Fertility Is a Leading Economic Indicator

Kasey Buckles (Notre Dame & NBER), Daniel Hungerman (Notre Dame & NBER)

and Steven Lugauer (University of Kentucky)

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Abstract

Many papers show that aggregate fertility is pro-cyclical. In this paper we do something else: using data on more than 100 million births and focusing on within-year changes in fertility, we show that for recent US recessions total conceptions begin to fall several quarters prior to economic decline. The fall in conceptions coincides with or even predates the changes in other economic indicators. We argue that the forward-looking, and indeed prescient, nature of conception is frequently overlooked by most studies on fertility.

I. Introduction

On August 7, 2009, the New York Times published an article describing how the Great Recession had impacted fertility in the United States. The article concluded that the economic downturn had caused a decrease in fertility, as the annual birth rate fell markedly in 2008, the first year of the Great Recession (Roberts, 2009). The fact that births fell during the Great Recession would be expected by most researchers studying fertility. A large literature across the social sciences has explored the cyclicality of fertility, with most studies concluding that fertility is pro-cyclical.[1]

Of course, the vast majority of births in 2008 were conceived in 2007. Thus, one possibility is that the 2008 annual birth rate fell because of a precipitous drop in conceptions early in that year. This would be intriguing, as early 2008 was before the severity, extent, or even existence of the recession had been widely acknowledged. Alternately, this decline could be explained by a large decrease in conceptions in the fall or summer of 2007. But this was before there was any recession at all.

In this article, we present basic evidence relating changes in fertility to the onset of recessions. Unlike most studies, we focus on *within-year* changes in fertility behavior. We use high-frequency data on essentially all live births in the U.S. to investigate whether changes in total conceptions anticipated the Great Recession and other recent economic downturns.

We find that fertility declines prior to economic downturns and that the decline is large and occurs several quarters *before* recessions begin. This pattern holds in the US for the Great Recession as well as for the recessions beginning in 1990 and 2001. The evidence suggests that the declines in fertility are not driven by a spike in abortions or fetal deaths, but rather reflect a fall in conceptions. Our evidence is largely graphical, but we consider standard statistics of Granger Causality and cross-correlations to verify that the anticipatory behavior we document is statistically significant. Moreover, the fall in conceptions is large. For example, the annual growth rate in conceptions fell by about five percentage points as the Great Recession began. We also

[1] Examples include Adsera (2004, 2009), Adsera and Menendez (2011), Currie and Schwandt (2014), Galbraith and Thomas (1941), Udny (1906), and Chatterjee and Vogle (2016), among many others. See Sobotka, Skirbekk, and Philipov (2011) for a survey and see below for discussion of additional studies.

consider changes in conceptions at the *end* of recessions; however, there the pattern is more complicated. Along with being a "jobless recovery", the Great Recession appears to have been a "baby-less recovery." We discuss the possible connection between these two phenomena more below.

Given that fertility is pro-cyclical, and that at least some individuals are forward-looking when making fertility decisions, the fact that conceptions fall prior to a recession may not seem surprising. But we take our findings as important for several reasons. First, prior work does not suggest our result is a foregone conclusion. Indeed, arguably the opposite is the case: some notable and well-executed studies conclude that the anticipatory patterns we identify are unlikely to exist. We discuss this in Section 4 below.

Next, the anticipatory pattern in fertility is remarkable in several ways. We show that for recent US recessions, conceptions fall coincident with or even prior to declines in other well-known indicators such as consumer confidence and durables purchases. Given that a large fraction of births are unplanned, that planned births face uncertain timing, and that these other indicators may also reflect forward looking behavior, we think the relative performance of conceptions is surprising.

Further, our use of quarterly data allows us to show that the decline in conceptions also occurs before any increase in unemployment. Again, this may not seem surprising, since unemployment often lags the business cycle. However, studies on the cyclicality of fertility discuss unemployment perhaps more frequently than any other measure of economic performance; Sobotka, Skirbekk, and Philipov (2011) survey the extant literature and conclude that unemployment and job instability represent the most important channels by which recessions could impact fertility. This certainly seems reasonable, since couples considering conception plausibly care as much (or more) about their own employment as they do about other measures of economic performance.

Our findings indicate, though, that this seemingly reasonable measure of economic wellbeing could be problematic. Since fertility leads recessions while unemployment lags recessions, our results suggest that this popular measure of economic wellbeing could, in some circumstances, produce misleading or confounding evidence. An alternate possibility, which we cannot discount, is that couples are primarily

concerned with employment and that they are so forward looking that their decisions anticipate both future employment declines and the deterioration of economic outcomes that precede them.

In either case, our results suggest that fertility behavior appears more forward-looking than it is often given credit for. Many studies consider unemployment at the time of conception as a determinant of fertility, but few go beyond this to explicitly control for *anticipated* economic circumstances, which, as suggested here, may be quite important. More generally, while it may be obvious that some individuals are forward-looking in making fertility decisions, we argue that this has been insufficiently appreciated by prior work on fertility.

The next section presents graphical evidence on conceptions and recessions. Section III provides statistical evidence on the robustness of these patterns. Section IV provides more discussion, and Section V concludes.

II. Conceptions and Recessions: Basic Evidence

II.A. Conceptions and GDP

Here we present graphical and statistical evidence relating the aggregate number of conceptions to the onset of economic recessions. Our data on conceptions come from the National Center for Health Statistics' Natality Detail Files. The data is publicly available and contains all births generating a birth certificate. Thus, our conceptions measure is constructed using live births; we return to this when we discuss fetal deaths and abortions in Section II.C.

