First Quarters in the National Income and Product Accounts

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Prompted by their expectations of an initial estimate of a marked slowdown in U.S. real gross domestic product growth in the first quarter of 2015, commentators and analysts have drawn attention to an apparent "first-quarter effect" in the U.S. national income and product accounts.[2] Over the past 30 years, U.S. real GDP growth in the first quarter has been slower on average than in other quarters. Such an effect is surprising because the U.S. Bureau of Economic Analysis's statisticians are supposed to remove any regularly occurring intra-year movements in the data through their seasonal adjustment procedures. Indeed, macroeconomists regularly use the adjusted data without paying much attention to the complex methods by which the statisticians remove the seasonal fluctuations. Economic forecasters, in particular, rely upon clean seasonal adjustment procedures to help them obtain informative signals about future business cycle fluctuations and future movements in trend growth. The signals are harder to read when apparent residual seasonal effects — such as the first-quarter effect — infect the data.

In this report, I document the first-quarter effect in the BEA's estimates for a broad range of components on the product side of the national income and product accounts, provide formal estimates of statistical significance for the first-quarter effect, and show that alternative measures of real GDP based on the work of Aruoba, Diebold, Nalewaik, Schorfheide, and Song (2013) are much less affected by the first-quarter effect than the BEA's official measure is.

The key findings are:

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[1] The views expressed here are those of the author and do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. Tom Stark is the assistant director and manager of the Real-Time Data Research Center in the Philadelphia Fed's Research Department and may be contacted at tom.stark@phil.frb.org.

[2] See the April 22, 2015, CNBC report by Steve Liesman in which UBS economist Drew Matus and I participated. Similarly, Goldman Sachs economists Kris Dawsey and Chris Mischaikow expressed concern in a private research note dated April 17, 2015, about potential statistical noise in the BEA's initial first quarter 2015 real GDP growth release and showed how their proprietary Current Activity Indicator is insulated from first-quarter effects.

- From 1985 to 2014, real GDP growth averaged just 1.87 percent (annual rate) in the first quarter, far below the average growth of 3.31 percent in the second quarter, 2.86 percent in the third quarter, and 2.74 percent in the fourth quarter. The differences between first-quarter growth and growth in the remaining quarters are statistically significant. Qualitatively similar results hold when I exclude the last four years from the analysis (2011 to 2014). Notably, the first-quarter effect disappears when I examine the longer sample period from 1959 to 2014, suggesting that the first-quarter effect does not extend as far back 1959.

- A first-quarter effect exists in such components of real GDP as business fixed investment, residential investment, government consumption expenditures, and exports and imports.

- Model-based estimates of real GDP that draw on the BEA's official measures for real GDP and real gross domestic income (GDI), such as the Federal Reserve Bank of Philadelphia's GDPplus, display little evidence of a first-quarter effect, suggesting that they provide better readings on first-quarter growth than the BEA's estimate of real GDP does.

- The absence of a first-quarter effect in the model-based estimates for real GDP carries over to a number of components on the income side of the national accounts, including real gross domestic income itself, suggesting that the first-quarter effect is largely confined to the product side of the U.S. national income and product accounts.

Some Stylized Facts on Growth over the Four Quarters of the Year: A First-Quarter Effect

Table 1 presents the basic evidence on the BEA's estimates for real GDP growth that has attracted so much recent attention. Based on the data available at the end of March 2015, the tables show average growth rates (annualized percentage points) for each of the four quarters of the year for real GDP and some components. Asterisks in each row show the quarter with the slowest growth among the four quarters of the year for each variable. Over the period 1959 to 2014 (top panel) there is little evidence of the slowest growth rates occurring in first quarters. Indeed, the evidence points to lower growth rates in the fourth quarter of the year for many variables. Over the period that begins in 1985, a number of variables have their lowest growth rates in the first quarter (middle panel). Real GDP, components of investment, real government consumption expenditures and gross investment, and exports and imports all have markedly lower growth rates in the first quarter than in the remaining quarters. This first-quarter effect remains when I exclude the last four years of the sample period from the calculations (bottom panel). [3]

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[3] All results in this report use the vintage of data available at the end of March 2015. Among other things, this means that all but the most recent observations have been subject to the BEA's process of revisions, including annual

Table 2 presents some findings suggesting that the average growth rates in each quarter are not dominated by a few quarters with extremely low growth. For each variable, the table shows the percent of years (in percentage points) in which growth was slowest in each quarter. (For any variable, the percentage across the four quarters must sum to 100.) Over the periods 1985–2014 (middle panel) and 1985–2010 (bottom panel) real GDP growth was slowest in the first quarter 50 percent of the time. Similarly high first-quarter percentages characterize the slowest growth rates for the components. Evidently, from 1985 to 2014, the BEA has issued its slowest growth estimates in first quarters a very large number of times.

Figures 1A–1D show time series plots of the quarters with the slowest growth rates each year from 1985 to 2014 for selected variables in the national accounts, the data on which the results of Table 2 are based. For real GDP growth (Figure 1A), in 15 out of 30 years, the slowest growth rates were for the first quarter. Notably, the pattern seems fairly uniform throughout the past 30 years. Real business fixed investment (Figure 1B) and real exports (Figure 1D) have had their slowest growth rates in first quarters almost continuously since 2009. Real government consumption expenditures and gross investment (Figure 1C) stands out both because its slowest growth is often in the first quarter and because its slowest growth has never occurred in a second quarter.

It is also true that when the BEA estimates *extremely* negative growth rates, they are likely for a first quarter. Table 3 considers the 10 smallest growth rates (these are the 10 most negative growth rates) for each variable over the sample periods and shows how many of them fall into each quarter. (The counts in each row sum to 10.) Over the period starting in 1985 (middle panel), six of the 10 most negative real GDP growth rates were for a first quarter. Extending the sample period back to 1959 (top panel) shows that only three of the most negative real GDP growth rates occurred in the first quarter.

Yes…But Is the Effect Statistically Significant?

Thus far, the results suggest something unusual about first quarters in the national income and product accounts. Although it appears that first quarters are characterized by economically meaningful slower growth rates than those of the remaining quarters, it is not clear whether the estimates are due to normal sampling variability or whether they carry statistical significance. One way to address this question is to estimate a regression of growth rates on zero-one quarterly dummy variables that take the value of unity in a particular quarter and a value of zero otherwise and test for statistically significant differential effects on growth rates, depending on the statistical significance of dummy variables. I estimate an equation of the form

$$Growth_t = \mu + \delta_2 Q_{2t} + \delta_3 Q_{3t} + \delta_4 Q_{4t} + \varepsilon_t$$

revisions. It is noteworthy that the BEA revises its seasonal factors in annual revisions. Excluding the last four years of observations provides a sample period in which the data have been subject to re-estimated seasonal factors.

where $Growth_t$ is the quarter-over-quarter growth rate of a variable from the national income and product accounts (expressed in annualized percentage points) , Q_{jt} is a dummy variable that takes a value of unity in quarter j , $j = 2, 3, 4$, and ε_t is a possibly serially correlated and heteroscedastic residual. The parameter μ measures average growth when all quarterly dummy variables take values of zero, which occurs only when the quarterly observations are for the first quarter, and the parameters δ_2, δ_3, and δ_4 measure differential growth in the second, third, and fourth quarters. To be even more precise, the equation says that average growth in the first quarter is μ , and average growth in each of the remaining quarters is $\mu + \delta_2$ (second quarter), $\mu + \delta_3$ (third quarter), and $\mu + \delta_4$ (fourth quarter). When δ_j is positive, growth in the jth quarter is greater than first-quarter growth.

Table 4 presents the results for a few variables and sample periods.[4] The table shows my point estimates for μ, δ_2, δ_3, and δ_4 (denoted const, Q2, Q3, Q4, respectively) along with three sets of double-sided p-values in parentheses. The p-values, which give an indication of statistical significance, reflect alternative assumptions about the presence serial correlation and heteroscedasticity in the regression residuals.[5] Low p-values (of, say, less than 0.10) indicate a statistically significant estimate. From 1959 to 2014 (top panel), I find little evidence of statistically significant effects of the quarter on average growth. The only exception is for the quarterly pattern of growth in government consumption expenditures and gross investment, which exhibits statistically significant slower growth in first quarters than in the second and third quarters. This result is consistent with the more informal analysis of Tables 1–4, which suggested little difference in the growth rates across quarters over a sample period that begins in 1959.

