ESSAYS ON APPLIED MACROECONOMICS

A Dissertation

by

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ABSTRACT

This thesis investigates the U.S. business cycle dynamics considering time-variations and breaks predominantly associated with the Great Recession in the late 2000s.

In the first essay, I evaluate the predictive content of financial variables and unconventional monetary policy measures for the U.S. output growth and inflation before, during, and after the Great Recession from 1960–2015. I compare the local forecasting performances of the variables with attention to the Great Recession period when the Federal Reserve System and market participants were not able to use the federal funds rate for a policy instrument and a leading indicator for the economy. This shows that the predictive ability of the credit spread, stock price, and market expectation measures for output growth and inflation change significantly increased during the Great Recession. The result is consistent with the idea that the Great Recession was primarily driven by a financial shock, and that financial condition measures might be useful indicators for the future economy to investors and central bankers. Additionally, it is important that financial market conditions are not exacerbated by a future economic shock to avoid a vicious cycle.

In the second essay, I examine how the conditional volatilities of the U.S. macroeconomic variables have changed before and during the Great Recession considering conditional mean changes. I implement multiple structural break tests in a reduced form model to find structural changes in the volatilities and means of the variables using the data from 1960–2015. The test results show that the increase in the volatility in the economy during the Great Recession was temporary, and there was no structural break in the growth rate of GDP during the Great Recession. But, there was a structural break in the growth rates of consumption variables, which are major parts of the economy, and demand-related variables, such as real disposable income and liabilities of consumers. A simulation result

suggests that a structural break in the growth rate of the economy might have occurred before the Great Recession if the recent sluggish economy continues in the coming years. This evidence suggests that the monetary policy in the period of the Great Moderation might be reconsidered for the sustainable growth of the economy beyond the short-run, and policy for improving the recent sluggish economy, especially consumption, might be necessary to avoid a structural decline in the growth rate of the economy.

DEDICATION

I dedicate this thesis to my family, Hanik Lee, Youngae Lee, Sunyeong Lee, and Barbell, for their constant support and love.

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1. INTRODUCTION

This dissertation examines the U.S. business cycle dynamics—a short-term economic fluctuation—mainly associated with the recent financial crisis, the Great Recession, which happened in December 2007. The thesis includes two essays. The title of the first essay is "Forecasting the U.S. Economy during the Great Recession: The Predictive Content of Financial Condition Measures," and the title of the second essay is "Examining the Great Moderation during the Great Recession."

The U.S. economy experienced an economic downturn starting in late 2007. Although there were many recessions in the U.S. business cycle after the Great Depression occurred, the recent crisis was more serious in depth, dispersion, and duration than any other recession. Also, the policy environment changed significantly after the crisis happened.

Since the mid-1980s, the monetary authority of the United States, the Federal Reserve System (henceforth, Fed) had used an active monetary policy for stabilizing the economy whenever there was an economic recession or a boom. At the same time, the U.S. economy also grew steadily without a serious recession during this period. Many economists called this period the Great Moderation to express the declines of volatilities or uncertainty in the economy, and they claimed that the success of monetary policy was one of the main contributors to the Great Moderation. In this period, there was a downward trend in the monetary policy instrument, and the federal funds rate. The issue of global imbalances, such as high savings and current account surpluses in emerging markets and low savings and high current account deficits in developed countries including the U.S., was not considered as a serious international economic problem among policy makers and economists.

However, after the crisis happened, the financial market was worsened seriously by the declines of financial asset prices, especially in the housing market. The problem in the financial market dispersed into the entire economy, and the U.S. economy fell into a serious recession. To address the crisis, the Fed lowered the federal funds rate to near zero percent. As a result, the Fed was not able to use the conventional monetary policy—adjusting the federal funds rate—anymore due to the zero lower bound constraint. Instead, the Fed started to implement an emergency policy and an unconventional monetary policy.

The Great Recession ended in June 2009 according to an announcement from the National Bureau of Economic Research (NBER). However, its influences on the economy and policy making are still an ongoing issue in economics. For example, the U.S. economy is sluggishly recovering after the Great Recession, the federal funds rate is still low meaning that the Fed could not lower it fully in a future recession, and some economists and policy makers have doubts about the previous accommodative monetary policy and the global imbalances due to the fear of another financial bubble or crisis.

In this thesis, I aim to understand the changes in the U.S. business cycle focusing on the Great Recession period because we can learn about the U.S. business cycle from this serious crisis when many new policies were implemented and its effects on the economy still exist. In the first essay, I evaluate the forecasting performances of various financial variables and unconventional monetary policy measures before, during, and after the Great Recession. I pay attention to the period of the Great Recession when the Fed was not able to use the federal funds rate, which had given information about the future economy to market participants including central bankers and investors. In the second essay, I implement structural break tests on the conditional volatilities and means of the U.S. macroeconomic variables to test whether there were structural breaks in the U.S. economy before and during the crisis. This analysis could provide information about the current business cycle to policy makers and economists for developing better policy and research.

1.1 Introduction to the First Essay

In forecasting output growth and inflation, central banks give considerable significance to asset prices and money aggregates. Central bankers presume that asset prices and money aggregates contain forward-looking information about the economic climate. This includes information about the real interest rate and expected inflation, according to the Fisher equation that the nominal interst rate equals the real interest rate plus the expected rate of inflation and the efficient market hypothesis (Fama, 1970). Various asset prices and money aggregates react to monetary policy and diverse shocks in the economy (Mishkin, 2001). Furthermore, a central bank principally implements monetary policy for its policy objective by using its granted power to issue currency.

Numerous researchers have studied the predictive content of asset prices and money aggregates for forecasting economic activity and inflation. Friedman and Schwartz (1963) state that the money stock predicted nominal income well from 1867-1960. Bernanke and Blinder (1992) suggest that the federal funds rate was informative about the future movement of real activity measures from 1959 to 1989 because it captured monetary policy actions. Friedman and Kuttner (1993) suggest that the paper-bill spread has the predictive content for real activity because it reflects the default risk change and the imperfect substitutability between the paper and bill. Estrella and Trubin (2006) claim that the term spread between Treasury securities is a good predictor of recessions because the yield curve of U.S. Treasuries captures the monetary policy of the Federal Reserve and economic conditions well.

The literature also points out, however, that a change in the economy may influence the forecasting performances of indicators. Lucas (1976) points out that a policy change could alter the accuracy of existing econometric models because people adapt their behavior to new situations. The Federal Reserve System has, over time, changed its target variables and indicators (Meulendyke, 1998). Stock and Watson (2003a) and Rossi and Sekhposyan (2010) show that the forecasting performances of asset prices declined during the period of the Great Moderation. Ng and Wright (2013) provide empirical evidence that the credit spread became more informative for forecasting real GDP change during the financial crisis.

One important issue for researchers and policy makers has been forecasting the performance of financial variables during a financial crisis. Bagehot (1888) emphasizes the importance of maintaining an adequate banking reserve—a gold reserve—and issuing bank notes by the Bank of England, instead of allowing gold withdrawal by depositors in a financial crisis to improve market confidence. Friedman and Schwartz (1963) point out that, during the Great Depression, the Fed failed to control the amount of money stock. Bernanke (1983) claims that, also during the Great depression, another important component besides the money stock was the nonmonetary policy effect, such as the credit spread between safe assets and risk assets. Bernanke et al. (1999, 2007); Gilchrist and Zakrajšek (2012) suggest that financial conditions have predictive content for the economy through the financial accelerator mechanism.

The monetary policy environment in the U.S. changed following the beginning of the Great Recession.[1] Before the crisis, the Federal Reserve System intervened primarily in the short-term Treasury bill market by targeting the federal funds rate. However, after the crisis began, the Fed implemented a more active monetary policy to address "the unusual and exigent circumstances" by implementing Section 13(3) of the Federal Reserve Act. This was because the financial market conditions failed to recover even after the federal funds rate dropped to near zero percent, and the economy was getting worse rapidly. The stock prices (S&P 500) fell from 1,565.15 on October 9, 2007 to 676.53 on March 9, 2009.

[1] According to business cycle reference dates of the National Bureau of Economic Research (NBER), the Great Recession started in December 2007 and ended in June 2009.

The real GDP growth also declined to -2.8 in 2009, and the unemployment rate increased from 4.7% in November 2007 to 10.0% in October 2009. The financial crisis tipped the economy into the Great Recession.

The Fed commenced implementing various unconventional monetary policies: expanding the Fed's balance sheet, changing the composition of the balance sheet, and implementing forward guidance.[2] With respect to changes in financial regulation, the Dodd-Frank Act was enacted in July 2010, and Basel III was introduced after the recession.

The motivations for this study are the Great Recession and the consequent policy environment change. I evaluate the predictive content of asset prices, money aggregates, lending measures, composite leading indicators, and surveys for forecasting output growth and inflation before, during, and after the Great Recession. I take a particular look at the credit spread, the size of the Fed's balance sheet, and the expectation measures that have potentially become more important in the context of the unconventional monetary policy environment.

1.2 Introduction to the Second Essay

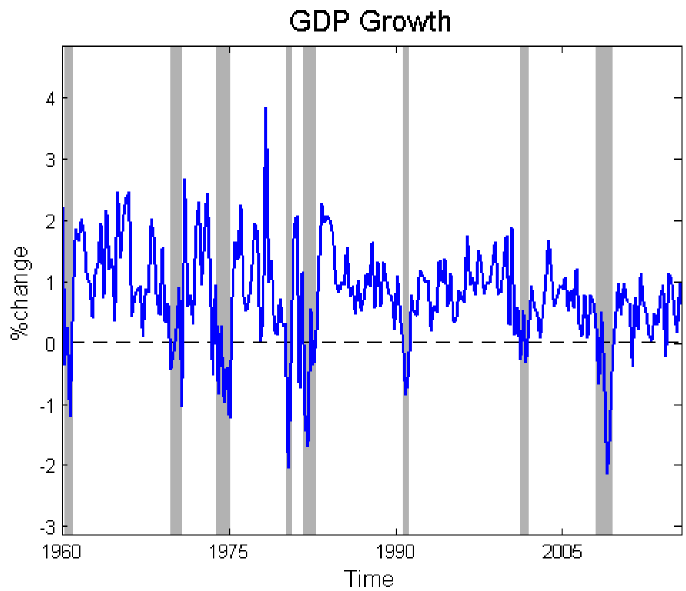
After the Great Recession began in 2007,[3] severe fluctuations appeared in U.S. macroeconomic variables, such as the growth rate of GDP and the unemployment rate. Compared to previous recessionary periods, the Great Recession was larger, longer and more extensive. The volatility[4] of real GDP can be seen in Figure 1.1, and the increased variances of the unemployment rate can be seen in Figure 1.2. Table 1.1 compares the recessions of the post-World War II era.

[2]For more details, see Bernanke (2009).

[3]According to the business cycle reference dates of the National Bureau of Economic Research (NBER), the Great Recession started in December 2007 and ended in June 2009.

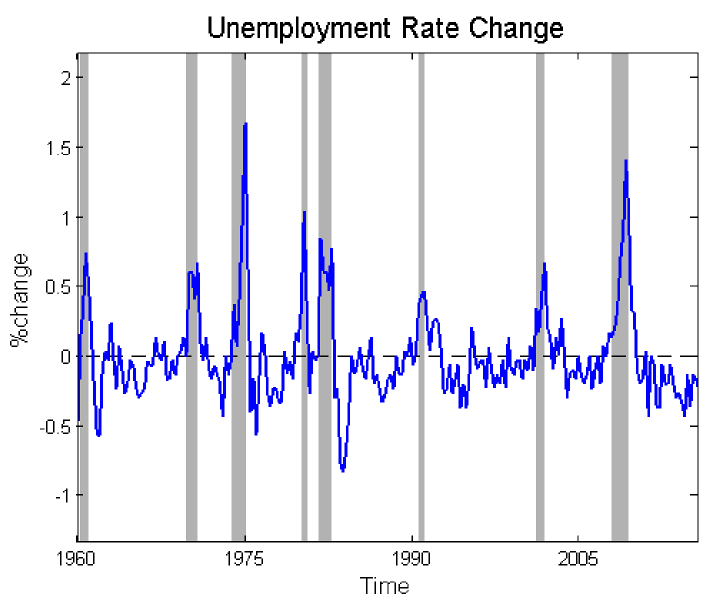
[4]Volatility is measured by the standard deviation from the mean.

Figure 1.1: GDP Growth Rates



Notes: GDP growth rates are calculated by $ln(GDP_t/GDP_{t-1})$.

Figure 1.2: Unemployment Rate Changes



Notes: Unemployment rate changes are calculated by $(Unemployment_t - Unemployment_{t-1})$.

Table 1.1: Recessions in the Post-World War II Era

Date(Quarter)	Months	Contraction of GDP	Max. Unemp Rate	Contraction of IP
Nov. 1948(IV)- Oct. 1949(IV)	11	1.7%	7.9%	10.3%
Jul. 1953(II)- May 1954(II)	10	2.6	6.1	10.0
Aug. 1957(III)- Apr. 1958(II)	8	3.7	7.5	13.6
Apr. 1960(II)- Feb. 1961(I)	10	1.4	7.1	9.0
Dec. 1969(IV)- Nov. 1970(IV)	11	0.6	6.1	7.2
Nov. 1973(IV)- Mar. 1975(I)	16	3.2	9.0	14.0
Jan. 1980(I)- Jul. 1980(III)	6	2.2	7.8	6.9
Jul. 1981(III)- Nov. 1982(IV)	16	2.9	10.8	9.7
Jul. 1990(III)- Mar. 1991(I)	8	1.3	7.8	4.3
Mar. 2001(I)- Nov. 2001(IV)	8	0.3	6.3	5.7
Dec. 2007(IV)- Jun. 2009(II)	18	4.3	10.0	19.0

Notes: Recession dates are from the National Bureau of Economic Research and National Income and Product Accounts, and data are from the Federal Reserve Bank of St. Louis. The contraction of GDP is calculated using quarterly data, and the other values are calculated using monthly data.

Table 1.2: Summary Statistics for 24 Macroeconomic Time Series, 1960:I-2015:II

Series	mean	std	mean	std	mean	std	mean	std
	1960:I-2015:III		1960:I-1983:IV		1984:I-2007:III		2007:IV-2015:II	
GDP	0.75	0.84	0.86	1.06	0.80	0.51	0.30	0.72
Consumption	0.81	0.68	0.91	0.82	0.86	0.48	0.35	0.51
Consumption–durables	1.31	2.95	1.30	3.54	1.49	2.46	0.79	2.25
Consumption–nondurables	0.60	0.72	0.64	0.84	0.66	0.59	0.28	0.64
Consumption–services	0.81	0.47	0.99	0.49	0.81	0.36	0.31	0.35
Investment (total)	0.93	4.06	1.09	5.09	1.00	2.65	0.23	4.10
Fixed investment–total	0.92	2.17	1.09	2.53	1.00	1.47	0.17	2.63
Nonresidential	1.12	2.08	1.29	2.27	1.18	1.69	0.39	2.46
Residential	0.39	4.59	0.59	5.88	0.51	2.68	-0.57	4.73
Δ (inventory investment)/GDP	0.51	0.60	0.70	0.68	0.43	0.44	0.16	0.55
Exports	1.42	3.61	1.42	4.96	1.64	1.90	0.76	2.55
Imports	1.39	3.35	1.40	4.47	1.72	1.82	0.37	2.76
Government spending	0.47	1.01	0.56	1.19	0.56	0.81	-0.06	0.76
Production								
Goods (total)	0.93	1.76	0.96	2.17	1.01	1.12	0.62	1.96
Nondurable goods	0.65	1.11	0.71	1.18	0.56	0.97	0.71	1.33
Durable goods	1.17	2.83	1.23	3.76	1.31	1.53	0.55	2.52
Services	0.72	0.48	0.86	0.56	0.74	0.33	0.26	0.25
Structures	0.36	2.45	0.55	2.93	0.44	1.62	-0.46	2.80
Nonagricultural employment	0.44	0.54	0.56	0.62	0.43	0.37	0.09	0.60
Price inflation (GDP deflator)	0.00	0.26	0.00	0.32	0.00	0.20	0.00	0.24
90-day T-bill rate	-0.02	0.73	0.05	0.99	-0.05	0.47	-0.13	0.35
10-year T-bond rate	-0.01	0.48	0.07	0.52	-0.07	0.46	-0.08	0.36

Notes: Summary statistics are calculated by the transformation code in the appendix. NIPA series are quarterly % changes. Inflation is calculated by $\Delta^2 log(x_t)$, and T-bill and T-bond are the first difference. Output per hour and compensation per hour are the first log difference. I used the variables from Stock and Watson (2003b) and the transformation code from McCracken and Ng (2015) in this table.

Compared to previous recessions, the Great Recession brought on greater volatilities for multiple economic variables. The changes of various macroeconomic time series in volatilities can be seen in Table 1.2. Many researchers are studying this change, trying to discern whether the increased volatilities are transitory or permanent.

Researchers have examined the characteristics of business cycles because understanding the state of the economy is important to consumers, producers, and policy makers as the economic growth and the volatility influence the standard of living, job creation, and investment. In fact, the Great Recession has significantly impacted the incomes and job statuses of many market participants. These participants have, in anticipation of the ensuing economic changes, made decisions to maximize their utility. By the same token, economists need to adjust their models according to economic conditions to obtain a precise analysis. For policy makers, if asset prices or volatility change irrationally away from fundamental factors, as was the case, for example, before the Great Recession or during the Great Recession, they should respond appropriately for the sake of financial and economic stability (Bernanke and Gertler, 1999). For investors, high volatility is related to the uncertainty[5] of return and ambiguity aversion, and investors require higher risk premium when market volatility is high.

Prior to the Great Recession, many researchers were paying attention to a decline in the volatilities of US macroeconomic activities after the mid-1980s, a period referred to as "the Great Moderation" (Stock and Watson, 2003b; Bernanke, 2004). During the Great Moderation, the U.S. economy grew steadily without a serious recessionary period. McConnell and Pérez-Quirós (2000) claim that the decline in the volatility of U.S. GDP growth was attributed to the decline in the volatility of durable goods production from improved inventory management, but Davis and Kahn (2008) provide empirical evidence that the Great

[5]Uncertainty can be divided into two categories: risk, which one can estimate own distribution of the stochastic events, and Knightian uncertainty, which one cannot know the distributoin of future events. For more discussion of the uncertainty, see Rossi et al. (2016)

Moderation did not reduce economic uncertainty for micro level data as much as it did for the uncertainty of macro level data. Bernanke (2004) suggests that there are three main explanations for the Great Moderation–structural change, improved government policies, and good luck. He claims that what contributed most to the Great Moderation was an improved monetary policy. In contrast, Stock and Watson (2003b) claim that the decline of volatilities was due to the good luck of smaller economic shocks.

Due to the declines of volatilities and moderate economic growth, consumers and producers could make economic decisions under less uncertainty, and a government and a central bank supported economic stabilization policies, particularly monetary policy. From the early 1980s under the chrairmanships of Volcker and Greenspan, the monetary authority intervened in the financial market aggressively to end the Great Inflation of the 1970s. The Fed implemented expansionary monetary policy to stabilize the economy when there was a financial crisis, such as Black Monday in 1987 and the dot-com bubble in 2001. Additionally, the Fed implemented contractionary monetary policy when there was inflationary pressure in the economy. As a result, many researchers paid attention to stabilization policies and optimal monetary policies, such as a Taylor rule (Taylor, 1993), by a monetary authority.

During the Great Recession, though, the GDP growth rate and unemployment rate, as noted above, fluctuated severely, and the U.S. economy experienced unprecedented economic hardship after the Great Depression. As a result, many researchers have investigated whether the Great Moderation is over not only because it is important to assess volatility of the economy per se but also it broke the belief among policy makers and researchers about the success of stabilization policy by a monetary authority.

How the present state of the economy is understood varies among researchers. Ng and Tambalotti (2012) and Canarella et al. (2008), using a forecasting analysis, state that the Great Moderation is over. However, Gadea Rivas et al. (2014) using real U.S. GDP data from 1953 to 2013, suggest that the Great Moderation continues.

By closely examining numerous macroeconomic variables, this study differs from previous literature as it provides comprehensive empirical evidence of whether the Great Moderation is over or not. Its aim is to identify a hidden trend associated with the Great Recession besides the break of the Great Moderation.

2. FORECASTING THE U.S. ECONOMY DURING THE GREAT RECESSION: THE PREDICTIVE CONTENT OF FINANCIAL CONDITION MEASURES

Section 2 is organized as follows. Section 2.1 describes the data; Section 2.2 introduces the model. In Section 2.3, I discuss the statistical tests, and Section 2.4 shows the estimation results. Finally, Section 2.5 shows the robustness.

2.1 Data

A subset of the explanatory variables chosen by Stock and Watson (2003a) is considered. As candidate variables for reflecting the unconventional monetary policy environment, I also include credit spreads (Bernanke, 1983, 1990), surveys for measuring market expectations (Krugman, 2000; Bernanke, 2013), [1] and various lending and bank balance sheet measures. I use the summation of the reserve balance and monetary base to measure the balance sheet size of the Federal Reserve Bank.[2] Table 2.1 provides definitions of candidate variables and predicted variables.

Data are obtained from the Federal Reserve Bank of St. Louis, the Federal Reserve Board of Governors, Yahoo Finance, the Organisation for Economic Co-operation and Development (OECD), and the Bank for International Settlements (BIS). Following Stock and Watson (2003a), the measures of output and inflation are, respectively, the Industrial Production (IP) and the Consumer Price Index (CPI). These two objective variables have been used widely to represent output and the price level in monthly data analysis. The data are transformed to remove stochastic and deterministic trends. To solve this issue, I treat the logarithm of output as I (1) and the logarithm of prices as I (2) following

[1] The Fed provided information about future monetary policy, as a policy tool, so as to influence market expectations, which consequently move output, inflation, and unemployment (Bernanke, 2013). In this paper, I consider the expectations measures of manufacturers and consumers, which are announced by OECD.

[2] The balance sheet measure of the Federal Reserve Bank is calculated by the summation of reserve balance and monetary base. Since the series is not seasonally adjusted, I use the X-11 method for it.

Table 2.1: Series Description

Label	Description	Source
	Asset prices	
FFR	Interest rate: Federal Funds(effective)	F
TR3M	Interest rate: US Treasury bill, 3-month	F
TR1Y	Interest rate: US Treasury constant maturities, 1-year	F
TR5Y	Interest rate: US Treasury constant maturities, 5-year	F
TR10Y	Interest rate: US Treasury constant maturities, 10-year	F
Aaa	Moody's seasoned Aaa long term corporate bond yield	F
Baa	Moody's seasoned Baa long term corporate bond yield	F
TRSPT	The spread: 10YTR-3MTR	F
TRSPO	The spread: 10YTR-1YTR	F
CPSP	The spread: Baa-10YTR	F
DFSP	The spread: Baa-Aaa	F
STOCK	S&P's common stock price index: composite	Y
EXTN	United States; effective nominal exchange rate	B
EXTR	United States; effective real exchange rate	B
	Money and Lendings	
MB	Monetary base (sa)	F
M1	M1 money stock (sa)	F
M2	M2 money stock (sa)	F
RMB	Real monetary base (sa)	F
RM1	Real M1 money stock (sa)	F
RM2	Real M2 money stock (sa)	F
FBS	Monetary base+reserve balance (nsa)	F
RFBS	Real FBS (nsa)	F
BCR	Bank Credit, all commercial banks (sa)	B
LLB	Loans and leases in bank credit, all commercial banks (sa)	B
CCO	Total consumer credit owned and securitized (sa)	F
TNR	Total nonrevolving credit owned and securitized (sa)	F
	Survey Expectations	
BCI	Business tendency survey: confidence, manufacturing	E
BTO	Business tendency survey: orders inflow, manufacturing	E
BTE	Business tendency survey: future employment tendency, manufacturing	E
CCI	Consumer opinion survey: confidence	E
	Leading indicators	
CLI	Composite leading indicators	E
	Real Activity	
IP	Industrial production total (sa)	F
	Price	
CPI	Consumer price index: all urban consumers (sa)	F

Notes: Sources are abbreviated as follows: the Federal Reserve Bank of St. Louis (F), the Federal Reserve Board of Governors (B), Yahoo finance (Y), the OECD (E), and the BIS (B). All data except the exchange rate (EXT) start in January 1960 and ends in July 2015. The exchange rate (EXT) starts in January 1964.

Table 2.2: Unit Root Test Results

Variable	Transformation	p-value	Variable	Transformation	p-value
FFR	lev	0.08	RM1	ln	0.98
FFR	1d	0	RM1	ln1d	0.01
TR3M	lev	0.2	RM1	ln2d	0
TR3M	1d	0	RM2	ln	0.93
TR1Y	lev	0.39	RM2	ln1d	0
TR1Y	1d	0	RM2	ln2d	0
TR5Y	lev	0.46	FBS	ln	1
TR5Y	1d	0	FBS	ln1d	0
TR10Y	lev	0.68	FBS	ln2d	0
TR10Y	1d	0	RFBS	ln	1
Aaa	lev	0.54	RFBS	ln1d	0
Aaa	1d	0	RFBS	ln2d	0
Baa	lev	0.58	BCR	ln	0.18
Baa	1d	0	BCR	ln1d	0
TRSPT	lev	0	BCR	ln2d	0
TRSPO	lev	0	LLB	ln	0.09
CPSP	lev	0.02	LLB	ln1d	0
DFSP	lev	0.02	LLB	ln2d	0
STOCK	ln	0.93	CCO	ln	0.54
STOCK	dln	0	CCO	ln1d	0
EXTN	ln	0.35	CCO	ln2d	0
EXTN	ln1d	0	TNR	ln	0.77
EXTR	ln	0.26	TNR	ln1d	0
EXTR	ln1d	0	TNR	ln2d	0
MB	ln	1	BCI	lev	0
MB	ln1d	0	BTO	lev	0
MB	ln2d	0	BTE	lev	0
M1	ln	0.96	CCI	lev	0.02
M1	lnd1	0.01	CCI	1d	0
M1	lnd2	0	CLI	lev	0
M2	ln	0.39	CLI	1d	0
M2	ln1d	0.01	IP	ln	0.24
M2	ln2d	0	IP	ln1d	0
RMB	ln	1	CPI	ln	0.37
RMB	ln1d	0	CPI	ln1d	0.08
RMB	ln2d	0	CPI	ln2d	0

Notes: The augmented Dickey-Fuller (ADF) test is implemented. Transformation label: lev=level (no transformation), 1d=first difference, ln=logarithm, ln1d=first difference of logarithm, and ln2d=second difference of logarithm. Test type: drift. The number of lags in the ADF test is determined by the AIC, where the maximum lag length is 19 (the default number of lags in Eviews).