To facilitate comparisons with other macroeconomic variables, we aggregate the conceptions data to a quarterly frequency and calculate the *annual growth rate* in the number of conceptions relative to the same quarter in the previous year: $\frac{c_q - c_{q-4}}{c_{q-4}}$, where c represents conceptions and q represents quarters.[2] We work with annual growth rates, rather than quarterly, because of the seasonality present in conceptions; e.g. the second quarter has the lowest number of conceptions in nearly every year. Below we consider both other

[2] Another common approximation of this growth rate is $\ln(c_q) - \ln(c_{q-4})$; using this alternate measure of the rate does not change the analysis below.

measures of birth rates and other ways to account for the seasonality; our conclusions are robust to these changes.

For our analysis, we focus on the period from 1988 through 2015, giving us 108 quarterly observations. Our focus on recent recessions accords with a body of prior work showing that the relationship between fertility and economic fundamentals changed in the 1970s/early 1980s.[3] Moreover, for some of our analysis data are unavailable for earlier periods.

The US averaged a little over one million conceptions per quarter during these years, leading to 109 million births. The annual growth rate in conceptions averaged a scant 0.12 percent over this period, though it varied—often at business cycle frequencies. The standard deviation in the annual growth rate over our sample equals 1.97 percent, with the largest growth (4.6%) occurring before the Great Recession began (between the first quarters of 2005 and 2006) and the largest decline (-4.2%) occurring just as the recession ended (between the last quarters of 2008 and 2009).

To explore how conceptions related to (or anticipated) the recessions, we compare the movements in aggregate conceptions to start and end dates of the last three recessions (beginning in 1990, 2001, and 2007) as determined by the National Bureau of Economic Research (NBER) and to movements in Gross Domestic Product (GDP), the standard measure of an economy's overall performance and one that allows us to relate conceptions to economic outcomes both within and across business cycles. We use real, chain-weighted, quarterly data on annual GDP growth from the Bureau of Economic Analysis (BEA NIPA Table 1.11.1 Real Gross Domestic Product: Percent Change From Quarter One Year Ago).[4] We use quarterly data as this is the most frequent GDP data available.[5] We then use the annual growth rate in this measure to side-

[3] A number of studies find that the relation between fertility and other socioeconomic phenomena are different following this period, e.g, Ahn and Mira (2002), Billari and Kohler (2004), D'Addio and d'Ercole (2005) (see figures 12 and 13 in their paper), Macunovich (1996), and the discussion in Section 4 of Adsera (2004). Scholars have identified several possible factors to explain the change. These include changes in contraception or other timing technologies, women's participation in the workforce, labor market institutions, and perhaps the distinct character of the recessions of the 1970s and early 1980s. We leave for future work exploring which of these possibilities matters most.

[4] The chain-weighted deflation method is a standard way to convert GDP from nominal to real terms because it adjusts the basket of goods used to calculate the change in the price of goods produced (as opposed to using a fixed basket). The correlation in the business cycle movements between this measure of GDP and other measures is generally high.

[5] This is also why we aggregate our conceptions data to the level of the quarter, even though it is possible to construct monthly conception rates using the birth certificate data. We replicate our results using monthly data in Appendix Figure 1.

step issues of residual seasonality in GDP (see Moulton and Cowan, 2016) and because we calculated the conception growth rate the same way. This comparison of GDP and conceptions thus allows us to control for the fact that both of these variables fluctuate seasonally and that both may trend over time. This measure also fits with the preferred method of investigating fertility and recessions advocated in Sobotka, Skirbekk, and Philipov (2011) (see their discussion on page 269). We consider results in levels and alternate detrending techniques below.

In Figure 1, we plot the annual growth rate in births (solid line) against this measure of GDP growth (dashed line). The vertical gray areas correspond to the start and end dates of recessions. Clearly, the growth rate in conceptions begins to fall prior to the beginning of each recession.[6] The magnitude of the drop in conceptions over the business cycle is extraordinarily large. For example, there are roughly 100,000 fewer births per quarter at the end of the Great Recession compared to at the beginning (for about a 10% decline). Further, the decline in conceptions leads the corresponding decline in GDP for each of the three recessions. As mentioned before, the 'recovery' in the conceptions growth rate does not seem to lead and instead occurs either contemporaneously or after GDP growth has rebounded.

Next, we look at the three recessions individually. We start with the Great Recession because it was large and occurred recently, and then briefly discuss the other two recessions. Since we are interested in conceptions near the beginning of the recession, a (brief) recapitulation of the dates of notable economic events around the start of the Great Recession may be helpful (see Table 1 for a detailed timeline). In late 2007, we think it is fair to say (as Table 1 suggests) that many experts were cautiously optimistic about the prospects of future economic growth, although at that point problems in (e.g.) the sub-prime mortgage market were known to some. The autumn of 2007 saw all-time highs in several stock markets and continued expressions of cautious optimism about the economy. In December of 2007 a poll of CEOs found that many business leaders were optimistic about the future. The recession began in this month, as later

[6] In fact, the absolute number of conceptions begins to decline before any of the recessions begin. This is somewhat obscured by the use of an annual growth rate in the figure. If conceptions trend up in the years before a recession, then a drop in conceptions in a quarter may still be consistent with a positive growth rate relative to four quarters prior. Below (in Figure 5) we present results that do not control for seasonality as we do here, and the anticipatory drop in the *level* of conceptions is clearer.

determined by the NBER, and by this time, the conception rate had already had been in rapid decline for months. Bear Stearns did not collapse until the end of the spring of 2008. Several months later, in September of 2008, Lehman Brothers collapsed, an event sometimes considered a catalyst in the Great Recession.[7] The total number of conceptions through the first three quarters of 2008 were already more than 100,000 lower than in the first three quarters of 2006 (a 3.5% decrease), and they were falling rapidly.