In contrast, over the sample period that begins in 1985 (bottom panel), statistically significant differences exist for real GDP growth as well as the government spending variable. It is, however, noteworthy that the economically significant differences in growth rates across quarters noted earlier for the other variables (in particular, real business fixed investment and residential investment) carry no statistical significance.

For real GDP growth rates from 1985 to 2014 (bottom panel), I estimate average growth at 1.87 percent in the first quarter (column labeled const), 3.32 percent in the second quarter (column labeled const plus column labeled Q2), 2.86 percent in the third quarter (const plus Q3) and 2.74 percent in the fourth

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[4] To conserve space, Table 4 shows only some of my results. A full set of results, including those for additional sample periods and variables, is available on request.

[5] As noted in the notes for the table, the first double-sided p-value assumes the absence of serial correlation and heteroscedasticity in the regression residuals. The second allows for heteroscedasticity but no serial correlation, and the third allows for the presence of serial correlation and heteroscedasticity.

quarter (const plus Q4). Moreover, the low p-values suggest statistically significant differences between average growth in the first and second quarters and average growth between the first and third quarters.

Evidently, the BEA's estimates for growth rates display some economically significant differences across the four quarters of the year beginning in 1985, and in the case of the estimates for real GDP and government spending, the economically significant differences are also statistically significant.

Alternative Remedies: The Case for GDPplus and Other Model-Based Estimates of Real GDP

To date, analysts have discussed a number of responses to what appear to be first-quarter effects in the BEA's estimates for real GDP growth. Dawsey and Mischaikow (2015) prefer to construct an activity measure comprised of components that do not suffer from a first quarter effect. However, some analysts question the existence of a statistically significant first quarter effect (Edgerton (2015)), while others (Boldin and Wright (2015)) advocate weather-adjusting the data because they think severe weather in first quarters may affect the data in ways not captured by the BEA's seasonal adjustment procedures. Here, I focus on the benefits of using signal extraction techniques for estimating real GDP growth along the lines of Aruoba et al. (2013), one example of which is the Federal Reserve Bank of Philadelphia's GDPplus estimates.[6]

As noted in Stark (2014), real-time model-based estimates of real GDP based on the BEA's official estimates for real GDP and real gross domestic income display revisions similar in size to those of the BEA's estimates for real GDP. Moreover, the model-based estimates are predictive in real time for real GDP itself and for nonfarm payroll employment. Indeed, the model-based estimates can be more predictive for real GDP than GDP itself and more predictive for nonfarm payroll employment than real GDP is. The models differ according to the indicator variables thought to inform estimates of real GDP and the assumptions made about cross-equation correlations.

Each model assumes that the true rate of growth in real GDP is unobserved and that the BEA's official estimates for real GDP and real GDI have important signals about true real GDP. True real GDP follows the first-order autoregressive process given by

$$GDPg_t = \alpha(1-\rho) + \rho GDPg_{t-1} + \varepsilon_{gt}$$

where GDP_g is the quarter-over-quarter growth of true real GDP. The first three models (denoted model 1, model 2, and model 3) assume that the BEA's estimates for real GDP growth and real GDI growth are related to $GDPg$ according to

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[6] The Philadelphia Fed's estimates of GDPplus can be found at www.philadelphiafed.org/research-and-data/real-time-center/gdpplus/.

$$\begin{pmatrix} GDP_t \\ GDI_t \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} GDPg_t + \begin{pmatrix} \varepsilon_{GDP,t} \\ \varepsilon_{GDI,t} \end{pmatrix}$$

where GDP_t and GDI_t are the BEA's official measures of real GDP growth and real GDI growth, respectively, and $\varepsilon_{GDP,t}$ and $\varepsilon_{GDI,t}$ are measurement errors. The first three models differ on the alternative assumptions made about the correlations among the three shocks $(\varepsilon_g, \varepsilon_{GDP}, \varepsilon_{GDI})$. The fourth model (denoted model 4) adds the quarter-over-quarter change in the unemployment rate to the preceding equation.

As discussed in Stark (2014), the models' parameters are estimated with the maximum likelihood method. The estimates for real GDP take the parameter estimates as given and use Kalman smoothing to extract a signal about underlying, but unobserved, real GDP.[7] The Kalman-smoothed values are the expectation of $GDPg_t$ conditional upon observing the BEA's entire sample of estimates for GDP and GDI over the period $t = 1, 2, ..., T$. That is, the Kalman-smoothed values are given as

$$GDPg_{t|T} = E\left(GDPg_t \mid GDP_T, GDP_{T-1}, ...; GDI_T, GDI_{T-1}, ...;\right), \ t = 1, ..., T$$

where $E(x|\Omega)$ denotes the expectation of x conditional on Ω.[8] Figure 2 plots the four model-based estimates and the BEA's official estimates. All series move together, but the BEA's estimates appear to have more high-frequency volatility than the model-based estimates.

The findings on testing for the existence of a first-quarter effect in the four model-based estimates of GDP presented above and in Aruoba et al. (2013), including the estimates from the model (model 3) behind GDPplus, suggest virtually no evidence for an economically meaningful and statistically significant first-quarter effect (Tables 5–8). Table 5 contrasts the previous results for average real GDP growth each quarter with those for the model-based estimates. From 1959 to 2014 (top panel), the lowest growth rates for all series occur in the fourth quarter, but the model-based series have much less variability in average growth rates across the quarters than the BEA's estimates. From 1985 to 2014 (bottom panel), the table shows that three of four model-based estimates have their slowest growth rates in the first quarter, but variability in the average growth rates across quarters is much lower than for the BEA's estimates.

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[7] I estimate the models on the data for the BEA's official estimates of real GDP and real GDI on a sample period from 1960 Q1 to 2014 Q4. The data are those available at the end of March 2015, following the BEA's release of the third estimate for real GDP in 2014 Q4. Note that the parameters of the models are estimated using more recent observations and a more recent data vintage than those of the Philadelphia Fed's official GDPplus series. These differences in estimation have only a trivial effect on my model-based estimates of GDPplus compared with the Philadelphia Fed's official estimates. The models are also estimated on continuously compounded quarter-over-quarter growth rates for GDP and GDI, and I convert the continuously compounded growth rates for GDPg to quarterly compounded growth rates so that I can compare model-based growth rates with the BEA's official estimates (which use the formula for quarterly compounding).

[8] In model 4, the conditioning information also includes the unemployment rate.

Table 6 shows that the percentage of years in which the slowest growth rates occurred in first quarters is somewhat lower for the model-based estimates than for the BEA's estimates over the post-1984 period (bottom panel). Table 7 shows that the 10 lowest quarter-over-quarter growth rates over the post-1984 period were most commonly those for the BEA's first-quarter estimates and more evenly spread over the four quarters for the model-based estimates.

Thus far, it seems clear that the model-based estimates for real GDP growth are less affected by slow growth in first quarters than the BEA's estimates are. Table 8 provides formal statistical evidence on the differences in the pattern of growth across the quarters, using the same regression method discussed above, in which I regress growth on a constant and three zero-one dummy variables for second, third, and fourth quarters. From 1959 to 2014, I find no statistically significant effects from the dummy variables for the BEA's estimates of growth or for the model-based estimates (top panel). In contrast, from 1985 to the present (bottom panel), the BEA's estimates have meaningful differences between first-quarter growth rates (measured by the constant) and growth rates in each of the remaining quarters. The differential effects (measured by the coefficient estimates on the dummy variables) are economically large and almost always statistically significant, as noted earlier. The model-based estimates, in contrast, show very small differential effects between first-quarter growth and growth in each of the remaining quarters. Moreover, in no cases do the model-based estimates show a statistically significant differential effect between growth in the first quarter and growth in the other quarters.

