Real-Time GDP Growth Forecasts

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December 1997

Research Department

Working Paper

97-10

Federal Reserve Bank of Dallas

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November 1997

This paper benefited greatly from comments and suggestions offered by Preston Miller and, especially, Ken Emery. The views expressed are those of the authors, and should not be taken to represent the official views of the Federal Reserve Bank of Dallas or the Federal Reserve System.

Abstract

We forecast current-quarter real GDP growth using monthly data that would have been available to an analyst in real time. We demonstrate that using real-time data is of major importance both when estimating GDP forecasting models and when evaluating their performance. Moreover, we show that the out-of-sample forecasting performance of our model is comparable or superior to that of the Blue-Chip consensus forecast provided that more than one month of current-quarter data are available.

Introduction

Both when making business plans and when formulating monetary policy, it is essential to have as clear a picture as possible of current economic conditions. In this regard, an important summary statistic is the growth rate of real gross domestic product (GDP). Economists devote substantial time and effort to constructing early estimates of current-quarter GDP growth, and their prognostications receive much press attention. Despite this effort and scrutiny, GDP forecasts are not very accurate. For example, since 1990, the root-mean-square error of the highly respected Blue Chip consensus forecast of current-quarter GDP has been 1.6 percentage points based on forecasts published in the second month of the quarter, and 1.2 percentage points based on forecasts published in the first month *after* the quarter. A 95% confidence interval for an early estimate of real GDP growth is fully 6.2 percentage points wide, while a 95% confidence interval for an end-of-quarter estimate of real GDP growth is 4.8 percentage points wide.[1]

This paper reports on an effort to use monthly, coincident indicators of real economic activity to forecast current-quarter GDP growth. In large part, the motivation for this effort is a desire to obtain more accurate and more timely forecasts than those currently available from private forecasting firms. Recent research suggests that the predictions of individual private analysts may have an irrational element (Lamont 1995, Ehrbeck and Waldmann 1996) or be rationally inaccurate (Laster, Bennett, and Geoum 1997). Consensus forecasts have a better record than most individual analysts (Graham 1996, McNees 1987), but often do not reflect all the information that one might wish. For example, the Blue Chip newsletter that a subscriber receives during the second week of a given month contains forecasts based on information that was available within the first week of that month. As a result, the forecasts contained in the July newsletter do not reflect industrial production and retail sales data for June, and may or may not reflect the June employment numbers, even though all these data are released by mid July.

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[1] These root-mean-square errors and confidence bounds assume that one is trying to forecast the Commerce Department's "final" GDP growth estimate, which becomes available with a three-month lag. If, instead, one is trying to predict the Commerce Department's "advance" estimate (available with a one-month lag), the early-quarter and end-of-quarter errors are 1.3 percentage points and 0.9 percentage points, respectively. The corresponding 95% confidence bounds are 5.1 and 3.6 percentage points wide.

Finally, it is not clear whether private analysts are trying to forecast the variables that are of greatest concern to policy makers. Within the current quarter, private analysts appear to focus on predicting the Commerce Department's first, or "advance" estimate of GDP growth (Trehan 1989). However, this initial government estimate is based on incomplete data. Arguably, policy makers are more interested in the third, or "final" estimate of GDP growth, which more accurately measures the actual behavior of the economy.[2] The model that does the best job of forecasting the advance GDP estimate is not necessarily the model that does the best job of forecasting the final estimate.

Our study is unique in its extensive use of real-time data. For each variable in our model at each month in our sample, we have a 12-month history of the data that were available at the time. This data set allows us to obtain an accurate assessment of how well our model is likely to perform in actual use. Moreover, it allows us to achieve a level of forecasting performance markedly superior to that which would have been possible had we estimated the model conventionally, using today's data. To minimize the dangers of over fitting, we rely heavily on rolling, out-of-sample forecast exercises when evaluating the performance of our model and when comparing its forecasts to the forecasts of others.

When we say we use real-time data, we mean that at every point in the sample, the data used in the estimation is always the data that would have been available to a private forecaster at the time. For example, when the left-hand-side variable is 1985:Q1 GDP growth, all right-hand-side variables are measured as they appeared in the first quarter of 1985. Thus, we use data of as many vintages as there are data points in the sample.

Closely related work includes Braun (1990), Trehan (1989, 1992), Fitzgerald and Miller

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[2] Of course, even the "final" estimate is not really final: it is followed by benchmark revisions and rebasings. However, both types of revision become available only so far after the fact as to be largely irrelevant to policy makers. Moreover, it is not at all clear that rebased statistics give a more accurate picture of GDP movements than do earlier releases. For example, 1985 real GDP growth is probably better measured in 1982 dollars than in 1992 dollars. Of course, rebasings are much less of an issue for chain-weight measures of real GDP than for fixed-weight measures.

(1989), and Miller and Chin (1996).[3] Braun predicts current-quarter output growth using monthly labor-market data. His procedure has two steps: estimating a relationship between output growth and the quarterly average of either aggregate hours or the unemployment rate, and forecasting the quarterly average of the relevant labor-market variable from available monthly observations of that variable. Although Braun is careful to use real-time hours and unemployment data in his estimations, the output-growth data are not real time. Moreover, only in-sample forecasting results are reported.[4]

Trehan, like Braun, uses a two-step approach to forecasting current-quarter aggregate output. Three monthly indicator variables are included in the model: non-farm employment, industrial production, and real retail sales. When complete data for a given quarter are unavailable, a Bayesian vector autoregression (BVAR) is used to fill in the missing information. Unfortunately, the model is estimated using current data rather than data that would have been available to an analyst forecasting in real time. Moreover, Trehan takes only a cursory look at the real-time performance of his model in comparison to the forecasting performance of private analysts.[5]

Miller and Chin take Trehan's approach one step farther, combining the GDP forecasts generated by a model that uses monthly data with those generated by a more conventional quarterly model. Like Trehan, Miller and Chin do most of their analysis using currently-available data and take only a brief look at the real-time performance of their model.

Unlike Trehan and Miller-Chin, Fitzgerald and Miller use only real-time data. However, the Fitzgerald-Miller definition of real-time data differs from the definition used here. Thus,

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[3] Zadrozny (1990) and Rathjens and Robins (1993) are somewhat less closely related to the current paper, as they use monthly data to improve forecasts of *next* quarter's output growth. Moreover, neither paper uses real-time data.

[4] The distinction between in-sample and out-of-sample results is potentially quite important in Braun's framework, because his output-growth forecasts are contingent on estimates of trend productivity growth (in the hours model) or the NAIRU and potential output (in the unemployment model). All three of these estimates are notoriously subject to revision.

[5] Table 3 in Trehan (1992) reports the real-time mean errors, mean absolute errors, and root mean square errors generated over a four-year period by the Trehan model and the Blue Chip consensus forecast.

Fitzgerald and Miller use data that is of a single vintage in each of their estimations: each right-hand-side variable is measured as it would have been at the end-date of the sample period. In contrast, we have as many vintages as data points: at each date within our sample, we use only data that would have been available at the time. Moreover, Fitzgerald and Miller limit themselves to predicting the advance estimate of output growth using monthly aggregate hours data. Forecasts from the Fitzgerald-Miller model are compared with those from the Minneapolis Fed's quarterly model, but not with the monthly forecasts of private analysts.

We have blended aspects of the Braun, Trehan, and Fitzgerald-Miller approaches to forecasting aggregate output. Like Trehan, we look to monthly employment, industrial production, and real retail sales for information on current-quarter real GDP. As in Braun, our right-hand-side variables are all measured as they would have been in real time. However, as in Fitzgerald and Miller, our aggregate output data is also real time, being either real GDP growth as initially reported or as reported in the Commerce Department's final (third) release. Real-time data sets are tedious to assemble. To keep the data requirements of the current exercise manageable, we do not follow Braun, Trehan, and Miller-Chin in estimating a separate model for forecasting missing monthly data.[6] Instead, we regress GDP growth directly on monthly employment, production, and sales data, and on lagged quarterly GDP growth rates.

Our principal findings are as follows. First, provided that we have two or three months of current-quarter data, the Blue Chip forecast contains no information beyond that already contained in the forecasts of our model, and our root-mean-square errors are substantially lower than those reported by Miller and Chin and Fitzgerald and Miller. On the other hand, our model does rather poorly when only one month of current quarter data are available. This comparative weakness probably reflects the fact that our model contains only coincident--not *leading*--indicators of real economic activity. Second, our out-of-sample predictions of the advance GDP estimate are somewhat more accurate than our predictions of the final GDP estimate. Both sets

[6] One might be tempted to include a short-term interest rate or a long-short interest-rate spread in the forecasting model, on the grounds that such variables are not subject to ex post revisions and tend to move in advance of real activity. However, any such forecasting relationship would likely be sensitive to the monetary authority's policy rule and, hence, unreliable.

of forecasts pass simple efficiency and stability tests, provided that two or three months of current-quarter data are available. Finally, we demonstrate how important it is that the estimation and evaluation of GDP forecasting models be conducted using data that would have been available to an analyst in real time. Out-of-sample forecasting exercises that use currently-available data rather than real-time data can give a very misleading impression of how well a forecasting model will do in real time. For the particular forecasting model developed in this paper, taking the conventional approach markedly *under*states real-time performance.[7]

The following section describes our model in detail. Next, the real-time data set is discussed and empirical results are presented. Concluding remarks complete the paper.