Stock and Watson (2003a). The unit root test results of variables are displayed in Table 2.2. I define : $y^h_{t+h} = (1200/h)ln(IP_{t+h}/IP_t)$ and $y_t = 1200ln(IP_t/IP_{t-1})$ for the Industrial Production; $y^h_{t+h} = (1200/h)ln(CPI_{t+h}/CPI_t) - 1200ln(CPI_t/CPI_{t-1})$ and $y_t = 1200ln(CPI_t/CPI_{t-1}) - 1200ln(CPI_{t-1}/CPI_{t-2})$ for inflation, where h is the forecasting horizon.

2.2 Model

This study focuses on the multi-step pseudo out-of-sample forecasting performance for the short term (h = 1) and the medium term (h = 12). The forecasting models are:

• *Bivariate* Forecast: $y^{BI}_{t+h} = \beta^h_0 + \beta^h_1(L)x_t + \beta^h_2(L)y_t + \epsilon_{t+h}, \quad t = 1, 2, ..., T,$ (1)

• *Autoregressive* Forecast: $y^{AR}_{t+h} = \gamma^h_0 + \gamma^h_1(L)y_t + \eta_{t+h}, \quad t = 1, 2, ..., T,$ (2)

where $\beta^h_1(L)x_t = \sum^p_{j=1} \beta^h_{1j}x_{t-j+1}$, $\beta^h_2(L)y_t = \sum^q_{j=1} \beta^h_{2j}y_{t-j+1}$, $\gamma^h_1(L)y_t = \sum^q_{j=1} \gamma^h_{1j}y_{t-j+1}$, and T is the sample size used for estimating equations (1) and (2). Equation (1) is the candidate model, where y^h_{t+h} is the h-period-ahead predicted variable, and x_t is a candidate variable. Equation (2) specifies the benchmark model. The lag orders are selected by BIC criteria from the ranges $1 \leq p, q \leq 12$. The lag length is chosen through the rolling lag selection. The lag length (q) in the AR model is determined continuously, and then length (p) in the bivariate model is also selected each time. In the process, the lag length (q) in Equations (1) and (2) are the same, but the lag lengths (p and q) in the models are updated each time. This lag selection would improve forecasting accuracy better than the lag selection using full sample estimation when there is at least one structural break.

I consider the pseudo out-of-sample estimation and a rolling window forecast. Compared to the in-sample estimation, the pseudo out-of-sample estimation could work better when there are structural changes over time (Diebold et al., 1995). Additionally, the pseudo out-of-sample estimation is a more realistic approach because it evaluates the forecasting accuracy based on the assumption that we were actually there for forecasting the future using available information at that time.

This study uses a 60-month (m = 60) rolling window to capture the features of the local forecasting performance. If the number of observations is too small, it is hard to calculate the test statistics. On the other hand, if it is too large, it is hard to capture the local forecasting performance. I also verify the robustness with a different choice of the window size (m = 120) in a later section.

To calculate the time variation in the relative performance, the h-step ahead relative mean squared forecast error (rMSFE) is defined as:

$$\text{rMSFE}_t = \frac{1}{m}\left(\sum_{j=t-m/2}^{t+m/2-1} \hat{\epsilon}_{j+h}^2 - \sum_{j=t-m/2}^{j=t+m/2-1} \hat{\eta}_{j+h}^2\right), \quad t = R+h+m/2, ..., T-m/2+1, \tag{3}$$

where R is an in-sample portion, and $\hat{\epsilon}_{t+h}$ and $\hat{\eta}_{t+h}$ are pseudo out-of-sample forecast errors of Equations (1) and (2), respectively. The number of the in-sample portion ($R = 120$) and the size of the rolling window ($m = 60$) are chosen to include a sufficient number of rMSFEs for identifying the relative forecasting performance during the sample period.

2.3 Statistical test

I use the Fluctuation test proposed by Giacomini and Rossi (2010). Compared to the Diebold-Mariaon test (Diebold et al., 1995), which is based on average performance over time, the Fluctuation test provides the local forecasting performance over time. Therefore, we can distinguish the relative forecasting performance of various indicators during the Great Recession.

The unconditional predictive test (Diebold et al., 1995; Clark and West, 2006) evaluates average performance of the models over the out-of-sample period. On the other hand, the conditional predictive test includes practical testing environments. For example, Giacomini and White (2006) consider that last period information could help explain relative predictive ability of the next period between the two models. Second, Giacomini and Rossi (2010) suggest tests for evaluating the relative performance of the models when the relative performance is changing. This study investigates the relative forecasting performance of indicators over time focusing on the time after the Great Recession began. Hence, in this study, I consider the Fluctuation test.

The Fluctuation test measures the local relative forecasting performance over rolling out-of-sample windows of size m. The null hypothesis is that the models' forecasting performances are the same at each point in time.

$$H_0 : E\left(\hat{\epsilon}_t^2 - \hat{\eta}_t^2\right) = 0, \quad t = R + h, ..., T - m/2 + 1. \tag{4}$$

The test statistic is defined as:

$$F_{t,m}^{OOS} = \hat{\sigma}^{-1} m^{-1/2} \times \left(\sum_{j=t-m/2}^{t+m/2-1} \hat{\epsilon}_{j+h}^2 - \sum_{j=t-m/2}^{t+m/2-1} \hat{\eta}_{j+h}^2 \right), \tag{5}$$

for $t = R+h+m/2, ..., T-m/2+1$, where $\hat{\sigma}^2$ is a Heteroskedasticy and Autocorrelation Consistent (HAC) estimator of the asymptotic variance $\sigma^2 = var\left(P^{-1/2}\sum_{j=R+h}^{T}\left(\epsilon_j^2 - \eta_j^2\right)\right)$, where P is an out-of-sample portion, and $P = T - R$. Following Newey and West (1987), HAC standard error is,

$$\hat{\sigma}^2 = \sum_{i=-q(P)+1}^{q(P)-1} (1 - |i/q(P)|) P^{-1} \times \sum_{j=R+h}^{T+m/2-1} \left(\hat{\epsilon}_j^2 - \hat{\eta}_j^2\right)\left(\hat{\epsilon}_{j-i}^2 - \hat{\eta}_{j-i}^2\right), \tag{6}$$

where $q(p)$ is a bandwidth, and we use $q(P) = P^{1/4}$.

Asymptotic critical values for various choices of the window and sample sizes are provided by Giacomini and Rossi (2010). The ratio between the rolling window and the out-of-sample portion is about 0.1 (m/P$\simeq$0.1) in the paper. Therefore, the null hypothesis is rejected against the two-sided alternative at the 10% significance level when $max_t|F_{t,m}^{OOS}| > 3.170$.

2.4 Estimation results

This section shows the short-term and medium-term forecasting performance of the candidate variables for output and inflation changes. The tables summarize the relative mean square forecast errors (rMSFEs) and p-values based on the full out-of-sample period for h = 1 and 12, respectively. When h = 1, the pseudo out-of-sample estimation starts in April 1970 and ends in July 2015, but the nominal and real exchange rates start in April 1974 and end in July 2015. When h = 12, the out-of-sample period starts in March 1971 and ends in July 2015, but the nominal and real exchange rates start in March 1975 and end in July 2015. The graphs show the Fluctuation tests. At h = 1 the starting point is October 1972 and the ending point is February 2013 except for the exchange rates. The exchange rates begin in October 1976 and end in February 2013. At h = 12, the starting point is September 1973, and the ending point is February 2013. The exchange rates start in September 1976 and end in February 2013.

The predictive content of financial condition measures for output increased significantly at h = 1 and for inflation change at h = 12. Therefore, this section focuses on the two cases.[3] This result suggests that the predictive contents of the variables are different by a dependent variable and a forecasting period, and financial condition measures are useful indicators for output in the short term and for inflation change in the medium term.

2.4.1 Forecasting Industrial Production Growth

In Table 2.3, the third column reports rMSFEs over the full out-of-sample period, and the fourth column provides p-values. The p-values are calculated based on the unconditional Giacomini and White (2006) test. A negative value indicates that a candidate variable provides additional forecasting information because an rMSFE is defined as Equation (3).

[3] The results for output at h = 12 and for inflation change at h = 1 are in the Online-Appendix.

Table 2.3: Forecasting IP Growth for h = 1 (m = 60, Rolling lag selection)

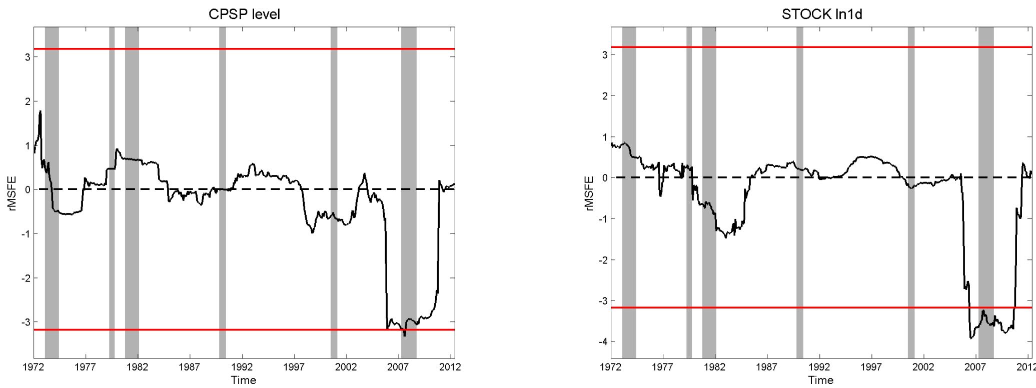
Variable	Trans	rMSFE	p-value	Variable	Trans	rMSFE	p-value
MB	ln1d	-0.45	0.65	BTE	level	-1.21	0.23
M1	ln1d	0.84	0.4	CCI	level	-1.31	0.19
M2	ln1d	0.71	0.48	CLI	level	-1.33	0.18
RMB	ln1d	1.42	0.16	CPI	1200*ln2d	1.25	0.21
RM1	ln1d	0.46	0.65	FBS	ln1d	0.81	0.42
RM2	ln1d	-1.54	0.12	RFBS	ln1d	0.92	0.36
BCR	ln1d	-0.01	1	MB	ln2d	1.12	0.26
LLB	ln1d	1.46	0.14	M1	ln2d	1.18	0.24
CCO	ln1d	-0.55	0.58	M2	ln2d	1.43	0.15
TNR	ln1d	1.3	0.19	FFR	level	-1.31	0.19
FFR	1d	-0.05	0.96	3MTR	level	-0.7	0.48
3MTR	1d	-0.67	0.5	1YTR	level	-0.46	0.65
1YTR	1d	-1.44	0.15	5YTR	level	0.01	0.99
5YTR	1d	-1.7	0.09	10YTR	level	0.24	0.81
10YTR	1d	-1.83	0.07	Aaa	level	0.66	0.51
Aaa	1d	0.85	0.4	Baa	level	0.58	0.56
Baa	1d	0.74	0.46	TRSPT	level	-0.43	0.67
TRSPT	1d	1.12	0.26	TRSPO	level	-0.64	0.52
TRSPO	1d	0.89	0.37	CPSP	level	-0.54	0.59
CPSP	1d	-1.1	0.27	DFSP	level	0.07	0.95
DFSP	1d	-1.39	0.16	CPI	ln1d	-0.26	0.79
STOCK	ln1d	-1.01	0.31	BCI	1d	-1.16	0.25
EXTN	ln1d	1.76	0.08	BTO	1d	-1.54	0.12
EXTR	ln1d	0.66	0.51	BTE	1d	-0.17	0.87
BCI	level	-1.1	0.27	CCI	1d	-1.33	0.18
BTO	level	-2.88	0	CLI	1d	-2.83	0

Notes: The rMSFE and p-value are calculated over the full out-of-sample period. A negative value of rMSFE indicates that the suggested model predicts better than the benchmark model.

At h = 1, many indicators show negative rMFSEs. For example, the government security rates, credit spreads, stock price, money aggregates, and market expectation measure report negative rMSFEs over time. We can reject the null hypotheses of the long-term interest rates, exchange rate, market expectation measure at the 10% significance level. However, a negative rMSFE value of an indicator does not necessarily mean that a p-value of the indicator is low because forecast errors and coefficients of explanatory variables could change over time.

Figure 2.1: Forecasting IP at 1 Month Horizon (Rolling lag selection, h = 1 and m = 60)

Credit spread | Stock price



Note: Negative values of the rMSFE_t (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

The Fluctuation tests represented in Figure 2.1 show a different aspect of forecasting performance. The rMSFEs and p-values previously mentioned report the forecasting performance on average, which includes the whole sample period, but I can distinguish the local performance of indicators over time using the Fluctuation test. Before the crisis, the credit spread and stock price had not predicted output and inflation better than the benchmark model. During the crisis, however, the credit spread and stock price significantly outperformed the benchmark model following the crisis declined quickly.[4]

2.4.2 Forecasting Inflation Change

This section focuses on the forecasting performance of indicators for inflation change. Table 5 displays the medium-term predictive ability of indicators for the full out-of-sample period. Most of the indicators show negative rMSFEs. We can reject the null hypothesis of the credit spread, money aggregates, balance sheet measure, and government security

[4]The results of the other variables are in the Online-Appendix.

interest rates at the 10% significance level.

Table 2.4: Forecasting Inflation Change for h = 12 (m = 60, Rolling lag selection)

Variable	Trans	rMSFE	p-value	Variable	Trans	rMSFE	p-value
MB	ln1d	1.90	0.06	BTE	level	-0.81	0.42
M1	ln1d	-0.80	0.42	CCI	level	-0.92	0.36
M2	ln1d	-0.41	0.68	CLI	level	-0.59	0.55
RMB	ln1d	-0.56	0.58	IP	1200*ln1d	-0.55	0.58
RM1	ln1d	-0.92	0.36	FBS	ln1d	1.88	0.06
RM2	ln1d	-2.18	0.03	RFBS	ln1d	-0.40	0.69
BCR	ln1d	0.38	0.70	MB	ln2d	0.29	0.77
LLB	ln1d	-0.73	0.47	M1	ln2d	0.38	0.71
CCO	ln1d	-0.39	0.69	M2	ln2d	0.65	0.52
TNR	ln1d	1.01	0.31	FFR	level	-1.77	0.08
FFR	1d	0.07	0.95	3MTR	level	-1.71	0.09
3MTR	1d	-1.13	0.26	1YTR	level	-1.34	0.18
1YTR	1d	-0.33	0.74	5YTR	level	-0.58	0.56
5YTR	1d	-0.17	0.87	10YTR	level	-0.75	0.45
10YTR	1d	0.33	0.74	Aaa	level	-0.38	0.71
Aaa	1d	0.29	0.77	Baa	level	-0.22	0.83
Baa	1d	-1.70	0.09	TRSPT	level	-0.89	0.37
TRSPT	1d	-0.16	0.87	TRSPO	level	-0.71	0.48
TRSPO	1d	-0.37	0.71	CPSP	level	1.72	0.09
CPSP	1d	-1.37	0.17	DFSP	level	0.11	0.91
DFSP	1d	-1.87	0.06	BCI	1d	-2.26	0.02
STOCK	ln1d	-0.62	0.54	BTO	1d	-0.70	0.48
EXTN	ln1d	-0.69	0.49	BTE	1d	-1.33	0.18
EXTR	ln1d	-0.99	0.32	CCI	1d	1.03	0.30
BCI	level	-1.21	0.23	CLI	1d	-1.75	0.08
BTO	level	-1.28	0.20				

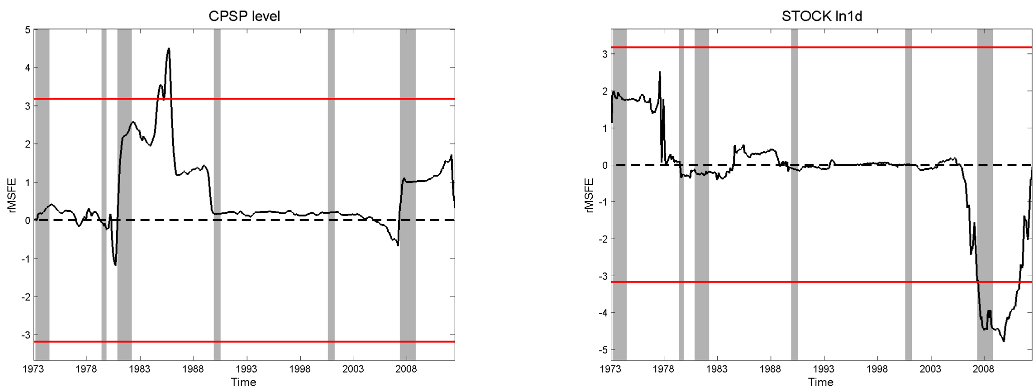
Notes: The rMSFE and p-value are calculated over the full out-of-sample period. A negative value of rMSFE indicates that the suggested model predicts better than the benchmark model.

Table 2.4 displays the medium-term predictive ability of indicators for the full out-of-sample period. Most of the indicators show negative rMSFEs. We can reject the null hypothesis of the credit spread, money aggregates, balance sheet measure, and government security interest rates at the 10% significance level.

Figure 2.2: Forecasting Inflation at 12 Month Horizon (Rolling lag selection, h = 12 and m = 60)

Credit spread

Stock price



Note: Negative values of the rMSFE$_t$ (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

Figure 2.2 presents the Fluctuation test for forecasting medium-term inflation change. The predictive ability of stock price significantly increased during the crisis.

2.4.3 The Performance of Indicators in the Great Recession

During the Great Recession, significant improvement was seen in the forecasting performance of the credit spread, stock price, and market expectation measures. This estimation result is consistent with the idea that the Great Recession was mainly driven by a financial shock (Ng and Wright, 2013), and financial market conditions are important factors in the business cycle (Bernanke et al., 1999; Gilchrist and Zakrajšek, 2012).

During the crisis, not only worsened economic conditions but also the declines in home prices and stock prices influenced consumption and investment of households and firms negatively. Due to the decrease in assets and worsened condition of borrowers' balance sheets, market conditions for secured loans and rollover of short-term debt deteriorated (Acharya et al., 2011). To address the financial crisis, the Fed bought a large amount of long-term Treasury bonds and agency securities to provide liquidity in the market. This policy, as well as a "flight-to-quality" buying by private investors, lowered the long-term government bond rates and stock price (Friedman and Kuttner, 1993; Gagnon et al., 2011). However, the corporate bond rates did not decline as much as the long-term government bond rates due to the fire sales by market participants who were afraid of the credit risk, liquidity risk, and collateral liquidation by the lender (Shleifer and Vishny, 2011). Also, market expectations declined significantly more than previous recessionary periods. Therefore, the worsened financial market condition and reverse wealth effect affected the consumption and investment of households and firms negatively, and these reduced consumption and investment exacerbated the economy through financial accelerator mechanism.

However, as the financial conditions improved, investors and financial institutions managed their portfolios to include corporate bonds and other risky assets to maximize their capital gains. Consequently, the forecasting performance of financial market condition declined after the Great Recession. To summarize, the forecasting performance of financial variables are not always better than the bench mark model. The predictive ability of specific financial variables increases significantly in a financial crisis.

2.5 Robustness Analysis

In this section, I re-estimate the predictive ability of the variables for robustness checks: different window size, fixed lag selection, real-time forecasting, and the Great Depression data.

2.5.1 Different window size (m = 120)

I recalculate the Fluctuation tests using a different window size (m = 120). The ratio between the rolling window and the out-of-sample portion is about 0.2 (m/P$\simeq$0.2). Therefore, the null hypothesis is rejected against the two-sided alternative at the 10% significance level when $max_t|F^{OOS}_{t,m}| > 2.948$ (Giacomini and Rossi, 2010).[5]

Figures 2.3 and 2.4 show the forecasting performance of indicators for the industrial production growth and inflation change, repectively when I use the different window size. The forecasting performances of the credit spread and stock price increased during the crisis, though in most cases the increase was not significant. This is because an increased number of observations in the test statistics dilute their values and variations. However, the forecasting performances of the credit spread for medium-term output growth and stock price for medium-term inflation were significantly better than the benchmark model.

2.5.2 Forecasting by Fixed Lag Selection

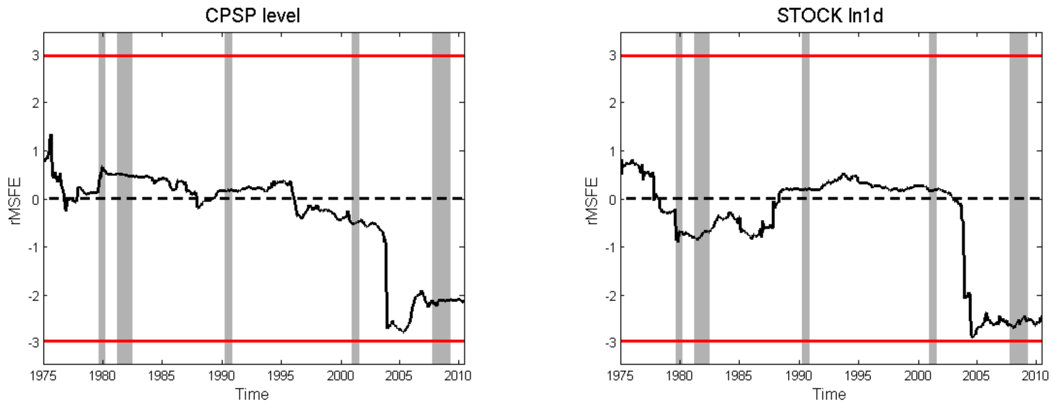
In the previous sections, the lag length was determined by the BIC criterion using rolling lag selection. In this section, the lag orders are selected by BIC criteria over the full sample estimation from the ranges $1 \leq p, q \leq 12$. The number of lag in the AR model, q, is selected first in Equation (2) on the full sample estimation, then the number of lag in the Bivariate model, p, is chosen on the full sample estimation in Equation (1).

Figures 2.5 and 2.6 display the Fluctuation tests when I use the fixed lag selection. Compared to the rolling lag estimation, the credit spread failed to forecast output growth or inflation better than the benchmark model in either the short- or medium-terms. During the crisis, however, the stock price outperformed the benchmark model at forecasting

[5]In terms of estimation period, at h = 1 the starting point is April 1975, and the ending point is August 2010 except exchange rates. In exchange rates, the starting point is April 1979, and the ending point is August 2010. At h = 12, the starting point is March 1976, and the ending point is August 2010. In exchange rates, it starts in March 1980, and it ends in August 2010.

Figure 2.3: Forecasting IP at 1 Month Horizon (Rolling lag selection, h = 1 and m = 120)

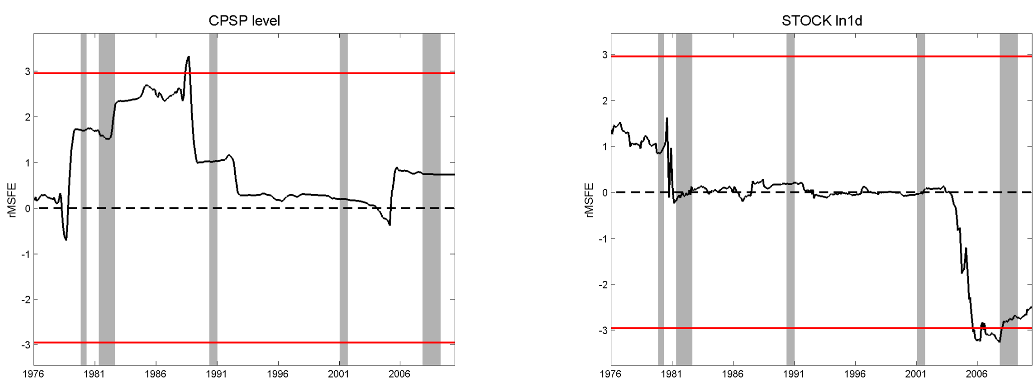
Credit spread | Stock price



Note: Negative values of the rMSFE$_t$ (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

Figure 2.4: Forecasting Inflation at 12 Month Horizon (Rolling lag selection, h = 12 and m = 120)

Credit spread | Stock price

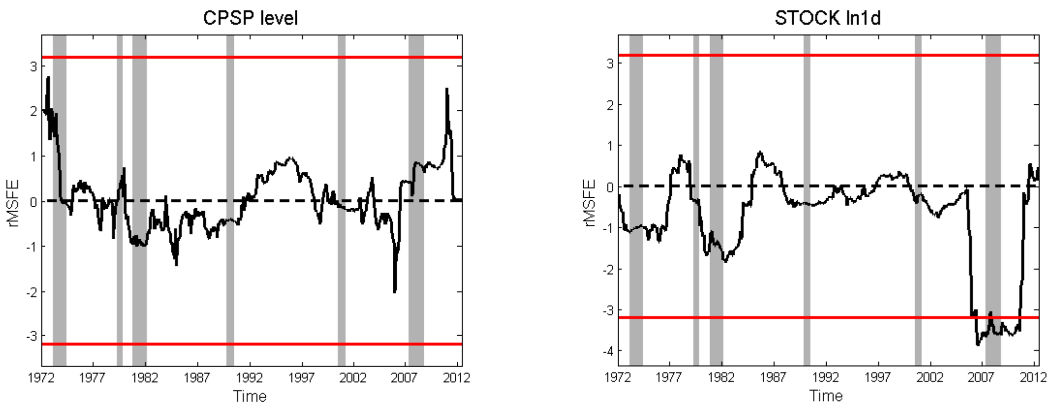


Note: Negative values of the rMSFE$_t$ (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

Figure 2.5: Forecasting IP at 1 Month Horizon (Fixed lag selection, h = 1 and m = 60)

Credit spread

Stock price

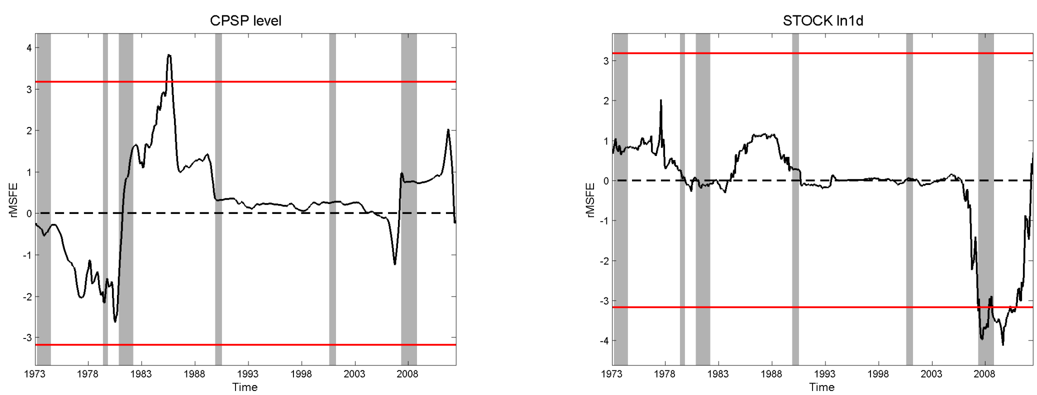


Note: Negative values of the $rMSFE_t$ (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

Figure 2.6: Forecasting Inflation at 12 Month Horizon (Fixed lag selection, h = 12 and m = 60)

Credit spread

Stock price



Note: Negative values of the $rMSFE_t$ (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

output growth in the short-term and inflation in the long-term. Thus during the crisis, in a different model specification, financial variables still contained information about the economy. However, this result suggests that the number of lags influences the forecasting performance of financial variables. In this study, the forecasting performance of the credit spread is sensitive to the number of lags, and this might be one reason why forecasting the economy is difficult, especially in a period when there is a recession or a turnaround in the economy.