It is worth noting that the results for the model-based real GDP growth series, which as noted above rely upon the BEA's official estimates for real GDP and real GDI, extend to gross domestic income itself, as well as a number of variables on the income side of the national accounts. To be precise, I find no evidence that gross domestic income has a first-quarter effect and little evidence that income-side variables such as employee compensation, wages and salaries, proprietors' income, and corporate profits are plagued by statistically significant first-quarter effects. This suggests that first-quarter effects are confined to the product side of the national accounts.

Table 9 shows estimates of average quarter-over-quarter growth rates in each quarter for real GDP, real GDI, and five additional income-side components. (For each variable, asterisks denote the quarter having the lowest average growth rate.) As noted above, real GDP growth reflects the first-quarter effect because its growth rate is much lower in first quarters than in the remaining quarters. Moreover, real GDP growth in the remaining quarters differs from that of the first quarter by economically significant amounts from 1985 to 2014 (top panel) and 1985 to 2010 (bottom panel). In contrast, real GDI growth is more evenly spread over the four quarters than real GDP growth is in both sample periods. It is also clear there is little tendency for slow growth in the income-side components to cluster in the first quarter. For example, growth in employee compensation is slowest in third quarters over both sample periods. But the differences across the four quarters are minimal.

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Table 10 confirms the lack of statistical significance for the income variables, using the regression methodology described above in which I regress quarterly growth rates on a constant and quarterly dummy variables for the second, third, and fourth quarters. (Recall that the coefficients on the quarterly dummy variables measure the differential effect on average growth in the second, third, and fourth quarters relative to first-quarter growth.) As noted previously, the results for real GDP growth reflect the first-quarter effect because the coefficients on the quarterly dummy variables (columns denoted Q2, Q3, and Q4) are positive, large, and (mostly) statistically significant. This result stands in strong contrast with my estimates for, in particular, real GDI growth, for which I estimate coefficients on the quarterly dummy variables as negative, small in absolute value, and not statistically significant. Moreover, across the additional income-side components (employee compensation, wages and salaries, proprietors' income, rental income, and corporate profits), I find only one example of a statistically significant differential effect, that for fourth-quarter corporate profits over the period from 1985 to 2010.

Summary and Conclusions

It seems clear that the BEA's averages for quarterly real GDP growth vary according to a consistent pattern over the four quarters of the year, suggesting that the BEA's seasonal adjustment procedures are not filtering out all the intra-year movements in the data. Notably, the BEA's estimates are lower in first quarters. This first-quarter effect is economically large and statistically significant, but it is confined to the post-1984 period. From 1985 to the present, half of the slowest intra-year quarterly growth rates occurred in the first quarter, and six of the 10 slowest growth rates over the entire period happened in a first quarter.

These first-quarter effects complicate the process of economic forecasting because economists must decide whether an observed slowdown in first quarter growth represents residual seasonality or the start of a cyclical slowdown. Notably, model-based estimates of real GDP growth that incorporate the BEA's official estimates for real GDP and real GDI fare better on the question of first-quarter effects. My estimates suggest that these model-based estimates, such as the Federal Reserve Bank of Philadelphia's GDPplus series, are not nearly as susceptible to the first-quarter effect as the BEA's official estimates for real GDP are.

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Table 1. Quarter-over-Quarter Growth Rates for Real GDP and Components, by Quarter
(Annualized Percentage Points)

	Q1	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	3.37	3.64	3.09	2.61*
Real PCE: Total	3.53	3.27	3.62	3.05*
Real PCE: Durables	7.82	5.55	8.40	2.79*
Real PCE: Nondurables	2.35	2.44	2.30*	2.77
Real PCE: Services	3.30*	3.35	3.31	3.59
Real Bus Fixed Invest	4.27*	5.41	5.57	4.80
Real Resid Invest	4.60	4.18	2.34	2.32*
Real Govt C & GI	1.23	2.88	2.68	1.21*
Real Govt C & GI: Federal	0.06	3.93	3.10	-0.24*
Real Govt C & GI: State/Local	2.56	2.46	2.36*	2.69
Real Exports	5.31	12.98	2.56*	7.81
Real Imports	5.60*	8.97	6.20	6.03
1985:01-2014:04				
Real GDP	1.87*	3.31	2.86	2.74
Real PCE: Total	2.90	2.90	3.43	2.66*
Real PCE: Durables	5.10	5.87	9.08	3.27*
Real PCE: Nondurables	2.13	2.07*	2.08	2.79
Real PCE: Services	2.88	2.68	2.89	2.66*
Real Bus Fixed Invest	2.60*	4.99	4.90	3.56
Real Resid Invest	0.30*	3.96	1.40	0.76
Real Govt C & GI	0.19*	3.47	2.11	0.67
Real Govt C & GI: Federal	-1.50*	5.23	2.95	-0.87
Real Govt C & GI: State/Local	1.59*	2.44	1.60	1.87
Real Exports	4.05*	7.00	5.71	8.29
Real Imports	4.00*	7.07	5.40	6.29
1985:01-2010:04				
Real GDP	2.11*	3.40	2.81	2.77
Real PCE: Total	2.98	3.10	3.61	2.63*
Real PCE: Durables	4.82	6.07	9.43	2.50*
Real PCE: Nondurables	2.13*	2.28	2.19	2.93
Real PCE: Services	3.05	2.88	3.06	2.70*
Real Bus Fixed Invest	2.70*	4.81	4.33	3.02
Real Resid Invest	-0.70*	3.13	0.20	-0.17
Real Govt C & GI	0.79*	3.96	2.25	1.29
Real Govt C & GI: Federal	-0.83*	6.18	2.93	0.28
Real Govt C & GI: State/Local	2.18	2.66	1.84*	2.14
Real Exports	4.93*	6.99	5.97	8.80
Real Imports	4.36*	7.12	6.13	6.77

Notes. The table reports estimates for the average quarter-over-quarter growth rate in each quarter over the indicated sample period. The growth rates are computed using the formula for quarterly compounding at an annual rate and expressed in percentage points. For each variable, an asterisk denotes the quarter having the lowest growth rate among the four quarters of the year (denoted Q1, Q2, Q3, and Q4). The data are those available at the end of March 2015.

Table 2. Percent of Years That the Lowest Quarterly Growth Rate of the Year Appears in Each Quarter (Percentage Points)

	Q1	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	35.7	16.1	17.9	30.4
Real PCE: Total	26.8	32.1	14.3	26.8
Real PCE: Durables	25.0	30.4	12.5	32.1
Real PCE: Nondurables	23.2	32.1	26.8	17.9
Real PCE: Services	25.0	17.9	25.0	32.1
Real Bus Fixed Invest	35.7	12.5	21.4	30.4
Real Resid Invest	25.0	17.9	19.6	37.5
Real Govt C & GI	37.5	10.7	19.6	32.1
Real Govt C & GI: Federal	39.3	8.9	21.4	30.4
Real Govt C & GI: State/Local	33.9	25.0	17.9	23.2
Real Exports	28.6	14.3	37.5	19.6
Real Imports	33.9	14.3	21.4	30.4
1985:01-2014:04				
Real GDP	50.0	13.3	16.7	20.0
Real PCE: Total	33.3	36.7	3.3	26.7
Real PCE: Durables	30.0	33.3	10.0	26.7
Real PCE: Nondurables	26.7	36.7	23.3	13.3
Real PCE: Services	23.3	20.0	20.0	36.7
Real Bus Fixed Invest	43.3	3.3	23.3	30.0
Real Resid Invest	33.3	13.3	23.3	30.0
Real Govt C & GI	43.3	0.0	16.7	40.0
Real Govt C & GI: Federal	40.0	3.3	16.7	40.0
Real Govt C & GI: State/Local	46.7	16.7	16.7	20.0
Real Exports	40.0	13.3	33.3	13.3
Real Imports	33.3	10.0	26.7	30.0
1985:01-2010:04				
Real GDP	50.0	11.5	19.2	19.2
Real PCE: Total	34.6	30.8	3.8	30.8
Real PCE: Durables	30.8	26.9	11.5	30.8
Real PCE: Nondurables	26.9	38.5	23.1	11.5
Real PCE: Services	26.9	15.4	19.2	38.5
Real Bus Fixed Invest	38.5	3.8	23.1	34.6
Real Resid Invest	30.8	11.5	26.9	30.8
Real Govt C & GI	42.3	0.0	19.2	38.5
Real Govt C & GI: Federal	42.3	3.8	19.2	34.6
Real Govt C & GI: State/Local	38.5	19.2	19.2	23.1
Real Exports	30.8	15.4	38.5	15.4
Real Imports	34.6	7.7	26.9	30.8

Notes. The table reports the percent of years (multiplied by 100) in which the lowest quarter-over-quarter growth rate occurred in each quarter. The numbers in each row sum to 100 percent (up to rounding error). The data are those available at the end of March 2015.