Figure 2 plots the annual conception and GDP growth rates, by quarter, from the first quarter of 2005 to the last quarter of 2012. The information in the figure is the same as in Figure 1, but the focus on a narrower time frame in Figure 2 makes much more visible the anticipatory nature of the conception rate. The figure clearly shows a decline in conceptions well ahead of the Great Recession. While GDP displays a decline in growth in the last quarter of 2007, and negative growth in mid 2008, conception growth turns negative in mid 2007 and breaks from trend over a year before. The fall in conceptions occurs before the recession began, and several quarters before the collapse of Bear Stearns (and even further before the collapse of Lehman Brothers). The magnitude of the decline is also quite notable—in proportionate terms, fertility- and economic growth contracted by roughly equal amounts, although fertility growth rates reach a nadir five quarters—more than a full year—before GDP. Note again that even after GDP growth rates turn positive in late 2009, fertility rates continue to decline relative to the prior year. In this sense the recession has been followed by a "baby-less recovery."

Figure 3 shows the recession of 2001, and Figure 4 focuses on the recession of 1990. The 2001 recession began in the first quarter of 2001 and lasted through the 4th quarter of 2001.[8] The 1990 recession began in the 3rd quarter of 1990 and lasted through the first quarter of 1991. In both pictures, we once again see conception growth falling below prior-year levels before the recessions begin. In Figure 3, conception growth rates recover along with GDP growth, but in Figure 4 conceptions continue to fall, with negative growth rates, even after the recession ends. The anticipatory drop in conceptions shown in Figure 2, before the most recent recession, is observed in these prior recessions as well.

[7] See Mian and Sufi (2014) for a discussion of the events surrounding the Great Recession. Their chapter 3 provides a skeptical discussion of the view of Lehman Brother's collapse as a driver of the Great Recession.
[8] As discussed earlier, GDP growth does not turn negative because we are using annual GDP growth rather than quarterly.

Figures 1-4 clearly show the growth rate in conceptions falling prior to each of the last three recessions. Figure 5 shows the same pattern is present when looking at conceptions in levels (rather than the growth rate) against the NBER dated recessions. Since the conceptions data has a strong seasonal component, we first seasonally adjusted the data using a method similar to that employed with GDP data.[9] Conceptions were falling, in absolute terms, prior to each of the last three recessions.

Finally, we also filtered the conceptions and GDP data to remove any potential long-term trends in the growth rates.[10] Figure 6 plots deviations from trend for both series, using the CF band pass filter of Christiano and Fitzgerald (2003) to remove the trends. Again, a similar pattern emerges; the deviations from the trend growth rate in conceptions break sharply downward prior to each recession and turn negative before GDP does. We also looked at this relationship between the growth rates and in levels using the Hodrick-Prescott (HP) filter (Hodrick and Prescott 1997), obtaining similar results.[11]

II.B. Conceptions and Other Economic Indicators

We next consider how changes in conceptions compare to two widely watched economic indicators: purchases of personal durable goods and the consumer confidence index. The comparison of conceptions to other indicators is instructive as it highlights how our patterns compare to patterns in other activities that are inherently forward looking. Indeed, since conception is at least sometimes unintended and even when done by forward-looking agents subject to uncertain timing, it would not be surprising if conceptions performed worse than other indicators. In fact, we find that conceptions perform as well or better. We only focus on only these two alternate indicators for brevity, but we have considered others; doing so generally confirms the results shown here.[12] One could perhaps also interpret the results here as suggesting that conceptions could

[9] We use the X11 procedure to estimate the seasonal components. As with the BEA GDP adjustment, this method may not eliminate all the seasonality.
[10] Note, the variables appear to be stationary. The null hypothesis of a unit root, or seasonal unit root, is rejected for both variables at better than the 1% level in a standard Augmented-Dickey-Fuller test.
[11] We first logged both series and then applied the HP filter with a smoothing parameter of 1600.
[12] We have also compared the conceptions movements to the Consumer Sentiment Index and the uncertainty measures of Baker, Bloom, and Davis (2016) and Jurado, Luvvigson, and Ng (2015). We do not report the results here, since the story remains unchanged. Conception growth declines at the same time or prior to the movements in these other indicators for each recession. As Jurado, Luvvigson, and Ng (2015) note, their uncertainty measure stays relatively high even as recessions come to an end. This continued uncertainty may be another factor contributing to the slow rebound

form the basis of an economic indicator useful for forecasting purposes. The utility of adopting conceptions, or some other measure of fertility, as an indicator would depend in part upon measuring conceptions in real time (or, e.g., in the prior quarter), something that would at present be difficult. We discuss this more in the conclusions.

Figure 7 plots the growth rate in conceptions against the consumer confidence index. The index is based on a monthly survey of household's optimism over the economy as measured by 5 questions on the current and future business climate, the household's current and future employment outlook, and the family's outlook for future income. The Federal Reserve Board has used the index as a way to gauge consumer sentiment, when considering interest rate changes. The stock market, too, may react to movements in the index.

Figure 8 considers the seasonally adjusted growth rate in the purchase of personal durable goods (taken from NIPA table 2.3.1 on the BEA website and transformed into a growth rate over the preceding year); these are goods typically purchased to be consumed over a long period of time, e.g., washing machines, dishwashers, and motor vehicles. Durable purchases are part of the consumption component of GDP and have strong cyclical properties. Mankiw (1985) states, "Understanding fluctuations in consumer purchases of durables is vital for understanding economic fluctuations generally;" also see Baxter (1996).