The Model

We actually estimate three completely separate models: one using a single month of current-quarter data, a second using two months of current-quarter data, and a third using a full three months of current-quarter data. In principle, there are restrictions that one could impose across the models to improve the efficiency of the estimation. We chose, instead, to focus our efforts on collecting an unusually complete set of real-time data (described below) and conducting a thorough set of out-of-sample real-time forecasting experiments.

Following Trehan (1992), our initial set of monthly indicator variables included non-farm employment, real retail sales (nominal sales deflated by the consumer price index), and industrial production. These variables are all important and closely-watched direct measures of current real economic activity. Non-farm employment and industrial production are among only four variables included in the Conference Board's composite coincident index, and real retail sales serve as a timely proxy for a third component of that index (real manufacturing and trade sales).[8,9]

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[7] Braun (1990) finds that exactly the opposite is true for his models.

[8] The fourth component of the coincident index--real personal income--is released substantially later than the employment, retail sales, CPI, and industrial production reports.

[9] Based on findings reported in Koenig (1996) and Fitzgerald and Miller (1989), we tried including manufacturing capacity utilization, the aggregate hours of workers in the service-

To obtain our forecasting models, we regressed the annualized quarter-to-quarter percentage change in real GDP on a constant, four lagged percentage changes in real GDP, and five annualized month-to-month percentage changes in each of our three coincident indicators. To be precise, we estimated equations the form:

$$\Delta y_t = \alpha_{0,s} + \Sigma_{i=1}^{4} \alpha_{i,s} \Delta y_{t-i} + \Sigma_{j=1}^{5} \beta_{j,s} \delta em_{t,s-j} + \Sigma_{j=1}^{5} \gamma_{j,s} \delta ip_{t,s-j} + \Sigma_{j=1}^{5} \epsilon_{j,s} \delta rs_{t,s-j},$$

where Δy_t denotes the annualized quarterly percentage change in real GDP in quarter t , and where $\delta em_{t,s}$, $\delta ip_{t,s}$, and $\delta rs_{t,s}$ are the annualized monthly percentage changes in non-farm employment, industrial production, and real retail sales, respectively, in month s of quarter t.[10] When s = 1, all right-hand-side variables are as they would have appeared to an analyst immediately after the release of the industrial production, retail sales, and CPI reports for the first month of quarter t. Similarly, when s = 2, all right-hand-side variables are as they would have appeared to an analyst after the release of the industrial production, retail sales, and CPI reports for the second month of quarter t. Finally, when s = 3, all right-hand-side variables are as they would have appeared to an analyst after the release of the industrial production, retail sales, and reports for the third month of quarter t. As alternative left-hand-side variables we used real GDP growth as estimated in the Commerce Department's "advance" report (generally released during the first month after the end of the quarter) and real GDP growth as estimated in the Commerce Department's "final" report (released during the third month after the end of the quarter).[11]

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producing sector, and the ratio of goods-producing to service-producing hours as additional right-hand-side variables. However, none of these variables was statistically significant, and we dropped them from our analysis. Below, we compare the out-of-sample forecasting performance of our model to that of the Fitzgerald-Miller model.

[10] If $x_{t,s}$ is a monthly variable, we define $x_{t,0} \equiv x_{t-1,3}$, $x_{t,-1} \equiv x_{t-1,2}$, $x_{t,-2} \equiv x_{t-1,1}$, etc.

[11] During the three-year period from 1984 through 1986, the Commerce Department released a "flash" current-quarter GNP estimate in the third month of each quarter. Our analysis ignores this estimate.

Equation 1 can be rationalized as follows. Let y_t denote the logarithm of quarterly aggregate output and suppose that there is a monthly measure of current real economic activity, $z_{t,s}$, such that $y_t = (z_{t,3} + z_{t,2} + z_{t,1})/3$ for all t. Then

$$y_t - y_{t-1} = [(z_{t,3} - z_{t,2}) + 2(z_{t,2} - z_{t,1}) + 3(z_{t,1} - z_{t-1,3}) + 2(z_{t-1,3} - z_{t-1,2}) + (z_{t-1,2} - z_{t-1,1})]/3. \quad (2)$$

Thus, the quarter-to-quarter percentage change in real GDP is a weighted average of five month-to-month percentage changes in the coincident indicator. In practice, one or more of the monthly percentage changes on the right-hand side of equation 2 will be either a preliminary estimate or entirely unavailable. If a preliminary estimate, then a regression will de-emphasize that percentage change in favor of others, measured more accurately. If entirely unavailable, then other lagged monthly changes in the coincident indicator may capture some of the missing information. For these reasons, when estimating equation 1 we do not restrict the coefficient weights attached to monthly percentage changes in employment, industrial production, and retail sales. Moreover, when s = 1 or s = 2, we extend the distributed lags in the coincident indicators back in time to include monthly changes from two quarters prior to t.

Data and Estimation Methodology

General Discussion. Table 1 illustrates how we went about estimating our models, using the 1997:Q1 GDP growth forecast as an example. As shown in the top third of the table, all data used in the 1-month model were available by February 19, when the last of the monthly data for January (the CPI) were released. In addition to January data, our forecast is based on lagged monthly growth rates of employment, sales, production and prices extending from September through December of 1996--all measured as of February, 1997--and on GDP growth rates over the period from 1996:Q1-1996:Q4. These lagged GDP growth rates are measured as of January 31, 1997, when the earliest estimate of 1996:Q4 GDP growth was released. Two different versions of the model are estimated. In one version, the left-hand-side variable is the advance estimate of 1997:Q1 GDP growth. In the other version, the left-hand-side variable is the final estimate of 1997:Q1 GDP growth.

As we move to the 2-month and 3-month GDP growth models, notice three things. First, the left-hand-side variables do not change. Second, all three forecasting equations have the same lags of GDP growth on their right-hand sides (1996:Q1 through 1996:Q4). However, the GDP data undergo revisions as we move from the 1-month model to the 2-month model to the 3-month model. Third, the time period covered by the monthly variables on the right-hand sides of the forecasting equations changes as we move from one model to the next. In particular, the range of months over which growth in employment, retail sales, industrial production, and the CPI are measured shifts forward by one month, and all these data go through an additional month of revisions.

Chain-Weight GDP. In constructing the data sets used to forecast chain-weight GDP growth, we treated the switch to chain-weight numbers just like any other GDP data revision or rebasing. In particular, the data sets begin with fixed-weight GDP numbers, and then change over to chain-weight numbers as they become available. We constructed two different data sets for each of the models. The first--used in forecasting "final" chain-weight GDP--switches to the chain-weight numbers when the "final" chain-weight numbers were first released, in the first quarter of 1993. The second, used in forecasting "advance" chain-weight GDP, switches to chain-weight numbers when the "advance" chain-weight numbers were first released. The Commerce Department did not begin publishing its "advance" estimates of chain-weight GDP growth until October of 1994, for the third quarter of 1994. In other words, prior to October of 1994, the chain-weight GDP numbers were released two and three months after each quarter, with no one-month estimate.

The Results

Forecasting Fixed-Weight GDP. We estimated our fixed-weight GDP forecasting equations using data from 1980:Q1 through 1989:Q4 and again using data from 1980:Q1 through 1996:Q4. As noted above, separate models were estimated for predicting the advance estimate of real GDP and predicting the final estimate of real GDP. Moreover, separate models were estimated for the cases in which the analyst would have had one-month of current-quarter data available, two months of current-quarter data available, and three-months of current-quarter data available. All data were real time--exactly the data that would have been available to a private forecaster over this period. For example, when predicting 1985:Q1 GDP growth, we measure all of our right-hand-side variables as they were measured in 1985:Q1.