Table 3. Number of Times the 10 Lowest Growth Rates in the Sample Fall into Each Quarter

                                           Q1   Q2 Q3 Q4

1959:01-2014:04

	Q1	Q2	Q3	Q4
Real GDP	3	1	1	5
Real PCE: Total	2	2	2	4
Real PCE: Durables	2	3	0	5
Real PCE: Nondurables	2	3	1	4
Real PCE: Services	3	2	3	2
Real Bus Fixed Invest	2	3	2	3
Real Resid Invest	2	2	1	5
Real Govt C & GI	4	0	3	3
Real Govt C & GI: Federal	5	0	2	3
Real Govt C & GI: State/Local	4	3	2	1
Real Exports	3	0	5	2
Real Imports	3	3	1	3

1985:01-2014:04

	Q1	Q2	Q3	Q4
Real GDP	6	0	2	2
Real PCE: Total	4	1	1	4
Real PCE: Durables	3	1	1	5
Real PCE: Nondurables	3	2	2	3
Real PCE: Services	2	2	2	4
Real Bus Fixed Invest	4	3	1	2
Real Resid Invest	2	1	4	3
Real Govt C & GI	5	0	0	5
Real Govt C & GI: Federal	6	0	0	4
Real Govt C & GI: State/Local	4	2	3	1
Real Exports	4	1	2	3
Real Imports	4	2	2	2

1985:01-2010:04

	Q1	Q2	Q3	Q4
Real GDP	4	1	3	2
Real PCE: Total	4	1	1	4
Real PCE: Durables	3	1	1	5
Real PCE: Nondurables	4	2	1	3
Real PCE: Services	2	2	2	4
Real Bus Fixed Invest	4	3	1	2
Real Resid Invest	2	1	4	3
Real Govt C & GI	6	0	0	4
Real Govt C & GI: Federal	7	0	0	3
Real Govt C & GI: State/Local	3	1	3	3
Real Exports	3	1	3	3
Real Imports	4	2	2	2

Notes. The 10 lowest growth rates are computed separately for each variable. The numbers in each row sum to 10 because the 10 lowest growth rates must by allocated to one of four quarters. The data are those available at the end of March 2015.

Table 4. Differential Calendar-Quarter Effects on Quarterly Growth Rates for Selected Variables in the National Income and Product Accounts

	Const	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	3.37	0.27	-0.28	-0.76
	(0.00)	(0.69)	(0.67)	(0.25)
	(0.00)	(0.71)	(0.66)	(0.29)
	(0.00)	(0.71)	(0.61)	(0.20)
Real PCE: Total	3.53	-0.25	0.09	-0.48
	(0.00)	(0.63)	(0.86)	(0.37)
	(0.00)	(0.63)	(0.84)	(0.40)
	(0.00)	(0.50)	(0.75)	(0.22)
Real Bus Fixed Invest	4.27	1.14	1.30	0.54
	(0.00)	(0.48)	(0.42)	(0.74)
	(0.00)	(0.51)	(0.41)	(0.75)
	(0.00)	(0.35)	(0.18)	(0.64)
Real Resid Invest	4.60	-0.43	-2.27	-2.29
	(0.07)	(0.91)	(0.53)	(0.52)
	(0.08)	(0.91)	(0.49)	(0.54)
	(0.12)	(0.86)	(0.31)	(0.26)
Real Govt C & GI	1.23	1.65	1.45	-0.03
	(0.03)	(0.04)	(0.07)	(0.97)
	(0.04)	(0.03)	(0.10)	(0.97)
	(0.11)	(0.07)	(0.18)	(0.97)
1985:01-2014:04				
Real GDP	1.87	1.45	0.99	0.87
	(0.00)	(0.02)	(0.12)	(0.17)
	(0.00)	(0.01)	(0.10)	(0.22)
	(0.00)	(0.01)	(0.04)	(0.11)
Real PCE: Total	2.90	-0.00	0.53	-0.24
	(0.00)	(0.99)	(0.36)	(0.67)
	(0.00)	(0.99)	(0.35)	(0.69)
	(0.00)	(0.99)	(0.14)	(0.57)
Real Bus Fixed Invest	2.60	2.38	2.30	0.96
	(0.07)	(0.23)	(0.25)	(0.63)
	(0.09)	(0.23)	(0.25)	(0.65)
	(0.17)	(0.05)	(0.11)	(0.58)
Real Resid Invest	0.30	3.66	1.10	0.46
	(0.90)	(0.28)	(0.75)	(0.89)
	(0.90)	(0.27)	(0.75)	(0.89)
	(0.92)	(0.09)	(0.62)	(0.85)
Real Govt C & GI	0.19	3.28	1.92	0.48
	(0.75)	(0.00)	(0.02)	(0.56)
	(0.76)	(0.00)	(0.02)	(0.58)
	(0.80)	(0.00)	(0.02)	(0.60)

Notes. The table reports parameter estimates and three sets of double-sided p-values for the regression (shown in the text) of quarter-over-quarter growth (quarterly compounding, annualized percentage points) on a constant and three zero-one quarterly dummy variables for the second, third, and fourth quarters. The dummy variables take a value of unity for the indicated quarter. The double-sided p-values are those for OLS using Student's T-distribution and HAC using a normal distribution and flat window with the truncation parameter set, alternatively to zero quarters and four quarters. The data are those available at the end of March 2015.

Table 5. Mean Growth Rates, by Quarter: Real GDP and Model-Based Estimates of Real GDP
(Annualized Percentage Points)

	Q1	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	3.37	3.64	3.09	2.61*
Real GDP - Model 1	3.34	3.20	3.16	2.89*
Real GDP - Model 2	3.24	3.18	3.13	2.98*
Real GDP - Model 3 (GDPplus)	3.31	3.09	3.10	3.06*
Real GDP - Model 4	3.19	3.12	3.20	3.01*
1985:01-2014:04				
Real GDP	1.87*	3.31	2.86	2.74
Real GDP - Model 1	2.60*	2.90	2.76	2.72
Real GDP - Model 2	2.69*	2.85	2.78	2.74
Real GDP - Model 3 (GDPplus)	2.90	2.76	2.70	2.67*
Real GDP - Model 4	2.94*	3.02	3.07	3.01

Notes. The table reports average quarter-over-quarter growth rates for each quarter over the indicated sample period for the BEA's official estimates of real GDP and four model-based estimates constructed as described in the text. The data are those available at the end of March 2015.

Table 6. Percent of Years the Lowest Quarterly Growth Rate of the Year Appears in Each Quarter: Real GDP and Model-Based Estimates of Real GDP (Percentage Points)

	Q1	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	35.7	16.1	17.9	30.4
Real GDP – Model 1	33.9	21.4	14.3	30.4
Real GDP – Model 2	39.3	16.1	14.3	30.4
Real GDP – Model 3 (GDPplus)	32.1	16.1	19.6	32.1
Real GDP – Model 4	33.9	21.4	16.1	28.6
1985:01-2014:04				
Real GDP	50.0	13.3	16.7	20.0
Real GDP – Model 1	46.7	20.0	16.7	16.7
Real GDP – Model 2	43.3	13.3	20.0	23.3
Real GDP – Model 3 (GDPplus)	33.3	13.3	23.3	30.0
Real GDP – Model 4	36.7	30.0	13.3	20.0

Notes. The table reports the percent of years (multiplied by 100) in which the lowest quarter-over-quarter growth rate occurred in each quarter for the BEA's official estimates and four model-based estimates as described in the text. The numbers in each row sum to 100 percent (up to rounding error). The data are those available at the end of March 2015.