2.5.3 Real-Time Forecasting

In the previous sections, the estimation results are based on the latest-available data, which have been revised. In practice, however, the latest-available data is not accessible to a real-time forecaster when predicting output growth and inflation. A real-time forecaster is only able to use real-time data. In this section, I calculate the forecasting performance of financial variables using real-time data.

The real-time data of the industrial production index is used as a data set, and the financial variables and unconventional monetary policy measures are used without change. The real-time macroeconomic data comes from the Philadelphia Fed in the Real-Time Data Set for Macroeconomists and the Bureau of Labor statistics (BLS). In regards to CPI, the vintage data sets of CPI start in November 1998, and the revision of CPI occurs when there is re-basing. Therefore, from the Bureau of Labor Statistics, CPI data was used with 1967 as the base year for the real-time data following Clark and McCracken (2010). Considering the real-time data availability, this section focuses on real-time forecasting for industrial production growth.

For estimation, the notation in Croushore (2006) is used. Equations (1) and (2) can be written using the data vintage, ν, as follows:

$$y^h_{t+h|t,\nu} = \beta_0 + \beta_1(L)x_{t,v} + \beta_2(L)y_{t,v} + \epsilon_{t+h} \tag{1'}$$

$$y^h_{t+h|t,\nu} = \beta_0 + \beta_2(L)y_{t,v} + \eta_{t+h} \tag{2'}$$

In this section, there are two main issues in real-time forecasting. First, in reality, a real-time forecaster is unable to use the current month's data for forecasting one-month ahead due to data availability. Thus, two-month ahead real-time forecasting corresponds to one-month ahead pseudo out-of-sample estimation. Likewise, thirteen-month ahead real-time forecasting matches with twelve-month ahead pseudo out-of-sample forecasting.

Next, it needs to be decided what to use as the value of "actual", y_{t+h}. One of many vintage data sets, such as the latest-available data or first announced data, can be used. To imitate a real-time forecaster, I use the first preliminary estimate as the actual value for comparison.

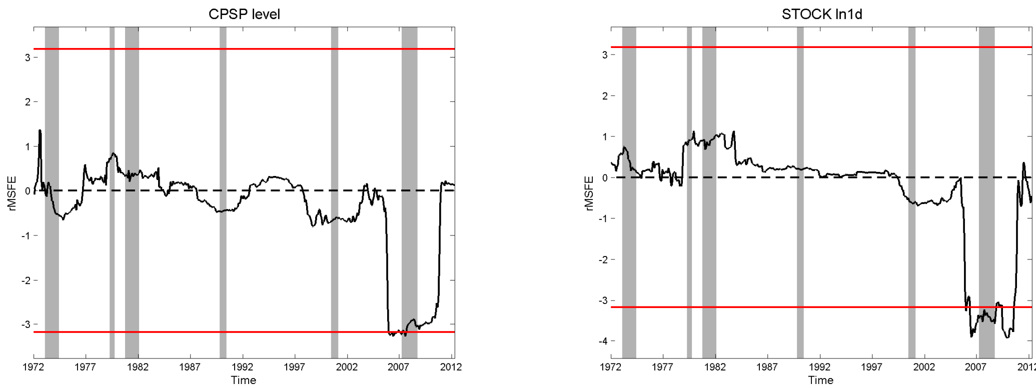
With respect to short-term forecasting, the pseudo out-of-sample period starts in June 1970 (announced in July 1970) and ends in June 2015 (announced in July 2015). The first pseudo out-of-sample estimate (June 1970) is calculated using the vintage data in May 1970, which includes data until April 1970. The forecast is compared to the vintage data in July 1970 considering a one-month delay in announcement.[6] On the other hand, in medium-term forecasting, the pseudo out-of-sample period starts in March 1972 and ends in June 2015.

The results of real-time forecasting are consistent with the latest-available data analysis. Figure 2.7 displays the Fluctuation tests when I use the real-time data set. For short-term output forecasting, the forecasting performances of the credit spread and stock price improved significantly over the benchmark model. Additionally, market confidence

[6]The estimation for exchange rates starts in four years later.

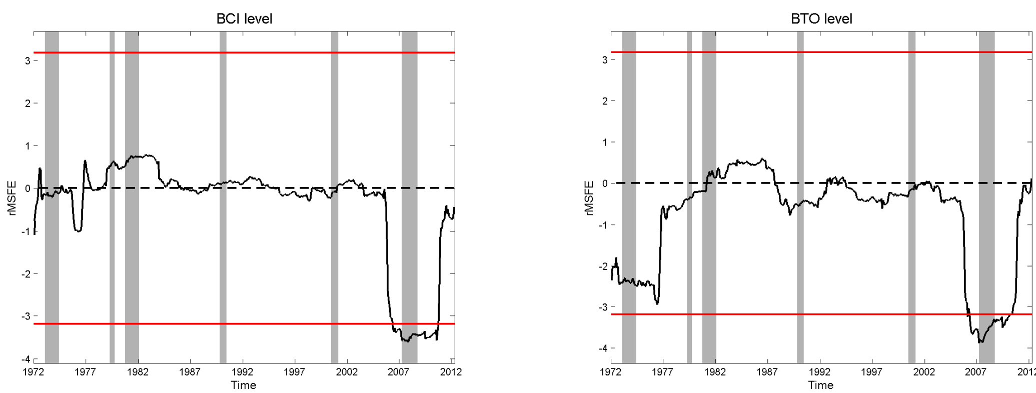
Figure 2.7: Forecasting IP at 1 Month Horizon (Real-time rolling lag selection, h = 1 and m = 60)

Credit spread | Stock price



Note: Negative values of the rMSFE_t (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

Business tendency surveys: confidence | Business tendency surveys: orders inflow



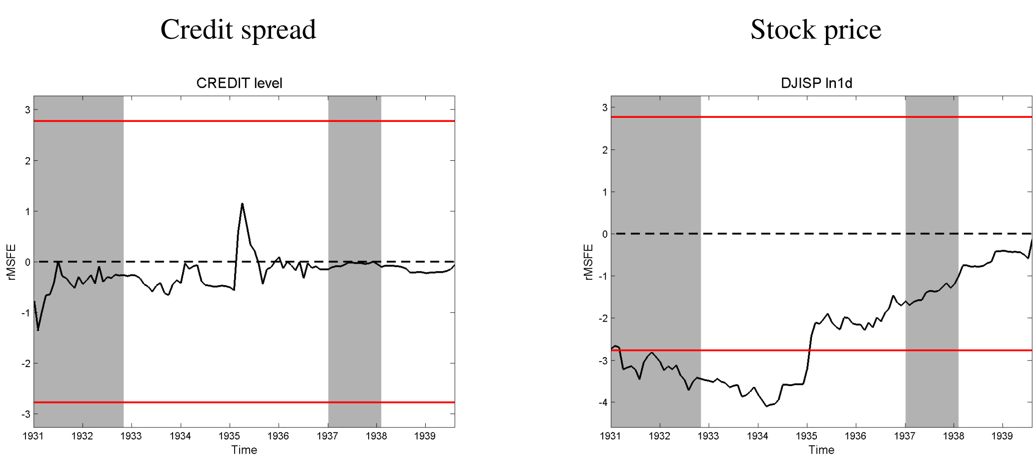
Note: Negative values of the rMSFE_t (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

measures, such as business tendency survey (confidence and orders inflow) also provided predictive content of output forecasting during the recent crisis. However, in medium-term forecasting, the four variables did not provide information about the future output growth.

2.5.4 The Performance of Indicators during the Great Depression

In this section, I implement the Fluctuation test using a credit spread and a stock price from January of 1919 to December of 1941 to see the performance of the indicators during the Great Recession, especially in the banking crises.[7] This is because the development of the Great Recession is similar to the development of the Great Depression. The Great Depression was triggered by the stock market crash after the stable growth in the 1920s, and the Great Recession was provoked by the subprime mortgage crisis after the stable growth in the Great Moderation period. The two contractions happened after long periods of stable growth in the 1920s and the Great Moderation, respectively (Friedman and Schwartz, 1963; Bernanke, 2004). Since the sample is fairly small, I use a window of 50 observations (m) and an in-sample portion of 120 observations.

Figure 2.8: Forecasting IP at 1 Month Horizon in the Great Depression (Rolling lag selection, h = 1 and m = 50)



Note: Negative values of the rMSFE_t (solid line) indicate that the suggested model forecasts better than the benchmark model. The shaded areas represent recessionary periods as determined by the NBER. The red lines are 90% significance bands for the null hypothesis that the models' relative forecasting performances are equal.

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[7]The data comes from *Banking and Monetary Statistics, 1914-1941*(Board Of Governors Of The Federal Reserve System, U.S., 1943). The stock price in this section is the Dow-Jones Industrial stock price index.

Figure 2.8 shows the Fluctuation tests when I used the data of the Great Depression. Only the forecasting performance of the stock price was significant during and after the Great Depression when h = 1. Bernanke (1983) claims that the credit spread, a nonmonetary policy effect, was also an important element in addition to the money stock during the Great Depression. However, the Fluctuation test result shows that the credit spread predicted the industrial production growth better than the AR model in the short-run, but it was not significant at h = 1.

Compared to the Great Recession, the dominant indicator in the Great Depression was the stock price change. This result implies that, during a financial crisis, declines of asset prices, or increases of liquidity risk and credit risk, could happen in different kinds of asset markets, such as stock markets, debt security markets, or housing markets. As a result, it is hard to decide on one variable as being a universal economic indicator. However, there are financial variables that provide information about the economy in a financial crisis.

3. EXAMINING THE GREAT MODERATION DURING THE GREAT RECESSION

Section 3 is organized as follows. Section 3.1 briefly provides the definitions of the terms concerning this study. Section 3.2 describes the data. Section 3.3 shows the model and test results. Finally, Section 3.4 reports the robustness checks.

3.1 Background

This section provides background information and the definitions of the terms in this study. First of all, the definition of business cycles defined by Burns and Mitchell (1946) is as follows:

> Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.

According to this definition, expansion or contraction of the economy is determined by the overall economic condition of the various macroeconomic variables. For example, Kuznets (1934) used national income accounts to describe the state of the U.S. economy for overcoming the Great Depression. Also, the National Bureau of Economic Research (NBER) defines a recession as follows:

> A recession is a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real

income, employment, industrial production, and wholesale-retail sales. A recession begins just after the economy reaches a peak of activity and ends as the economy reaches its trough. Between trough and peak, the economy is in an expansion. Expansion is the normal state of the economy; most recessions are brief and they have been rare in recent decades.

Next, the Great Moderation means the reduction in the volatilities of the macroeconomic variables from the mid-1980s (Stock and Watson, 2003b). The decline in volatility occurred across various macroeconomic variables (Stock and Watson, 2003b). Finally, the Great Recession indicates the recent financial crisis from December 2007 to June 2009. Its depth, duration, and dispersion of the decline in various economic measures were more serious than any other recession after the Great Depression (1929-1939).

3.2 Data

I use a data set from FRED-QD: a quarterly database for macroeconomic research by McCracken and Ng (2015) and Stock and Watson (2003b) to examine the characteristics of the U.S. business cycle comprehensively. The data set consists of 261 quarterly series from the first quarter of 1959 to the third quarter of 2015. Some variables start in different years. The detailed description and period of the data are described in the appendix. This data set considers the criteria of Stock and Watson (1996) following McCracken and Ng (2015).[1]

FRED-QD is organized into 14 groups: (1) national income and product accounts (NIPA), (2) industrial production, (2) employment and unemployment, (4) housing, (5) inventories, orders, and sales, (6) prices, (7) earnings and productivity, (8) interest rates,

[1] The critera of Stock and Watson (1996) are as follows: First, the sample should include the main monthly economic aggregates and coincident indicators. Second, the sample should include important leading economic indicators. Third, the sample should represent different broad classes of variables that can be expected to have quite different time series properties. Fourth, the series should have consistent historical definitions or, when the definitions are inconsistent, it should be possible to adjust the series with a simple additive or multiplicative splice.

(9) money and credit, (10) household balance sheets, (11) exchange rates, (12) other, (13) stock markets, and (14) non-household balance sheets.

The variables are transformed by the methods in Stock and Watson (2003b) and McCracken and Ng (2015). For example, the formula for growth rate is $100 \times ln(X_t/X_{t-1})$, the unemployment rate is transformed by $X_t - X_{t-1}$, and the personal consumption expenditure is transformed by $100 \times (ln(X_t/X_{t-1}) - ln(X_{t-1}/X_{t-2}))$. The transformation of the data are provided in the appendix.

3.3 Model and Tests

In this study, I implement tests for detecting structural breaks from 1960-2015, focusing on a break around the Great Recession. Since there were two important economic events - the Great Moderation and the Great Recession - during this period, I implement multiple structural break tests on unconditional volatilities. First, I focus on changes in means and then consider changes in variances for avoiding the misspecification of the conditional mean in the models.

For the structural break point tests, I consider an AR(1) model, which is suggested by McConnell and Pérez-Quirós (2000); Gadea Rivas et al. (2014). They decide the number of lag by the Schwarz information criterion. Equation (1) considers the mean and the autoregressive terms.

$$y_t = \mu + \rho y_{t-1} + \varepsilon_t \tag{3.1}$$

where y_t is a stationary dependent variable, such as growth rates or first differences, μ is a constant term, and ρ is a coefficient of the first lag. This AR(1) model might simplify the movements of the macroeconomic variables. However, this model could provide interpretation of a conditional mean and persistence of a previous period value, and it follows the consistent interpretation of previous literature. As a result, I use this AR(1) model in this study.

3.3.1 The Parameter Instability Test

I implement the parameter instability test in linear models suggested by Hansen (1992). This test provides overall information about a structural break both in an individual parameter (individual L_c tests) and a set of parameters (Joint test), and the test statistic is based on the first-order conditions of least squares and its average of the squared cumulative sums.

Table 3.1 shows summarized test results for the 22 series in the data set. I selected variables from the table in Stock and Watson (2003b). Detailed estimation results of the macroeconomic variables are provided in the appendix. The Joint tests reject that there is a parameter stability in every variables at the 5% significance level. This instability is mainly concerned with the variances and constant terms. The null hypothesis that there was a break in the constant term of GDP is not rejected, but the null hypothesis of durable consumption, consumption-services, the share of inventory changes in GDP, government spending, and services production is rejected at the 5% significance level. The null hypothesis of variance stability of most variables is rejected.

The results of the data set are provided in the online-appendix. The null hypothesis that there is no parameter change in the variances and Joint tests in the most variables of the data set is rejected. The null hypothesis in the constant term and the first coefficient in some variables is also rejected. The parameter instability is not concentrated on a few groups, but it exists widely in every groups. Therefore, there is at least one widespread instability in the economy during the sample period, and this result is still consistent with previous literature that there is a structural break although I include the observations of the Great Recession and its recovery.

Table 3.1: Parameter Instability Tests (NYBLOM's L Test)

Specification: $y_t = \mu + \phi y_{t-1} + \varepsilon_t$							
	Estimate			L_c			
Series	μ	ϕ	σ^2	μ	ϕ	σ^2	Joint
GDP	0.50 (0.08)	0.33 (0.07)	0.62 (0.08)	0.45	0.06	1.16	1.76
Consumption	0.54 (0.09)	0.33 (0.08)	0.41 (0.05)	0.62	0.09	1.18	2.39
Consumption–durables	1.37 (0.24)	-0.06 (0.07)	8.73 (1.27)	0.06	0.05	0.65	0.90
Consumption–nondurables	0.49 (0.07)	0.18 (0.07)	0.51 (0.07)	0.27	0.17	0.40	0.70
Consumption–services	0.41 (0.06)	0.50 (0.07)	0.17 (0.02)	1.64	0.35	1.07	3.49
Investment (total)	0.72 (0.29)	0.19 (0.08)	15.74 (2.24)	0.05	0.58	0.90	1.66
Fixed investment–total	0.39 (0.16)	0.57 (0.08)	3.20 (0.44)	0.08	0.14	0.50	0.82
Nonresidential	0.46 (0.15)	0.58 (0.06)	2.89 (0.35)	0.08	0.13	0.23	0.58
Residential	0.18 (0.28)	0.51 (0.09)	15.70 (2.30)	0.06	0.08	0.85	0.98
Δ (inventory investment)/GDP	0.20 (0.04)	0.60 (0.06)	0.22 (0.03)	0.71	0.09	1.06	2.43
Exports	1.73 (0.34)	-0.24 (0.12)	11.90 (2.04)	0.12	0.86	1.36	1.76
Imports	1.30 (0.35)	0.06 (0.13)	11.23 (2.01)	0.10	0.56	1.29	1.51
Government spending	0.39 (0.07)	0.19 (0.07)	0.97 (0.11)	0.79	0.09	1.29	2.07
Production							
Goods (total)	0.87 (0.15)	0.06 (0.08)	3.04 (0.38)	0.04	0.13	0.51	0.80
Nondurable goods	0.76 (0.09)	-0.18 (0.07)	1.21 (0.16)	0.09	0.23	0.19	0.46
Durable goods	1.08 (0.23)	0.04 (0.09)	7.73 (1.19)	0.05	0.48	1.25	1.87
Services	0.57 (0.06)	0.22 (0.07)	0.21 (0.02)	2.80	0.44	2.36	5.62
Structures	0.21 (0.16)	0.35 (0.07)	5.28 (0.67)	0.18	0.07	0.51	0.81
Nonagricultural employment	0.07 (0.04)	0.82 (0.05)	0.09 (0.01)	0.17	0.05	1.23	1.49
Price inflation (GDP deflator)	0.00 (0.02)	-0.26 (0.09)	0.06 (0.01)	0.09	0.12	1.01	1.28
90-day T-bill rate	-0.01 (0.05)	0.23 (0.09)	0.51 (0.14)	0.09	0.16	0.61	0.74
10-year T-bond rate	-0.01 (0.03)	0.24 (0.10)	0.22 (0.03)	0.21	0.01	0.63	0.92

Notes: The critical values for L_c are 0.748 (1%), 0.470 (5%), 0.353 (10%) for an individual L_c and 1.35 (1%), 1.01 (5%), and 0.846 (10%) for a Joint.

However, this result does not show the timing of the structural change, such as in the Great Moderation or the Great Recession. Therefore, I use tests which show the timing of a change in conditional means and conditional volatilities of the variables from the next section.

3.3.2 Identifying Multiple Structural Breaks

There were at least two important economic events from 1960 to 2015, the Great Moderation and the Great Recession. Therefore, I consider multiple structural breaks in mean and volatility.

I implement the multiple structural tests suggested by Bai and Perron (1998, 2003a,b). They consider a multiple linear regression model with m breaks (m+1 regimes).

$$y_t = x_t'\beta + z_t'\delta_j + u_t, \quad t = T_{j-1} + 1, ..., T_j \tag{3.2}$$

for $j = 1, ..., m + 1$, and where y_t is the dependent variable; $x_t(p \times 1)$ and $z_t(q \times 1)$ are independent variables; u_t is the disturbance. The break points $(T_1, ..., T_m)$ are unknown. β is invariant, and δ_j $(j = 1, ..., m + 1)$ is time-varying coefficients. When $p = 0$, this equation becomes a pure structural change model where all the coefficients could change. The variance of u_t could change whenever there is a break,

In terms of the test statistics, they propose the three multiple structural breaks tests: $supF$ test, double maximum tests, and a test of l versus $l + 1$ breaks. Compared to previous tests, they consider a partial structural change model allowing serial correlation and heteroskedasticity in the erros, trending regressors, lagged dependent variables, and different distributions for the errors and the regressors across segments. The estimates of the break points is decided by global minimizers of the sum of squared residuals based on the principle of dynamic programming.

$$(\hat{T}_1, ..., \hat{T}_m) = argmin_{T_1,...,T_m} S_T(T_1, ..., T_m), \tag{3.3}$$

where $T_i - T_{i-1} \geq q$.

Firstly, the null hypothesis of the $supF$ test is that there is no structural break, and the alternative hypothesis is that there are $m = k$ breaks. This is a generalization of the $supF$ test, which is proposed by Andrews (1993). Secondly, the null hypothesis of the double maximum tests is that there is no structural break against an unknown number of breaks. Thirdly, the null hypothesis of $supF_T(l+1|l)$ is that there are 'l' breaks, and the alternative hypothesis is that there are 'l+1' breaks.

Bai and Perron (2003a) recommend a useful strategy for finding structural breaks. It is to first use the $UDmax$ or $WDmax$ tests (Bai and Perron, 1998) to find out whether there is at least one break. If the tests reject the null hypothesis, then apply the sup$F(l + 1|l)$ tests to decide multiple breaks. This is because it is difficult to reject the null hypothesis when there are 2 changes, and the coefficients return to its originals after the second break.

In terms of the multiple structural breaks in means, I consider Equation (1), $y_t = \mu_j + \rho_j y_{t-1} + \epsilon_t$, which allows a constant term and a coefficient of the lag time-varying, for the tests. This is an extension of the model by McConnell and Pérez-Quirós (2000), which considers a one-time break. I assume that there are 3 as a maximum number of breaks, and a trimming (ϵ) is 0.10 following Gadea Rivas et al. (2014) for a break date of the Great Recession besides a break date of the Great Moderation. The structural break test detects multiple structural breaks from 1965 to 2010.

For finding structural breaks in volatility, I use the test for the detection of multiple changes in unconditional variance, which is suggested by Inclan and Tiao (1994). This test is extended by Sansó et al. (2004) considering two cases; the failure of the assumption of normal distribution in disturbances (κ_1); and heteroskedastic conditional variance processes (κ_2).

$$
\begin{aligned}
& IT(\kappa_1) = \text{sup}_k |\sqrt{T}/B_k| \quad \text{where} \\
& C_k = \sum_{t=1}^{k} \varepsilon_t^2 \\
& B_k = \frac{C_k - \frac{k}{T} C_T}{\sqrt{\hat{\eta}_t - \hat{\sigma}^4}} \\
& \hat{\eta}_t = T^{-1} \sum_{t=1}^{T} \varepsilon_t^4, \hat{\sigma}^4 = T^{-1} C_T
\end{aligned}
\tag{3.4}
$$

$$
\begin{aligned}
& IT(\kappa_2) = \text{sup}_k |\sqrt{T}/G_k| \quad \text{where} \\
& G_k = \hat{\hat{\omega}}_4^{-1/2} (C_k - \frac{k}{T} C_T)
\end{aligned}
\tag{3.5}
$$

where $\hat{\hat{\omega}}_4$ is a consistent estimator of ω_4. $\omega_4 = lim_{T \to \infty} E(T^{-1}(\sum_{t=1}^{T}(\varepsilon_t^2 - \sigma^2))^2 < \infty$, and ω_4 is the long-run fourth order moment of ε_t.

$$
\hat{\omega}_t = \frac{1}{T} \sum_{t=1}^{T} (\varepsilon_t^2 - \hat{\sigma}^2)^2 + \frac{2}{T} \sum_{l=1}^{m} w(l,m) \sum_{t=l+1}^{T} (\varepsilon_t^2 - \hat{\sigma}^2)(\varepsilon_{t-l}^2 - \hat{\sigma}^2) \tag{3.6}
$$

where $w(l,m) = 1 - l/(m+1)$, and it is a lag window. The bandwidth m could be chosen in the method suggested by Newey and West (1994).

Additionally, I use the method in McConnell and Pérez-Quirós (2000) and Bai and Perron (2003a), which utilize the absolute value of the residuals assuming a normal distribution of residuals, for the multiple structural break tests.

3.3.2.1 Multiple Structural Breaks in Mean

In this section, I focus on the multiple structural breaks in means. I first consider the representative variables, which I consider in the previous section. I then consider the various variables in the data set.

Table 3.2 shows the results of the multiple structural break tests, and Table 3.3 displays estimated conditional means with structural breaks. Each column shows the test statistics and critical values at the 5% significance level, and break dates are estimated by the strategy, which is suggested by Bai and Perron (2003a).