Tables 2A-C present summary statistics for the in-sample regressions, including the joint statistical significance of the lags of each of the right-hand-side variables, the sum of the coefficients attached to the lags of each of the right-hand-side variables, and the statistical significance of the sum of the coefficients attached to each of the right-hand-side variables. Collectively, the monthly percentage changes in employment, industrial production, and retail sales are always highly statistically significant. (See the F-test results toward the bottom of the tables.) However, due to colinearity between the three indicators, the monthly percentage changes in any particular indicator are sometimes not significant. Advance GDP is consistently easier to predict than final GDP. Possible explanations of this result are discussed below. In predicting final GDP, the overall weight placed on monthly employment data noticeably increases as one goes from forecasts based on one month of current-quarter data to forecasts based on two months of current-quarter data to forecasts based on three months of current-quarter data. Serial correlation is a significant problem only in the model that predicts final real GDP using two months of current-quarter data.

Our out-of-sample forecasting exercises were conducted using rolling samples. Thus, coefficient estimates obtained using data through 1989:Q4 were used to forecast real GDP growth in 1990:Q1. The sample period was then extended by one quarter, the models re-estimated, and the new coefficient estimates were used to forecast 1990:Q2 GDP growth. In this way, we obtained forecasts running from 1990:Q1 through 1995:Q3. The ending date was chosen to preserve comparability with the Miller-Chin and Blue-Chip consensus forecasts. (Miller-Chin's real-time results are confined to 1990:Q1-1995:Q3, and Blue-Chip participants abandoned fixed-weight GDP forecasting in favor of chain-weight GDP forecasting beginning in 1996:Q1.) As always, at each date we used only data that would actually have been available to a private forecaster. Summary statistics from these rolling, out-of-sample forecasting exercises are displayed in Table 3A, in the rows labeled "KD." Plots of actual and forecasted GDP growth are displayed in Figure 1A (the advance GDP estimate) and Figure 1B (the final GDP estimate).

In two important respects, our results are similar to those reported by other analysts. First, we find that it is easier to predict the advance estimate of GDP growth than it is to predict the final estimate. For example, with three months of current-quarter data, the root-mean-square error of our forecast of advance GDP is 0.82 percentage points--1/3 smaller than the 1.23-percentage-point-root-mean-square error that we obtain when forecasting final GDP. Second, we find that the improvement in forecasting performance that is achieved by going from one month of current-quarter data to two months of current quarter data is much larger than that achieved by going from two months of current-quarter data to three months of current-quarter data. Thus, the root-mean-square error of our forecasts of advance GDP drop from 1.63 to 0.93 to 0.82 as we move from 1 month to 2 months to 3 months of current-quarter data. In predicting the final estimate of GDP growth, the root-mean-square error is cut by over 1/3 as a result of adding a second month of data, and not at all as a result of adding a third month of data.[12]

Our first thought was that the relative ease with which we are able to predict the advance GDP estimate might reflect our use of real-time data, rather than revised data, for our right-hand-side variables. For example, our 3-month forecasts are based on data of the same vintage as that available to the Commerce Department when it was preparing the advance estimate of GDP. The data used by the Commerce Department to construct the final GDP estimate, in contrast, is at least two months older than ours. In an effort to test the importance of this "vintage effect" we estimated a version of our 3-month model of final GDP in which the right-hand-side variables

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[12] We experimented with a model intermediate between the 1-month and 2-month Koenig-Dolmas models described above. It used two months of current-quarter employment data, but only one month of current-quarter sales and production data. (The rationale is that sales and production data are not released until about two weeks after the employment data become available.) As might be expected, out-of-sample performance was intermediate between that of our 1-month and 2-month models. However, performance was not as good as the Miller-Chin, Fitzgerald-Miller, and Blue Chip consensus forecasts that would have been available at about the same time (the first week of the third month of the quarter). A model intermediate between our 2-month and 3-month models performed no better than our 2-month model. Given that our 2-month and 3-month models perform about equally well, this result is also not particularly surprising.

were measured three months after the close of the quarter (matching the vintage of the final GDP estimate). Surprisingly, the in-sample and out-of-sample forecasting performance of the model *deteriorated* slightly rather than improved. Apparently, revisions to our monthly indicators are not highly correlated with revisions to the Commerce Department's GDP estimates. The monthly data that probably *are* correlated with GDP revisions are data for variables like inventory investment and net export growth, that are not included in our set of indicators.

As for the result that the third month of current-quarter data has a smaller impact on forecast performance than does the second month, a large part of the explanation is apparent in equation 2: in calculating the quarter-to-quarter change in real activity, the third month of current-quarter data receives only ½ as much weight as the second month of current-quarter data.

Our out-of-sample forecast period includes one outright recession and several quarters in which estimated GDP growth dropped below 1%, but remained positive. For a policy maker, the distinction between outright recessions and growth recessions is important, and it is essential that a forecasting model not confuse the two. In this regard, Figure 1 suggests that our 1-month model is much less satisfactory than our 2-month and 3-month models. The 1-month model often recognizes recessions and slowdowns after the fact, and tends to convert quarters of weak but positive growth into quarters of GDP decline.

How do our forecasts stack up against the real-time forecasts of others? In addition to summary performance measures for the Koenig-Dolmas model, Table 3A gives comparable measures of the performance for the Miller-Chin and Fitzgerald-Miller models and the Blue Chip consensus forecast. The table lists the various forecasts in the order in which they become available. For example, the first forecast listed is the Blue Chip consensus forecast published in the second week of the first month of the quarter, before any current-quarter data are available. The second and third forecasts listed are those obtained from the Miller-Chin and Fitzgerald-Miller models in the first week of the second month of the quarter, just after the release of the employment report for the first month of the quarter. The final forecast is the Commerce Department's own "advance" GDP estimate, released toward the end of the first month of the following quarter. (In the table, the first month of the following quarter is labeled "month four" of the current quarter.)

Forecasting performance ought to improve as more current-quarter data become available. A general tendency in this direction is apparent in the root-mean-square errors reported in Table 3A, but there are notable exceptions. First, the root-mean-square error of each Miller-Chin and each Fitzgerald-Miller forecast is never lower than the root-mean-square error of the Blue Chip forecast released the previous month. Second, the Koenig-Dolmas and Fitzgerald-Miller forecasts that become available during the second month of the quarter yield root-mean-square errors that are strikingly higher than those of the Blue Chip and Miller-Chin forecasts. This poor performance probably reflects the fact that the Koenig-Dolmas and Fitzgerald-Miller forecasts are based solely on coincident indicators of economic activity. In contrast, the Miller-Chin and Blue Chip forecasts incorporate information on variables that tend to lead the business cycle.

One would expect the importance of leading indicators to diminish as more and more current-quarter data become available. Consistent with this expectation, the performance of the Koenig-Dolmas models improves relative to the performance of the Blue Chip forecasts as we move from 1-month results to 2-month and 3-month results. Indeed, our 2-month and 3-month models nearly always yield root-mean-square errors that are lower than those obtained from the Blue Chip newsletter released the same month. The forecasting performance of our 2-month model is nearly as good as that of the Blue Chip newsletter released the *following* month.

In predicting final GDP, the Commerce Department's own advance GDP estimate clearly dominates all challengers.

How is it that our 2-month and 3-month models perform so well, despite their limited information sets and relatively unsophisticated econometrics? We think that the key is our real-time data set. Evidence consistent with this hypothesis is contained in Table 3B. The "KD (rev.)" results in this table are from models estimated using today's data (specifically, data as they appeared in March, 1997), but used to forecast in real time (that is, real-time data are plugged into the estimated equations to generate forecasts). The effect of using today's data in the estimation of the 2-month and 3-month models is to increase their root-mean-square errors by about 50% when predicting advance GDP and by between 22% and 35% when predicting final

GDP.[13] Clearly, the real-time forecasting performance of these models is quite sensitive to how they are estimated: for optimal performance it is important that at each date within the sample period, the data contained in the sample be exactly the data that would have been available to an analyst at the time.

Suppose that we not only estimate our models' equations using today's data, but also plug today's data into the estimated equations to generate forecasts of GDP growth. Moreover, suppose that we compare our forecasts with GDP growth as it is currently reported. In other words, suppose that we do what analysts *usually* do when estimating and evaluating their models and reporting their results. In Table 3B, this exercise is labeled "Naive KD."[14] For the 2-month and 3-month models, root-mean-square errors are 40% to 50% higher than those recorded for the same models estimated and evaluated using real-time data. Root-mean-square errors are between 10% and 15% higher than those reported in the lines labeled "KD (rev.)," where the models are estimated using today's data but evaluated using real-time data. The lesson is that one must use real-time data in both estimation and evaluation if one is to get an accurate sense of how well a given forecasting model is capable of performing in actual use. For our models, the usual approach--which only makes use of today's data--markedly understates actual performance.