Table 7. Number of Times the 10 Lowest Growth Rates in the Sample Fall Into Each Quarter: Real GDP and Model-Based Estimates of Real GDP

	Q1	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	3	1	1	5
Real GDP – Model 1	4	1	0	5
Real GDP – Model 2	4	1	2	3
Real GDP – Model 3 (GDPplus)	3	2	2	3
Real GDP – Model 4	3	1	2	4
1985:01-2014:04				
Real GDP	6	0	2	2
Real GDP – Model 1	4	0	3	3
Real GDP – Model 2	3	2	3	2
Real GDP – Model 3 (GDPplus)	1	1	4	4
Real GDP – Model 4	2	2	3	3

Notes. The 10 lowest growth rates are computed separately for each variable. The numbers in each row sum to 10 because the 10 lowest growth rates must by allocated to one of four quarters. The data are those available at the end of March 2015.

Table 8. Differential Calendar Quarter-Effects on Growth Rates: Real GDP and Model-Based Estimates of Real GDP

	Const	Q2	Q3	Q4
1959:01-2014:04				
Real GDP	3.37	0.27	-0.28	-0.76
	(0.00)	(0.69)	(0.67)	(0.25)
	(0.00)	(0.71)	(0.66)	(0.29)
	(0.00)	(0.71)	(0.61)	(0.20)
Real GDP - Model 1	3.34	-0.14	-0.18	-0.45
	(0.00)	(0.81)	(0.76)	(0.43)
	(0.00)	(0.81)	(0.75)	(0.47)
	(0.00)	(0.78)	(0.62)	(0.17)
Real GDP - Model 2	3.24	-0.06	-0.11	-0.26
	(0.00)	(0.90)	(0.81)	(0.58)
	(0.00)	(0.90)	(0.81)	(0.61)
	(0.00)	(0.84)	(0.64)	(0.18)
Real GDP - Model 3 (GDPplus)	3.31	-0.22	-0.21	-0.26
	(0.00)	(0.67)	(0.67)	(0.61)
	(0.00)	(0.66)	(0.66)	(0.64)
	(0.00)	(0.49)	(0.43)	(0.28)
Real GDP - Model 4	3.19	-0.07	0.01	-0.18
	(0.00)	(0.88)	(0.97)	(0.69)
	(0.00)	(0.88)	(0.97)	(0.71)
	(0.00)	(0.77)	(0.92)	(0.14)

Table 8 (continued). Differential Calendar Quarter-Effects on Growth Rates: Real GDP and Model-Based Estimates of Real GDP

	Const	Q2	Q3	Q4
1985:01-2014:04				
Real GDP	1.87	1.45	0.99	0.87
	(0.00)	(0.02)	(0.12)	(0.17)
	(0.00)	(0.01)	(0.10)	(0.22)
	(0.00)	(0.01)	(0.04)	(0.11)
Real GDP – Model 1	2.60	0.30	0.16	0.12
	(0.00)	(0.61)	(0.79)	(0.84)
	(0.00)	(0.58)	(0.78)	(0.85)
	(0.00)	(0.51)	(0.76)	(0.81)
Real GDP – Model 2	2.69	0.16	0.09	0.05
	(0.00)	(0.74)	(0.85)	(0.92)
	(0.00)	(0.72)	(0.85)	(0.93)
	(0.00)	(0.59)	(0.80)	(0.89)
Real GDP – Model 3 (GDPplus)	2.90	-0.15	-0.20	-0.24
	(0.00)	(0.79)	(0.72)	(0.67)
	(0.00)	(0.78)	(0.71)	(0.69)
	(0.00)	(0.71)	(0.66)	(0.58)
Real GDP – Model 4	2.94	0.07	0.13	0.07
	(0.00)	(0.88)	(0.79)	(0.88)
	(0.00)	(0.87)	(0.78)	(0.89)
	(0.00)	(0.78)	(0.69)	(0.84)

Notes. The table reports parameter estimates and three sets of double-sided p-values for the regression (shown in the text) of quarter-over-quarter growth (quarterly compounding, annualized percentage points) on a constant and three zero-one quarterly dummy variables for the second, third, and fourth quarters. The dummy variables take a value of unity for the indicated quarter. The double-sided p-values are those for OLS using Student's T-distribution and HAC using a normal distribution and flat window with the truncation parameter set, alternatively to zero quarters and four quarters. The growth rates are those for the BEA's official measure of real GDP and four model-based estimates as described in the text. The data are those available at the end of March 2015.

Table 9. Quarter-over-Quarter Growth Rates for Real GDP, Real GDI and Some Components on the Income Side of the National Accounts, by Quarter (Annualized Percentage Points)

	Q1	Q2	Q3	Q4
1985:01-2014:04				
Real GDP	1.87*	3.31	2.86	2.74
Real GDI	2.92	2.74	2.69*	2.72
Real Employee Compensation	2.69	2.37	2.23*	3.06
Real Wages and Salaries	2.46	2.33	2.13*	3.09
Real Prop Income (with IVA & CCAdj)	5.89	3.58	3.53*	4.19
Real Rental Income (with CCAdj)	8.05*	10.32	12.16	15.99
Real Corp Profits After Tax (with IVA & CCAdj)	11.47	10.53	6.78	0.42*
1985:01-2010:04				
Real GDP	2.11*	3.40	2.81	2.77
Real GDI	3.05	2.80	2.68	2.66*
Real Employee Compensation	2.47	2.66	2.39*	3.07
Real Wages and Salaries	2.15*	2.60	2.25	3.06
Real Prop Income (with IVA & CCAdj)	5.30	3.37*	3.47	4.20
Real Rental Income (with CCAdj)	7.06*	10.54	12.91	17.04
Real Corp Profits After Tax (with IVA & CCAdj)	17.72	8.18	5.77	-0.15*

Notes. The table reports estimates for the average quarter-over-quarter growth rate in each quarter over the indicated sample period. The growth rates are computed using the formula for quarterly compounding at an annual rate and expressed in percentage points. For each variable, an asterisk denotes the quarter having the lowest growth rate among the four quarters of the year (denoted Q1, Q2, Q3, and Q4). The data are those available at the end of March 2015. Following the BEA's practice, I deflate nominal gross domestic income with the implicit price deflator for GDP. I use the same deflator for other income-side components (employee compensation, wages and salaries, proprietors' income, rental income, and corporate profits). Note that the series for profits is that for corporate profits after tax with inventory valuation and capital consumption adjustments, which differs from the series that feeds directly into the BEA's calculation of gross domestic income. Note also that gross domestic income is comprised of more components than the ones included in the table above.