First, in Table 3.2, the GDP growth rate does not show a structural break during the sample period. However, consumption, consumption-services, residential, exports, imports, production-nondurable goods, production-durable goods, production-services, and 90-day T-bill rate show at least one structural break before the crisis. Consumption-services and residential show two structural breaks, and production-services show three structural breaks. However, only the structural breaks of consumption, consumption-services, residential, and production-services happened after the Great Moderation began in the mid-1980s.

The timing of a structural break of the consumption, consumption-services, residential, and production services happened before and during the Great Recession. The constant terms became smaller and the coefficients of the first lag became larger in consumption, consumption-services, production-services. As a result, the growth rates of those variables are predicted to be lower than before when a previous quarter growth rate is low. However, the slow recovery of the overall economy, GDP, is not related with a structural break by this empirical evidence. This result suggests that declined previous growth rates are the main source of present state of the economy.

Table 3.2: Multiple Structural Break Tests in Conditional Means

Series	SupF(k)			Sup(l+1/l)		UDmax	WDmax	T(SBIC)	T(LWZ)	T(sequential)	Break dates
	k=1	k=2	k=3	l=1	l=2						
GDP	11.50(12.25)	4.00(10.58)	5.70(9.29)	3.12(12.25)	8.20(13.83)	11.50(12.59)	11.50(13.66)	0	0	0	
Consumption	19.21(12.25)	12.28(10.58)	11.20(9.29)	5.47(12.25)	4.63(13.83)	19.21(12.59)	19.21(13.66)	0	0	1	2006Q4
Consumption–durables	3.37(12.25)	2.22(10.58)	3.23(9.29)	6.31(12.25)	5.29(13.83)	3.37(12.59)	4.70(13.66)	0	0	0	
Consumption–nondurables	8.72(12.25)	11.38(10.58)	9.43(9.29)	11.37(12.25)	6.42(13.83)	11.38(12.59)	14.28(13.66)	0	0	0	
Consumption–services	32.81(12.25)	28.66(10.58)	20.89(9.29)	13.92(12.25)	5.43(13.83)	32.81(12.59)	35.97(13.66)	1	0	2	1973Q1, 1999Q4
Investment (total)	9.45(12.25)	7.67(10.58)	8.67(9.29)	4.64(12.25)	4.21(13.83)	9.45(12.59)	12.62(13.66)	0	0	0	
Fixed investment–total	2.75(12.25)	7.56(10.58)	15.98(9.29)	27.76(12.25)	27.17(13.83)	15.98(12.59)	23.27(13.66)	0	0	0	
Nonresidential	3.39(12.25)	21.47(10.58)	17.04(9.29)	34.15(12.25)	8.46(13.83)	21.47(12.59)	26.95(13.66)	0	0	0	
Residential	22.43(12.25)	22.68(10.58)	19.07(9.29)	15.21(12.25)	6.66(13.83)	22.68(12.59)	28.47(13.66)	0	0	2	1981Q1, 2009Q2
Δ (inventory investment)/GDP	9.45(12.25)	9.58(10.58)	8.07(9.29)	7.32(12.25)	3.60(13.83)	9.58(12.59)	12.03(13.66)	0	0	0	
Exports	33.76(12.25)	22.58(10.58)	15.15(9.29)	7.31(12.25)	6.98(13.83)	33.76(12.59)	33.76(13.66)	1	1	1	1972Q3
Imports	21.33(12.25)	12.93(10.58)	10.67(9.29)	3.83(12.25)	2.90(13.83)	21.33(12.59)	21.33(13.66)	1	1	1	1974Q3
Government spending	10.91(12.25)	18.34(10.58)	17.31(9.29)	23.60(12.25)	9.88(13.83)	18.34(12.59)	25.20(13.66)	1	0	0	1967Q1, 2009Q4
Production											
Goods (total)	5.29(12.25)	8.88(10.58)	6.33(9.29)	15.35(12.25)	1.74(13.83)	8.88(12.59)	11.15(13.66)	0	0	0	
Nondurable goods	16.40(12.25)	9.90(10.58)	9.70(9.29)	5.03(12.25)	8.76(13.83)	16.40(12.59)	16.40(13.66)	0	0	1	1974Q4
Durable goods	12.64(12.25)	9.95(10.58)	7.22(9.29)	4.49(12.25)	1.73(13.83)	12.64(12.59)	12.64(13.66)	1	0	1	1972Q1
Services	56.38(12.25)	63.75(10.58)	50.48(9.29)	50.83(12.25)	15.58(13.83)	63.75(12.59)	80.00(13.66)	2	1	3	1969Q2, 2000Q2, 2006Q4
Structures	11.35(12.25)	14.15(10.58)	12.97(9.29)	15.12(12.25)	8.12(13.83)	14.15(12.59)	18.88(13.66)	0	0	0	
Nonagricultural employment	2.61(12.25)	5.58(10.58)	7.53(9.29)	15.31(12.25)	15.31(13.83)	7.53(12.59)	10.96(13.66)	0	0	0	
Price inflation (GDP deflator)	2.68(12.25)	6.16(10.58)	4.56(9.29)	13.28(12.25)	1.85(13.83)	6.16(12.59)	7.73(13.66)	0	0	0	
90-day T-bill rate	15.23(12.25)	7.58(10.58)	6.92(9.29)	4.04(12.25)	15.99(13.83)	15.23(12.59)	15.23(13.66)	0	0	1	1982Q2
10-year T-bond rate	8.82(12.25)	10.00(10.58)	4.08(9.29)	6.81(12.25)	3.97(13.83)	10.00(12.59)	12.55(13.66)	0	0	0	

Notes: I test the multiple structural break tests based on Bai and Perron (1998, 2003a,b). The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$ for j=1, 2, 3. The values in parentheses are the critical values at the 5% significance level. The break dates are calculated from the strategy suggestedy by Bai and Perron (2003a).

Table 3.3: Estimated Conditional Means

Series	μ_j	ϕ_j	Break Dates
GDP	0.50	0.33	
Consumption	$0.68, 0.15,$	$0.23, 0.58$	2006Q4
Consumption–durables	1.37	-0.06	
Consumption–nondurables	0.49	0.18	
Consumption–services	$1.09, 0.62, 0.13,$	$0.05, 0.27, 0.72$	1973Q1, 1999Q4
Investment (total)	0.72	0.19	
Fixed investment–total	0.39	0.57	
Nonresidential	0.46	0.58	
Residential	$0.25, -0.01, 1.65,$	$0.37, 0.80, -0.25$	1981Q1, 2009Q2
Δ (inventory investment)/GDP	0.20	0.60	
Exports	$2.28, 0.94$	$-0.54, 0.30$	1972Q3
Imports	$2.11, 0.78$	$-0.35, 0.41$	1974Q3
Government spending	$1.26, 0.43, -0.23$	$0.06, 0.04, 0.32$	1967Q1, 2009Q4
Production			
Goods (total)	0.86	0.06	
Nondurable goods	$0.48, 0.81,$	$0.24, -0.27$	1974Q4
Durable goods	$1.50, 0.82,$	$-0.30, 0.27$	1972Q1
Services	$1.50, 0.65, 0.77, 0.15$	$-0.30, 0.13, -0.28, 0.43$	1969Q2, 2000Q2, 2006Q4
Structures	0.22	0.35	
Nonagricultural employment	0.07	0.82	
Price inflation (GDP deflator)	0.00	-0.27	
90-day T-bill rate	$0.09, -0.04,$	$0.08, 0.51$	1982Q2
10-year T-bond rate	-0.01	0.23	

Notes: The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma_t^2)$ for j=1, 2, 3.

The results for the data set are summarized in the online-appendix. The table shows that there is a widespread instability in the mean. The Sequential test rejects the null hypothesis that there is no break in the mean in the eighty-seven variables of the two hundred and sixty-one variables, but the break dates are various by series.

In the group of employment and unemployment, the null hypothesis that there was no structural break in the mean in the number of total nonfarm employee is not rejected, but the null of the number of service-providing industries, financial activities, and professional & business services are rejected. In the group of earnings and productivity, real average hourly earnings variables and real output per hour do not show a structural break around the Great Recession. But, there is a structural break in real compensation per hour in nonfarm business sector and business sector during the Great Recession, and it shows a decline of the growth rates. In the group of money and credits, real M1 shows a radical increase on the constant term and a decline in the coefficient of the first lag in the third quarter of 2008, but real M2 shows no structural break during the Great Recession although there were quantitative easing policies. The null of the mean of the real estate loans by all commercial banks in the fourth quarter of 2006 and liabilities of households and nonprofit organizations relative to disposable income in the first quarter of 2008 is rejected.

3.3.2.2 Multiple Structural Breaks in Volatility

In this section, I implement the multiple structural breaks in volatility using the multiple structural breaks of the means in the previous section.

Table 3.4 reports the results of multiple structural break tests and Table 3.5 displays estimated conditional volatilities of the representative variables. Each column shows the break dates by the each test at the 5% significance level in Table 6. The null hypothesis that there is no structural break in the volatilites of the most variables is rejected. The timing of the structural breaks of the variables are not associated with the Great Recession in most cases. The breaks are mainly concentrated in the 1980s. Only the break dates of consumption-durables, production-structures, price inflation, and T-bill rate fall between the third quarter of 2006 and the second quarter of 2011. Also, conditional volatilities of the variables except price inflation are still low even after the Great Recession happened. With respect to price inflation, the volatilities increased in the third quarter of 2006 by

$IT(\kappa_1)$ and $IT(\kappa_2)$ tests. However, the multiple structural break test indicates that the volatility of prince inflation declined in the second quarter of 1985. This is accountable for the recent low inflation contrary to the previous moderate inflation because the recent variance becomes larger, when there is no change in the mean of the inflation.

Table 3.4: Multiple Structural Break Tests in Conditional Volatilities

Series	ICSS algorithm		Bai-Perron
	$IT(\kappa_1)$	$IT(\kappa_2)$	
GDP	1984Q1	1984Q1	1984Q1
Consumption	1992Q1	1992Q1	1992Q1
Consumption–durables	1988Q1	1988Q1	1991Q1, 2009Q4
Consumption–nondurables	1980Q1		
Consumption–services	1992Q1	1992Q1	1993Q3
Investment (total)	1984Q1	1984Q1	1984Q1
Fixed investment–total	1983Q4	1983Q4	1983Q4
Nonresidential			
Residential	1983Q1	1983Q1	1983Q1
Δ (inventory investment)/GDP	1988Q1	1988Q1	1988Q1
Exports	1978Q2	1978Q2	1978Q4
Imports	1985Q4	1985Q4	1986Q2
Government spending	2002Q2	2002Q2	1987Q1
Production			
Goods (total)	1984Q1	1984Q1	1984Q1
Nondurable goods			
Durable goods	1983Q4	1983Q4	1983Q4
Services	1969Q1, 1998Q2	1969Q1, 1998Q2	1969Q1, 1998Q2
Structures	1974Q2, 1983Q3, 2007Q3, 2011Q2		1974Q2, 1983Q3
Nonagricultural employment	1974Q3, 1983Q4	1983Q4	1983Q4
Price inflation (GDP deflator)	1970Q2, 1985Q2, 2006Q3	1985Q2, 2006Q3	1970Q2, 1985Q2
90-day T-bill rate	1970Q3, 1979Q3, 1984Q4		1984Q4, 2009Q1
10-year T-bond rate	1966Q2, 1969Q3,1987Q4		1966Q2, 1979Q3, 1986Q2

Notes: The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$ for $j = 1, 2, 3$, $\varepsilon_t \sim N(0, \sigma^2_{j'})$, $j' = 1, 2, 3$ using the identified mean changes in Table 3.3. Bai-Perron indicates the multiple structural break tests (Bai and Perron, 1998, 2003a,b). For IT tests, I use the quadratic spectral window with automatic bandwidth selection.

Table 3.5: Estimated Conditional Volatilities

Series	IT(κ_1)		IT(κ_2)		Bai-Perron	
	ε_t^2	Break Dates	ε_t^2	Break Dates	ε_t^2	Break Dates
GDP	1.02, 0.55	1984Q1	1.02, 0.55	1984Q1	1.02, 0.55	1984Q1
Consumption	0.76, 0.37	1992Q1	0.76, 0.37	1992Q1	0.76, 0.37	1992Q1
Consumption–durables	3.55, 2.18	1988Q1	3.55, 2.18	1988Q1	3.50, 2.31, 0.97	1991Q1, 2009Q4
Consumption–nondurables	0.86, 0.61	1980Q1	0.71		0.71	
Consumption–services	0.44, 0.24	1992Q1	0.44, 0.24	1992Q1	0.44, 0.24	1993Q3
Investment (total)	5.07, 2.86	1984Q1	5.07, 2.86	1984Q1	5.07, 2.86	1984Q1
Fixed investment–total	2.18, 1.42	1983Q4	2.18, 1.42	1983Q4	2.18, 1.42	1983Q4
Nonresidential	1.70		1.70		1.70	
Residential	5.11, 2.32	1983Q1	5.11, 2.32	1983Q1	5.11, 2.32	1983Q1
Δ (inventory investment)/GDP	0.58, 0.31	1988Q1	0.58, 0.31	1988Q1	0.58, 0.31	1988Q1
Exports	4.62, 2.04	1978Q2	4.62, 2.04	1978Q2	4.58, 2.03	1978Q4
Imports	4.15, 1.74	1985Q4	4.15, 1.74	1985Q4	4.13, 1.71	1986Q2
Government spending	1.00, 0.55	2002Q2	1.00, 0.55	2002Q2	1.10, 0.69	1987Q1
Production						
Goods (total)	2.15, 1.36	1984Q1	2.15, 1.36	1984Q1	2.15, 1.36	1984Q1
Nondurable goods	1.08,		1.08		1.08	
Durable goods	3.53, 1.77	1983Q4	3.53, 1.77	1983Q4	3.53, 1.77	1983Q4
Services	0.60, 0.36, 0.23	1969Q1, 1998Q2	0.60, 0.36, 0.23	1969Q1, 1998Q2	0.60, 0.36, 0.23	1969Q1, 1998Q2
Structures	2.15, 3.57, 1.52, 3.19, 1.17	1974Q2, 1983Q3, 2007Q3, 2011Q2	2.30		2.15, 3.62, 1.84	1974Q2, 1983Q3
Nonagricultural employment	0.33, 0.51, 0.20	1974Q3, 1983Q4	0.41, 0.20	1983Q4	0.41, 0.20	1983Q4
Price inflation (GDP deflator)	0.20, 0.38, 0.14, 0.26	1970Q2, 1985Q2, 2006Q3	0.32, 0.14, 0.26	1985Q2, 2006Q3	0.20, 0.38, 0.19	1970Q2, 1985Q2
90-day T-bill rate	0.37, 0.75, 1.85, 0.32	1970Q3, 1979Q3, 1984Q4	0.69		0.98, 0.36, 0.04	1984Q4, 2009Q1
10-year T-bond rate	0.22, 0.33, 0.93, 0.37	1966Q2, 1969Q3, 1987Q4	0.46		0.14, 0.32, 0.97, 0.38	1966Q2, 1979Q3, 1986Q2

Notes: The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma_{j'}^2)$, $j' = 1, 2, 3$ using the identified mean changes and volatility changes in Tables 3.3 and 3.4.

The results for the data set are summarized in the appendix. The table reports that there is an extensive instability in the volatility. The $IT(\kappa_1), IT(\kappa_2),$ and Bai-Perron's multiple structural break tests reject the null hypothesis that there is no break in the volatility in the one hundered and seventy-six, eighty-nine, and one hundred and fifty-one variables of the two hundred and sixty-one variables, respectively. An increase or a decrease in a volatility are different by variable, but the most variables show declines in volatilities.

In the group of industrial production, the break dates of the most variables are concentrated in the 1980s, and the declined volatilities after the break dates are remained unchanged during the Great Recession. In the group of housing, most of the variables show at least one structural break, and volatilities increased around the beginning of the Great Recession. This evidence shows the serious impact of the Great Recession on the housing market. Most of the earnings and productivity variables show declines in volatilities except unit labor cost variables, and many interest rate variables also show declines in volatilities. But, real estate loans, real total assets of households and nonprofit organizations, real net worth of households and nonprofit organizations, and net worth of households and nonprofit organizations relative to disposable personal income display increased volatilities from the late 1990s.

To summarize, the volatilities in the variables of national income and product accounts (NIPA) have been low since the Great Moderation began. This result suggest that the low variance of the overall economy is present. However, there are increased volatilities in housing, credit, and balance sheets of households and nonprofit organizations, which were related with the credit expansion, from the late 1990s in the economy.

3.3.3 A Structural Break in the Great Recession

In the previous sections, I tested multiple structural breaks in the means and volatilities, found the breaks, and estimated the conditional means and volatilities. In this section, I analyze the breaks and changes in the means and volatilities of the variables focusing on the period of the Great Recession. First, I focus on the volatilities and growth rates of the national income and product accounts variables, and I consider the volatilities and growth rates of selected macroeconomic variables, which could be associated with the structural changes of the national income and product accounts variables during and before the Great Recession.

The previous result shows that the increased volatility of the economy during the Great Recession was temporary because the null hypothesis that there was no a structural break in the volatilities of most variables was not rejected. Therefore, the volatility of the economy is still low, and the Great Moderation is not over in the U.S. economy.

However, a structural break after the Great Recession ended cannot be detected because the number of observations is not enough. Therefore, this research cannot explain the characteristics of the economy directly after the Great Recession ended, but the volatility of the economy after the Great Recession ended has been as low as the period of the Great Moderation. Therefore, this empirical evidence suggests that the volatility of the current economy is low.

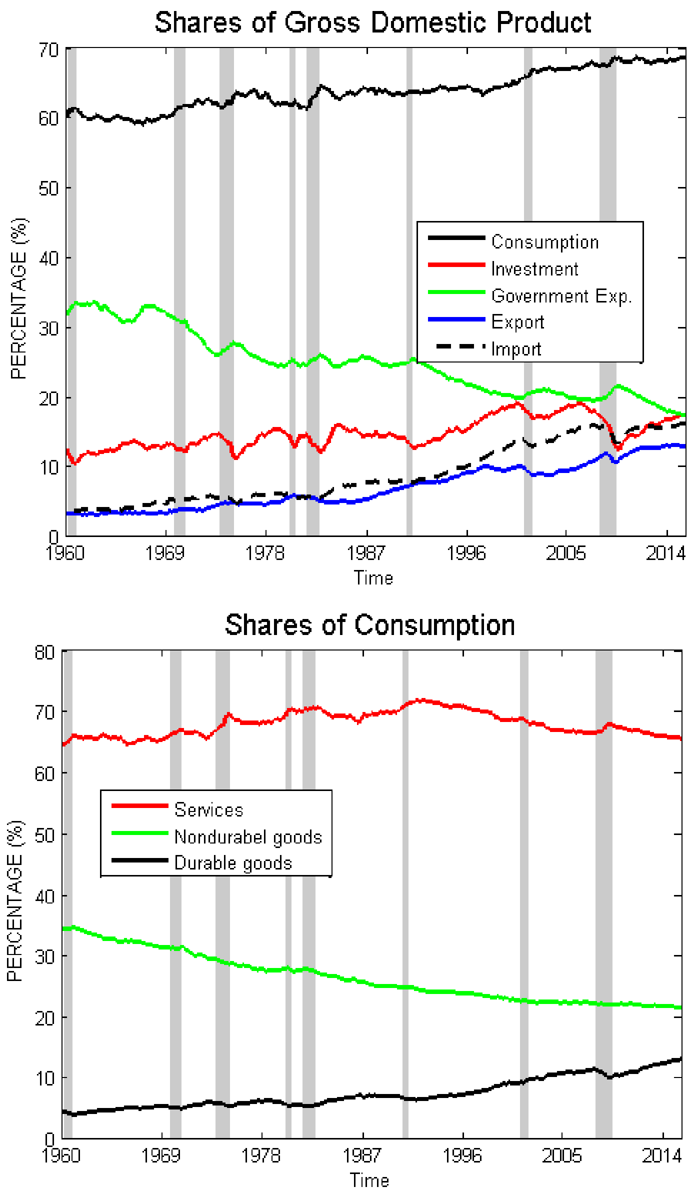
In regards to the growth rates of macroeconomic variables, there was no structural break in GDP before or during the Great Recession. However, there was a structural break in consumption in the third quarter of 2006. Consumption's constant term declined, and the coefficient of the first lag increased. Consumption-services and production-services also changed as consumption did in the fourth quarter of 1999 and the second quarter of 2009, respectively. As a result, the growth rates of those variables would be expected to decline when a previous growth rate was low because of the increased persistence.[2] The changed coefficients of consumption could lower the growth rate of GDP because consumption is the largest contributor to GDP.

In the national income and product accounts (NIPA), GDP is the summation of consumption, investment, government spending, and net exports by the expenditure approach. In 2015, the proportion of consumption was about 65%, the proportion of consumption-services to GDP was about 45%, and the proportion of consumption-services to consumption was about 65%. On the other hand, the ratio of services to GDP was about 60% in 2015 by the production method, in which GDP is made up of goods, services, and structures. Figure 3.1 shows the shares of GDP and consumption by the expenditure approach, and Figure 3.2 shows the shares of GDP by the production approach from 1960 to 2015. These figures indicate that consumption, consumption-services, and production-services are important components in the economy.

The decline in consumption and consumption-services could contribute to the sluggish economic growth with other conditions remaining the same. During the Great Recession, consumption, investment, and export declined significantly. Figures 3.3 and 3.4 display the contributions of components to percentage change in GDP by the expenditure method and the production method, respectively, and Table 3.6 reports the contributions of each period. They show that only government spending and imports stabilized the economy during the financial crisis. After the recession, however, contributions to GDP growth of government spending and imports declined, and the contributions of consumption, investment, and exports recovered. However, the recent contribution of consumption is weaker than the average contribution was from the first quarter of 1960 to the third quarter of 2007.

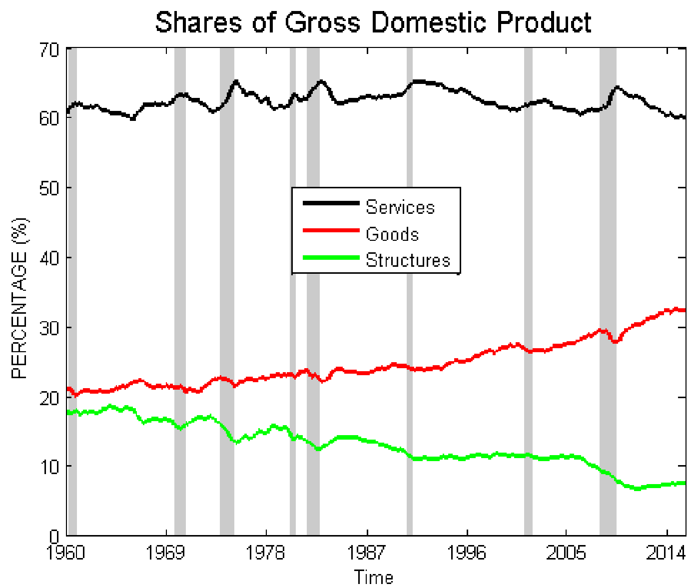
[2]When a previous growth rate of consumption was higher than 1.51%, or 6.06% (annualized), a current growth rate is higher than before the structural break. Considering the recent slow growth rate of consumption, the structural change implies the low growth rate of consumption due to the decline of the constant term and increased coefficient of the first lag.

Figure 3.1: Shares of Gross Domestic Product by the Expenditure Approach



Notes: Each components are measured by the expenditure method.

Figure 3.2: Shares of Gross Domestic Product by the Production Approach

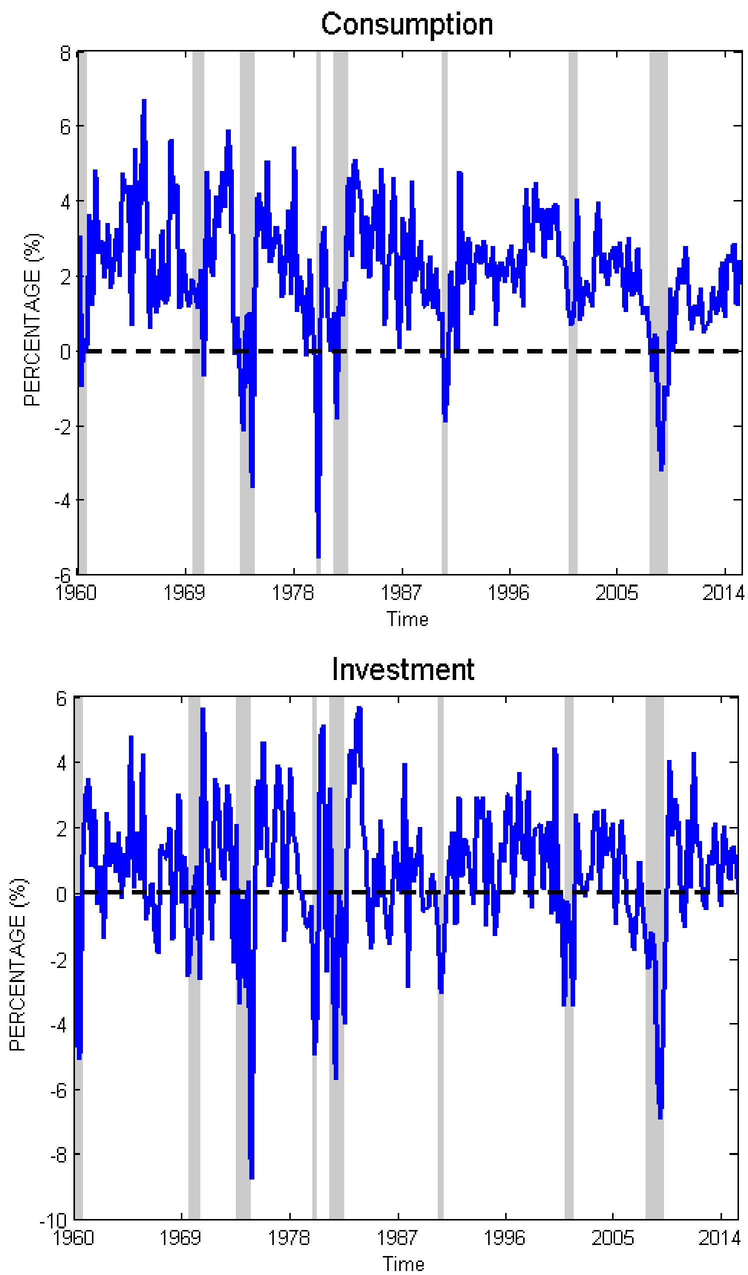


Notes: Each components are measured by the production method.