The two figures show that the downturn in conceptions coincides or even anticipates these two indicators, for each of the three recessions. Each figure plots the two trends on separate axes (with conception growth on the left), as the magnitude of the variations differ.[13] In Figure 7, the fall in conception growth does actually appear to precede the decline in confidence prior to the Great Recession. We also can see that conceptions turn negative slightly before consumer confidence prior to the 1990 recession, as well as before the 2001 recession.

The drop in conceptions prior to the Great Recession happens at about the same time or slightly before the drop in durables purchases in Figure 8. Conception growth moves closely with durables for the

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in conceptions at the end of recessions. Appendix Figure 3 reports results using several other indicators and measures of uncertainty.

[13] The observation that durables show much greater variation in the face of the business cycle than does fertility goes back at least to Becker (1960).

1990 recession, but conception growth goes negative before the fall in durables growth for the next two recessions. Overall, the pictures show that deviations in the growth rate of conceptions perform similarly to other well-known economic indicators prior to recessions.

While employment may not move in anticipation of economic declines in the fashion of these indicators, it is nonetheless an outcome of critical importance to families (and potential families). Figure 9 plots conceptions against the unemployment rate. Following the literature (discussed more momentarily), here we simply use the basic, unadjusted unemployment rate, but 4th quarter differences produce similar results (as reported in Appendix Table 4). For the Great Recession, unemployment is rising slightly at the time conceptions fall, but does not notably increase until late in 2008; when the recession is well underway. By that point conceptions had already fallen to well below their prior-year values. The large decline in conceptions comes before the large increase in unemployment. The other two recessions again display the same pattern—conceptions start to fall before unemployment starts to rise. Changes to aggregate employment tend to lag the cycle, whereas conceptions lead.

II.C. Abortions and Fetal Deaths

Our estimates of conceptions come from live births. However, a "missing birth" could be due to an abortion or fetal death, rather than a missing conception. Of course, these channels are not mutually exclusive—conceptions could fall prior to the recession and, upon conceiving, a greater fraction of women could choose to abort or experience a fetal death. But it is important to consider the relative importance of these channels if we wish to understand the extent to which the patterns observed above represent forward-looking behavior. If our results are driven by abortions rather than conceptions, fertility might be less forward-looking by about one quarter, since the abortion decision usually takes place one to four months after conception. The same is true for fetal deaths; moreover, if our result is driven by fetal deaths, that would suggest another channel altogether—one that is driven by physiological factors (perhaps induced by stress) rather than by an active decision about fertility.

We consider fetal deaths and abortions in turn. Fetal deaths at fewer than 20 weeks gestation are referred to as miscarriages; those after 20 weeks are considered stillbirths. Over ninety-five percent of fetal deaths are miscarriages, so we focus on them in this discussion. Miscarriages provide a potentially important channel, given that fifteen to twenty percent of pregnancies end in a miscarriage (Sagili and Divers, 2007). About half of miscarriages are due to chromosomal abnormalities of the fetus, and can be considered effectively random. However, stress and nutrition—which could be related to economic downturns—have also been identified as risk factors for miscarriage in early pregnancy (Atik, Hepworth-Jones, and Doyle, 2010).

We begin with a simple back-of-the-envelope calculation. The miscarriage rate implies that there may be as many as one million miscarriages each year in the United States. For miscarriages to explain the decrease of 70,000 births between 2007 and 2008, we would need to see miscarriages increase by seven percent. If half of miscarriages are effectively random, then the non-random portion would need to increase fourteen percent. We view this as unlikely, but to explore this further we turn to data on miscarriages.

Unfortunately we have been unable to find time series data on miscarriages at the national level. However, a few states do collect information on fetal deaths; we were able to acquire data from the state of New York (excluding New York City).[14] Fetal deaths appear in the data if there is a fetal death certificate, which can be issued by a medical facility or by a funeral home. The data include the number of fetal deaths, by month of occurrence and gestation at the time of death. We used this information to construct approximate measures of the number of fetal deaths by quarter of conception, for the years 1993-2012. We limit the sample to fetal deaths occurring in the first trimester because these are most likely to be affected by changes in stress or nutrition; these deaths account for over three-fourths of all fetal deaths in our data and our results are similar if we drop this restriction. Our restricted sample includes approximately 100,000 first-trimester fetal deaths. Fetal deaths are under-reported; this is about 22% of the number we would expect to see if twenty percent of pregnancies end in a miscarriage.

[14] We thank Larry Schoen of the New York Department of Health for helping us compile this information. These data exclude New York City, which has a separate vital statistics system; we were unsuccessful in obtaining records from them. We also collected data from Virginia (and thank Lewis Hughes for help with this effort), but we were unable to use these data due to issues with inconsistent data collection over time.

We construct annual growth rates in first-trimester fetal deaths by quarter of conception, analogous to the growth rates in conceptions used above. The trend is shown in Figure 10. The main result is that we see no meaningful increase in this growth rate before either the 2001 or the 2007 recession. We interpret these data with caution because they come from a subset of one state, and because fetal deaths are under-reported. [15] Nevertheless, the data provide no evidence of an increase in miscarriages leading up to recessions that is anywhere near the magnitude that would be required to explain a significant portion of the observed decrease in births.

Next, do abortions increase before or during recessions? We are unaware of a good source of intra-year abortion data, and even annual national-level abortion data must be estimated. In Table 2 we report annual estimates from Jones and Jerman (2014). The total number of abortions is in the first column (in 1000s), the abortion rate is in the second column (abortions per 1000 women ages 15-44), and the ratio of abortions per 100 live births is in the third column. The data go from 1991 to 2011 and show an overall long-term decline in abortions during this time period.