Tables 4A-C present results from efficiency tests and tests of marginal predictive power. First, we regressed Commerce Department GDP estimates on a constant and each of several out-of-sample forecasts, including forecasts generated by our own real-time models. A forecast is called efficient if the constant term in this regression is not significantly different from 0 and the coefficient attached to the forecast is not significantly different from 1. The only forecasts that are consistently inefficient are those that our model generates when it is estimated using today's data. [See the results labeled "KD(rev.)."] In addition, our 3-month model estimated with real-

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[13] We conducted a similar exercise in which our models were estimated using data as they appeared at the start of the out-of-sample forecast period, in 1989:Q4. Errors were even larger than those generated by the models estimated with 1997 data.

[14] We report these results in columns headed "Predicting Final Fixed-Weight GDP" even though in this particular case we are comparing the forecasts generated by our model to *today's* GDP growth data rather than real-time Commerce Department "final" estimates.

time data appears to be inefficient when used to predict the final GDP release.[15]

Next, we regressed Commerce Department GDP estimates on a constant, the forecasts of one of our real-time models, and an alternative forecast, such as the Blue Chip consensus. If the alternative forecast has predictive power beyond that of the forecast generated by our real-time model, then the alternative forecast will enter this regression with a statistically significant coefficient. According to Table 4A, not only do the Blue Chip forecasts have predictive power beyond those of our 1-month model, they totally dominate our 1-month forecasts. (Our model fails to have any marginal predictive power beyond the Blue Chip forecasts.) Finally, the entries in the bottom row of Table 4A indicate that there is no advantage to using real-time data when estimating our 1-month model.

Results for our 2-month and 3-month models are considerably more encouraging. According to Tables 4B and 4C, these models, estimated using real-time data, dominate the Blue Chip forecasts released the same month. (In row 5 of the tables, our models have marginal predictive power and the Blue Chip forecasts do not.) Indeed, in predicting the Commerce Department's advance GDP estimate, the performance of our 2-month model compares favorably with that of the Blue Chip newsletter released the *following* month. (In row 6 of Table 4B, our 2-month forecast and the Blue Chip forecast each receive about 50% weight. Multicolinearity prevents either coefficient from achieving statistical significance.) The importance of using real-time data when estimating GDP forecasting equations is illustrated by the results reported in the very last rows of Tables 4B and 4C, which show that our 2-month and 3-month real-time models dominate the same models estimated using today's data.

Row 6 of Table 4C pits our 3-month model of final GDP against the Commerce Department's advance GDP release. One cannot reject the hypothesis that our forecast contains no information beyond that included in the official advance estimate. In contrast, Trehan (1989)

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[15] For this model, the joint hypothesis that the constant term in the efficiency regression is 0 and the slope coefficient is 1 has marginal probability .033.

presents evidence that the advance GDP estimate was inefficient during the 1980s.[16] In an effort to shed further light on the efficiency of the official advance estimate, we again compared the Commerce Department's advance estimates with the forecasts of our 3-month model, this time using in-sample forecasts extending back all the way to 1980:Q1. Results are reported in Table 5, row 1. In results similar to those reported by Trehan and strikingly different from the results reported in Table 4C, our model's forecasts receive 50% weight over the extended sample period, and are highly statistically significant.

A clue to what is happening is displayed in Figure 2, which shows the number of days delay with which the advance GDP estimate was released, beginning in 1980:Q1 and running through 1996:Q4. Over the early part of the sample (through 1987:Q3) the advance GDP estimate was released with an average lag of about 20 days. Beginning in 1987:Q4 the release date was shifted back by a week. A second, smaller shift appears to have occurred in 1996, so that the average lag is now in excess of 30 days.[17] These shifts suggest that since 1988 the Commerce Department has been exercising more care in the preparation of its advance GDP estimates, and that the advance estimates of the late 1980s and early 1990s incorporate more complete information than do the advance estimates of the early-and-mid 1980s. Rows 2, 3, and 4 of Table 5 present evidence consistent with this conjecture. These rows show what happens when the sample period for the efficiency-test regression is split in two, with 1987:Q4 as the dividing point. Quite clearly, the weight attached to the Commerce Department's estimate rises relative to that attached to our model's forecasts as the sample period is extended. Our model's forecast is statistically significant in the late sample period, but its coefficient is cut nearly in half.

In summary, the information content of the Commerce Department's advance GDP estimate has increased, over the years, relative to that of our model's forecasts. However, this increase in relative information content has come at a price. During most of the 1980s, the

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[16] Trehan pits the advance GNP estimate against what appear to be in-sample predictions from his forecasting model. The GNP-GDP distinction is inconsequential for his results.

[17] The 54-day delay in the release of the initial estimate of 95:Q4 GDP was due to the January, 1996 government funding crisis.

Commerce Department's advance estimate was released at about the same time that our 3-month forecast would have been available. Now, the advance estimate is typically not available until fully two weeks after our forecast.

Forecasting Chain-Weight GDP. Real-time Commerce Department chain-weight national income accounts data are available for only a few years, complicating the estimation and evaluation of forecasting models for chain-weight GDP. We experimented with several approaches to estimating such forecasting models. Ultimately, we decided to handle the switch from fixed-weight to chain-weight GDP exactly as if it were a change in the base year of the fixed-weight GDP statistics. Thus, when estimating a model designed to predict the Commerce Department's advance chain-weight GDP release, each of our samples contains nothing but fixed weight data until 1994:Q3 (when advance chain-weight estimates first become available) and uses chain-weight data thereafter. When estimating a model designed to predict the Commerce Department's final chain-weight GDP release, each of our samples contains fixed-weight data through 1992, and chain-weight data from 1993:Q1 onward.

Figures 3A and 3B are the chain-weight counterparts of Figures 1A and 1B. They show actual GDP growth estimates along with forecasts generated by our 1-month, 2-month, and 3-month models of chain-weight GDP. Similarly, Table 6 is the chain-weight counterpart of Table 3. It gives the mean errors, mean absolute errors, and root-mean-square errors generated by our forecasting models. As before, our models are estimated using only real-time data and forecasts are obtained by substituting real time data into the right-hand sides of the estimated equations. Then the sample period is extended by one quarter and the process is repeated.

Both qualitatively and quantitatively, results are little changed by the move from fixed-weight to chain-weight GDP. Comparing Tables 3 and 6, mean absolute errors and root-mean-square errors are quite similar. Moreover, Table 6, like Table 3, suggests that it is generally easier to predict the advance GDP release than to predict the final GDP release; Table 6, like Table 3, suggests that obtaining a second month of current-quarter data has a much larger impact on forecast accuracy than does obtaining a third month of current-quarter data; and Table 6, like Table 3, shows that in predicting the final GDP release, even our 3-month model is no match for the Commerce Department's advance estimate.

Table 7 presents tests of the efficiency with which our models predict chain-weight GDP. Here, as in Table 4, we regress actual GDP growth on a constant and our forecast of GDP growth. Forecasts are efficient if the estimated constant is not significantly different from 0 and the estimated slope coefficient is not significantly different from 1. For the 2-month and 3-month models, efficiency cannot be rejected. However, the constant term in the 1-month regressions is too large to be consistent with efficiency.

Unfortunately, few analysts bothered to forecast chain-weight GDP until 1996, leaving us with too short a track record to meaningfully compare our models' predictions to the real-time predictions of others.

Stability of the Forecasting Models. In an effort to test the stability of our forecasting models, we estimated a series of regressions in which we included one or more dummy variables on the right-hand side of our forecasting equations. Specifically, for each model we estimated one regression in which we included a separate dummy variable for each quarter of our out-of-sample forecast period, and another regression in which we included a single dummy variable defined to equal 1 over the *entire* out-of-sample forecast period. The joint significance of the quarterly dummies in the first regression is a test of whether or not the model's out-of-sample forecasting performance is significantly poorer than its in-sample performance (Dufour 1980). The t statistic of the single dummy in the second regression provides a test for systematic bias in the out-of-sample forecasts of the model.

In Table 8, the probability values for F tests of the joint significance of the separate quarterly dummies are reported in the rows labeled "Dufour," while the P values for the t test of the single dummies are reported in the rows labeled "Single." None of the P values falls below the 0.05 cutoff for statistical significance. The only test statistic that comes close to statistical significance is that for the single dummy in the 3-month model of final, fixed-weight GDP. The suggestion is that the out-of-sample forecasts of this model may exhibit systematic bias.

To provide the reader with an alternative, informal sense of how stable our models are during the 1990s, Table 8 also reports two root-mean-square error statistics for each model.

Specifically, we compare the root-mean-square error that each of our models would have generated had we held its coefficients fixed over the out-of-sample forecast period to the root-mean-square errors that the same model generates when we allow quarter-by-quarter re-estimation of the forecast equations. The first of these root-mean-square errors is labeled "RMS." The second is labeled "Rolling RMSE." For a given model, when these two numbers are close, re-estimation of the model's coefficients is not important to its out-of-sample forecast performance. Without exception, the two root-mean-square errors are within 10% of one another.