Similarly, there was a structural break in production-services in the fourth quarter of 2006. Production-services' constant term declined significantly even though the coefficient of the first lag increased.[3] The declined growth of production-services is attributable to the current sluggish economy. Table 3.7 reports the average of each GDP component's contributions to the GDP growth rate by the major type of production method in different time periods. This analysis suggests that the decreased growth rates of services in both production and expenditure may be associated with the sluggish economy after the Great Recession.

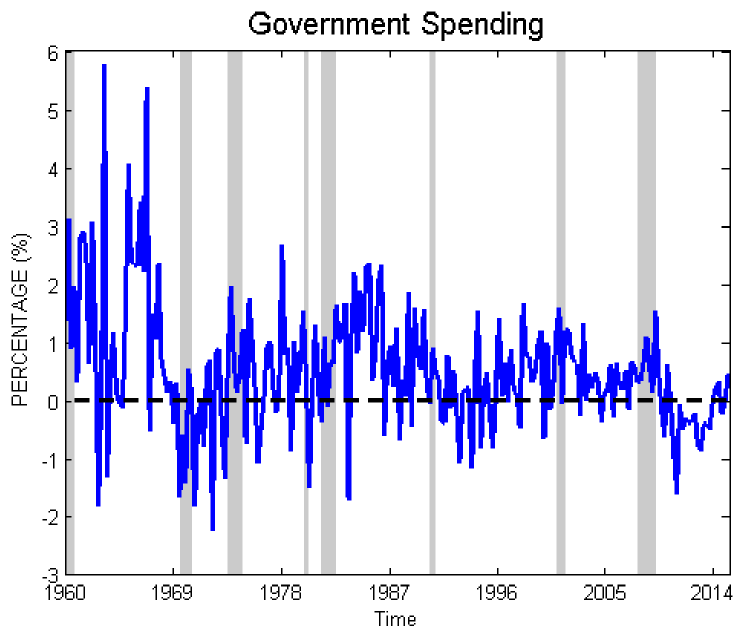
[3]When a previous growth rate of production-services was higher than 0.87%, or 3.48% (annualized), a current growth rate is higher than before the structural break.

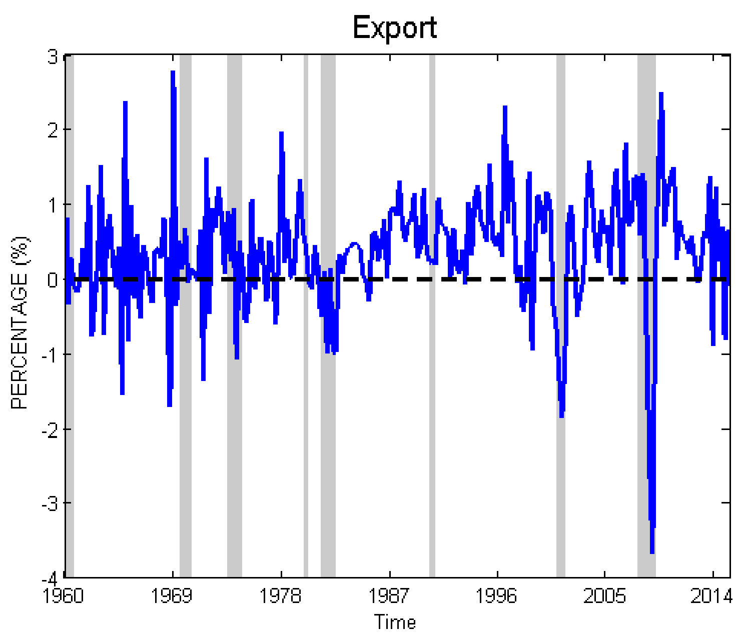
Figure 3.3: Contributions to Percentage Change in GDP by the Expenditure Method



Notes: The component is measured by the expenditure method.

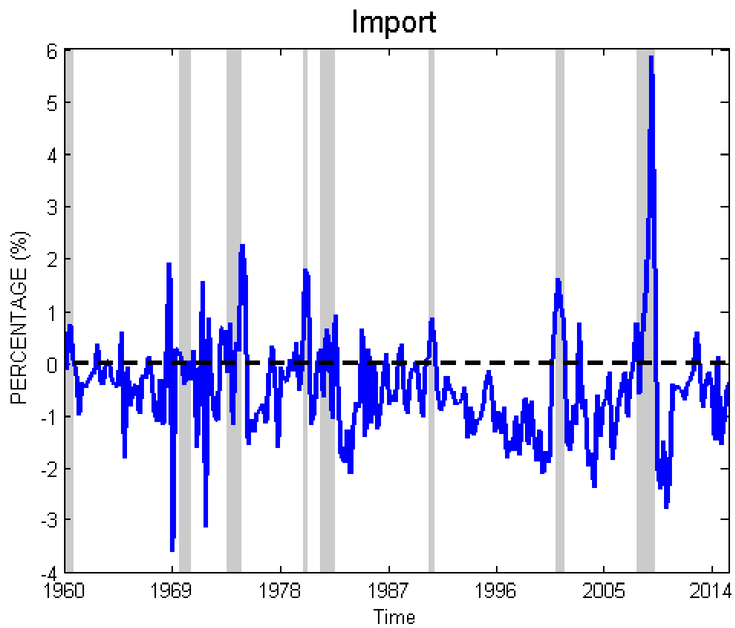
Figure 3.3 Continued





Notes: The component is measured by the expenditure method.

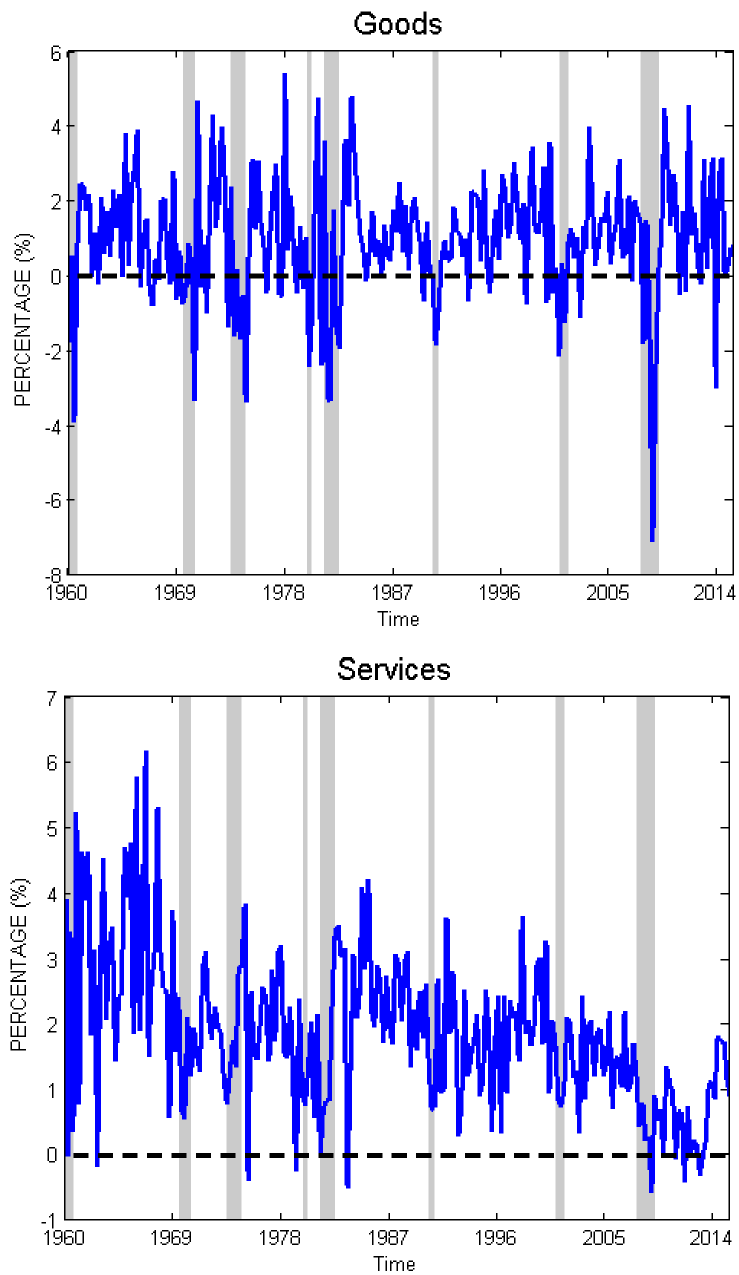
Figure 3.3 Continued



Notes: The component is measured by the expenditure method.

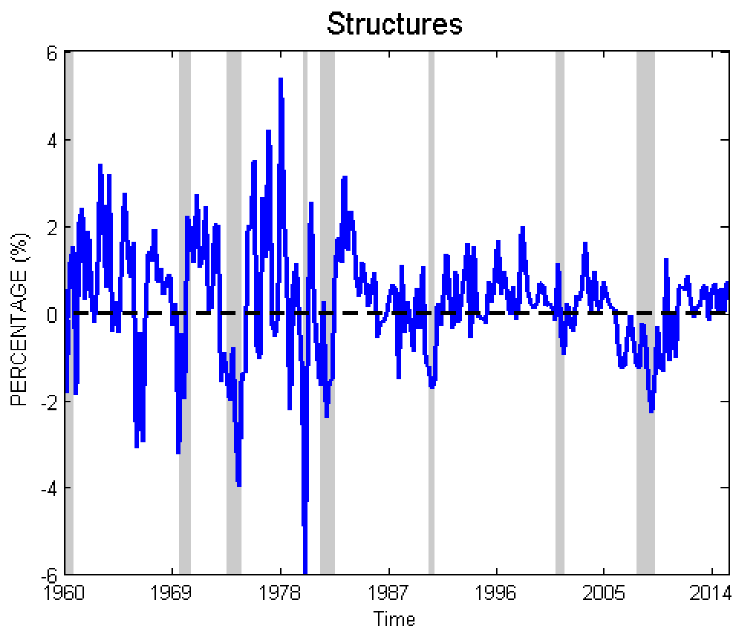
With respect to long-run growth-related variables, the number of total nonfarm employees and real output per hour of all persons are considered. Figures 3.5 and 3.6 show the historical data and growth rates of total nonfarm payrolls and real output per hour of all persons in the nonfarm business sector, respectively. Table 3.8 reports the conditional mean changes of the variables. The null hypothesis that there was no a structural break in the growth rate of total nonfarm employee is not rejected. Although the retirement of baby boomers is increasing, its effect on the size of the labor force was not significant before or during the Great Recession. The null hypotheses of real output per hour of all persons in manufacturing, nonfarm business, and business sectors are not rejected. This result suggests that declines in the number of workers and productivity were not significant before or during the Great Recession. In the case of the productvity, there is a downward trend. But the null is not rejected because the number of observations is not enough to detect

Figure 3.4: Contributions to Percentage Change in GDP by the Production Method



Notes: The component is measured by the production method.

Figure 3.4 Continued



Notes: The component is measured by the production method.

Table 3.6: Contributions to Percentage Change in GDP by the Expenditure Method

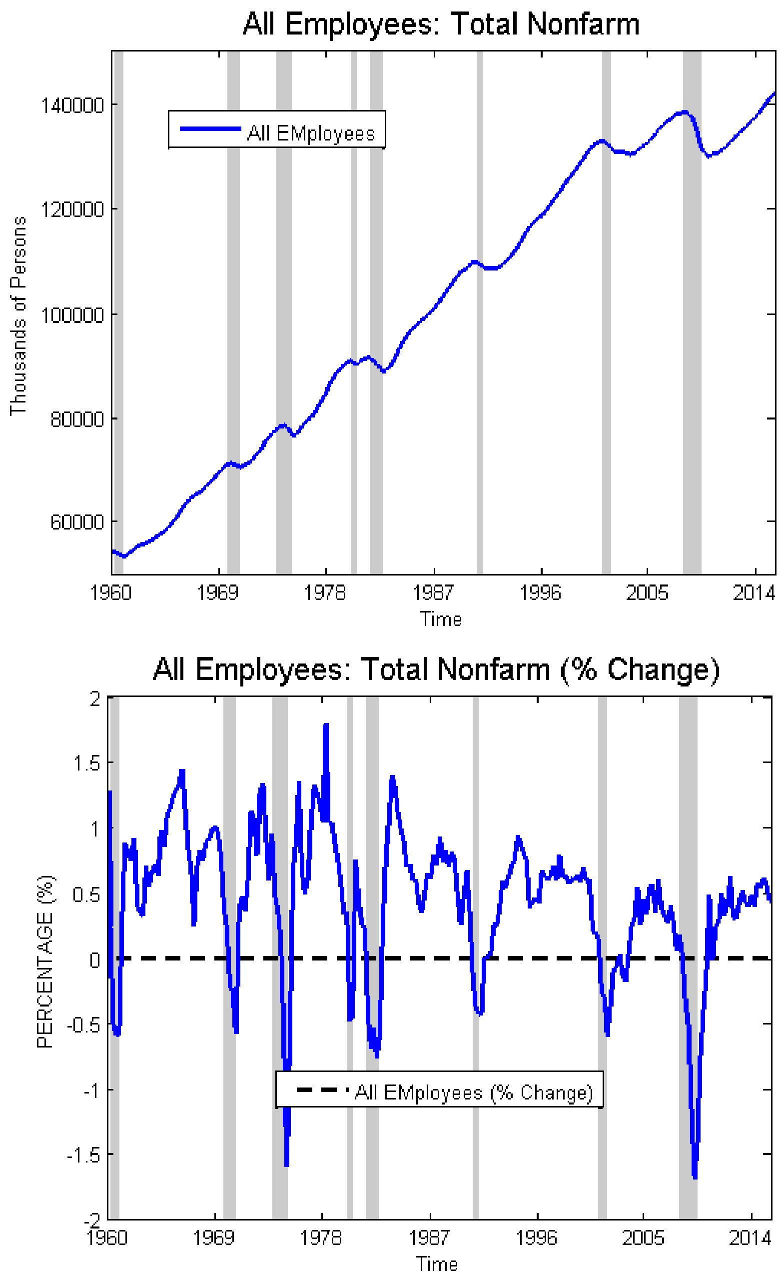
Period	Consumption	Con-Services	Inv.	Gov. Spending	Export	Import
1960Q1-2015Q3	2.06	1.40	0.55	0.50	0.37	-0.47
1960Q1-2007Q3	2.24	1.54	0.62	0.60	0.37	-0.51
Great Recession	-1.02	-0.14	-3.25	0.65	-0.50	1.80
2009Q3-2015Q3	1.51	0.75	1.10	-0.24	0.62	-0.81

Notes: The component is measured by the expenditure method. The Great Recession started in the fourth quarter of 2007 and ended in the second quarter of 2009 by the National Bureau of Economic Research.

a break in it after the Great Recession ended. This implies that the causes of the Great Recession might not be attributable to the changes of the long-run growth variables.

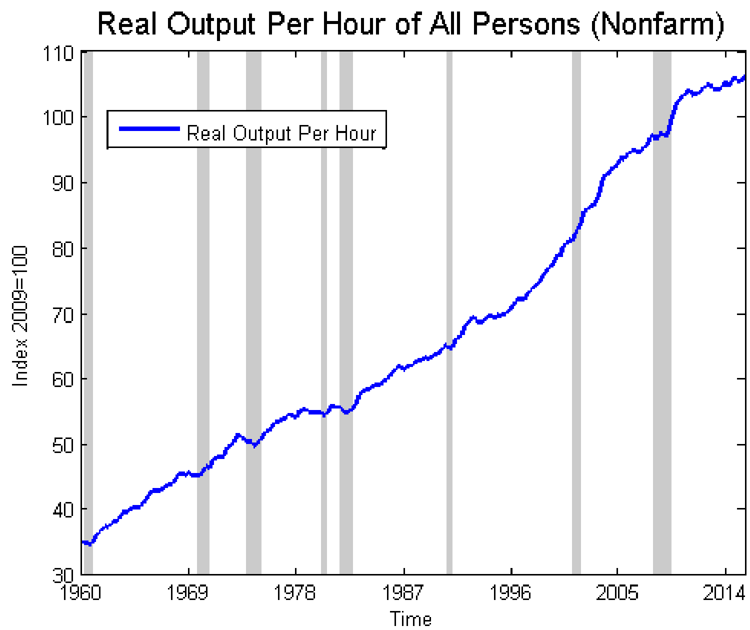
On the other hand, with respect to short-run fluctuation-related variables, or demand-related variables, I examine real disposable income and liabilities of households and non-profit organizations relative to personal disposable income. Figures 3.7 and 3.8 display the historical data and growth rates of the two variables, respectively. The null hypothesis of real disposable personal income is rejected in the third quarter of 2000 at the 5% significance level. This result suggests that consumers' purchasing power declined before the Great Recession began. The result of liabilities of households and nonprofit organizations relative to personal disposable income shows that it increased structurally from the first quarter of 2001, and it declined from the first quarter of 2008. This suggests that financial leveraging by private sectors might contribute the growth of the economy in the early 2000s although the real disposable income declined, and deleveraging by private sectors might contribute the current sluggish economy after the Great Recession happened because of negative wealth effects and stricter screening in financial markets. The null hypothesis of real total liabilities of households and nonprofit organizations is also rejected. Both the growth rate of liabilities and the relative value of liabilities started to decline when the Great Recession approached.

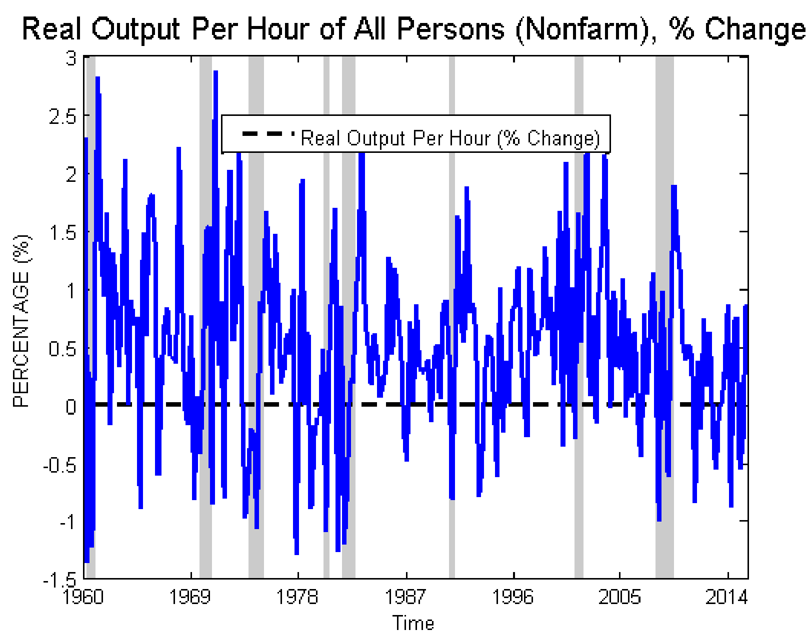
Figure 3.5: All Employees: Total Nonfarm Payrolls



Notes: Shaded areas indicate recessionary period

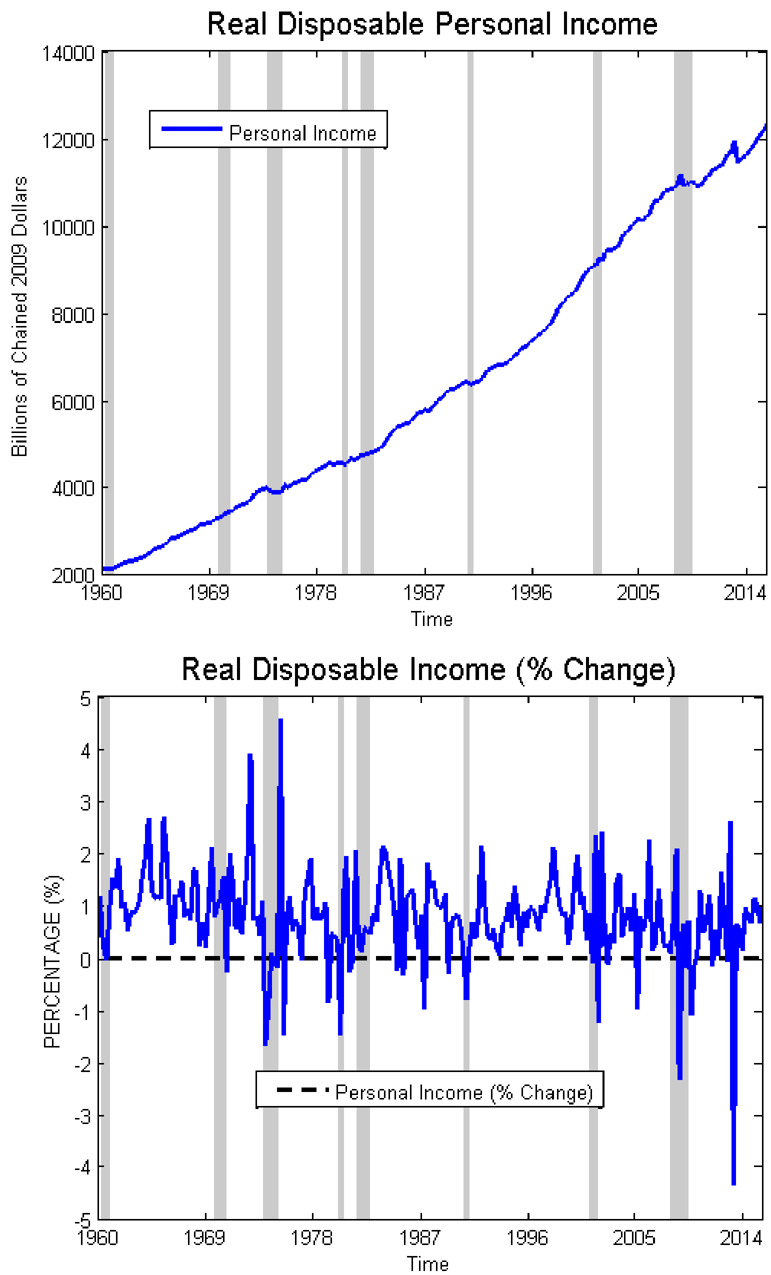
Figure 3.6: Nonfarm Business Sector: Real Output Per Hour of All Persons





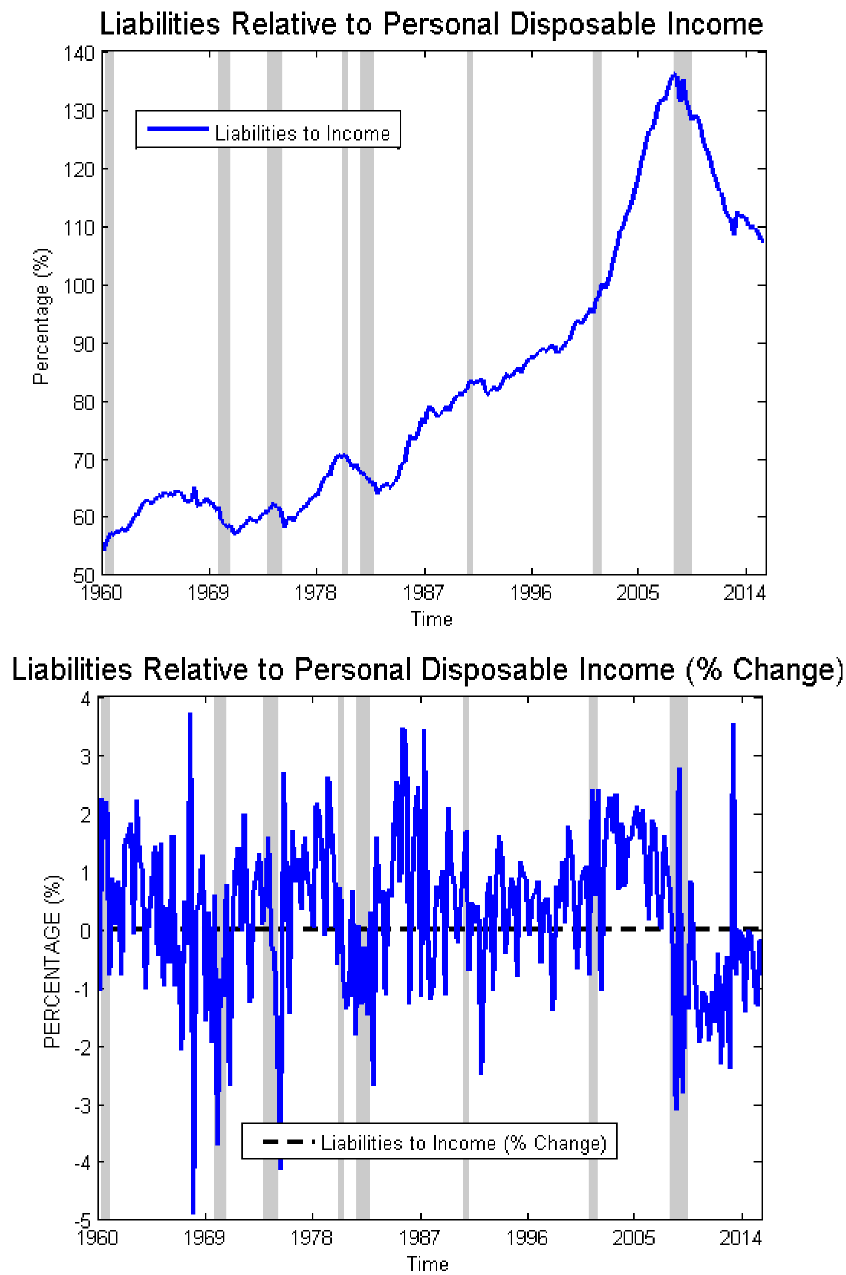
Notes: Shaded areas indicate recessionary period

Figure 3.7: Real Disposable Personal Income



Notes: Shaded areas indicate recessionary period

Figure 3.8: Liabilities of Households and Nonprofit Organizations Relative to Personal Disposable Income



Notes: Shaded areas indicate recessionary period

Table 3.7: Contributions to Percentage Change in GDP by the Production Method

Period	Goods	Services	Structures
1960Q1-2015Q3	0.94	1.84	0.24
1960Q1-2007Q3	0.96	2.04	0.31
Great Recession	-1.42	0.47	-1.28
2009Q3-2015Q3	1.41	0.68	0.13

Notes: The component is measured by the major type of product method. The Great Recession started in the fourth quarter of 2007 and ended in the second quarter of 2009 by the National Bureau of Economic Research.