Looking closely at the data around the Great Recession, we see that abortions are somewhat flat between 2005 and 2008, and are essentially unchanged in 2008 relative to the year before—and that the 2007 and 2008 levels are both *lower* than the number of abortions in 2006. The abortion rate is similarly stable across these years. There is a slight increase in the abortion ratio in 2008, but this is unsurprising since births declined (the denominator decreased). There is also no break from trend in any of the abortion measures around the 2001 recession.[16]

Moreover, a quick look at the magnitudes in the table indicates that abortion is unlikely to play an important role in the earlier pictures. Abortions increased by 3,000 from 2007 to 2008—while births fell by nearly 70,000 (NVSS, 2015). Even a tenfold increase in the number of abortions beyond what is reported in

[15] One might wonder if conceptions in the state of New York display the anticipatory behavior shown with national data earlier. We used restricted-access Natality Detail Files with state identifiers to construct conceptions per quarter for New York, analogous to the national measure constructed above. Our data agreement does not allow us to report the time series for a single state, but we were able to confirm that the trend in conceptions in New York qualitatively matches the national trend.

[16] The CDC publishes annual national-level data for fetal deaths similar to the data in Table 2, although unlike the data we presented above from New York, this source of fetal-death data omits deaths at less than 20 weeks gestation. Reassuringly, the national fetal-death data also shows no annual increase whatsoever around the time of the Great Recessions. (Gregory, MacDorman, Martin, 2014).

Table 2 would fail to account for most of the decline we identify. Abortions do not drive the cyclical pattern in conceptions.

III. Statistically Documenting the Relationship between Conceptions and Business Cycles

Figures 1-9 graphically show that conceptions decline prior to recessions. Here we quantify the relationship through a few simple statistics. Table 3 reports the correlation between the growth rate of GDP and the growth rate of conceptions at different lags. The first row reports the correlations over the entire sample. GDP growth and conceptions growth are highly correlated, both contemporaneously and for conceptions lagged 1 to 5 quarters. The correlations range from 0.49 to 0.25. With a sample size of about 100, each of the correlations in the first row are statistically different from zero at the 1% level.

The correlations within the entire sample, however, mask variation in the relationship over the business cycle. The rest of Table 3 shows that the correlation between lagged conceptions and GDP is high during recessions, but the two variables are less related during other parts of the business cycle. Row 2 reports the correlations between conceptions and GDP in the first four quarters of the NBER dated recessions (the 1990 recession only lasted three quarters, but we use four). While the contemporaneous correlation is actually quite negative (-0.42), during the recessions, the correlations between GDP and lagged conception growth are highly positive at lags 2, 3, and 4. The next 3 rows break the correlations out for each recession period. The degree of correlation varies across the recessions and sample sizes are small; however, the decline in GDP growth during a recession is highly correlated with declining conception growth beginning about one year (t-5 to t-4) earlier, for each recession—just as we saw graphically.

Rows 6 and 7 of Table 3 demonstrate that the correlations outside of the recession time periods behave differently. Row 6 reports the correlations, dropping the dates from one quarter before the recession to two quarters after. Compared to row 1, these non-recession periods have lower correlations with every lag. Row 7 isolates the post-recession period further by using only the 12 quarters of data after each recession (36 observations total). During these periods, GDP growth has almost no correlation with conception growth lagged up to four periods. In a sense, the relationship is asymmetric over the business cycle. During the

beginning of a recession, GDP movements closely follow lagged conception growth. After the recession, the correlation disappears. As we saw graphically, conceptions growth does not tend to return to pre-recession levels until after the economic recovery is well underway.

Next, we report tests of Granger causality.[17] Granger causality is a standard method for identifying whether movement in time series variable x and past values of x help to predict movements in another time series y. Granger Causality should not be confused with the more usual concept of causality. We are not arguing here that a decline in conceptions causes there to be a recession. Instead, we think that the factors behind the last three recessions also had a profound (and very rapid) effect on fertility decisions. In fact, these factors seem to have impacted fertility decisions before large parts of the economy. In this way, declining conceptions might be a proxy or early warning for whatever shocks did create the recessions.

Table 4 shows the results from a series of Granger causality tests. Our test of Granger causality boils down to a Wald test applied to one equation in a bi-variate vector autoregression (estimated by ordinary least squares). Specifically, we regress GDP growth on GDP lagged one quarter and various lags of conception growth and check to see whether the lagged conception terms are collectively statistically significant.[18] The null is then that conceptions do not "Granger cause" GDP growth, and the stars in Table 4 indicate that this null can be rejected with the indicated levels of certainty.

Row 1 of Table 4 presents the results using the entire sample and different numbers of lags. For example, the column marked '5' reports the test using lags 1-5 in the regression equation. When using the entire sample, the null of non-Granger causality cannot be rejected at the 10% level in any of these 5 model specifications.

However, the 'asymmetric' nature of the correlations over the cycle (as documented in Table 3) make these results difficult to interpret. The Granger causality results are not necessarily robust to the number of lags included in the test, nor, as will become evident, changes in the dates. This sensitivity of the Granger

[17] A standard Johansen test (Johansen 1988 and Johansen 1991) indicates that a null of no co-integration between GDP and conceptions can be rejected.