Concluding Remarks

The results of this paper are generally encouraging. They suggest that a simple forecasting model is capable of matching the near-term GDP forecasting performance of private analysts (as captured in the Blue Chip consensus forecast). The key to successful forecasting is that the forecasting equations be estimated with real-time data. By this we mean that at each date within each sample period, the model-builder must not use any data that would have been unavailable to an analyst at the time. In our estimations, for example, whenever we are predicting 1985:Q1 GDP growth, it is always using only employment, sales, and industrial production data that were released within the first quarter of 1985 (or, in the case of our 3-month model, released within a few weeks of the end of the first quarter). Most forecasting models are not estimated in this way. Instead, analysts estimate and re-estimate their models using the most up-to-date data.

Clearly, there is room for improvement in our model and our estimation procedures. We have not made more than a cursory effort to search over alternative coincident indicators of real activity. We have made no effort at all to include leading indicators in our analysis--an omission that especially limits the performance of our 1-month model. Finally, we have not imposed any of the cross-equation restrictions that might be expected to improve the efficiency of our estimations.

Of necessity, our forecast comparisons are limited to fixed-weight measures of GDP. With the passage of time, it should be possible to extend these comparisons to the new chain-weight measures.

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TABLE 1. Data Used for Predicting 1997;Q1 Real GDP Growth

	L-H-S Variable	Right-Hand-Side Variables				
	ΔGDP	ΔGDP	δEmployment	δRetail Sales	δIndustrial Prod.	δCPI
1-Month Model						
Data included:	97:Q1	96:Q1-96:Q4	96:09-96:12, 97:01	96:09-96:12, 97:01	96:09-96:12, 97:01	96:09-96:12, 97:01
Release Date:	4-28-97 Adv. 6-30-97 Final	1-31-97	2-7-97	2-15-97	2-15-97	2-19-97
2-Month Model						
Data included:	97:Q1	96:Q1-96:Q4	96:10-96:12, 97:01-97:02	96:10-96:12, 97:01-97:02	96:10-96:12, 97:01-97:02	96:10-96:12, 97:01-97:02
Release Date:	4-28-97 Adv. 6-30-97 Final	2-28-97	3-7-97	3-13-97	3-13-97	3-19-97
3-Month Model						
Data included:	97:Q1	96:Q1-96:Q4	96:11-96:12, 97:01-97:03	96:11-96:12, 97:01-97:03	96:11-96:12, 97:01-97:03	96:11-96:12, 97:01-97:03
Release Date:	4-28-97 Adv. 6-30-97 Final	3-28-97	4-4-97	4-11-97	4-16-97	4-16-97

TABLE 2A. Summary of Estimation Results--1 Month of Current-Quarter Data

	Predicting Advance Fixed-Wt. GDP		Predicting Final Fixed-Wt. GDP	
	1980:Q1-1989:Q4	1980:Q1-1996:Q4	1980:Q1-1989:Q4	1980:Q1-1996:Q4
Employment				
Joint Signif.	0.061	0.125	0.161	0.181
Sum of Coeff.	0.040	0.208	-0.201	0.055
Signif. of Sum	0.906	0.432	0.598	0.850
Industrial Prod.				
Joint Signif.	0.231	0.257	0.219	0.357
Sum of Coeff.	0.155	0.140	0.156	0.120
Signif. of Sum	0.153	0.125	0.198	0.232
Real Retail Sales				
Joint Signif.	0.019	0.000	0.022	0.001
Sum of Coeff.	0.170	0.184	0.122	0.157
Signif. of Sum	0.042	0.004	0.178	0.026
Overall				
Adjusted R^2	0.820	0.725	0.768	0.672
Std. Error of Est.	1.484	1.537	1.662	1.698
Significance of F	0.000	0.000	0.000	0.000
Significance of Q	0.855	0.722	0.870	0.342

TABLE 2B. Summary of Estimation Results--2 Months of Current-Quarter Data

	Predicting Advance Fixed-Wt. GDP		Predicting Final Fixed-Wt. GDP	
	1980:Q1-1989:Q4	1980:Q1-1996:Q4	1980:Q1-1989:Q4	1980:Q1-1996:Q4
Employment				
Joint Signif.	0.345	0.033	0.533	0.057
Sum of Coeff.	0.359	0.291	0.301	0.289
Signif. of Sum	0.290	0.110	0.464	0.188
Industrial Prod.				
Joint Signif.	0.111	0.000	0.034	0.000
Sum of Coeff.	0.271	0.260	0.280	0.263
Signif. of Sum	0.002	0.000	0.008	0.000
Real Retail Sales				
Joint Signif.	0.013	0.000	0.065	0.000
Sum of Coeff.	0.159	0.145	0.101	0.120
Signif. of Sum	0.017	0.000	0.188	0.014
Overall				
Adjusted R^2	0.832	0.847	0.742	0.780
Std. Error of Est.	1.433	1.146	1.751	1.390
Significance of F	0.000	0.000	0.000	0.000
Significance of Q	0.669	0.270	0.022	0.044

TABLE 2C. Summary of Estimation Results--3 Months of Current-Quarter Data

	Predicting Advance Fixed-Wt. GDP		Predicting Final Fixed-Wt. GDP	
	1980:Q1-1989:Q4	1980:Q1-1996:Q4	1980:Q1-1989:Q4	1980:Q1-1996:Q4
Employment				
Joint Signif.	0.365	0.083	0.201	0.033
Sum of Coeff.	0.421	0.307	0.711	0.478
Signif. of Sum	0.291	0.135	0.087	0.043
Industrial Prod.				
Joint Signif.	0.141	0.000	0.283	0.011
Sum of Coeff.	0.229	0.249	0.156	0.192
Signif. of Sum	0.024	0.000	0.117	0.002
Real Retail Sales				
Joint Signif.	0.074	0.000	0.142	0.001
Sum of Coeff.	0.138	0.130	0.102	0.118
Signif. of Sum	0.011	0.000	0.057	0.002
Overall				
Adjusted R^2	0.801	0.842	0.789	0.800
Std. Error of Est.	1.558	1.163	1.585	1.326
Significance of F	0.000	0.000	0.000	0.000
Significance of Q	0.104	0.132	0.916	0.448

TABLE 3A. Summary Statistics for Out-of-Sample Forecasting Exercise, 90:Q1 - 95:Q3

Forecast	Release Date: Month, Week	Predicting Advance Fixed-Weight GDP			Predicting Final Fixed-Weight GDP		
		Mean Error	Mean Ab. Er.	RMSE	Mean Error	Mean Ab. Er.	RMSE
BC	M1, W2	-0.02	1.06	1.32	0.05	1.32	1.58
MC	M2, W1	-0.43	1.04	1.36	---	---	---
FM	M2, W1	-0.01	1.34	1.58	0.19	1.51	1.93
BC	M2, W2	0.12	1.05	1.28	0.19	1.29	1.56
1-Month KD	**M2, W3**	**0.07**	**1.28**	**1.63**	**0.16**	**1.60**	**1.94**
MC	M3, W1	0.10	0.99	1.34	---	---	---
FM	M3, W1	0.40	1.22	1.53	0.67	1.40	1.81
BC	M3, W2	0.23	0.97	1.14	0.30	1.16	1.44
2-Month KD	**M3, W3**	**0.07**	**0.79**	**0.93**	**0.31**	**1.10**	**1.24**
MC	M4, W1	0.10	0.92	1.15	---	---	---
FM	M4, W1	0.24	0.96	1.27	0.49	1.20	1.57
BC	M4, W2	0.29	0.76	0.89	0.36	0.94	1.20
3-Month KD	**M4, W3**	**0.26**	**0.63**	**0.82**	**0.56**	**0.98**	**1.23**
Advance	M4, W4,5	---	---	---	0.07	0.56	0.64

Notes:

"BC" is the Blue Chip consensus forecast published during the second week of each month.

"MC" is the Miller-Chin real-time forecast of current-quarter advance GDP, available in the first week of each month from the second month of the quarter through the first month of the following quarter.

"FM" is the Fitzgerald-Miller real-time forecast of current-quarter GDP, available in the first week of each month from the second month of the quarter through the first month of the following quarter.

"KD" is the Koenig-Dolmas real-time forecast of current-quarter GDP, available in the third week of each month from the second month of the quarter through the first month of the following quarter.

"Advance" is the Commerce Department's advance (first) estimate of real GDP growth, available one full month after the close of the quarter.