Table 3.8: Estimated Conditional Means of the Selected Macroeconomic Variables

Series	μ_j	ϕ_j	Break Dates
All Employees (total nonfarm)	0.07	0.82	
Real Output Per Hour of All Persons (manufacturing)	0.32	0.60	
Real Output Per Hour of All Persons (nonfarm)	0.47	0.05	
Real Output Per Hour of All Persons (business)	0.52	0.01	
Real Disposable Personal Income	$0.79, 0.73$	$0.11, -0.37$	2000Q3
Real Total Liabilities of Households and Nonprofit Organizations	$1.15, -0.30$	$0.14, 0.26$	2007Q4
Liabilities Relative to Personal Disposable Income	$0.35, 1.48, -1.13$	$-0.03, -0.17, -0.39$	2001Q1, 2008Q1

Notes: The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$ for $j = 1, 2, 3$.

3.3.3.1 Granger Causality Test

In this section, I implement the Granger Causality test to see the predictive content of the consumption growth for the GDP growth. [4] The Granger causality test is a statistical hypothesis test that the lags of one time series is useful in forecasting a dependent variable. Therefore, the Granger causality test in this section provides information about whether the slow growth of the consumption has a predictive content for the slow growth of GDP. However, the Granger causality does not imply that there is a causality from the regressor to the dependent variable.

To test the null hypothesis that the growth rate of consumption does not Granger-cause the growth rate of GDP, I use an autoregressive distributed lag model with p lags of the growth rate of GDP and q lags of the growth rate of consumption:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \delta_1 x_{t-1} + \delta_2 x_{t-2} + \cdots + \delta_q x_{t-q}, \qquad (3.7)$$

and the null hypothesis is

$$H_0 : \delta_1 = \delta_1 = \cdots = \delta_q = 0, \qquad (3.8)$$

The numbers of lags, p and q, are chosen 4 because I use the quarterly data.[5]

Table 3.9 reports the Granger causality test, and Table 3.10 reports estimated coefficients. The F-statistic of the null hypothesis is 5.37 and p-value is 0.02. Therefore, The null hypothesis is rejected at the 5% significance level. Also, the estimated coefficients imply that the low growth rates of consumption forecast the low growth rates of GDP. Therefore,

[4] I also implement the Granger Causality test to see the predictive content of the government spending growth for the GDP growth. The test result shows that the government spending does not Granger-cause the growth rate of GDP when the number of lags is four(p-value is 0.35), and the growth rate of GDP also does not Granger-cause the government spending growth (p-value is 0.16).

[5] There is no change in the result when the numbers of lags, p and q, are 1.

the declined growth rates of consumption might imply the decline in the growth rate of GDP in the future.

Table 3.9: Granger Causality Test

Null Hypothesis	Obs	F-Statistics	Prob
X does not Granger Cause Y	221	5.37	0.02
Y does not Granger Cause X	221	0.29	0.59

Notes: X denotes the growth rate of consumption, and Y denotes the growth rate of GDP.

Table 3.10: Granger Causality Test-Estimated Coefficients

	Coefficient	Std. Error	t-Statistic	Prob.
β_0	-0.05	0.09	-0.53	0.60
β_1	0.11	0.06	1.96	0.05
β_2	0.08	0.06	1.40	0.16
β_3	-0.07	0.05	-1.31	0.19
β_4	0.05	0.05	1.01	0.32
δ_1	-0.06	0.07	-0.94	0.35
δ_2	0.07	0.07	1.00	0.32
δ_3	0.09	0.07	1.26	0.21
δ_4	0.74	0.07	10.52	0.00

Notes: I use an ADL equation, $y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \delta_1 x_{t-1} + \delta_2 x_{t-2} + \cdots + \delta_q x_{t-q}$ and the null hypothesis is $H_0 : \delta_1 = \delta_2 = \cdots = \delta_q = 0$.

3.4 Robustness Analysis

In this section, I implement robustness checks: one-time structural break tests, different number of lags as determined by the Schwarz Information Criterion, and a simulation method.

3.4.1 One Time Structural Break Tests

I use one-time structural break tests, the approach used by McConnell and Pérez-Quirós (2000). By using the one-time structural break tests when data includes observations from 2000, this section shows whether observing the early 2000s, the Great Recession, and its recovery altered the timing of the Great Moderation.

I implement the one-time structural break tests suggested by Andrews (1993); Andrews and Ploberger (1994), and I use critical values suggested by Hansen (2000). The Sup, Exp, and Ave test statistics provide the date of the break point, which maximizes the test statistics.

Andrews (1993) suggests the function $F_n(T)$ as follows:

$$\sup_{T_1 \leq T \leq T_2} F_n = \text{sup} F_n(T) \tag{4.9}$$

In this test, n is the number of observations, and *T*, which maximizes the $F_n(T)$, is the estimated break point. Andrews and Ploberger (1994) propose two test statistics as follows:

$$\text{exp} F_n = \ln(1/(T_2 - T_1 + 1)) \times \sum_{T=T_1}^{T_2} \text{exp}(\frac{1}{2} \times F_n(T)) \tag{4.10}$$

$$\text{ave}F_n = (1/(T_2 - T_1 + 1)) \times \sum_{T=T_1}^{T_2} F_n(T) \tag{4.11}$$

3.4.1.1 A Structural Break in Mean

Table 3.11 shows the results of the tests. The test shows when a structural break test happens, but it does not provide the timings of both changes in means and volatilties at the same time. Therefore, I consider changes in means and then estimate changes in volatilities using the changes in means. I use a trimming parameter of $\epsilon = 0.10$.

The timing of a break point in a mean is decided by the significance level of less than 5%. I use a break point of the joint stability test following McConnell and Pérez-Quirós (2000). For example, in GDP-consumption, I consider the fourth quarter of 2006, and the date of the individual stability test is close to the date of the Joint test.

The null hypothesis that there was no a structural break in the mean in GDP is not rejected at the 5% significance level, but the null hypothesis of consumption, consumption-services, exports, government spending, production-services, and compensation per hour is rejected at the 5% significance level. However, the timings of the break are different by the variables. The timings of consumption, consumption-services, exports, production-services, and compensation per hour are before the financial crisis, and the timing of the government spending is the second quarter of 2009.

With respect to the means, these results imply that the Great Recession influenced mainly consumption of GDP, especially service industry, and the means of many economic activity measures, such as the production-services, and compensation per hour, already changed before the financial crisis happened.

Table 3.11: One Time Structural Break Tests in Conditional Means

Series	Break Date			Sup			Exp			Ave		
	Joint	μ	ϕ	Joint	μ	ϕ	Joint	μ	ϕ	Joint	μ	ϕ
GDP	2006Q1	2000Q2	2009Q4	8.79(0.18)	8.43(0.07)	6.55(0.15)	2.45(0.11)	2.28(0.04)	0.55(0.42)	3.72(0.09)	3.29(0.03)	0.59(0.60)
Consumption	2006Q4	2006Q4	2009Q2	13.20(0.03)	13.04(0.01)	5.43(0.24)	4.07(0.02)	3.98(0.00)	0.50(0.46)	5.29(0.03)	4.57(0.01)	0.75(0.49)
Consumption–durables	1966Q1	2005Q2	2009Q4	2.75(0.96)	2.19(0.81)	1.84(0.89)	0.48(0.91)	0.30(0.68)	0.23(0.78)	0.84(0.89)	0.51(0.66)	0.41(0.75)
Consumption–nondurables	2006Q4	2006Q4	1999Q4	7.99(0.25)	7.99(0.08)	2.18(0.81)	1.58(0.30)	1.39(0.12)	0.44(0.52)	2.34(0.29)	1.80(0.13)	0.81(0.44)
Consumption–services	2000Q4	2000Q2	2000Q2	23.38(0.00)	23.01(0.00)	9.18(0.05)	9.21(0.00)	8.77(0.00)	2.22(0.04)	13.37(0.00)	11.30(0.00)	3.26(0.03)
Investment (total)	1975Q3	2009Q3	1975Q3	6.68(0.38)	2.59(0.72)	6.63(0.15)	2.07(0.17)	0.24(0.77)	1.88(0.06)	3.79(0.09)	0.39(0.77)	3.41(0.03)
Fixed investment–total	2009Q4	2000Q2	1981Q4	5.59(0.54)	2.42(0.75)	1.95(0.86)	0.93(0.60)	0.35(0.62)	0.52(0.45)	1.65(0.51)	0.59(0.60)	0.96(0.37)
Nonresidential	2009Q4	2000Q2	1994Q1	4.39(0.73)	2.82(0.66)	2.18(0.81)	0.76(0.71)	0.34(0.63)	0.40(0.56)	1.35(0.64)	0.59(0.60)	0.71(0.51)
Residential	2009Q2	2005Q2	1970Q3	4.58(0.70)	1.92(0.87)	4.11(0.42)	0.77(0.70)	0.20(0.84)	0.56(0.41)	1.22(0.70)	0.34(0.82)	0.89(0.40)
Δ (inventory investment)/GDP	1979Q2	1979Q2	2009Q3	10.40(0.10)	9.29(0.04)	2.34(0.77)	3.35(0.04)	2.86(0.02)	0.26(0.74)	5.93(0.02)	4.98(0.01)	0.45(0.72)
Exports	1978Q1	1997Q3	1978Q1	18.20(0.00)	4.06(0.43)	18.19(0.00)	6.99(0.00)	0.62(0.37)	6.94(0.00)	9.52(0.00)	0.90(0.40)	9.27(0.00)
Imports	1983Q1	2006Q1	1983Q1	11.87(0.05)	4.33(0.38)	10.97(0.02)	3.78(0.03)	0.73(0.31)	3.56(0.01)	6.01(0.01)	0.91(0.39)	5.55(0.00)
Government spending	2009Q2	2009Q2	2009Q4	17.90(0.00)	17.45(0.00)	6.10(0.18)	5.27(0.01)	5.07(0.00)	0.86(0.25)	6.04(0.01)	5.65(0.00)	1.02(0.34)
Production												
Goods (total)	1981Q4	1966Q1	1981Q4	4.96(0.64)	1.32(0.98)	4.35(0.38)	0.72(0.73)	0.14(0.95)	0.47(0.49)	1.28(0.67)	0.27(0.90)	0.78(0.47)
Nondurable goods	1974Q4	1973Q1	1974Q4	9.45(0.14)	3.13(0.60)	7.48(0.10)	1.63(0.28)	0.42(0.53)	1.45(0.11)	1.97(0.40)	0.68(0.53)	1.82(0.13)
Durable goods	1972Q1	2007Q4	1972Q1	8.28(0.22)	2.47(0.74)	7.96(0.08)	2.13(0.16)	0.29(0.69)	1.85(0.06)	3.53(0.11)	0.47(0.70)	2.90(0.04)
Services	2000Q4	2000Q4	2001Q1	36.11(0.00)	36.10(0.00)	19.71(0.00)	15.23(0.00)	15.20(0.00)	7.22(0.00)	21.69(0.00)	19.24(0.00)	7.68(0.00)
Structures	1966Q3	2005Q2	2010Q1	6.14(0.46)	3.83(0.46)	3.09(0.61)	1.22(0.44)	0.71(0.32)	0.33(0.64)	1.86(0.43)	1.15(0.29)	0.56(0.62)
Nonagricultural employment	2009Q3	1999Q4	2009Q2	4.68(0.68)	2.81(0.67)	2.54(0.73)	0.72(0.73)	0.55(0.42)	0.15(0.94)	1.29(0.67)	0.98(0.36)	0.26(0.90)
Price inflation (GDP deflator)	1974Q4	1974Q4	1983Q2	4.35(0.74)	3.79(0.47)	3.26(0.57)	0.85(0.64)	0.26(0.73)	0.53(0.44)	1.52(0.57)	0.41(0.76)	0.97(0.36)
90-day T-bill rate	1985Q1	1980Q1	1985Q1	11.79(0.06)	3.37(0.55)	11.76(0.01)	3.78(0.03)	0.41(0.55)	3.74(0.00)	4.81(0.04)	0.67(0.54)	4.38(0.01)
10-year T-bond rate	1981Q3	1981Q3	2001Q1	9.21(0.16)	8.78(0.06)	1.45(0.96)	1.56(0.30)	1.26(0.14)	0.13(0.98)	1.77(0.47)	1.40(0.21)	0.24(0.93)

Notes: I test the one time structural break tests based on Andrews (1993) and Andrews and Ploberger (1994). The model is $y_t = \mu + \phi y_{t-1} + \varepsilon$. "Sup," "Exp", and "Ave" indicate the supremum, exponential, and average test statistics. The values in parentheses are p-values.

3.4.1.2 A Structural Break in Volatility

In this section, I implement one time structural break tests. The equation for the tests are as follows:

$$y_t = \mu + \rho y_{t-1} + \epsilon_t \tag{4.12}$$

$$\sqrt{\frac{\pi}{2}}|\hat{\epsilon}_t| = \alpha_1 D_{1t} + \alpha_2 D_{2t} + u_t \tag{4.13}$$

$$D_{1t} = \left\{ \begin{array}{c} 1 \text{ if } t \leq T \\ 0 \text{ if } t > T \end{array} \right\}$$

$$D_{2t} = \left\{ \begin{array}{c} 0 \text{ if } t \leq T \\ 1 \text{ if } t > T \end{array} \right\}$$

The test for a break is a test of the null hypothesis of $\alpha_1 = \alpha_2$. When ε_t follows a normal distribution, $\sqrt{\frac{\pi}{2}}|\hat{\varepsilon}_t|$ is an unbiased estimator of the standard deviation of ε because of the half-normal distribution, and it can be expressed as follows: $\sqrt{\frac{\pi}{2}}|\hat{\varepsilon}_t| = \alpha + \epsilon_t$. The one-time structural break test statistics suggested by Andrews (1993); Andrews and Ploberger (1994), and critical values in Hansen (2000) are used.

Table 3.12 displays the test results of the selected macroeconomic time series. The test results confirm the decline of the conditional volatilities in the various macroeconomic variables when the Great Recession's observations are included. However, the timings of a break date are delayed due to the Great Recession in consumptions, the share of inventory changes in GDP, exports, and 90-day T-bill rate. Therefore, the Great Recession did not structurally increase the volatilities of various macroeconomic variables.

However, there are mean changes in the macroeconomic variables in the previous section. Therefore, I implement tests for a break in the volatility of the variables using the identified conditional mean changes, which are shown in the previous section. For a mean change, I estimate:

$$y_t = \mu_1 D_1 + \mu_t D_2 + \phi_1 y_{t-1} D_1 + \phi_2 y_{t-1} D_2 + \varepsilon_t \tag{4.14}$$

$$D_{1t} = \left\{ \begin{array}{c} 1 \text{ if } t \leq \kappa \\ 0 \text{ if } t > \kappa \end{array} \right\}$$

$$D_{2t} = \left\{ \begin{array}{c} 0 \text{ if } t \leq \kappa \\ 1 \text{ if } t > \kappa \end{array} \right\}$$

where D_1 and D_2 are dummy variables. I use this equation from McConnell and Pérez-Quirós (2000). I consider a Joint break in the constant and the AR coefficient.

Table 3.13 shows the results of the one time structural break tests in volatility using the identified break in means. It also shows that the Great Recession did not increase the volatilities structurally. The Great Recession delayed a one time break date of several macroeconomic variables, such as consumption-durables, consumption-nondurables, etc, of which break dates were earlier before the Great Recession happened.

The one-time structural break tests show that the volatilities of macroeconomic variables increased temporarily at the beginning of the Great Recession, but the growth rates of several macroeconomic variables declined structurally.

Table 3.12: One Time Structural Break Tests in Conditional Volatilities

Series	Break Date	Sup	Exp	Ave
GDP	1984Q2	10.47(0.04)	2.94(0.02)	3.87(0.01)
Consumption	2010Q1	8.76(0.10)	2.42(0.03)	3.56(0.02)
Consumption–durables	2009Q4	19.76(0.00)	5.18(0.00)	3.68(0.01)
Consumption–nondurables	2009Q2	4.91(0.47)	0.67(0.38)	1.02(0.35)
Consumption–services	1987Q1	3.65(0.70)	0.76(0.33)	1.13(0.29)
Investment (total)	1984Q1	7.21(0.19)	1.91(0.06)	2.76(0.04)
Fixed investment–total	1983Q4	3.84(0.67)	0.61(0.43)	0.93(0.39)
Nonresidential	1966Q4	1.23(1.00)	0.13(1.00)	0.24(0.98)
Residential	1983Q3	7.51(0.17)	1.59(0.09)	1.97(0.10)
Δ (inventory investment)/GDP	2010Q1	9.57(0.07)	2.12(0.05)	2.81(0.04)
Exports	2009Q4	13.67(0.01)	4.54(0.00)	7.53(0.00)
Imports	1991Q2	11.21(0.03)	4.06(0.00)	5.84(0.00)
Government spending	1967Q2	3.54(0.73)	1.06(0.20)	1.97(0.10)
Production				
Goods (total)	1984Q1	7.17(0.20)	1.45(0.11)	1.72(0.13)
Nondurable goods	1971Q1	5.06(0.45)	0.71(0.36)	0.95(0.38)
Durable goods	1985Q1	9.02(0.09)	2.89(0.02)	4.69(0.00)
Services	1985Q3	5.77(0.34)	1.77(0.07)	2.93(0.03)
Structures	1984Q2	4.97(0.46)	0.94(0.24)	1.35(0.22)
Nonagricultural employment	2010Q1	6.75(0.23)	1.04(0.21)	1.40(0.20)
Price inflation (GDP deflator)	1985Q2	6.09(0.30)	1.30(0.14)	1.80(0.12)
90-day T-bill rate	2009Q3	29.91(0.00)	10.94(0.00)	5.70(0.00)
10-year T-bond rate	1965Q4	33.43(0.00)	12.09(0.00)	4.22(0.01)

Notes: I test the one time structural break tests based on Andrews (1993) and Andrews and Ploberger (1994). The model is $y_t = \mu + \phi y_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma_t^2)$ where $\sigma_t^2 = \sigma_1^2$ if $t \leq T$ and $\sigma_t^2 = \sigma_2^2$ if $t > T$."Sup," "Exp", and "Ave" indicate the supremum, exponential, and average test statistics. The values in parentheses are p-values.

Table 3.13: One Time Structural Break Tests in Conditional Volatilities Using an Identified Break in Conditional Means

Series	Break Date	Sup	Exp	Ave
GDP	1984Q2	10.47(0.04)	2.94(0.02)	3.87(0.01)
Consumption	1992Q1	10.74(0.04)	3.23(0.01)	4.52(0.00)
Consumption–durables	2009Q4	19.76(0.00)	5.18(0.00)	3.68(0.01)
Consumption–nondurables	2009Q2	4.91(0.47)	0.67(0.38)	1.02(0.35)
Consumption–services	2000Q3	30.10(0.00)	9.89(0.00)	2.38(0.06)
Investment (total)	1984Q1	7.21(0.19)	1.91(0.06)	2.76(0.04)
Fixed investment–total	1983Q4	3.84(0.67)	0.61(0.43)	0.93(0.39)
Nonresidential	1966Q4	1.23(1.00)	0.13(1.00)	0.24(0.98)
Residential	1983Q3	7.51(0.17)	1.59(0.09)	1.97(0.10)
Δ (inventory investment)/GDP	2010Q1	9.57(0.07)	2.12(0.05)	2.81(0.04)
Exports	2010Q1	31.43(0.00)	11.09(0.00)	11.48(0.00)
Imports	1991Q2	11.21(0.03)	4.06(0.00)	5.84(0.00)
Government spending	2009Q1	8.46(0.11)	2.14(0.05)	3.62(0.01)
Production				
Goods (total)	1984Q1	7.17(0.20)	1.45(0.11)	1.72(0.13)
Nondurable goods	1971Q1	5.06(0.45)	0.71(0.36)	0.95(0.38)
Durable goods	1985Q1	9.02(0.09)	2.89(0.02)	4.69(0.00)
Services	2000Q3	18.63(0.00)	4.21(0.00)	3.13(0.03)
Structures	1984Q2	4.97(0.46)	0.94(0.24)	1.35(0.22)
Nonagricultural employment	2010Q1	6.75(0.23)	1.04(0.21)	1.40(0.20)
Price inflation (GDP deflator)	1985Q2	6.09(0.30)	1.30(0.14)	1.80(0.12)
90-day T-bill rate	2009Q3	29.91(0.00)	10.94(0.00)	5.70(0.00)
10-year T-bond rate	1965Q4	33.43(0.00)	12.09(0.00)	4.22(0.01)

Notes: I test the one time structural break tests based on Andrews (1993) and Andrews and Ploberger (1994). The model is $y_t = \mu_j + \phi_j y_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma_t^2)$ where $\mu_j = \mu_1$ and $\phi_j = \phi_1$if $t \leq \kappa$ and $\mu_j = \mu_2$ and $\phi_j = \phi_2$ if $t > \kappa$ and $\sigma_t^2 = \sigma_1^2$ if $t \leq T$ and $\sigma_t^2 = \sigma_2^2$ if $t > T$. κ is chosen by the Joint test. “Sup,” “Exp”, and “Ave” indicate the supremum, exponential, and average test statistics. The values in parentheses are p-values.

3.4.2 Different Number of Lags: The Schwarz Information Criterion (SIC)

In this section, I use the Schwarz Information Criterion (SIC) to decide the number of lags, and I consider GDP and the five main components of GDP, consumption, investment, government spending, and net exports (exports and imports). The lag orders are selected by the SIC from the ranges $1 \leq p \leq 4$. Among those variables, the number of lags in investment, exports, and imports are one as determined by the SIC. Therefore, I reestimate the structural breaks in GDP, consumption, and government spending in this section.

Tables 3.14 and 3.15 show the structural break tests on the conditional means and volatilities of the variables, respectively, and Table 3.16 shows the estimated conditional volatilities. The results are consistent with the previous results. The null hypothesis that there was no structural break in the conditional means is not rejected, but the null hypothesis that there was no structural break in the conditional volatilities is rejected only during the period of the Great Moderation. Therefore, this evidence also shows that the increased volatility in the economy during the Great Recession was temporary, and the Great Moderation has not ended because the conditional volatilities of the variables have declined since the end of the Great Recession.

In the previous section, the model specification is the AR (1) in consumption, and there was a structural break before the Great Recession happened. In this section, however, it is the AR (2), and there was no structural break in consumption when I used the SIC lag selection. Therefore, in the case of a structural break test for a conditional mean, a test result might be different depending on a model specification. However, there was no structural break in conditional volatilities of the variables in this section, too. Thus, the results in this section also suggest that the increased volatility during the Great Recession was temporary, and the Great Moderation is not over.

Table 3.14: Multiple Structural Break Tests in Conditional Means of the Components of GDP

Series	SupF(k)			Sup(l+1/l)		UDmax	WDmax	T(SBIC)	T(LWZ)	T(sequential)	Break dates
	k=1	k=2	k=3	l=1	l=2						
GDP	8.5(14.6)	4.39(12.82)	4.43(11.46)	5.08(14.6)	9.69(16.53)	8.5(14.85)	8.5(16.07)	0	0	0	
Consumption	8.59(16.76)	7.21(14.72)	9.59(13.3)	6.55(16.76)	9.56(18.56)	9.59(17)	13(18.38)	0	0	0	
Government spending	5.79(18.68)	13.37(16.5)	16.4(15.07)	9.69(18.68)	11.85(20.57)	16.41(18.91)	22.44(20.3)	0	0	0	

Notes: I test the multiple structural break tests based on Bai and Perron (1998, 2003a,b). The model is $y_t = \mu_j + \phi_{1j} y_{t-1} + \phi_{2j} y_{t-2} + \phi_{3j} y_{t-3} + \phi_{4j} y_{t-4} + \varepsilon_t$ for j=1, 2, 3. The number of lags is decided by the SIC. The number of lags in GDP, consumption, and government spending is 2, 3, and 4, respectively. The values in parentheses are the critical values at the 5% significance level. The break dates are calculated from the strategy suggested by Bai and Perron (2003a).

Table 3.15: Multiple Structural Break Tests in Conditional Volatilities of the Components of GDP

Series	ICSS algorithm		Bai-Perron
	$IT(\kappa_1)$	$IT(\kappa_2)$	
GDP	1983Q2	1983Q2	1984Q1
Consumption	1992Q1	1983Q2	1992Q1
Government spending	1986Q4	1967Q2, 1989Q2	1967Q2, 2001Q4

Notes: The model is $y_t = \mu_j + \phi_{1j}y_{t-1} + \phi_{2j}y_{t-2} + \phi_{3j}y_{t-3} + \phi_{4j}y_{t-4} + \varepsilon_t$, $j = 1, 2, 3$, $\varepsilon_t \sim N(0, \sigma^2_{j'})$, $j' = 1, 2, 3$. The number of lags is decided by the SIC. The number of lags in GDP, consumption, and government spending is 2, 3, and 4, respectively. Bai-Perron indicates the multiple structural break tests (Bai and Perron, 1998, 2003a,b). For IT tests, I use the quadratic spectral window with automatic bandwidth selection.