Table 10. Differential Calendar Quarter-Effects on Growth Rates: Real GDP, Real GDI and Some Components on the Income Side of the National Accounts, by Quarter (Annualized Percentage Points)
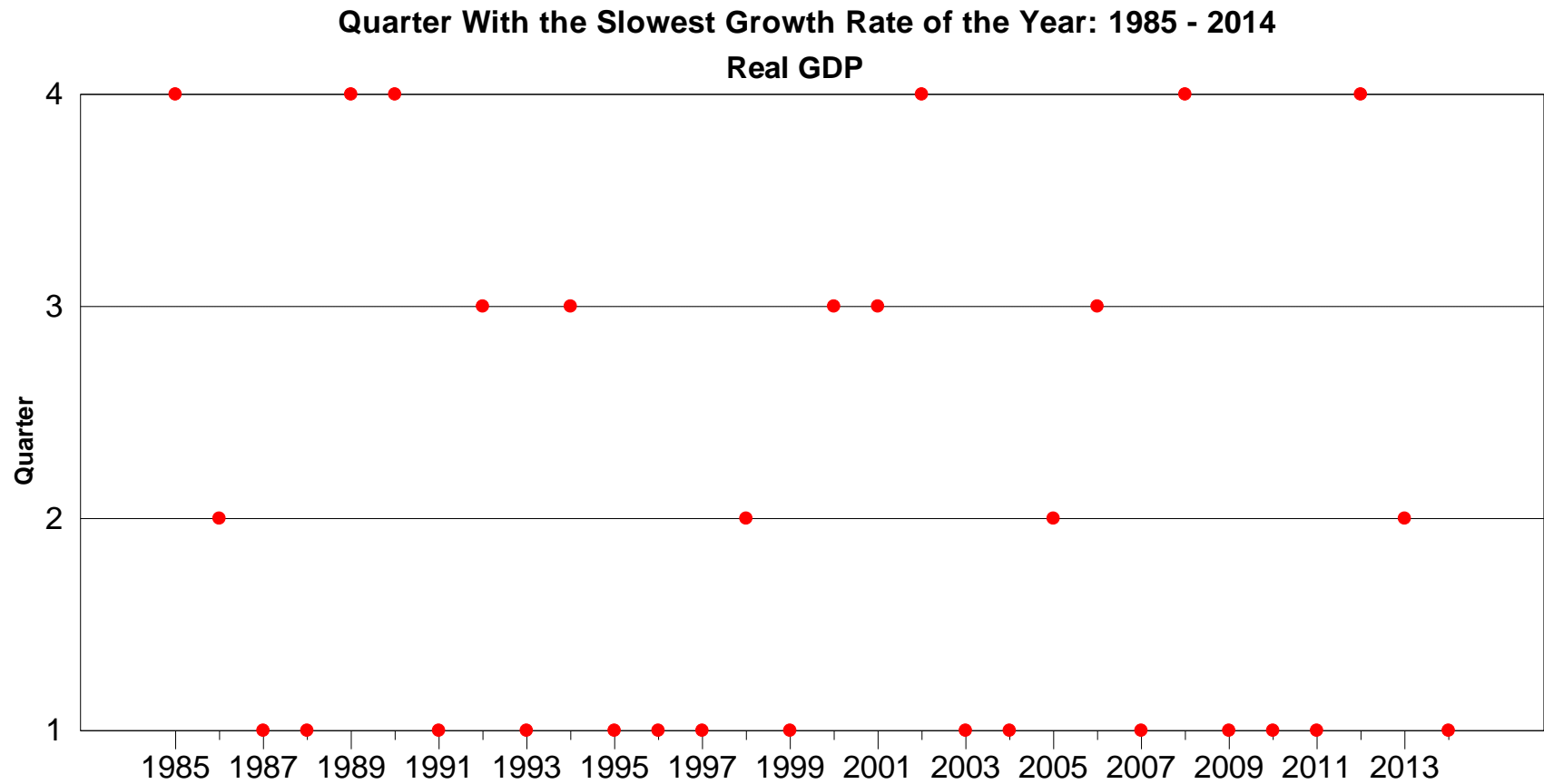
	Const	Q2	Q3	Q4
1985:01-2014:04				
Real GDP	1.87	1.45	0.99	0.87
	(0.00)	(0.02)	(0.12)	(0.17)
	(0.00)	(0.01)	(0.10)	(0.22)
	(0.00)	(0.01)	(0.04)	(0.11)
Real GDI	2.92	−0.19	−0.23	−0.21
	(0.00)	(0.79)	(0.74)	(0.77)
	(0.00)	(0.78)	(0.75)	(0.80)
	(0.00)	(0.79)	(0.73)	(0.78)
Real Employee Compensation	2.69	−0.31	−0.46	0.38
	(0.00)	(0.72)	(0.60)	(0.66)
	(0.00)	(0.75)	(0.64)	(0.72)
	(0.01)	(0.78)	(0.59)	(0.66)
Real Wages and Salaries	2.46	−0.13	−0.33	0.63
	(0.00)	(0.89)	(0.73)	(0.51)
	(0.01)	(0.91)	(0.76)	(0.59)
	(0.03)	(0.92)	(0.74)	(0.54)
Real Prop Income (with IVA & CCAdj)	5.89	−2.31	−2.37	−1.70
	(0.00)	(0.30)	(0.29)	(0.44)
	(0.01)	(0.36)	(0.34)	(0.51)
	(0.00)	(0.25)	(0.16)	(0.47)
Real Rental Income (with CCAdj)	8.05	2.26	4.10	7.93
	(0.14)	(0.77)	(0.59)	(0.30)
	(0.08)	(0.72)	(0.56)	(0.33)
	(0.14)	(0.49)	(0.39)	(0.39)
Real Corp Profits After Tax (with IVA & CCAdj)	11.47	−0.94	−4.70	−11.05
	(0.03)	(0.90)	(0.53)	(0.14)
	(0.18)	(0.92)	(0.61)	(0.24)
	(0.16)	(0.92)	(0.58)	(0.23)

Table 10 (continued). Differential Calendar Quarter-Effects on Growth Rates: Real GDP, Real GDI and Some Components on the Income Side of the National Accounts, by Quarter (Annualized Percentage Points)

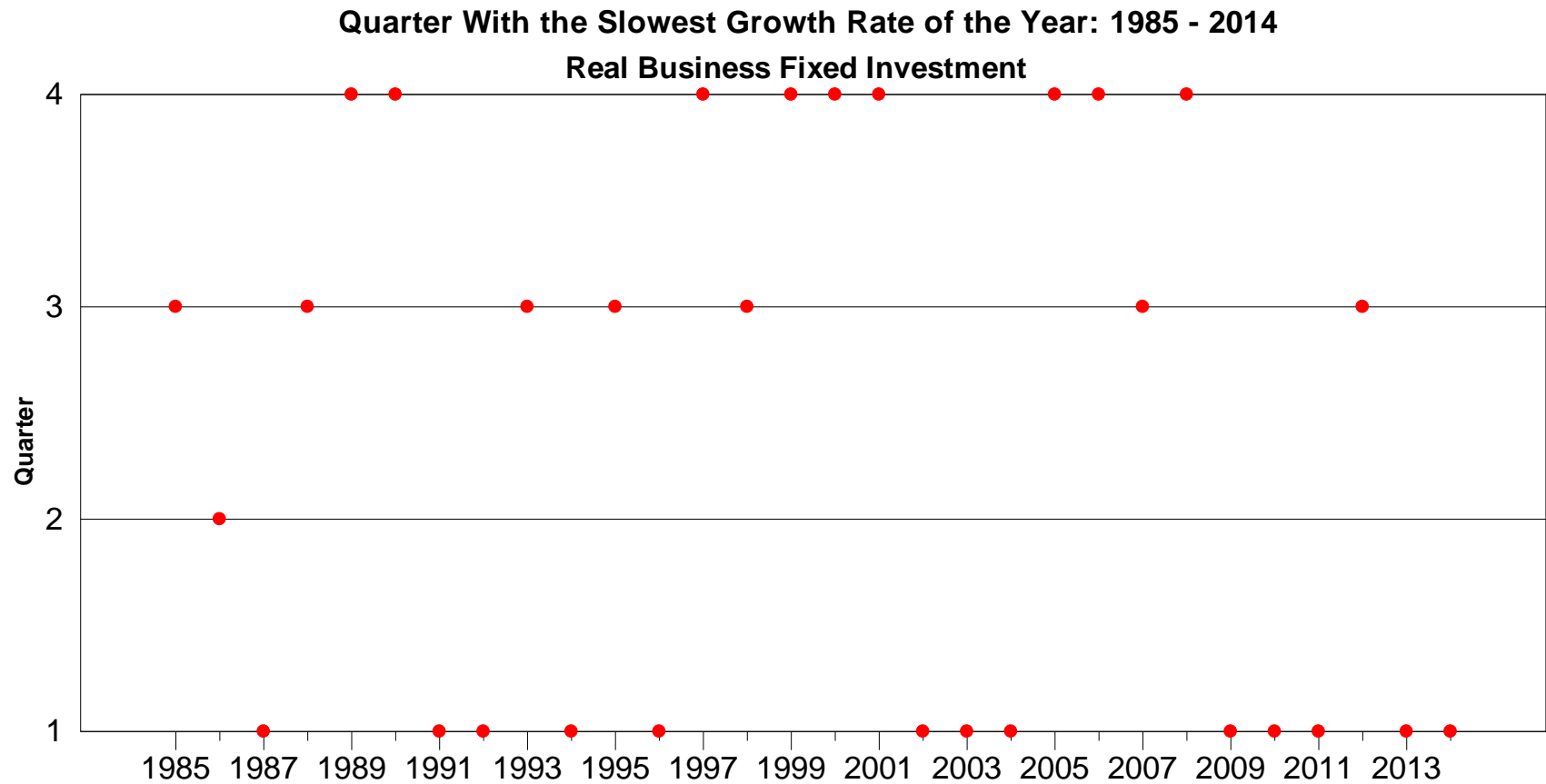|	Const	Q2	Q3	Q4
1985:01-2010:04				
Real GDP	2.11	1.30	0.70	0.66
	(0.00)	(0.06)	(0.31)	(0.34)
	(0.00)	(0.03)	(0.27)	(0.40)
	(0.00)	(0.02)	(0.14)	(0.26)
Real GDI	3.05	-0.25	-0.37	-0.39
	(0.00)	(0.75)	(0.64)	(0.62)
	(0.00)	(0.74)	(0.63)	(0.66)
	(0.00)	(0.74)	(0.61)	(0.63)
Real Employee Compensation	2.47	0.19	-0.08	0.60
	(0.00)	(0.83)	(0.93)	(0.51)
	(0.01)	(0.85)	(0.94)	(0.58)
	(0.03)	(0.88)	(0.93)	(0.52)
Real Wages and Salaries	2.15	0.45	0.10	0.90
	(0.00)	(0.66)	(0.92)	(0.38)
	(0.04)	(0.71)	(0.93)	(0.46)
	(0.11)	(0.76)	(0.93)	(0.42)
Real Prop Income (with IVA & CCAdj)	5.30	-1.92	-1.83	-1.09
	(0.00)	(0.45)	(0.47)	(0.66)
	(0.03)	(0.50)	(0.52)	(0.71)
	(0.01)	(0.40)	(0.35)	(0.69)
Real Rental Income (with CCAdj)	7.06	3.49	5.85	9.98
	(0.26)	(0.69)	(0.51)	(0.26)
	(0.18)	(0.63)	(0.47)	(0.29)
	(0.25)	(0.32)	(0.26)	(0.34)
Real Corp Profits After Tax (with IVA & CCAdj)	17.72	-9.54	-11.95	-17.87
	(0.00)	(0.24)	(0.14)	(0.03)
	(0.05)	(0.32)	(0.23)	(0.07)
	(0.03)	(0.25)	(0.12)	(0.05)