TABLE 3B. Summary Statistics for Out-of-Sample Forecasting Exercise, 90:Q1 - 95:Q3

Forecast	Predicting Advance Fixed-Weight GDP			Predicting Final Fixed-Weight GDP		
	Mean Error	Mean Ab. Er.	RMSE	Mean Error	Mean Ab. Er.	RMSE
1-Month						
KD	0.07	1.28	1.63	0.16	1.60	1.94
KD (rev.)	0.65	1.31	1.58	0.73	1.58	1.91
Naive KD	---	---	---	-0.39	1.58	1.97
2-Month						
KD	0.07	0.79	0.93	0.31	1.10	1.24
KD (rev.)	0.40	1.14	1.37	0.47	1.42	1.67
Naive KD	---	---	---	-0.47	1.48	1.83
3-Month						
KD	0.26	0.63	0.82	0.56	0.98	1.23
KD (rev.)	0.47	1.00	1.28	0.54	1.26	1.50
Naive KD	---	---	---	-0.34	1.39	1.75

Notes:

"KD" is the Koenig-Dolmas real-time forecast of current-quarter GDP.

"KD (rev.)" is the Koenig-Dolmas model estimated with today's data, and used to forecast GDP in real time.

"Naive KD" is the Koenig-Dolmas model estimated with today's data, and used to forecast GDP growth as currently estimated.

TABLE 4A. Tests of Efficiency and Marginal Predictive Power
1 Month of Current-Quarter Data, 90:Q1 - 95:Q3

Predicting Advance Fixed-Weight GDP					Predicting Final Fixed-Weight GDP				
Constant	KD	Blue Chip	BC + 1	KD(rev.)	Constant	KD	Blue Chip	BC + 1	KD(rev.)
0.758 (0.533)	0.666+ (0.202)	---	---	---	0.779 (0.654)	0.695* (0.250)	---	---	---
-0.185 (0.528)	---	1.152+ (0.225)	---	---	-0.421 (0.628)	---	1.306+ (0.268)	---	---
-0.018 (0.414)	---	---	1.130+ (0.178)	---	-0.198 (0.511)	---	---	1.264+ (0.219)	---
1.111+ (0.351)	---	---	---	0.689+ (0.141)	1.151* (0.452)	---	---	---	0.711+ (0.182)
-0.271 (0.532)	0.230 (0.210)	0.961+ (0.284)	---	---	-0.605 (0.642)	0.269 (0.230)	1.124+ (0.308)	---	---
-0.083 (0.434)	0.117 (0.193)	---	1.038+ (0.236)	---	-0.355 (0.544)	0.190 (0.216)	---	1.142+ (0.260)	---
1.033* (0.470)	0.070 (0.272)	---	---	0.644+ (0.226)	0.962 (0.598)	0.158 (0.321)	---	---	0.619* (0.263)

Notes:

* Significant at the 5% level.

+ Significant at the 1% level.

"KD" is the Koenig-Dolmas real-time forecast of current-quarter GDP.

"Blue Chip" is the Blue Chip consensus forecast published in the month during which the Koenig-Dolmas forecast becomes available.

"BC + 1" is the Blue Chip consensus forecast published in the month *following* the availability of the Koenig-Dolmas forecast.

"KD(rev.)" is the Koenig-Dolmas model estimated with today's data, but used to forecast GDP in real time.

TABLE 4B. Tests of Efficiency and Marginal Predictive Power
2 Months of Current-Quarter Data, 90:Q1 - 95:Q3

Predicting Advance Fixed-Weight GDP					**Predicting Final Fixed-Weight GDP**				
Constant	KD	Blue Chip	BC + 1	KD(rev.)	Constant	KD	Blue Chip	BC + 1	KD(rev.)
0.496 (0.245)	0.791+ (0.082)	---	---	---	0.467 (0.357)	0.917+ (0.130)	---	---	---
-0.018 (0.414)	---	1.130+ (0.178)	---	---	-0.198 (0.511)	---	1.264+ (0.219)	---	---
0.158 (0.281)	---	---	1.070+ (0.116)	---	0.003 (0.371)	---	---	1.194+ (0.153)	---
0.977+ (0.281)	---	---	---	0.666+ (0.096)	0.995* (0.388)	---	---	---	0.698+ (0.132)
0.380 (0.324)	0.708+ (0.169)	0.151 (0.269)	---	---	-0.010 (0.428)	0.637+ (0.197)	0.530 (0.291)	---	---
0.290 (0.271)	0.456 (0.229)	---	0.487 (0.312)	---	0.048 (0.352)	0.410 (0.222)	---	0.748* (0.281)	---
0.527 (0.254)	0.690+ (0.188)	---	---	0.102 (0.171)	0.483 (0.356)	0.723+ (0.219)	---	---	0.204 (0.186)

Notes:

* Significant at the 5% level.

+ Significant at the 1% level.

"KD" is the Koenig-Dolmas real-time forecast of current-quarter GDP.

"Blue Chip" is the Blue Chip consensus forecast published in the month during which the Koenig-Dolmas forecast becomes available.

"BC + 1" is the Blue Chip consensus forecast published in the month *following* the availability of the Koenig-Dolmas forecast.

"KD(rev.)" is the Koenig-Dolmas model estimated with today's data, but used to forecast GDP in real time.

TABLE 4C. Tests of Efficiency and Marginal Predictive Power
3 Months of Current-Quarter Data, 90:Q1 - 95:Q3

Predicting Advance Fixed-Weight GDP					Predicting Final Fixed-Weight GDP				
Constant	KD	Blue Chip	Advance	KD(rev.)	Constant	KD	Blue Chip	Advance	KD(rev.)
0.451 (0.228)	0.898+ (0.085)	---	---	---	0.213 (0.329)	1.210+ (0.144)	---	---	---
0.158 (0.281)	---	1.070+ (0.116)	---	---	0.003 (0.371)	---	1.194+ (0.153)	---	---
---	---	---	---	---	-0.170 (0.198)	---	---	1.114+ (0.070)	---
0.923+ (0.282)	---	---	---	0.727+ (0.103)	0.877* (0.364)	---	---	---	0.798+ (0.133)
0.312 (0.257)	0.633* (0.246)	0.344 (0.300)	---	---	0.045 (0.344)	0.755* (0.357)	0.497 (0.359)	---	---
---	---	---	---	---	-0.198 (0.189)	0.273 (0.154)	---	0.917+ (0.130)	---
0.403 (0.242)	1.057+ (0.248)	---	---	-0.149 (0.219)	0.216 (0.351)	1.201+ (0.346)	---	---	0.007 (0.252)

Notes:

* Significant at the 5% level.

+ Significant at the 1% level.

"KD" is the Koenig-Dolmas real-time forecast of current-quarter GDP.

"Blue Chip" is the Blue Chip consensus forecast published in the month during which the Koenig-Dolmas forecast becomes available.

"Advance" is the Commerce Department's advance (first) estimate of real GDP growth.

"KD(rev.)" is the Koenig-Dolmas model estimated with today's data, but used to forecast GDP in real time.

TABLE 5. Does Our 3-Month Model Contain Information Beyond that in the Commerce Department's Advance GDP Estimate? Additional Tests

Final GDP Growth Regressed on a Constant and Alternative Forecasts

Sample Period	Constant	KD (3-month)	Advance GDP
80:Q1-96:Q4	-0.033 (0.156)	0.511+ (0.106)	0.501+ (0.099)
87:Q4-96:Q4	-0.176 (0.272)	0.386* (0.172)	0.739+ (0.151)
80:Q1-87:Q3	-0.211 (0.204)	0.693+ (0.133)	0.298* (0.126)
Coeff. Change (row2 - row3)	0.035 (0.340)	-0.307 (0.218)	0.440* (0.196)

* Significant at the 5% level. + Significant at the 1% level.

TABLE 6. Summary Statistics for Out-of-Sample Forecasting Exercise--Chain-Weight GDP

	Predicting Advance Chain-Weight GDP			Predicting Final Chain-Weight GDP		
1-Month:	Mean Error	Mean Abs. Er.	RMSE	Mean Error	Mean Abs. Er.	RMSE
KD 94:3 - 96:4	0.78	1.41	1.79	1.25	1.39	1.86
KD 93:1 - 96:4	---	---	---	0.82	1.41	1.82
2-Month:						
KD 94:3 - 96:4	-0.24	0.88	1.16	0.10	0.90	1.01
KD 93:1 - 96:4	---	---	---	0.14	1.08	1.28
3-Month:						
KD 94:3 - 96:4	0.04	0.75	0.86	0.27	0.80	1.12
Advance 94:3 - 96:4	---	---	---	-0.03	0.53	0.58
KD 93:1 - 96:4	---	---	---	0.23	0.93	1.19

TABLE 7. Tests of Predictive Efficiency--Chain-Weight GDP

	Predicting Advance GDP, 94:Q3-96:Q4		Predicting Final GDP, 93:Q1 - 96:Q4	
	Constant	KD	Constant	KD
1-Month	2.10* (0.78)	0.38 (0.43)	1.87* (0.73)	0.47 (0.31)
2-Month	0.74 (0.80)	0.66* (0.25)	0.78 (0.73)	0.76+ (0.25)
3-Month	-0.15 (0.83)	1.07+ (0.29)	-0.00 (0.86)	1.09+ (0.31)

* Significant at 5% level. + Significant at 1% level.