[18] Several different model specifications for the Granger causality tests lead to similar (but not identical) findings. We have tried to report the more conservative set of results. For example, if we included contemporaneous conception growth and more lags of GDP as explanatory variables and estimated the model via maximum likelihood, then the evidence in favor Granger causality would look far stronger. More on this below.

causality test has been found in many other applications (Hamilton 1994, page 305). Thus, we again consider subsets of the sample and show that over portions of the business cycle conceptions do appear to Granger cause GDP.

Row 2 of Table 4 uses only the first 4 quarters of data following the beginning of each of the 3 recessions. Using these 12 data points, and including at least the first four lags of conceptions, provides evidence in favor of Granger causality (i.e. the null of non-causality can be rejected). Row 3 omits all the recessionary periods plus 1 quarter before and 2 quarters after, and the evidence of Granger causality disappears. In the first 3 rows, we bolded the entry which corresponds to lowest value for the Akaike Information Criteria (AIC), but, following convention, in each of these all lags were included up to the specified number.[19] In rows 4 and 5, we include only the lags of conception growth that correspond to the model with the lowest AIC of those models examined. Row 5, based on including conception growth lagged 5 quarters (and not including any other lags) and GDP growth lagged 1 quarter, indicates a strong rejection of the null. Even using the entire sample in row 4 shows some evidence that conception growth Granger causes GDP growth, when only the lags which minimize the AIC are used.

Finally, a large literature (e.g., considering how oil prices effect the economy) has encountered a potential 'asymmetry' similar to what we see see with conceptions. Following this literature, we test for the presence of an asymmetrical relationship in a straightforward way. We define a new explanatory variable equal to conception growth as long as conception growth is greater than zero, and equal to zero otherwise. The new variable is meant to capture whether times of positive conception growth affect GDP differently (or asymmetrically) than periods of zero or negative growth. Rows 6 and 7 of Table 4 report the Granger causality test on conceptions and the new variable (and their lags up to 5 periods). Also, we have done the regression using maximum likelihood and five lags of GDP growth. Now, with this specification meant to capture the asymmetry, the null of non-Granger causality can be rejected in the entire sample (row 6) and easily rejected for the recession years (row 7). Note, a joint hypothesis test on just the lags of the new variable (i.e. a test on if there is asymmetry present) shows strong evidence that these variables are statistically

[19] One reason we report the specifications that do not minimize the AIC is that the choice of lags to include is sensitive to the criteria employed. For example, the Schwarz Bayesian Criteria would suggest different specifications.

significant.[20] We conclude that the movements of fertility are asymmetric over the business cycle, mainly because fertility falls prior to the beginning of recessions.

Collectively, we interpret the statistical results in Tables 3 and 4 as showing a relationship between conceptions and the onset of recent recessions, but not for recoveries. This pattern matches the idea of a 'baby-less' recovery suggested earlier, and may not be entirely surprising. The prolonged decline in births after the Great Recession is an international phenomenon that has been noted in other countries as well (cf. The Economist, 2016). And, researchers have spent considerable effort attempting to explain why other important household outcomes, such as employment, have recovered so slowly following the Great Recession's end and why some outcomes more generally appear to respond to business cycles asymmetrically (e.g., Ferraro 2016).

On the one hand, the two phenomena may be connected—persistently low fertility could reflect a correctly-anticipated jobless recovery. Returning to Figure 9, this anticipation does not appear to be an entirely satisfactory answer. As the figure shows, while unemployment was persistently high after the recession ended, it has gradually and steadily fallen. Meanwhile, while fertility growth rates were much higher in 2011 and 2012 than in the first quarter of 2008, they were still typically negative. That is, unemployment fell slowly, but fertility did not rise slowly; instead it continued to fall. Another possibility is that, as age at birth has risen, births delayed due to a recession may prove more difficult for older women to retime. Even for younger women, Currie and Schwandt (2014) provide evidence that short-term effects of unemployment on fertility can be quite persistent. Alternately, the most recent recession occurred in an era where long-term contraception was more widely available, and its use could slow a rebound in the birth rate. We know of no rigorous work on this, but note anecdotal evidence (Alderman, 2009) that the Great Recession saw an increase in vasectomies.

Another possible explanation for this asymmetry over the business cycle is an asymmetry inherent in the timing of conception. Couples who start attempting conception may not achieve immediate (or even

[20] Many papers employ tests for asymmetric relationships in a variety of applications (see Kilian and Vigfusson 2011 and Hatemi-J 2012 for example); however, the results can sometimes be sensitive to the exact model specification (see Herrera, Lagalo, and Wada 2015 and Hamilton 2011). Exploring the many possible specifications would take us too far afield from the focus of this paper.

eventual) success. Thus, if many couples at the end of a recession begin efforts to conceive, this may appear gradually in the data. But if many couples *stop* efforts to conceive in a certain period, this will be immediately visible even if some efforts to stop (e.g., efforts to contracept) are unsuccessful. Figure 1 suggests that the decline in fertility continued more than a year after economic recovery began, a sufficiently long period that it is doubtful that typical time-to-conception delays could be the sole driving force, but delays could still be part of the story. It is even possible that the prolonged slump in conceptions following the last recession may eventually give way to a subsequent "baby boom", a notion considered by Jones and Schoonbroodt (2011).[21]