Table 3.16: Estimated Conditional Volatilities of the Components of GDP

Series	IT(κ_1)		IT(κ_2)		Bai-Perron	
	ε_t^2	Break Dates	ε_t^2	Break Dates	ε_t^2	Break Dates
GDP	$1.01, 0.53$	1983Q2	$1.02, 0.55$	1984Q1	$1.02, 0.55$	1984Q1
Consumption	$0.74, 0.38$	1992Q1	$0.78, 0.45$	1983Q2	$0.74, 0.38$	1992Q1
Government spending	$1.09, 0.69$	1986Q4	$1.44, 0.93, 0.68$	1967Q2, 1989Q2	$1.44, 0.87, 0.58$	1967Q2, 2001Q4

Notes: The model is $y_t = \mu_j + \phi_{1j}y_{t-1} + \phi_{2j}y_{t-2} + \phi_{3j}y_{t-3} + \phi_{4j}y_{t-4} + \varepsilon_t$, $j = 1, 2, 3$, $\varepsilon_t \sim N(0, \sigma^2_{j'})$, $j' = 1, 2, 3$. The number of lags is decided by the SIC. The number of lags in GDP, consumption, and government spending is 2, 3, and 4, respectively

3.4.3 Simulating the Recent Economy for the Structural Break Test

The data set includes a small number of observations from after the Great Recession began in the fourth quarter of 2008 according to the NBER business cycle date. Because it has only been a few years since the end of the recession, the number of observations during and after the Great Recession is only twenty-seven. In this section, I use the simulation method suggested by Gadea Rivas et al. (2014) to address this issue by simulating the duration of the Great Recession and its recovery. I consider the GDP data series, use the AR (1) model, and implement the multiple structural break tests on the conditional mean and variance of the GDP data.

I use the stationary bootstrap method proposed by Politis and Romano (1994). In the procedure, a pseudo-time series is generated by resampling blocks that have different lengths that follow a geometric distribution.[6] The first simulation combines the observations of the Great Recession and its recovery, and the second simulation only uses the observations of the recovery. I lengthen both cases by 5 years and 10 years.

In the first scenario where I enlarge the simulation by 5 years using the observations of the Great Recession and its recovery, the null hypothesis that there was no a structural break is rejected about 72.9% of the simulated growth rates of GDP in, most often, the first quarter of 2006. The results of the structural break tests in the volatility were the same as in the previous section. There was only one break around 1984 in almost all simulations.

In the second scenario where I only use the observations of the recovery, the null hypothesis that there was no structural break of about 10.7% in the growth rates of GDP is rejected. The timing of most breaks was also the first quarter of 2006. The results of the structural break tests in the volatility also show that there was a structural break around 1984 in most simulations.

When I enlarge the length of both cases by 10 years, the null hypothesis that there was no structural break in the growth rate is rejected at the 5% significance level in most simulations of both cases . The timing of the break in the first scenario was around 2006, and the timing of the break in the second scenario was around 2000. However, both scenarios also display that there was a structural break in the volatility of the economy around 1984.[7]

[6] I use 0.06 for the probability of the geometric distribution so that the average is 16 quaters, the average duration of expansions following Gadea Rivas et al. (2014). I run 10,000 iterations.

[7] When I used the AR (2) instead of the AR (1), the null hypothesis that there was no structural break of the growth rate of GDP is rejected about 6.7% and 49% by 5 years and 10 years, respectively, in the first scenario. The null hypothesis is rejected about 5.2% and 32% by 5 years and 10 years, respectively, in the second scenario. However, the test detects a structural break in the volatility only around 1984 in most of both cases. With respect to consumption in the AR (1) model, the null hypothesis of most simulated conditional means is rejected around the start of the Great Recession, and the null hypothesis of most simulated conditional volatilities is rejected in the early 1990s.

The two simulation scenarios suggest that the Great Recession and its recovery could influence the growth rates of GDP if the current sluggish economy continues or another financial crisis happens, but the Great Moderation is not over.

4. SUMMARY AND CONCLUSIONS

In the first essay, I evaluated the local forecasting performances of financial variables and financial condition measures for output growth and inflation before, during, and after the Great Recession. The empirical evidence suggests that financial condition measures had the predictive content for output growth and inflation change during the Great Recession.

Compared to previous recessionary periods, financial market condition measures became important indicators for the economy during the Great Recession. For example, the credit spread and stock price forecasted output and inflation better than the benchmark model during the Great Recession. Also playing an important role during the financial crisis were market confidence measures. These results suggest that the Great Recession was primarily driven by a financial shock, which is unlike those of previous recessions, which were usually supply or monetary policy shocks (Ng and Wright, 2013). Also, the results are consistent with the idea that the financial condition is important in the business cycle (Bernanke et al., 1999; Gilchrist and Zakrajšek, 2012). Finally, a real-time forecaster was able to predict output growth using real-time data. Therefore, the real-time data analysis was consistent with the latest available data analysis during the Great Recession.

Whether the predictive ability of the credit spread, stock price, and market sentiment measures will increase in future recessions depends on the kind of shock and the type of recession in the economy. However, the extremely low short-term interest rate and zero lower bound constraint could occur again in the coming years due to the sluggish economy and recent low interest rate trends. Therefore, the unconventional monetary policy may be considered more often in the future to deal with a recession. In this situation, financial condition measures might be useful indicators for investors and central bankers, and it is important that financial market conditions are not exacerbated by an economic shock to prevent a serious recession.

In the second essay, I investigated the characterization of the U.S. business cycle, focusing on the Great Recession. I implemented the multiple structural break tests on the conditional means and the volatilities of the various macroeconomic variables in a reduced model to find any changes in the variables around the Great Recession.

This study shows that the increase of the volatility in the economy during the Great Recession was temporary, and the low volatility of the economy is still present today. Therefore, the Great Moderation still holds in the U.S. business cycle. Also, there was no structural break in the growth rate of GDP, but there was a structural break before or during the Great Recession in the growth rates of consumption, consumption-services, and production-services, which compose major parts of the economy, and there was also a structural break in real disposable income and liabilities of consumers, which are associated with consumption and demand. Therefore, the recent sluggish economy might be related with the low volatility of the economy and the recent low growth rates in consumption. Finally, the empirical evidence casts doubt on the effectiveness of active monetary policy for sustaining a stable economy beyond the short-run, which many policy makers and researchers supported during the Great Moderation.

The multiple structural break tests in this study cannot detect changes after the Great Recession ended because the number of observations after the Great Recession ended is small. Therefore, the detected structural breaks cannot be directly accountable for the recent sluggish economy. However, the simulation result suggests that a structural break in the growth rate of GDP might have occurred before the Great Recession if the recent sluggish economy continues, and there was no structural break in the volatility around the Great Recession. Therefore, policy for improving the economy, especially consumption, might be necessary to avoid a structural decline in the growth rate of the economy.

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APPENDIX A

DATA DESCRIPTION OF THE SECOND ESSAY

The data was obtained from FRED-QD at the Federal Reserve Bank of St. Louis. The transformation codes (TCODE) are as follows: (1) no transformation; (2) Δx_t; (3) $\Delta^2 x_t$; (4) $log(x_t)$; (5) $\Delta log(x_t)$; (6) $\Delta^2 log(x_t)$; and (7) $\Delta(x_t/x_{t-1} - 1.0)$.

Table A.1: Group 1. NIPA

Number	TCODE	FRED MNEMONIC	Description
1	5	GDPC96	Real Gross Domestic Product (Billions of Chained 2009 Dollars)
2	5	PCECC96	Real Personal Consumption Expenditures (Billions of Chained 2009 Dollars)
3	5	PCDGx	Real personal consumption expenditures: Durable goods (Billions of Chained 2009 Dollars)
4	5	PCESVx	Real Personal Consumption Expenditures: Services (Billions of Chained 2009 Dollars)
5	5	PCNDx	Real Personal Consumption Expenditures: Nondurable Goods (Billions of Chained 2009 Dollars)
6	5	GPDIC96	Real Gross Private Domestic Investment, (Billions of Chained 2009 Dollars)
7	5	FPIx	Real private Fixed investment (Billions of Chained 2009 Dollars)
8	5	Y033RC1Q027SBEAx	Real Gross Private Domestic Investment: Fixed Investment: Nonresidential: Equipment (Billions of Chained 2009 Dollars)
9	5	PNFIx	Real private Fixed investment: Nonresidential (Billions of Chained 2009 Dollars)
10	5	PRFIx	Real private Fixed investment: Residential (Billions of Chained 2009 Dollars)

Table A.1 Continued

Number	TCODE	FRED MNEMONIC	Description
11	1	A014RE1Q156NBEA	Shares of gross domestic product: Gross private domestic investment: Change in private inventories (Billions of Chained 2009 Dollars)
12	5	GCEC96	Real Government Consumption Expenditures & Gross Investment (Billions of Chained 2009 Dollars)
13	1	A823RL1Q225SBEA	Real Government Consumption Expenditures and Gross Investment: Federal (Percent Change from Preceding Period)
14	5	FGRECPTx	Gov Receipts Real Federal Government Current Receipts (Billions of Chained 2009 Dollars)
15	5	SLCEx	Real government state and local consumption expenditures (Billions of Chained 2009 Dollars)
16	5	EXPGSC96	Real Exports of Goods & Services, (Billions of Chained 2009 Dollars)
17	5	IMPGSC96	Real Imports of Goods & Services, (Billions of Chained 2009 Dollars)
18	5	DPIC96	Real Disposable Personal Income (Billions of Chained 2009 Dollars)
19	5	OUTNFB	Nonfarm Business Sector: Real Output (Index 2009=100)
20	5	OUTBS	Business Sector: Real Output (Index 2009=100)

Table A.1 Continued

Number	TCODE	FRED MNEMONIC	Description
21	5	OUTMS	Manufacturing Sector: Real Output (Index 2009=100)
22	2	B020RE1Q156NBEA	Shares of gross domestic product: Exports of goods and services (Percent)
23	2	B021RE1Q156NBEA	Shares of gross domestic product: Imports of goods and services (Percent)
24	5	A353RX1Q020SBEA	Real gross domestic product: Goods, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate
25	5	A334RA3Q086SBEA	Real gross domestic product: Nondurable goods: Final sales (chain-type quantity index), Index 2009=100, Quarterly, Seasonally Adjusted
26	5	A354RA3Q086SBEA	Real gross domestic product: Durable goods (chain-type quantity index), Index 2009=100, Quarterly, Seasonally Adjusted
27	5	A341RX1Q020SBEA	Real gross domestic product: Services, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate
28	5	A755RX1Q020SBEA	Real gross domestic product: Structures, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted Annual Rate

Table A.2: Group 2. Industrial Production

Number	TCODE	FRED MNEMONIC	Description
29	5	INDPRO	Industrial Production Index (Index 2012=100)
30	5	IPFINAL	Industrial Production: Final Products (Market Group) (Index 2012=100)
31	5	IPCONGD	Industrial Production: Consumer Goods (Index 2012=100)
32	5	IPMAT	Industrial Production: Materials (Index 2012=100)
33	5	IPDMAT	Industrial Production: Durable Materials (Index 2012=100)
34	5	IPNMAT	Industrial Production: Nondurable Materials (Index 2012=100)
35	5	IPDCONGD	Industrial Production: Durable Consumer Goods (Index 2012=100)
36	5	IPB51110SQ	Industrial Production: Durable Goods: Automotive products (Index 2012=100)
37	5	IPNCONGD	Industrial Production: Nondurable Consumer Goods (Index 2012=100)
38	5	IPBUSEQ	Industrial Production: Business Equipment (Index 2012=100)

Table A.2 Continued

Number	TCODE	FRED MNEMONIC	Description
39	5	IPB51220SQ	Industrial Production: Consumer energy products (Index 2012=100)
40	1	TCU	Capacity Utilization: Total Industry (Percent of Capacity)
41	1	CUMFNS	Capacity Utilization: Manufacturing (SIC) (Percent of Capacity)
42	5	IPMANSICS	Industrial Production: Manufacturing (SIC) (Index 2012=100)
43	5	IPB51222S	Industrial Production: Residential Utilities (Index 2012=100)
44	5	IPFUELS	Industrial Production: Fuels (Index 2012=100)
45	1	NAPMPI	IMS Manufacturing: Production Index
46	1	NAPM	IMS Manufacturing: PMI Composite Index

Table A.3: Group 3. Employment and Unemployment

Number	TCODE	FRED MNEMONIC	Description
47	5	PAYEMS	All Employees: Total nonfarm (Thousands of Persons)
48	5	USPRIV	All Employees: Total Private Industries (Thousands of Persons)
49	5	MANEMP	All Employees: Manufacturing (Thousands of Persons)
50	5	SRVPRD	All Employees: Service-Providing Industries (Thousands of Persons)
51	5	USGOOD	All Employees: Goods-Producing Industries (Thousands of Persons)
52	5	DMANEMP	All Employees: Durable goods (Thousands of Persons)
53	5	NDMANEMP	All Employees: Nondurable goods (Thousands of Persons)
54	5	USCONS	All Employees: Construction (Thousands of Persons)
55	5	USEHS	All Employees: Education & Health Services (Thousands of Persons)
56	5	USFIRE	All Employees: Financial Activities (Thousands of Persons)

Table A.3 Continued

Number	TCODE	FRED MNEMONIC	Description
57	5	USINFO	All Employees: Information Services (Thousands of Persons)
58	5	USPBS	All Employees: Professional & Business Services (Thousands of Persons)
59	5	USLAH	All Employees: Leisure & Hospitality (Thousands of Persons)
60	5	USSERV	All Employees: Other Services (Thousands of Persons)
61	5	USMINE	All Employees: Mining and logging (Thousands of Persons)
62	5	USTPU	All Employees: Trade, Transportation & Utilities (Thousands of Persons)
63	5	USGOVT	All Employees: Government (Thousands of Persons)
64	5	USTRADE	All Employees: Retail Trade (Thousands of Persons)
65	5	USWTRADE	All Employees: Wholesale Trade (Thousands of Persons)
66	5	CES9091000001	All Employees: Government: Federal (Thousands of Persons)

Table A.3 Continued

Number	TCODE	FRED MNEMONIC	Description
67	5	CES9092000001	All Employees: Government: State Government (Thousands of Persons)
68	5	CES9093000001	All Employees: Government: Local Government (Thousands of Persons)
69	5	CE16OV	Civilian Employment (Thousands of Persons)
70	2	CIVPART	Civilian Labor Force Participation Rate (Percent)
71	2	UNRATE	Civilian Unemployment Rate (Percent)
72	2	UNRATESTx	Unemployment Rate less than 27 weeks (Percent)
73	2	UNRATELTx	Unemployment Rate for more than 27 weeks (Percent)
74	2	LNS14000012	Unemployment Rate - 16 to 19 years (Percent)
75	2	LNS14000025	Unemployment Rate - 20 years and over, Men (Percent)
76	2	LNS14000026	Unemployment Rate - 20 years and over, Women (Percent)

Table A.3 Continued

Number	TCODE	FRED MNEMONIC	Description
77	5	UEMPLT5	Number of Civilians Unemployed - Less Than 5 Weeks (Thousands of Persons)
78	5	UEMP5TO14	Number of Civilians Unemployed for 5 to 14 Weeks (Thousands of Persons)
79	5	UEMP15T26	Number of Civilians Unemployed for 15 to 26 Weeks (Thousands of Persons)
80	5	UEMP27OV	Number of Civilians Unemployed for 27 Weeks and Over (Thousands of Persons)
81	5	LNS13023621	Unemployment Level - Job Losers (Thousands of Persons)
82	5	LNS13023557	Unemployment Level - Reentrants to Labor Force (Thousands of Persons)
83	5	LNS13023705	Unemployment Level - Job Leavers (Thousands of Persons)
84	5	LNS13023569	Unemployment Level - New Entrants (Thousands of Persons)
85	5	LNS12032194	Employment Level - Part-Time for Economic Reasons, All Industries (Thousands of Persons)
86	5	HOABS	Business Sector: Hours of All Persons (Index 2009=100)

Table A.3 Continued

Number	TCODE	FRED MNEMONIC	Description
87	5	HOAMS	Manufacturing Sector: Hours of All Persons (Index 2009=100)
88	5	HOANBS	Nonfarm Business Sector: Hours of All Persons (Index 2009=100)
89	1	AWHMAN	Average Weekly Hours of Production and Nonsupervisory Employees: Manufacturing (Hours)
90	2	AWHNONAG	Average Weekly Hours Of Production And Nonsupervisory Employees: Total private (Hours)
91	2	AWOTMAN	Average Weekly Overtime Hours of Production and Nonsupervisory Employees: Manufacturing (Hours)
92	1	HWIx	Help-Wanted Index
93	2	UEMPMEAN	Average (Mean) Duration of Unemployment (Weeks)
94	2	CES0600000007	Average Weekly Hours of Production and Nonsupervisory Employees: Goods-Producing
95	1	NAPMEI	ISM Manufacturing: Employment Index
96	2	HWIURATIO	Ratio of Help Wanted/No. Unemployed

Table A.4: Group 4. Housing

Number	TCODE	FRED MNEMONIC	Description
97	5	CLAIMSx	Initial Claims
98	5	HOUST	Housing Starts: Total: New Privately Owned Housing Units Started (Thousands of Units)
99	5	HOUST5F	Privately Owned Housing Starts: 5-Unit Structures or More (Thousands of Units)
100	5	PERMIT	New Private Housing Units Authorized by Building Permits (Thousands of Units)
101	5	HOUSTMW	Housing Starts in Midwest Census Region (Thousands of Units)
102	5	HOUSTNE	Housing Starts in Northeast Census Region (Thousands of Units)
103	5	HOUSTS	Housing Starts in South Census Region (Thousands of Units)
104	5	HOUSTW	Housing Starts in West Census Region (Thousands of Units)
105	5	USSTHPI	All-Transactions House Price Index for the United States (Index 1980 Q1=100)
106	5	SPCS10RSA	S&P/Case-Shiller 10-City Composite Home Price Index (Index January 2000=100)

Table A.4 Continued

Number	TCODE	FRED MNEMONIC	Description
107	5	SPCS20RSA	S&P/Case-Shiller 20-City Composite Home Price Index (Index January 2000=100)
108	5	PERMITNE	Private Housing Units Authorized by Building Permits in the Northeast Census Region (Thousands, SAAR)
109	5	PERMITMW	Private Housing Units Authorized by Building Permits in the Midwest Census Region (Thousands, SAAR)
110	5	PERMITS	Private Housing Units Authorized by Building Permits in the South Census Region (Thousands, SAAR)
111	5	PERMITW	Private Housing Units Authorized by Building Permits in the West Census Region (Thousands, SAAR)

Table A.5: Group 5. Inventories, Orders, and Sales

Number	TCODE	FRED MNEMONIC	Description
112	5	CMRMTSPLx	Sales Real Manufacturing and Trade Industries Sales (Millions of Chained 2009 Dollars)
113	5	RSAFSx	Sale Real Retail and Food Services Sales (Millions of Chained 2009 Dollars), deflated by Core PCE
114	5	AMDMNOx	(DurMfg) Real Manufacturers' New Orders: Durable Goods (Millions of 2009 Dollars), delfated by Core PCE
115	5	ACOGNOx	Real Value of Manufacturers' New Orders for Consumer Goods Industries (Millions of 2009 Dollars), delfated by Core PCE
116	5	AMDMUOx	Real Value of Manufacturers' Unfilled Orders for Durable Goods Industries (Millions of 2009 Dollars), delfated by Core PCE
117	5	ANDENOx	Real Value of Manufacturers' New Orders for Capital Goods: Nondefense Capital Goods Industires (Millions of 2009 Dollars), delfated by Core PCE
118	1	NAPMSDI	ISM Manufacturing: Supplier Deliveries Index (lin)
119	5	INVCQRMTSPL	Invent Real Manufacturing and Trade Inventories (Millions of 2009 Dollars)
120	1	NAPMNOI	Manufacturing: New Orders Index
121	1	NAPMII	Manufacturing: Inventories Index
122	5	BUSINVx	Business Inventories (Millions of Dollars)
123	2	ISRATIOx	Business: Inventories to Sales Ratio

Table A.6: Group 6. Prices

Number	TCODE	FRED MNEMONIC	Description
124	6	PCECTPI	Personal Consumption Expenditures: Chain-type Price Index (Index 2009=100)
125	6	PCEPILFE	Personal Consumption Expenditures Excluding Food and Energy (Chain-Type Price Index) (Index 2009=100)
126	6	GDPCTPI	Gross Domestic Product: Chain-type Price Index (Index 2009=100)
127	6	GPDICTPI	Gross Private Domestic Investment: Chain-type Price Index (Index 2009=100)
128	6	IPDBS	Business Sector: Implicit Price Deflator (Index 2009=100)
129	6	DGDSRG3Q086SBEA	Personal consumption expenditure: Goods Personal consumption expenditures: Goods (chain-type price index)
130	6	DDURRG3Q086SBEA	Personal consumption expenditure: Durable Goods Personal consumption expenditures: Durable goods (chain-type price)
131	6	DSERRG3Q086SBEA	Personal consumption expenditure: Service Personal consumption expenditures: Services (chain-type price index)
132	6	DND-GRG3Q086SBEA	Personal consumption expenditures: Nondurable goods (chain-type price index)
133	6	DHCERG3Q086SBEA	Personal consumption expenditures: Services: Household consumption expenditure (chain-type price index)

Table A.6 Continued

Number	TCODE	FRED MNEMONIC	Description
134	6	DMOTRG3Q086SBEA	Personal consumption expenditures: Durable goods: Motor vehicles and parts (chain-type price index)
135	6	DFDHRG3Q086SBEA	Personal consumption expenditures: Durable goods: Furnishings and durable household equipment (chain-type price index)
136	6	DREQRG3Q086SBEA	Personal consumption expenditures: Durable goods: Recreational goods and vehicles (chain-type price index)
137	6	DOD-GRG3Q086SBEA	Personal consumption expenditures: Durable goods: Other durable goods (chain-type price index)
138	6	DFXARG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Food and beverages purchased for off-premises consumption (chain-type price index)
139	6	DCLORG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Clothing and footwear (chain-type price index)
140	6	DGOERG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Gasoline and other energy goods (chain-type price index)
141	6	DON-GRG3Q086SBEA	Personal consumption expenditures: Nondurable goods: Other nondurable goods (chain-type price index)
142	6	DHUTRG3Q086SBEA	Personal consumption expenditures: Services: Housing and utilities (chain-type price index)
143	6	DHLCRG3Q086SBEA	Personal consumption expenditures: Services: Health care (chain-type price index)

Table A.6 Continued

Number	TCODE	FRED MNEMONIC	Description
144	6	DTRSRG3Q086SBEA	Personal consumption expenditures: Transportation services (chain-type price index)
145	6	DRCARG3Q086SBEA	Personal consumption expenditures: Recreation services (chain-type price index)
146	6	DFSARG3Q086SBEA	Personal consumption expenditures: Services: Food services and accommodations (chain-type price index)
147	6	DIFSRG3Q086SBEA	Personal consumption expenditures: Financial services and insurance (chain-type price index)
148	6	DOTSRG3Q086SBEA	Personal consumption expenditures: Other services (chain-type price index)
149	6	CPIAUCSL	Consumer Price Index for All Urban Consumers: All Items (Index 1982-84=100)
150	6	CPILFESL	Consumer Price Index for All Urban Consumers: All Items Less Food & Energy (Index 1982-84=100)
151	6	PPIFGS	Producer Price Index by Commodity for Finished Goods (Index 1982=100)
152	6	PPIACO	Producer Price Index for All Commodities (Index 1982=100)
153	6	PPIFCG	Producer Price Index by Commodity for Finished Consumer Goods (Index 1982=100)

Table A.6 Continued

Number	TCODE	FRED MNEMONIC	Description
154	6	PPIFCF	Producer Price Index by Commodity for Finished Consumer Foods (Index 1982=100)
155	6	PPIIDC	Producer Price Index by Commodity Industrial Commodities (Index 1982=100)
156	6	PPIITM	Producer Price Index by Commodity Intermediate Materials: Supplies & Components (Index 1982=100)
157	1	NAPMPRI	ISM Manufacturing: Prices Index (Index)
158	5	WPU0531	Producer Price Index by Commodity for Fuels and Related Products and Power : Natural Gas (Index 1982=100)
159	5	WPU0561	Price:Oil Producer Price Index by Commodity for Fuels and Related Products and Crude Petroleum (Domestic Production) (Index 1982=100)
160	5	OILPRICEx	Crudeoil Price Real Crude Oil Prices: West Texas Intermediate (WTI) - Cushing, Oklahoma (2009 Dollars per Barrel), deflated by Core PCE
161	6	PPICRM	Price Index: Crude Materials for Further Processing (Index 1982=100)
162	6	PPICMM	Price Index: Commodities: Metals and metal products: Primary nonferrous metals (Index 1982=100)
163	6	CPIAPPSL	Price Index for All Urban Consumers: Apparel (Index 1982-84=100)

Table A.6 Continued

Number	TCODE	FRED MNEMONIC	Description
164	6	CPITRNSL	Price Index for All Urban Consumers: Transportation (Index 1982-84=100)
165	6	CPIMEDSL	Price Index for All Urban Consumers: Medical Care (Index 1982-84=100)
166	6	CUSR0000SAC	Price Index for All Urban Consumers: Commodities (Index 1982-84=100)
167	6	CUUR0000SAD	Price Index for All Urban Consumers: Durables (Index 1982-84=100)
168	6	CUSR0000SAS	Price Index for All Urban Consumers: Services (Index 1982-84=100)
169	6	CPIULFSL	Price Index for All Urban Consumers: All Items Less Food (Index 1982-84=100)
170	6	CUUR0000SA0L2	Price Index for All Urban Consumers: All items less shelter (Index 1982-84=100)
171	6	CUSR0000SA0L5	Price Index for All Urban Consumers: All items less medical care (Index 1982-84=100)
172	6	CUSR0000SEHC	CPI for All Urban Consumers: Owners' equivalent rent of residences (Index Dec1982=100)