TABLE 8. **Testing the Stability of the Forecasting Model**

1-Month:	Advance Fixed-Weight GDP, 90:Q1-96:Q4 Mean	P-Value	RMS	Rolling RMSE	Final Fixed-Weight GDP, 90:Q1-96:Q4 Mean	P-Value	RMS	Rolling RMSE
Dufour	0.36	0.401	1.86	1.82	0.22	0.442	2.15	2.03
Single	0.41	0.394	---	---	0.55	0.301	---	---
2-Month:								
Dufour	0.15	0.990	1.02	1.01	0.37	0.993	1.23	1.22
Single	0.18	0.606	---	---	0.47	0.267	---	---
3-Month:								
Dufour	0.34	1.000	0.85	0.87	0.67	0.961	1.34	1.24
Single	0.36	0.299	---	---	0.69	0.079	---	---

1-Month:	Advance Chain-Weight GDP, 94:Q3-96:Q4 Mean	P-Value	RMS	Rolling RMSE	Final Chain-Weight GDP, 93:Q1-96:Q4 Mean	P-Value	RMS	Rolling RMSE
Dufour	0.75	0.284	1.76	1.79	0.87	0.537	1.92	1.82
Single	0.77	0.184	---	---	0.75	0.169	---	---
2-Month:								
Dufour	-0.34	0.622	1.16	1.16	0.03	0.849	1.27	1.32
Single	-0.38	0.422	---	---	0.13	0.779	---	---
3-Month:								
Dufour	-0.01	0.934	0.86	0.86	0.19	0.823	1.17	1.19
Single	-0.09	0.844	---	---	0.27	0.522	---	---