IV. Discussion

Many studies have shown that fertility falls during a recession. But we are unaware of rigorous evidence showing that conceptions decline several quarters before recessions begin. Indeed, prior work suggests that such behavior is unlikely. In an excellent and well-known overview of fertility and the business cycle, Sobotka, Skirbekk, and Philipov (2011) write that during a recession (pg. 270) "downward shifts in fertility start with a short time lag of one to two and a half years," and that "some time lag should be expected even if couples responded rapidly to changing economic conditions, considering the time between the initiation of pregnancy attempts and achieving a conception and between conception and childbirth." Since most studies consider annual data, they would struggle to identify the relationship we document here (unless they did so by implication, as was the case with the New York Times Article mentioned in the introduction). Ananat, Gassman-Pines, and Gibson-Davis (2013) *do* consider within-year variation in births in relation to job loss, focusing on teen births in North Carolina. They present evidence that black teen births decline 0 to 4 months before job losses in North Carolina, but fail to find this for white births or when looking at losses 7 to 9 months after conception. They conclude that their findings "provide reassurances that job losses are

[21] In the long term, demographic shifts could alter the business cycle. Jaimovich and Siu (2009) and Lugauer (2012) show that economies with a relatively younger labor force (i.e. a high fraction of the population between 16 and 35) experience larger business cycle fluctuations. The quick reduction in conceptions (and the potentially related changes in housing and durable goods purchases) by this child-bearing age group at the beginning of a recession represents one way in which this empirical relationship might manifest itself.

unanticipated" (page 2159), a conclusion that might hold for white teenagers in North Carolina but appears hard to reconcile with our decades-spanning evidence based on millions of births across the country.[22]

Further, many studies in this literature consider employment as a measure of economic wellbeing (e.g., Ahn and Mira, 2002; Noguera, Golsch, and Steinhage, 2002; Adsera, 2004, 2011; D'Addio and d'Ercole, 2005; Adsera and Menendez, 2011; Schaller, forthcoming; Andersen and Ozcan, 2013; Ananat, Gassman-Pines, and Gibson-Davis, 2013; Huttenen and Kellokumpu, 2017; Currie and Schwandt, 2014). In situations where employment significantly *lags* the overall economy, and where conceptions *lead* the economy, use of employment could produce misleading or even reversed results.

Looking again at Figure 9 illustrates this possibility by reporting unemployment and growth rates of conception. The figure shows conceptions falling prior to an increase in unemployment and a sharp break in trend for conceptions several quarters before unemployment starts to rise. If conceptions lead recessions, and unemployment lags it, then over certain ranges the two trends may appear positively related. The implication of this for future work on fertility and the economy is that other outcomes beyond employment at the time of conception should be considered as measures of the economy. Further, future work on fertility and outcomes specific to employment should take into account the potentially confounding effects of anticipatory changes in fertility.

Beyond considering other economic measures contemporary with conception, our results also suggest that greater care be taken to capture expectations—or even realizations—of the future. Our work is not the first to call attention to the fact that fertility is a forward-looking, or more generally a dynamic, decision. The well-known survey by Hotz, Klerman, and Willis (1997) describes dynamic work on fertility as "nascent". And more recently, for example, Kearney and Levine (2014) argue that variation in early non-marital childbearing can be partly explained by the sense of hopelessness created from income inequality; their discussion implicitly recognizes the importance of future economic outcomes, as captured via present

[22] One possibility is that teens have different cyclicality in their fertility. Arkes and Klerman (2009) produce evidence for those under 18 suggesting counter-cyclical behavior; see also Colen, Geronimus, and Phipps (2006).

economic circumstances.[23] Other studies closer to our work use present economic conditions as a way to represent future outcomes. For example, Fokkema, de Valk, de Beer, and van Duin (2008) look at fertility and annual consumer confidence lagged two years in the Netherlands (see also Sobotka, Skirbekk, and Philipov, 2011), and several studies emphasize the importance of contemporary unemployment as representing uncertainty about the future (e.g,. Noguera, Golsch, and Steinhage, 2002).

Our findings certainly support these studies' recognition of the value in modeling future economic conditions—but our results point to the converse of this relationship, showing that if future economic conditions matter for current conception decisions, then if expectations are at least somewhat rational, movements in current conceptions may likely be harbingers of future conditions.[24] This point goes beyond discussions of cyclicality of fertility. In a recent paper, Buckles and Hungerman (2013) consider maternal characteristics of newborns and find that anticipated circumstances *at birth* (e.g., weather) do a far better job than circumstances *at conception* in explaining these characteristics. Future research on fertility should consider the remarkable explanatory power of conditions subsequent to conception. The dynamic aspects of fertility decisions are too seldom studied, and the remarkably prescient nature of fertility has been sorely underappreciated in quantitative research.

V. Conclusion

This paper shows that conceptions fall before recessions begin, and that conceptions compare well with or even outperform other economic indicators in anticipating recessions. We argue that future work on all aspects of fertility and birth-related outcomes should take care to consider the possible empirical relevance of *future* events occurring after conceptions occur.

[23] In our data, fertility of married and un-married women follow almost the exact pattern of the aggregate, with only the levels differing. Splitting the data by native-born versus non-native born also does not change the fertility patterns, during the years in which this data is available. This is shown in Appendix Figure 2.

[24] This is not to say that studies of contemporaneous or lagged economic circumstances are of no value. A number of studies consider long-term effects of economic conditions on fertility over a period of years, such as Lovenheim and Mumford (2013), Huttenen and Kellokumpu (2017), and Chaterjee and Vogl (2016). Understanding how an economic shock impacts fertility many years later is of course worthwhile, but does not gainsay the point that fertility can be—and indeed is—anticipatory of economic conditions.

Our paper focuses on the US experience. We leave to future work a consideration of outcomes in other countries. While there can be important differences between, for example, labor market institutions in different countries, the pro-cyclical behavior of fertility has been found in many settings. Whether the particular anticipatory behavior we identify here holds in other settings we cannot say.