Notes. The table reports parameter estimates and three sets of double-sided p-values for the regression (shown in the text) of quarter-over-quarter growth (quarterly compounding, annualized percentage points) on a constant and three zero-one quarterly dummy variables for the second, third, and fourth quarters. The dummy variables take a value of unity for the indicated quarter. The double-sided p-values are those for OLS using Student's T-distribution and HAC using a normal distribution and flat window with the truncation parameter set, alternatively to zero quarters and four quarters. The data are those available at the end of March 2015. Following the BEA's practice, I deflate nominal gross domestic income with the implicit price deflator for GDP. I use the same deflator for other income-side components (employee compensation, wages and salaries, proprietors' income, rental income, and corporate profits). Note that the series for profits is that for corporate profits after tax with inventory valuation and capital consumption adjustments, which differs from the series that feeds directly into the BEA's calculation of gross domestic income. Note also that gross domestic income is comprised of more components than the ones included in the table above.

Figure 1A.

Quarter With the Slowest Growth Rate of the Year: 1985 - 2014
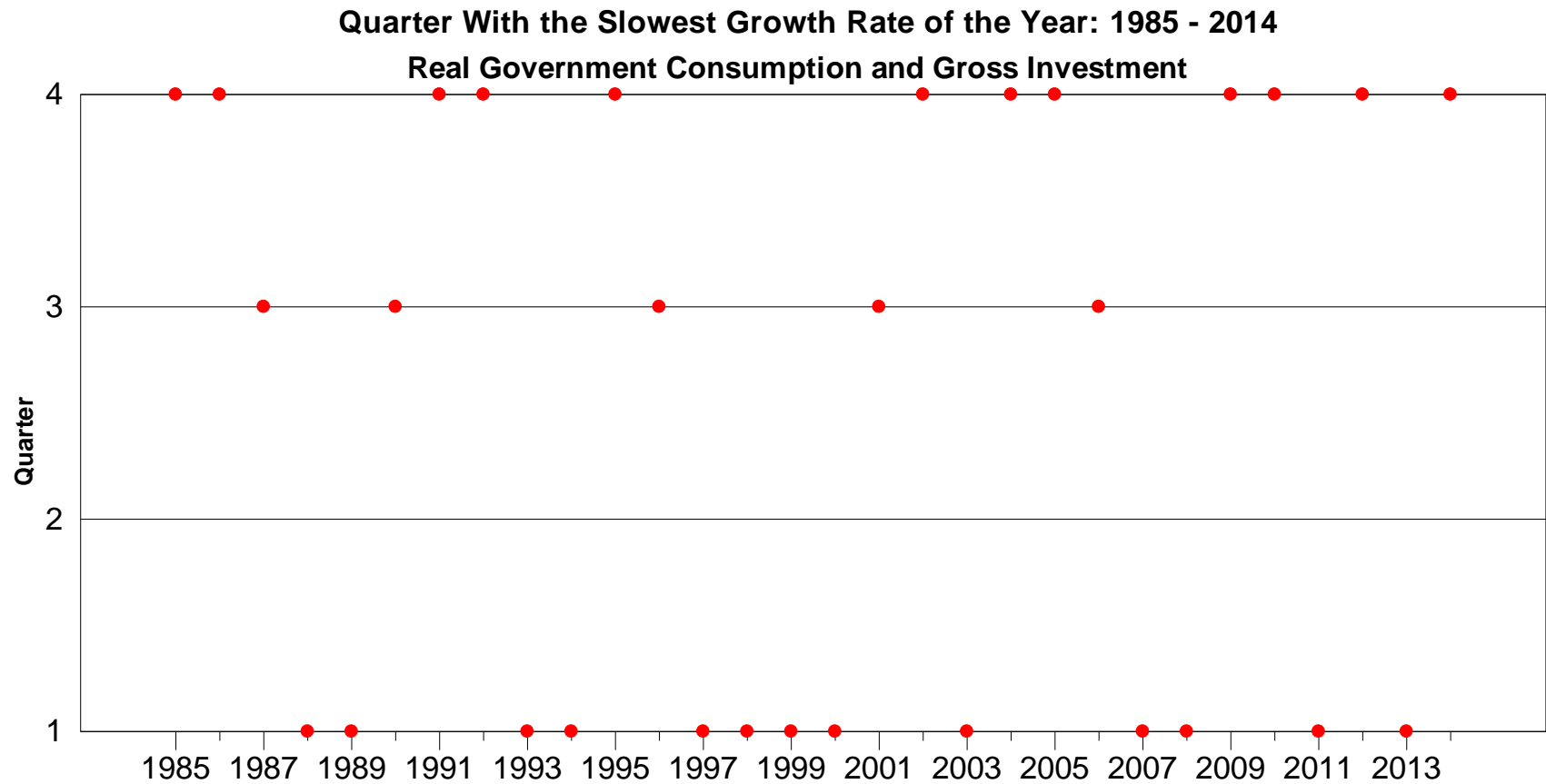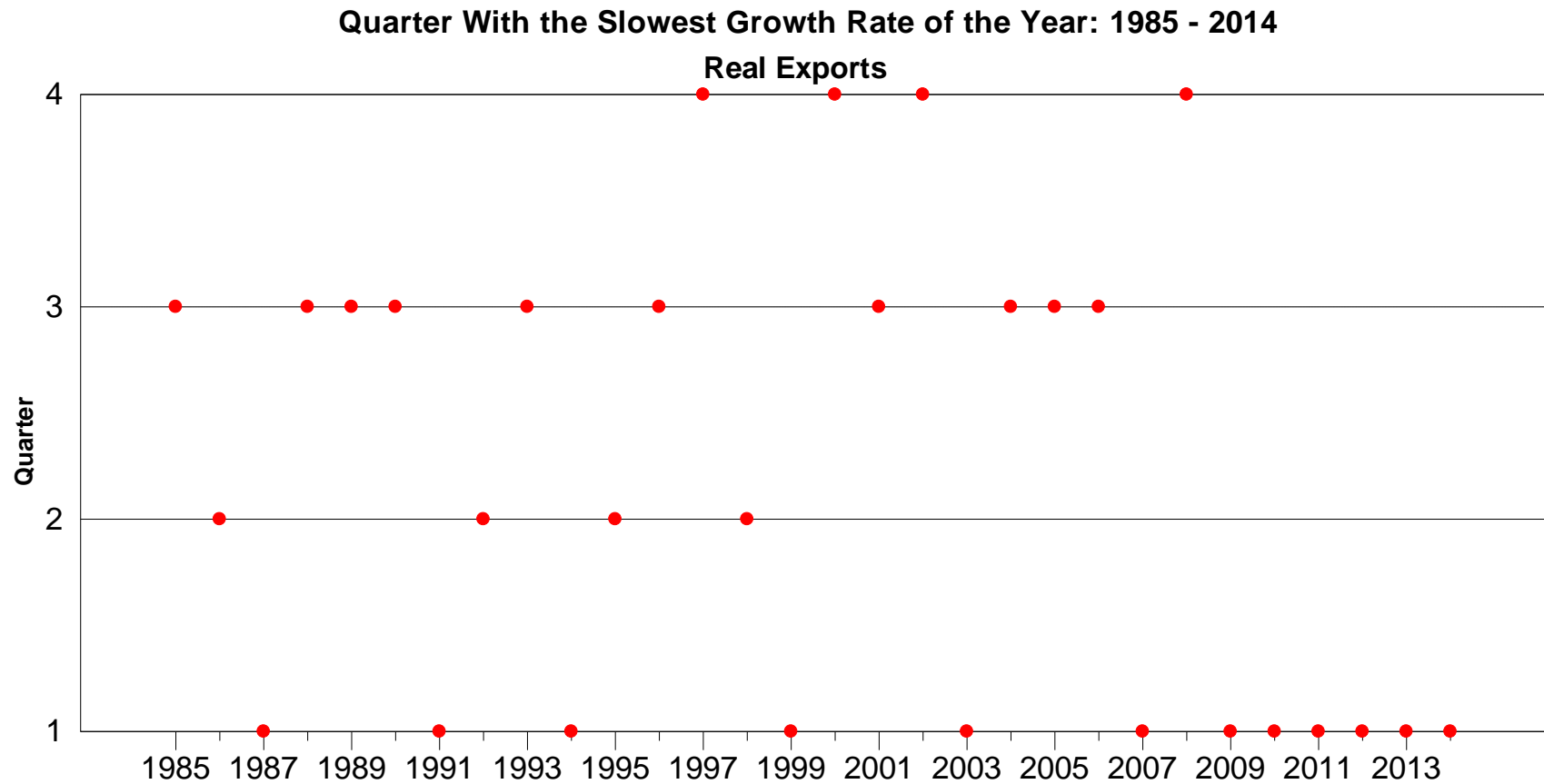
Real GDP