Table A.7: Group 7. Earnings and Productivity

Number	TCODE	FRED MNEMONIC	Description
173	5	AHETPIx	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private (2009 Dollars per Hour), deflated by Core PCE
174	5	CES2000000008x	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Construction (2009 Dollars per Hour), deflated by Core PCE
175	5	CES3000000008x	Real Average Hourly Earnings of Production and Nonsupervisory Employees: Manufacturing (2009 Dollars per Hour), deflated by Core PCE
176	5	COMPRMS	Manufacturing Sector: Real Compensation Per Hour (Index 2009=100)
177	5	COMPRNFB	Nonfarm Business Sector: Real Compensation Per Hour (Index 2009=100)
178	5	RCPHBS	Business Sector: Real Compensation Per Hour (Index 2009=100)
179	5	OPHMFG	Manufacturing Sector: Real Output Per Hour of All Persons (Index 2009=100)
180	5	OPHNFB	Nonfarm Business Sector: Real Output Per Hour of All Persons (Index 2009=100)
181	5	OPHPBS	Business Sector: Real Output Per Hour of All Persons (Index 2009=100)
182	5	ULCBS	Business Sector: Unit Labor Cost (Index 2009=100)

Table A.7 Continued

Number	TCODE	FRED MNEMONIC	Description
183	5	ULCMFG	Manufacturing Sector: Unit Labor Cost (Index 2009=100)
184	5	ULCNFB	Nonfarm Business Sector: Unit Labor Cost (Index 2009=100)
185	5	UNLPNBS	Nonfarm Business Sector: Unit Nonlabor Payments (Index 2009=100)
186	6	CES0600000008	Average Hourly Earnings of Production and Nonsupervisory Employees: Goods-Producing (Dollars per Hour)

Table A.8: Group 8. Interest Rates

Number	TCODE	FRED MNEMONIC	Description
187	2	FEDFUNDS	Effective Federal Funds Rate (Percent)
188	2	TB3MS	3-Month Treasury Bill: Secondary Market Rate (Percent)
189	2	TB6MS	6-Month Treasury Bill: Secondary Market Rate (Percent)
190	2	MED3	3-Month Eurodollar Deposit Rate (London) (Percent)
191	2	GS1	1-Year Treasury Constant Maturity Rate (Percent)
192	2	GS10	10-Year Treasury Constant Maturity Rate (Percent)
193	2	MORTG	30-Year Conventional Mortgage Rate (Percent)
194	2	AAA	Moody's Seasoned Aaa Corporate Bond Yield (Percent)
195	2	BAA	Moody's Seasoned Baa Corporate Bond Yield (Percent)
196	1	BAA10YM	Moody's Seasoned Baa Corporate Bond Yield Relative to Yield on 10-Year Treasury Constant Maturity (Percent)

Table A.8 Continued

Number	TCODE	FRED MNEMONIC	Description
197	1	MORTG10YRx	30-Year Conventional Mortgage Rate Relative to 10-Year Treasury Constant Maturity (Percent)
198	1	TB6M3Mx	6-Month Treasury Bill Minus 3-Month Treasury Bill, secondary market (Percent)
199	1	GS1TB3Mx	1-Year Treasury Constant Maturity Minus 3-Month Treasury Bill, secondary market (Percent)
200	1	GS10TB3Mx	10-Year Treasury Constant Maturity Minus 3-Month Treasury Bill, secondary market (Percent)
201	1	CPF3MTB3Mx	3-Month Commercial Paper Minus 3-Month Treasury Bill, secondary market (Percent)
202	1	MED3TB3Mx	3-Month Eurodollar Deposit Minus 3-Month Treasury Bill, secondary market (Percent)
203	2	GS5	5-Year Treasury Constant Maturity Rate
204	1	TB3SMFFM	5-Month Treasury Constant Maturity Minus Federal Funds Rate
205	1	T5YFFM	5-Year Treasury Constant Maturity Minus Federal Funds Rate
206	1	AAAFFM	Moody's Seasoned Aaa Corporate Bond Minus Federal Funds Rate
207	2	CP3M	3-Month AA Financial Commercial Paper Rate
208	1	COMPAPFF	3-Month Commercial Paper Minus Federal Funds Rate

Table A.9: Group 9. Money and Credits

Number	TCODE	FRED MNEMONIC	Description
209	5	AMBSLREALx	St. Louis Adjusted Monetary Base (Billions of 1982-84 Dollars), deflated by CPI
210	5	IMFSLx	Real Institutional Money Funds (Billions of 2009 Dollars), deflated by CPI
211	5	M1REALx	Real M1 Money Stock (Billions of 1982-84 Dollars), deflated by CPI
212	5	M2REALx	Real M2 Money Stock (Billions of 1982-84 Dollars), deflated by CPI
213	5	MZMREALx	Real MZM Money Stock (Billions of 1982-84 Dollars), deflated by CPI
214	5	BUSLOANSx	Real Commercial and Industrial Loans, All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE
215	5	CONSUMERx	Real Consumer Loans at All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE
216	5	NONREVSLx	Total Real Nonrevolving Credit Owned and Securitized, Outstanding (Billions of 2009 U.S. Dollars), deflated by Core PCE
217	5	REALLNx	Real Estate Loans, All Commercial Banks (Billions of 2009 U.S. Dollars), deflated by Core PCE
218	5	REVOLSLx	Total Real Revolving Credit Owned and Securitized, Outstanding (Billions of 2009 U.S. Dollars), deflated by Core PCE

Table A.9 Continued

Number	TCODE	FRED MNEMONIC	Description
219	5	TOTALSLx	Total Consumer Credit Outstanding, deflated by Core PCE
220	1	DRIWCIL	FRB Senior Loans Officer Opions. Net Percentage of Domestic Respondents Reporting Increased Willingness to Make Consumer Installment Loans
221	6	TOTRESNS	Total Reserves of Depository Institutions (Billions of Dollars)
222	7	NONBORRES	Reserves Of Depository Institutions, Nonborrowed (Millions of Dollars)
223	6	DTCOLNVHFNM	Consumer Motor Vehicle Loans Outstanding Owned by Finance Companies (Millions of Dollars)
224	6	DTCTHFNM	Total Consumer Loans and Leases Outstanding Owned and Securitized by Finance Companies (Millions of Dollars)
225	6	INVEST	Securities in Bank Credit at All Commercial Banks (Billions of Dollars)

Table A.10: Group 10. Household Balance Sheets

Number	TCODE	FRED MNEMONIC	Description
226	5	TABSHNOx	Real Total Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE
227	5	TLBSHNOx	Real Total Liabilities of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE
228	5	LIABPIx	Liabilities of Households and Nonprofit Organizations Relative to Personal Disposable Income (Percent)
229	5	TNWBSHNOx	Real Net Worth of Households and Nonprofitt Organizations (Billions of 2009 Dollars), deflated by Core PCE
230	1	NWPIx	Net Worth of Households and Nonprofitt Organizations Relative to Disposable Personal Income (Percent)
231	5	TARESAx	Real Assets of Households and Nonprofit Organizations excluding Real Estate Assets (Billions of 2009 Dollars), deflated by Core PCE
232	5	HNOREMQ027Sx	Real Estate Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE
233	5	TFAABSHNOx	Real Total Financial Assets of Households and Nonprofit Organizations (Billions of 2009 Dollars), deflated by Core PCE
234	2	CONSPI	Nonrevolving consumer credit to Personal Income

Table A.11: Group 11. Exchange Rates

Number	TCODE	FRED MNEMONIC	Description
235	5	TWEXMMTH	Trade Weighted U.S. Dollar Index: Major Currencies (Index March 1973=100)
236	5	EXUSEU	U.S. / Euro Foreign Exchange Rate (U.S. Dollars to One Euro)
237	5	EXSZUSx	Switzerland / U.S. Foreign Exchange Rate
238	5	EXJPUSx	Japan / U.S. Foreign Exchange Rate
239	5	EXUSUKx	U.S. / U.K. Foreign Exchange Rate
240	5	EXCAUSx	Canada / U.S. Foreign Exchange Rate

Table A.12: Group 12. Other

Number	TCODE	FRED MNEMONIC	Description
241	1	UMCSENTx	University of Michigan: Consumer Sentiment (Index 1st Quarter 1966=100)
242	2	USEPUINDXM	Economic Policy Uncertainty Index for United States

Table A.13: Group 13. Stock Markets

Number	TCODE	FRED MNEMONIC	Description
243	1	VXOCLSX	CBOE S&P 100 Volatility Index: VXO
244	5	NIKKEI225	Nikei Stock Average
245	5	NASDAQCOM	NASDAQ Composite (Index Feb 5, 1971=100)
246	5	S&P 500	S&P's Common Stock Price Index: Composite
247	5	S&P: industry	S&P's Common Stock Price Index: Industrials
248	2	S&P: div yield	S&P's Composite Common Stock: Dividend Yield
249	5	S&P PE ratio	S&P's Composite Common Stock: Price-Earnings Ratio

Table A.14: Group 14. Non-Household Balance Sheets

Number	TCODE	FRED MNEMONIC	Description
250	2	GFDEGDQ188S	Federal Debt: Total Public Debt as Percent of GDP (Percent)
251	2	GFDEBTNx	Federal Debt: Total Public Debt (Millions of 2009 Dollars), deflated by PCE
252	5	TLBSNNCBx	Real Nonfinancial Corporate Business Sector Liabilities (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS
253	1	TLBSNNCBBDIx	Nonfinancial Corporate Business Sector Liabilities to Disposable Business Income (Percent)
254	5	TTAABSNNCBx	Nonfinancial Corporate Business Sector Assets (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS
255	5	TNWMVBSNNCBx	Nonfinancial Corporate Business Sector Net Worth (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS
256	5	NNBTILQ027Sx	Real Nonfinancial Noncorporate Business Sector Liabilities (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS
257	1	NNBTILQ027SBDIx	Nonfinancial Noncorporate Business Sector Liabilities to Disposable Business Income (Percent)
258	5	NNBTASQ027Sx	Real Nonfinancial Noncorporate Business Sector Assets (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS

Table A.14 Continued

Number	TCODE	FRED MNEMONIC	Description
259	5	TNWBSNNBx	Real Nonfinancial Noncorporate Business Sector Net Worth (Billions of 2009 Dollars), Deflated by Implicit Price Deflator for Business Sector IPDBS
260	2	TNWBSNNBBDIx	Nonfinancial Noncorporate Business Sector Net Worth to Disposable Business Income (Percent)
261	5	CNCFx	Real Disposable Business Income, Billions of 2009 Dollars (Corporate cash flow with IVA minus taxes on corporate income, deflated by Implicit Price Deflator for Business Sector IPDBS)

Table A.15: Series Period

Series	Period‖	Series	Period
GDPC96	1960:Q1 - 2015:Q3	NDMANEMP	1960:Q1 - 2015:Q3
PCECC96	1960:Q1 - 2015:Q3	USCONS	1960:Q1 - 2015:Q3
PCDGx	1960:Q1 - 2015:Q3	USEHS	1960:Q1 - 2015:Q3
PCESVx	1960:Q1 - 2015:Q3	USFIRE	1960:Q1 - 2015:Q3
PCNDx	1960:Q1 - 2015:Q3	USINFO	1960:Q1 - 2015:Q3
GPDIC96	1960:Q1 - 2015:Q3	USPBS	1960:Q1 - 2015:Q3
FPIx	1960:Q1 - 2015:Q3	USLAH	1960:02 - 2015:Q3
Y033RC1Q027SBEAx	1960:Q1 - 2015:Q3	USSERV	1987:02 - 2015:Q3
PNFIx	1960:Q1 - 2015:Q3	USMINE	1960:Q1 - 2015:Q3
PRFIx	1960:Q1 - 2015:Q3	USTPU	1960:Q1 - 2015:Q3
A014RE1Q156NBEA	1960:Q1 - 2015:Q3	USGOVT	1960:Q1 - 2015:Q3
GCEC96	1960:Q1 - 2015:Q3	USTRADE	1960:Q1 - 2015:Q3
A823RL1Q225SBEA	1960:Q1 - 2015:Q3	USWTRADE	1960:Q1 - 2015:Q3
FGRECPTx	1960:Q1 - 2015:Q3	CES9091000001	1960:Q1 - 2015:Q3
SLCEx	1960:Q1 - 2015:Q3	CES9092000001	1960:Q1 - 2015:Q3
EXPGSC96	1960:Q1 - 2015:Q3	CES9093000001	1960:Q1 - 2015:Q3
IMPGSC96	1960:Q1 - 2015:Q3	CE16OV	1960:Q1 - 2015:Q3
DPIC96	1960:Q1 - 2015:Q3	CIVPART	1960:Q1 - 2015:Q3
OUTNFB	1960:Q1 - 2015:Q3	UNRATE	1960:Q1 - 2015:Q3
OUTBS	1960:Q1 - 2015:Q3	UNRATESTx	1960:Q3 - 2015:Q3
OUTMS	1987:Q1 - 2015:Q3	UNRATELTx	1987:Q3 - 2015:Q3
INDPRO	1960:Q1 - 2015:Q3	LNS14000012	1960:Q1 - 2015:Q3
IPFINAL	1960:Q1 - 2015:Q3	LNS14000025	1960:Q1 - 2015:Q3
IPCONGD	1960:Q1 - 2015:Q3	LNS14000026	1960:Q1 - 2015:Q3
IPMAT	1960:Q1 - 2015:Q3	UEMPLT5	1960:Q1 - 2015:Q3
IPDMAT	1960:Q1 - 2015:Q3	UEMP5TO14	1960:Q1 - 2015:Q3
IPNMAT	1960:Q1 - 2015:Q3	UEMP15T26	1960:Q1 - 2015:Q3
IPDCONGD	1960:Q1 - 2015:Q3	UEMP27OV	1960:Q1 - 2015:Q3
IPB51110SQ	1960:Q1 - 2015:Q3	LNS13023621	1967:Q1 - 2015:Q3
IPNCONGD	1960:Q1 - 2015:Q3	LNS13023557	1967:Q1 - 2015:Q3

Table A.15 Continued

Series	Period	Series	Period
IPBUSEQ	1960:Q1 - 2015:Q3	LNS13023705	1967:Q1 - 2015:Q3
IPB51220SQ	1960:Q1 - 2015:Q3	LNS13023569	1967:Q1 - 2015:Q3
TCU	1967:Q1 - 2015:Q3	LNS12032194	1960:Q1 - 2015:Q3
CUMFNS	1960:Q1 - 2015:Q3	HOABS	1960:Q1 - 2015:Q3
PAYEMS	1987:Q1 - 2015:Q3	HOAMS	1987:Q1 - 2015:Q3
USPRIV	1960:Q1 - 2015:Q3	HOANBS	1960:Q1 - 2015:Q3
MANEMP	1960:Q1 - 2015:Q3	AWHMAN	1960:Q1 - 2015:Q3
SRVPRD	1960:Q1 - 2015:Q3	AWHNONAG	1964:Q1 - 2015:Q3
USGOOD	1960:Q1 - 2015:Q3	AWOTMAN	1960:Q1 - 2015:Q3
DMANEMP	1960:Q1 - 2015:Q3	HWIx	1960:Q1 - 2015:Q1
HOUST	1960:Q1 - 2015:Q3	CPIAUCSL	1960:Q1 - 2015:Q3
HOUST5F	1960:Q1 - 2015:Q3	CPILFESL	1960:Q1 - 2015:Q3
PERMIT	1960:Q1 - 2015:Q3	PPIFGS	1960:Q1 - 2015:Q3
HOUSTMW	1960:Q1 - 2015:Q3	PPIACO	1960:Q1 - 2015:Q3
HOUSTNE	1960:Q1 - 2015:Q3	PPIFCG	1960:Q1 - 2015:Q3
HOUSTS	1960:Q1 - 2015:Q3	PPIFCF	1960:Q1 - 2015:Q3
HOUSTW	1960:Q1 - 2015:Q3	PPIIDC	1960:Q1 - 2015:Q3
CMRMTSPLx	1960:Q1 - 2015:Q3	PPIITM	1960:Q1 - 2015:Q3
RSAFSx	1960:Q1 - 2015:Q3	NAPMPRI	1960:Q1 - 2015:Q3
AMDMNOx	1960:Q1 - 2015:Q3	WPU0531	1967:Q1 - 2015:Q3
ACOGNOx	1992:Q1 - 2015:Q3	WPU0561	1960:Q1 - 2015:Q3
AMDMUOx	1960:Q1 - 2015:Q3	OILPRICEx	1960:Q1 - 2015:Q3
ANDENOx	1968:Q1 - 2015:Q3	AHETPIx	1964:Q1 - 2015:Q3
NAPMSDI	1960:Q1 - 2015:Q3	CES2000000008x	1960:Q1 - 2015:Q3
INVCQRMTSPL	1967:Q1 - 2015:Q3	CES3000000008x	1960:Q1 - 2015:Q3
PCECTPI	1960:Q1 - 2015:Q3	COMPRMS	1987:Q1 - 2015:Q3
PCEPILFE	1960:Q1 - 2015:Q3	COMPRNFB	1960:Q1 - 2015:Q3
GDPCTPI	1960:Q1 - 2015:Q3	RCPHBS	1960:Q1 - 2015:Q3
GPDICTPI	1960:Q1 - 2015:Q3	OPHMFG	1987:Q1 - 2015:Q3
IPDBS	1960:Q1 - 2015:Q3	OPHNFB	1960:Q1 - 2015:Q3

Table A.15 Continued

Series	Period‖	Series	Period
DGDSRG3Q086SBEA	1960:Q1 - 2015:Q3	OPHPBS	1960:Q1 - 2015:Q3
DDURRG3Q086SBEA	1960:Q1 - 2015:Q3	ULCBS	1960:Q1 - 2015:Q3
DSERRG3Q086SBEA	1960:Q1 - 2015:Q3	ULCMFG	1987:Q1 - 2015:Q3
DNDGRG3Q086SBEA	1960:Q1 - 2015:Q3	ULCNFB	1960:Q1 - 2015:Q3
DHCERG3Q086SBEA	1960:Q1 - 2015:Q3	UNLPNBS	1960:Q1 - 2015:Q3
DMOTRG3Q086SBEA	1960:Q1 - 2015:Q3	FEDFUNDS	1960:Q1 - 2015:Q3
DFDHRG3Q086SBEA	1960:Q1 - 2015:Q3	TB3MS	1960:Q1 - 2015:Q3
DREQRG3Q086SBEA	1960:Q1 - 2015:Q3	TB6MS	1960:Q1 - 2015:Q3
DODGRG3Q086SBEA	1960:Q1 - 2015:Q3	MED3	1971:Q1 - 2015:Q3
DFXARG3Q086SBEA	1960:Q1 - 2015:Q3	GS1	1960:Q1 - 2015:Q3
DCLORG3Q086SBEA	1960:Q1 - 2015:Q3	GS10	1960:Q1 - 2015:Q3
DGOERG3Q086SBEA	1960:Q1 - 2015:Q3	MORTG	1971:Q2 - 2015:Q3
DONGRG3Q086SBEA	1960:Q1 - 2015:Q3	AAA	1960:Q1 - 2015:Q3
DHUTRG3Q086SBEA	1960:Q1 - 2015:Q3	BAA	1960:Q1 - 2015:Q3
DHLCRG3Q086SBEA	1960:Q1 - 2015:Q3	BAA10YM	1960:Q1 - 2015:Q3
DTRSRG3Q086SBEA	1960:Q1 - 2015:Q3	MORTG10YRx	1971:Q2 - 2015:Q3
DRCARG3Q086SBEA	1960:Q1 - 2015:Q3	TB6M3Mx	1960:Q1 - 2015:Q3
DFSARG3Q086SBEA	1960:Q1 - 2015:Q3	GS1TB3Mx	1960:Q1 - 2015:Q3
DIFSRG3Q086SBEA	1960:Q1 - 2015:Q3	GS10TB3Mx	1960:Q1 - 2015:Q3
DOTSRG3Q086SBEA	1960:Q1 - 2015:Q3	CPF3MTB3Mx	1960:Q1 - 2015:Q3
MED3TB3Mx	1971:Q1 - 2015:Q3	NAPMPI	1960:Q1 - 2015:Q3
AMBSLREALx	1960:Q1 - 2015:Q3	UEMPMEAN	1960:Q1 - 2015:Q3
IMFSLx	1980:Q1 - 2015:Q3	CES0600000007	1960:Q1 - 2015:Q3
M1REALx	1960:Q1 - 2015:Q3	NAPMEI	1960:Q1 - 2015:Q3
M2REALx	1960:Q1 - 2015:Q3	NAPM	1960:Q1 - 2015:Q3
MZMREALx	1960:Q1 - 2015:Q3	NAPMNOI	1960:Q1 - 2015:Q3
BUSLOANSx	1960:Q1 - 2015:Q3	NAPMII	1960:Q1 - 2015:Q3
CONSUMERx	1960:Q1 - 2015:Q3	TOTRESNS	1960:Q1 - 2015:Q3
NONREVSLx	1960:Q1 - 2015:Q3	NONBORRES	1960:Q1 - 2015:Q3
REALLNx	1960:Q1 - 2015:Q3	GS5	1960:Q1 - 2015:Q3

Table A.15 Continued

Series	Period	Series	Period
REVOLSLx	1968:Q1 - 2015:Q3	TB3SMFFM	1960:Q1 - 2015:Q3
TOTALSLx	1960:Q1 - 2015:Q3	T5YFFM	1960:Q1 - 2015:Q3
DRIWCIL	1982:Q2 - 2015:Q3	AAAFFM	1960:Q1 - 2015:Q3
TABSHNOx	1960:Q1 - 2015:Q2	PPICRM	1960:Q1 - 2015:Q3
TLBSHNOx	1960:Q1 - 2015:Q2	PPICMM	1960:Q1 - 2015:Q3
LIABPIx	1960:Q1 - 2015:Q2	CPIAPPSL	1960:Q1 - 2015:Q3
TNWBSHNOx	1960:Q1 - 2015:Q2	CPITRNSL	1960:Q1 - 2015:Q3
NWPIx	1960:Q1 - 2015:Q2	CPIMEDSL	1960:Q1 - 2015:Q3
TARESAx	1960:Q1 - 2015:Q2	CUSR0000SAC	1960:Q1 - 2015:Q3
HNOREMQ027Sx	1960:Q1 - 2015:Q2	CUUR0000SAD	1960:Q1 - 2015:Q3
TFAABSHNOx	1960:Q1 - 2015:Q2	CUSR0000SAS	1960:Q1 - 2015:Q3
VXOCLSX	1962:Q3 - 2015:Q3	CPIULFSL	1960:Q1 - 2015:Q3
USSTHPI	1975:Q1 - 2015:Q3	CUUR0000SA0L2	1960:Q1 - 2015:Q3
SPCS10RSA	1987:Q1 - 2015:Q3	CUSR0000SA0L5	1960:Q1 - 2015:Q3
SPCS20RSA	2000:Q1 - 2015:Q3	CES0600000008	1960:Q1 - 2015:Q3
TWEXMMTH	1973:Q1 - 2015:Q3	DTCOLNVHFNM	1960:Q1 - 2015:Q3
EXUSEU	1999:Q1 - 2015:Q3	DTCTHFNM	1960:Q1 - 2015:Q3
EXSZUSx	1960:Q1 - 2015:Q3	INVEST	1960:Q1 - 2015:Q3
EXJPUSx	1960:Q1 - 2015:Q3	HWIURATIO	1960:Q1 - 2015:Q1
EXUSUKx	1960:Q1 - 2015:Q3	CLAIMSx	1960:Q1 - 2015:Q3
EXCAUSx	1960:Q1 - 2015:Q3	BUSINVx	1960:Q1 - 2015:Q3
UMCSENTx	1960:Q1 - 2015:Q2	ISRATIOx	1960:Q1 - 2015:Q3
USEPUINDXM	1985:Q1 - 2015:Q3	CONSPI	1960:Q1 - 2015:Q3
B020RE1Q156NBEA	1960:Q1 - 2015:Q3	CP3M	1960:Q1 - 2015:Q3
B021RE1Q156NBEA	1960:Q1 - 2015:Q3	COMPAPFF	1960:Q1 - 2015:Q3
GFDEGDQ188S	1966:Q1 - 2015:Q2	PERMITNE	1960:Q1 - 2015:Q3
GFDEBTNx	1966:Q1 - 2015:Q2	PERMITMW	1960:Q1 - 2015:Q3
IPMANSICS	1960:Q1 - 2015:Q3	PERMITS	1960:Q1 - 2015:Q3
IPB51222S	1960:Q1 - 2015:Q3	PERMITW	1960:Q1 - 2015:Q3
IPFUELS	1960:Q1 - 2015:Q3	NIKKEI225	1960:Q1 - 2015:Q3

Table A.15 Continued

Series	Period		
NASDAQCOM	1971:Q1 - 2015:Q3	CNCFx	1960:Q1 - 2015:Q3
CUSR0000SEHC	1982:Q4 - 2015:Q3	S&P 500	1960:Q1 - 2015:Q3
TLBSNNCBx	1960:Q1 - 2015:Q2	S&P: indust	1960:Q1 - 2015:Q3
TLBSNNCBBDIx	1960:Q1 - 2015:Q2	S&P div yield	1960:Q1 - 2015:Q3
TTAABSNNCBx	1960:Q1 - 2015:Q2	S&P PE ratio	1960:Q1 - 2015:Q2
TNWMVBSNNCBx	1960:Q1 - 2015:Q2	GDPG	1960:Q1 - 2015:Q3
TNWMVBSNNCBBDIx	1960:Q1 - 2015:Q2	GDPNG	1960:Q1 - 2015:Q3
NNBTILQ027Sx	1960:Q1 - 2015:Q2	GDPD	1960:Q1 - 2015:Q3
NNBTASQ027Sx	1960:Q1 - 2015:Q2	GDPSV	1960:Q1 - 2015:Q3
TNWBSNNBx	1960:Q1 - 2015:Q2	GDPST	1960:Q1 - 2015:Q3
TNWBSNNBBDIx	1960:Q1 - 2015:Q2		