Figure 1A. Advance Fixed-Weight GDP

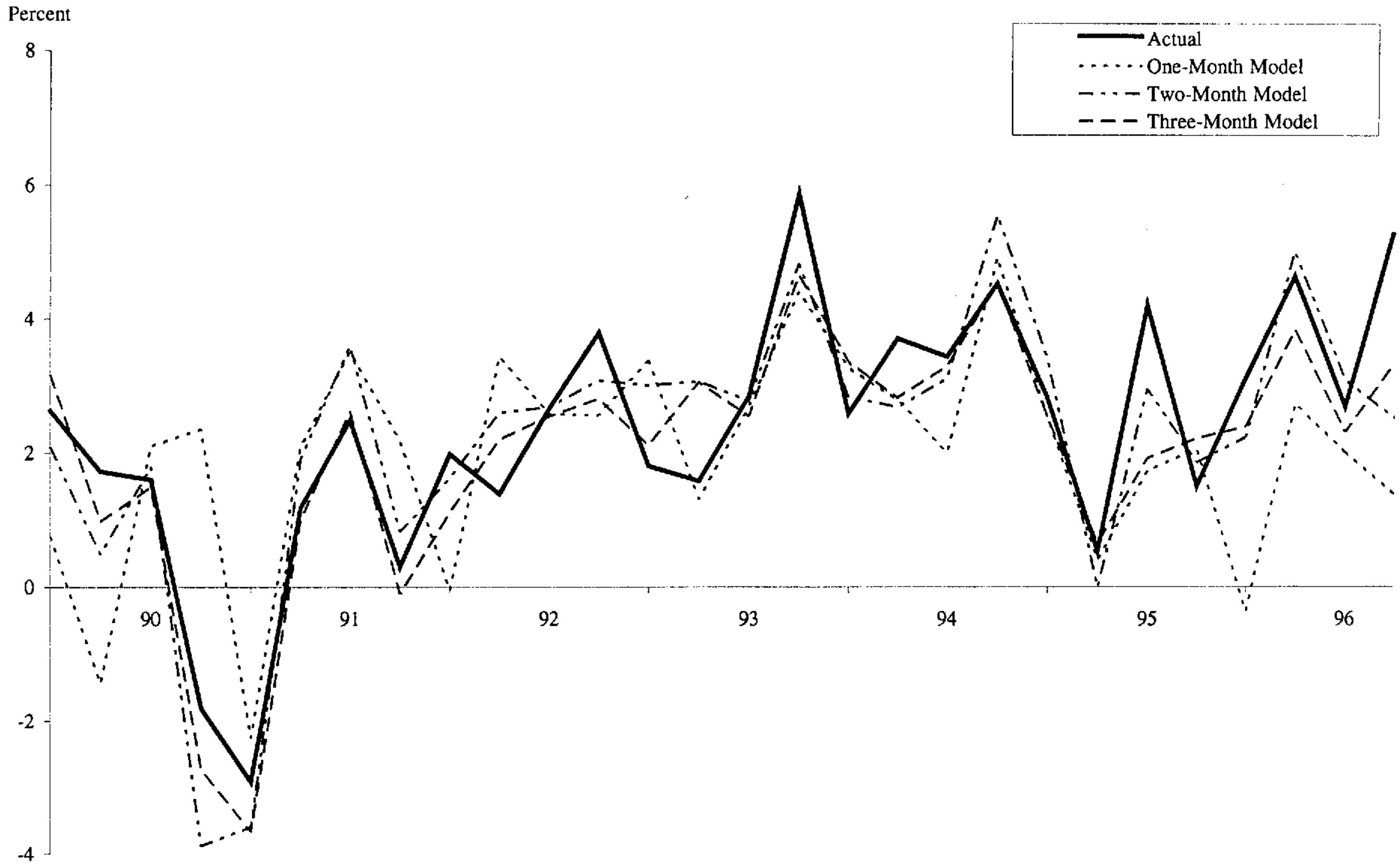


Figure 1B. Final Fixed-Weight GDP

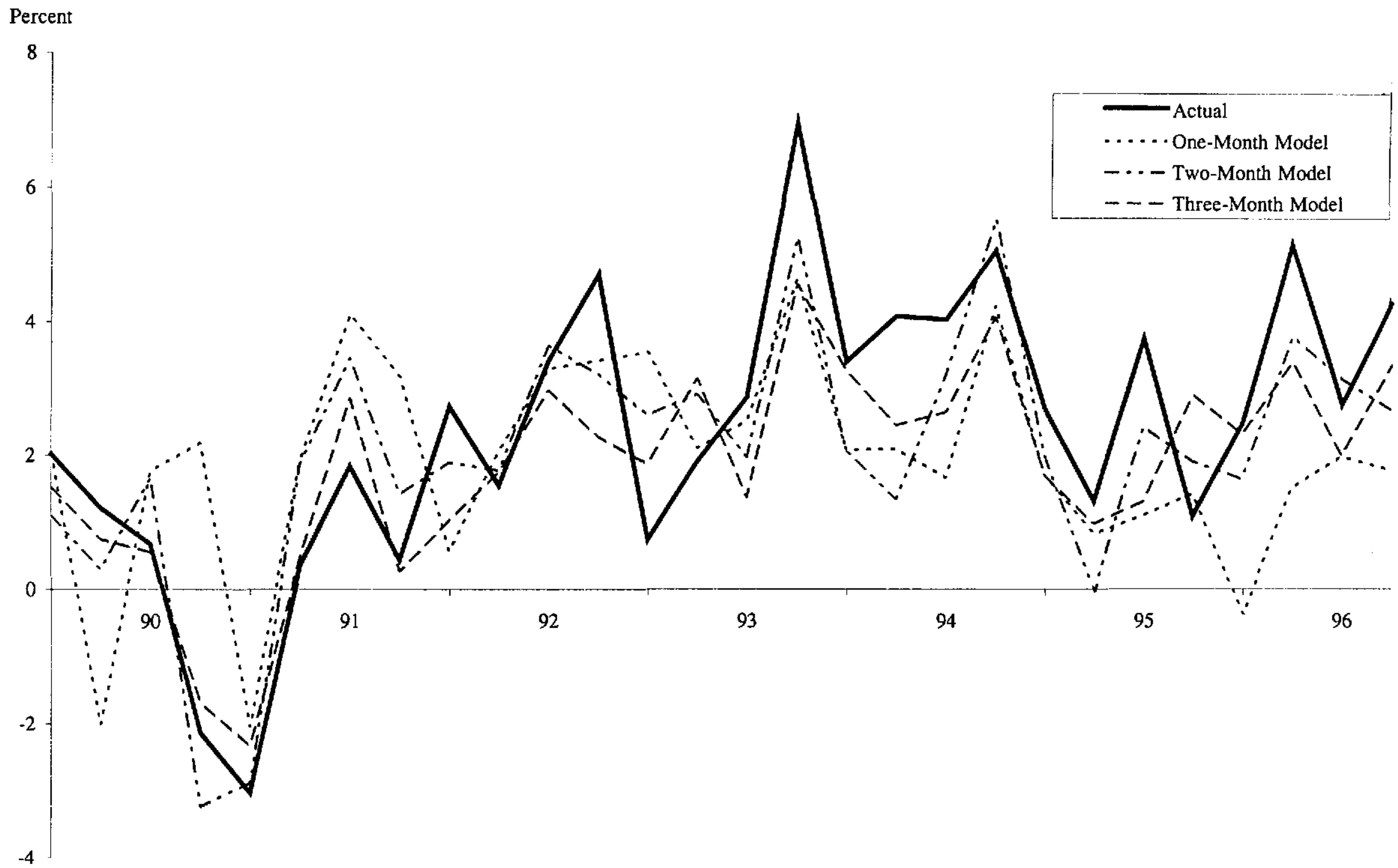


Figure 2. Timing of Advance GDP Release
Number of Days after Quarter Ends

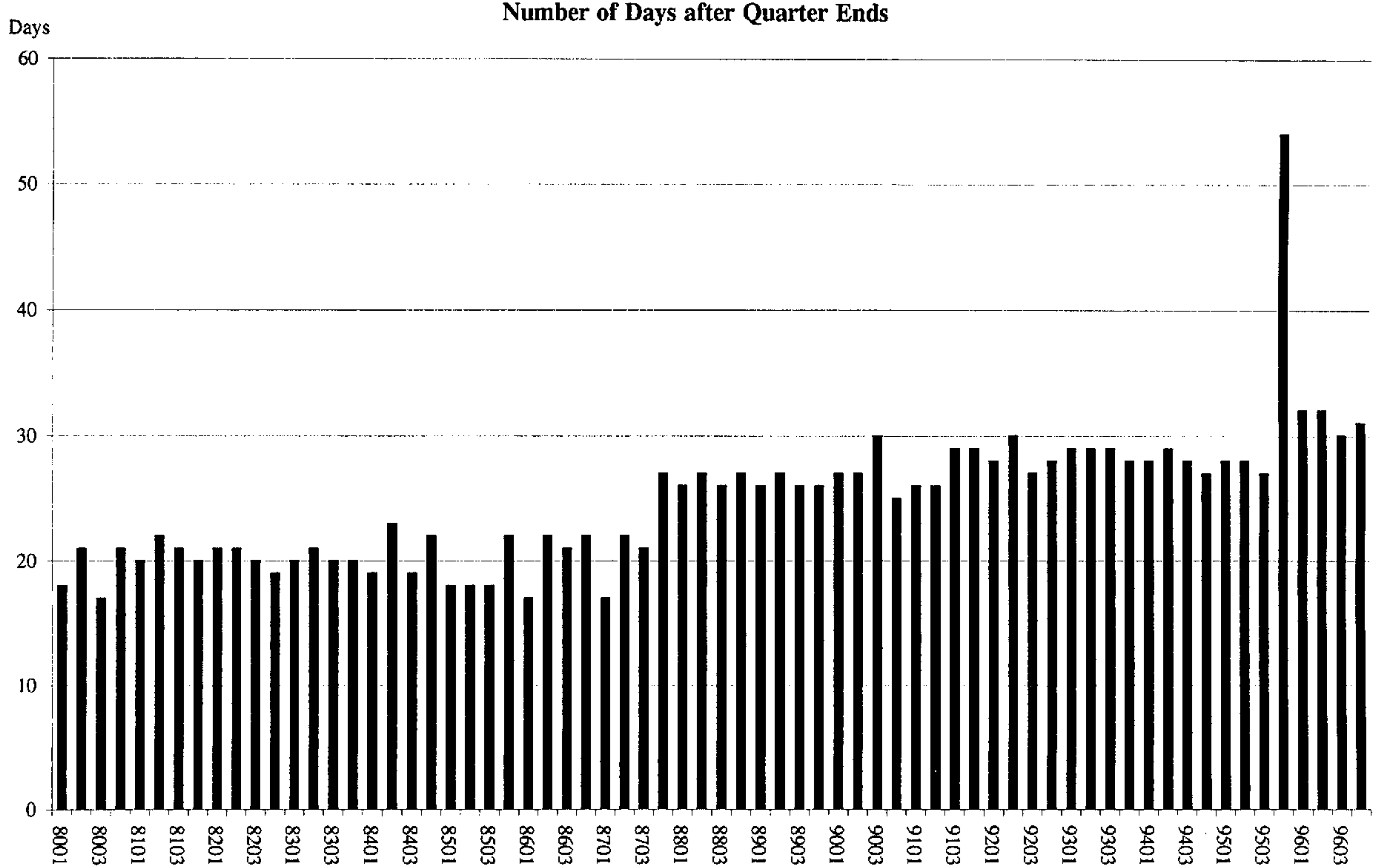
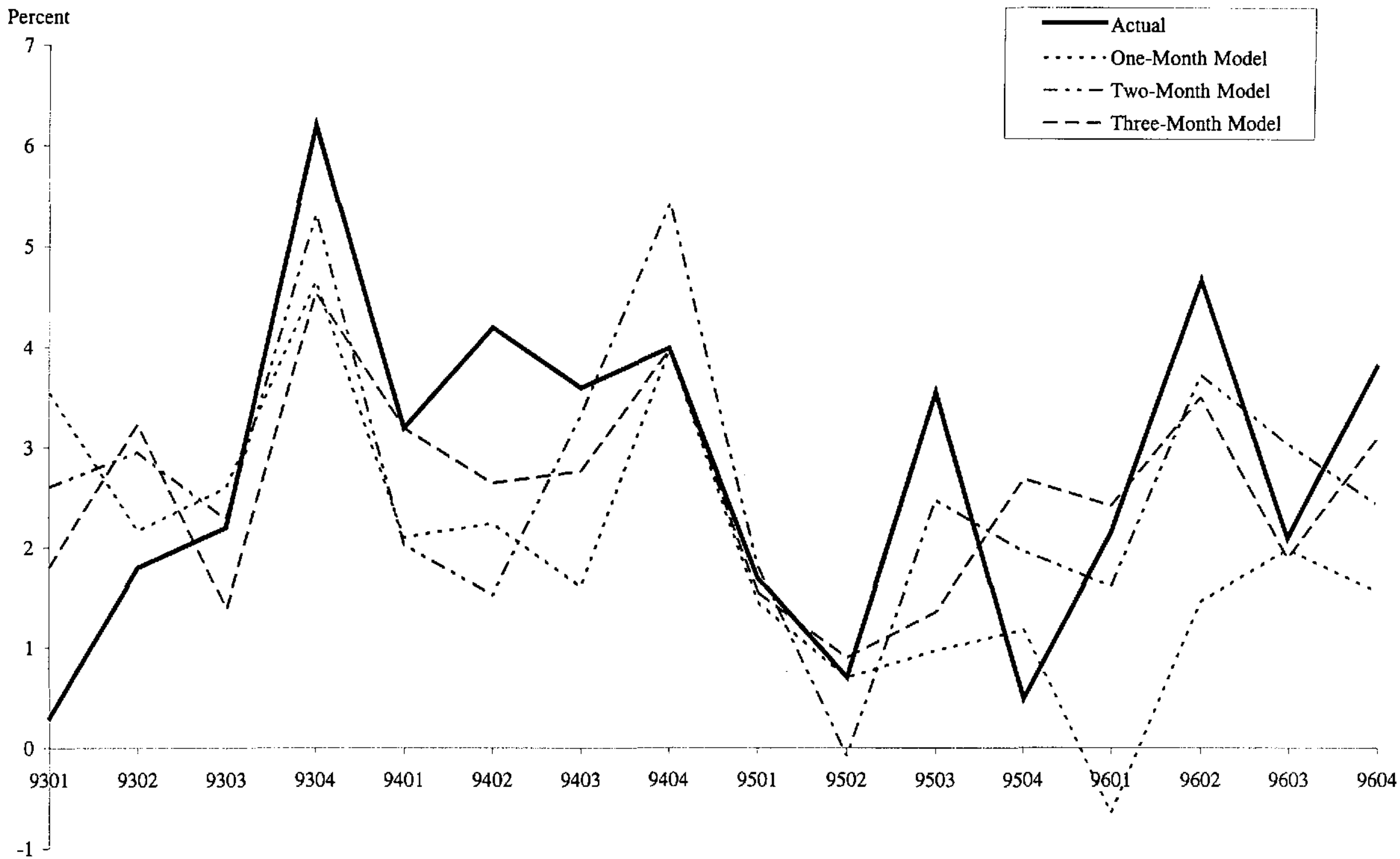


Figure 3B. Final Chain-Weight GDP



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