The figure plots the quarter (first, second, third, or fourth) with the slowest growth of the year. Sources: Bureau of Economic Analysis, author's calculations.

Figure 1B.

Quarter With the Slowest Growth Rate of the Year: 1985 - 2014

Real Business Fixed Investment

The figure plots the quarter (first, second, third, or fourth) with the slowest growth of the year. Sources: Bureau of Economic Analysis, author's calculations.

Figure 1C.

Quarter With the Slowest Growth Rate of the Year: 1985 - 2014
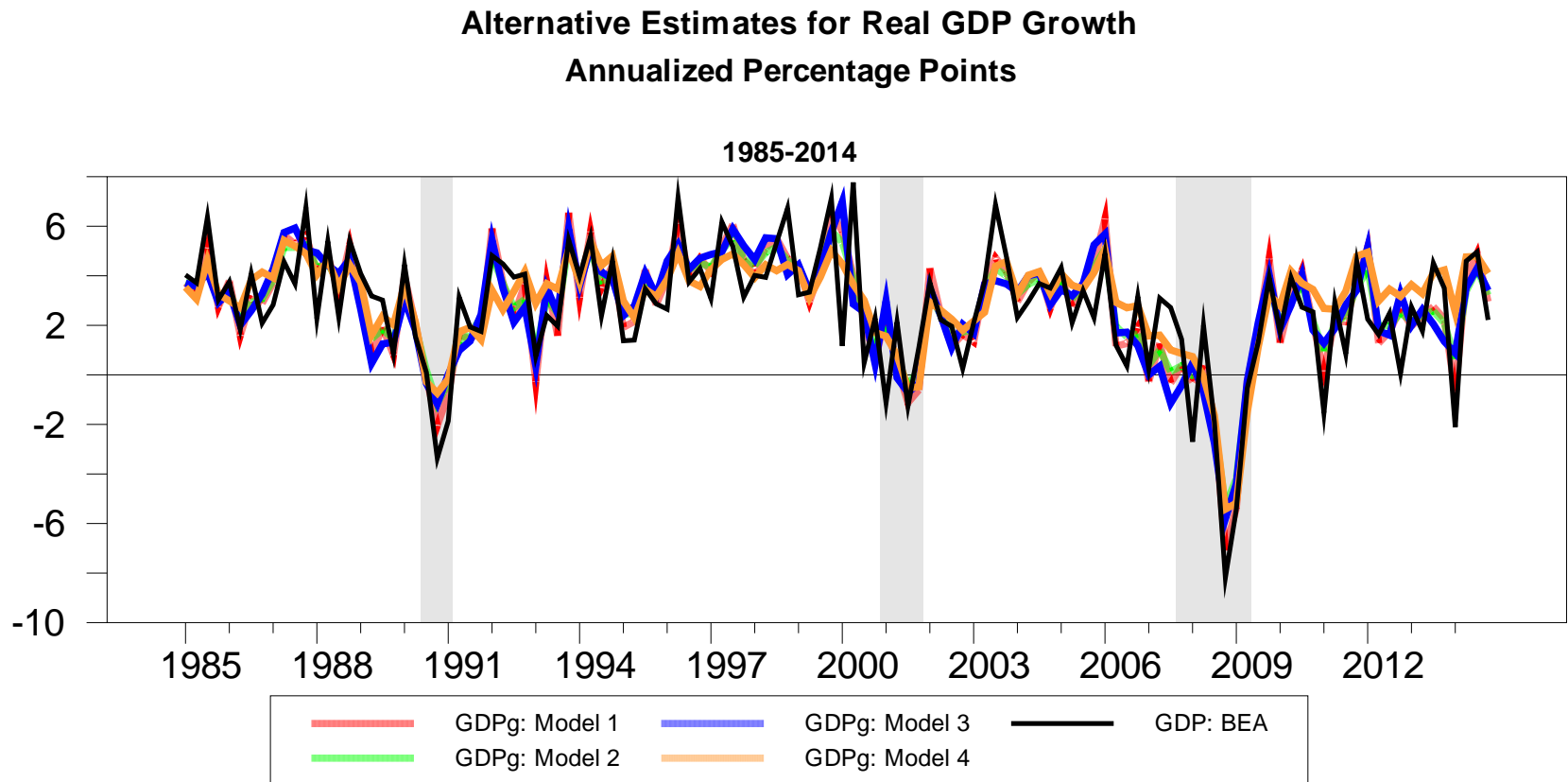Real Government Consumption and Gross Investment

The figure plots the quarter (first, second, third, or fourth) with the slowest growth of the year. Sources: Bureau of Economic Analysis, author's calculations.

Figure 1D.

Quarter With the Slowest Growth Rate of the Year: 1985 - 2014

Real Exports

The figure plots the quarter (first, second, third, or fourth) with the slowest growth of the year. Sources: Bureau of Economic Analysis, author's calculations.

Figure 2.

Alternative Estimates for Real GDP Growth
Annualized Percentage Points

1985-2014

The figure shows four model-based estimates of real GDP growth and the estimates from the BEA. Shading denotes recessions as defined by the NBER.