and results suggest Granger causality runs from GDP growth to the unemployment rate only. To find what happens to the Okun's Law in the post-Great

[8] We utilize the Granger causality test to determine the causal-relationship between GDP growth and unemployment. The Granger causality test and its application are explained in detail in Silvia et al. (2014). *Economic and Business Forecasting*. Wiley.

Recession world, we utilize the 2009:Q3-2015:Q1 period.[9] Results (Table 1, Box F) indicate there is no Granger-causality between GDP growth and the unemployment rate.

Summing up, using several different samples/sub-sample periods, our analysis suggest that Okun's Law needs to be reevaluated and may not be utilized (without further investigation) as a guide in decision making. This is a good example of a heuristic guideline in forecasting and policy that does not stand up to standard statistical analysis.

Concluding Remarks: Economies Evolve, So Must our Evaluation

Often economic and financial theories are utilized as a guide for decision making. In our view, theories may be utilized as a first step, but must be re-evaluated over time before implementation in practice. The reason is that economies evolve over time, as do relationships between variables. That is, the impact of a change in policy or a variable could be different across sectors as well as time periods.

For decision makers in an ever evolving world, one must goes beyond the light posts to search for "keys" to effective decision making.

Our econometric results suggest that the effect of a one percentage point increase in employment growth on key labor market variables is different between variables and over time. Second, the change in the fed funds rates produces a heterogeneous effect for multiple markets, ranging from the largest change of 0.12 percentage point in the PCE deflator to no meaningful change in S&P 500 returns and the growth rate of housing starts. Furthermore, the effect of a change in the fed funds rate is different for different time periods, which suggest past benchmarks on policy impacts need to be re-evaluated. Finally, our econometric analysis found that the conventional relationship between GDP growth and the unemployment rate (Okun's Law) is not stable—it cannot be utilized as a guide (without further investigation) for public policy decision making. For decision makers in an ever evolving world, one must goes beyond the light posts to search for "keys" (reliable results) to effective decision making.

[9] It is important to note that this sample period is too-short for the Granger causality test and results may not be reliable.

Appendix
A Case for the Multiple-Markets: 1983-2008

Figure 17

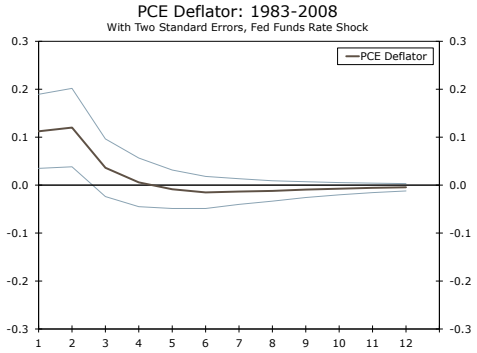


Figure 18

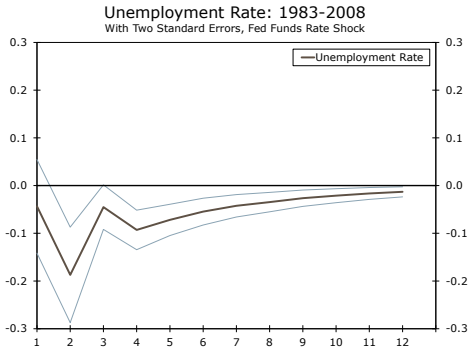


Figure 19

Figure 20

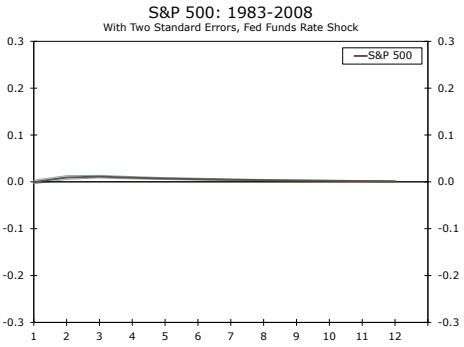
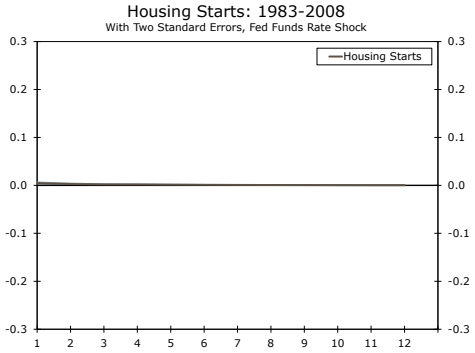


Figure 21



Source: U.S. Department of Commerce, U.S. Department of Labor, IHS Global Insight, Federal Reserve Board and Wells Fargo Securities, LLC

The Labor Market: 1983-2008

Figure 22

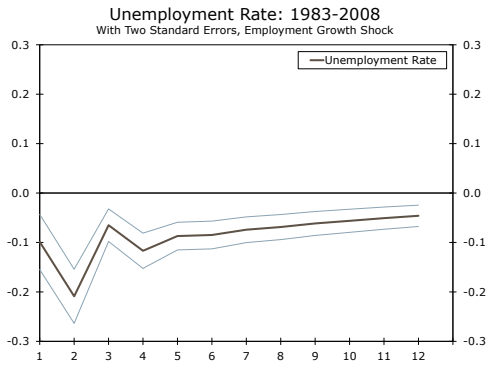


Figure 23

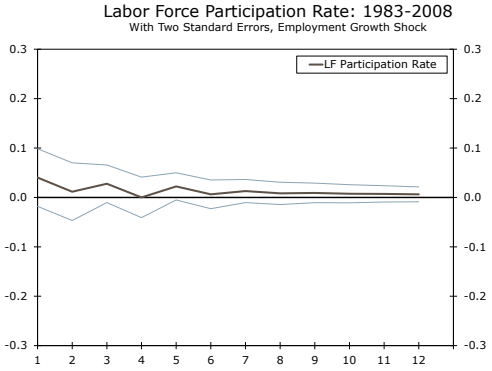
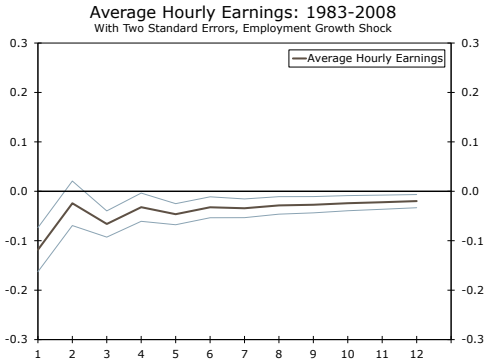


Figure 24



Source: U.S. Department of Labor and Wells Fargo Securities, LLC

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