Based on our results, one might wonder, could conceptions be used as a conventional economic indicator? An obvious difficulty in doing so is that, even compared to other indicators, conceptions are difficult to measure in real time. However, certain consumer goods might be especially likely to be purchased by couples conceiving (e.g., pregnancy tests) and perhaps, if purchases of these products match trends in conceptions sufficiently closely, then they could be used as an alternate to durables. This information could be useful in settings where purchases of durables are less frequent or less well-measured, such as in development settings. The possibility, or utility, of using such goods as an economic indicator compared to other conventional measures we leave to future work.

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Table 1: Selected Events Before and During the Start of the Great Recession

Date	Event
August 2007	The Congressional Budget Office predicts economic growth for the year of 2.1 percent. The New York Times reports that most economists "predict continued economic growth for the rest of the year and into 2008" but that some are revising their projections downwards (Andrews, 2007).
October 9, 2007	Dow reaches an intraday record high of 14,167; the S&P hits an all-time high of 1565. The Nasdaq climbs to 2806, its highest level since January 2001 (Bloomberg News, 2007).
October 31, 2007	The Federal Open Market Committee (FOMC) of the Federal Reserve lowers its target for the federal funds rate 25 basis points. The FOMC reports that "Economic growth was solid in the third quarter, and strains in financial markets have eased somewhat on balance. However the pace of economic expansion will likely slow in the near term." (Federal Reserve, 2007a).
November 8, 2007	In testimony before the Joint Economic Committee, Ben Bernanke states "the U.S. Economy has performed reasonably well" but that "the economic outlook has been importantly affected by recent developments in financial markets." Describing the October FOMC meeting, he said, "Growth was seen as remaining sluggish during the first part of next year, then strengthening as the effects of tighter credit and the housing correction began to wane" (Bernanke, 2007).
December 5, 2007	A survey of CEOs predicts economic growth in the coming year. 70% of CEOs expect their company's sales will rise in the next six months. (Hagenbaugh, 2007).
December 8, 2007	Responding to a labor department report of jobs gains, the Washington Post concludes "Hiring, wages increase modestly, housing credit fallout appears to be confined" (Irwin, 2007).
December 11, 2007	The FOMC again lowers its target for the federal funds rate 25 basis points. The FOMC reports that "Economic growth is slowing...Strains in financial markets have increased in recent weeks. Today's action, combined with the policy actions taken earlier, should help promote moderate growth over time." (Federal Reserve, 2007b).
December 2007	The recession begins, as subsequently determined by the National Bureau of Economic Research (in November, 2008).
January 2, 2008	Overviewing the stock market's outlook, USA Today summarizes, "5-year winning streak has a good shot at a 6th; 2008 could start out bumpy, but signs point to a sweet finish" (Shell, 2008).
January 17, 2008	Tom Hoenig, president of the Federal Reserve Bank of Kansas City, addresses a group of legislators and bankers and states "the economy is slowing, but I don't see any immediate evidence that we're going into a recession" (Rouse, 2008).
March 13, 2008	Bear Stearns contacts the federal reserve to report its severe financial distress, J.P. Morgan Chase subsequently agrees to purchase Bear Stearns.
March 14, 2008	In a poll, 71 percent of economists say the US is in recession (Business World, 2008).
September 15, 2008	Lehman Brothers files for bankruptcy.
October 3, 2008	President Bush signs into law the Emergency Economic Stabilization Act of 2008.
December 19, 2008	The US government bails out General Motors and Chrysler (Christian Science Monitor, 2013).

Table 2: Annual Abortion Data

Year	Abortions (1000s)	Abortion Rate	Abortion Ratio	Interpolated?
1991	1,557	26.3	27.4	
1992	1,529	25.7	27.5	
1993	1,495	25	27.4	Yes
1994	1,423	23.7	26.6	Yes
1995	1,359	22.5	25.9	
1996	1,360	22.4	25.9	
1997	1,335	21.9	25.5	Yes
1998	1,319	21.5	25.1	Yes
1999	1,315	21.4	24.6	
2000	1,313	21.3	24.5	
2001	1,291	20.9	24.4	Yes
2002	1,269	20.5	23.8	Yes
2003	1,250	20.2	23.3	Yes
2004	1,222	19.7	22.9	
2005	1,206	19.4	22.4	
2006	1,242	19.9	22.9	Yes
2007	1,210	19.4	21.9	
2008	1,212	19.4	22.5	
2009	1,152	18.5	22.2	Yes
2010	1,103	17.7	21.7	
2011	1,059	16.9	21.2	

Source: Jones and Jerman (2014). The abortion rate is abortions per 1000 women ages 15-44 as of July 1st each year. The abortion ratio is abortions per 100 pregnancies ending in abortion or live birth, for each year; the ratio is based on birth during the 12 month period starting July of that year. Interpolations adjusted using state health department reports.

Table 3: Correlations between Conceptions and GDP

Period	Sample Size	Contemporaneous (t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)
(1) 1988-2012	108	0.47	0.47	0.44	0.39	0.34	0.24
(2) Recession 1st 4 Qtr	12	-0.41	0.29	0.65	0.42	0.49	0.18
(3) 2007Q4 – 2009Q2	7	-0.09	0.05	0.56	0.84	0.96	0.90
(4) 2001Q1 – 2001Q4	4	-0.99	0.37	0.49	-0.09	0.78	0.31
(5) 1990Q3 – 1991Q1	3	-0.94	0.40	0.83	0.89	0.79	0.91
(6) Non-recession years	85	0.24	0.29	0.22	0.14	0.08	0.04
(7) Post-Recession	36	-0.08	-0.01	0.06	0.03	0.13	0.32

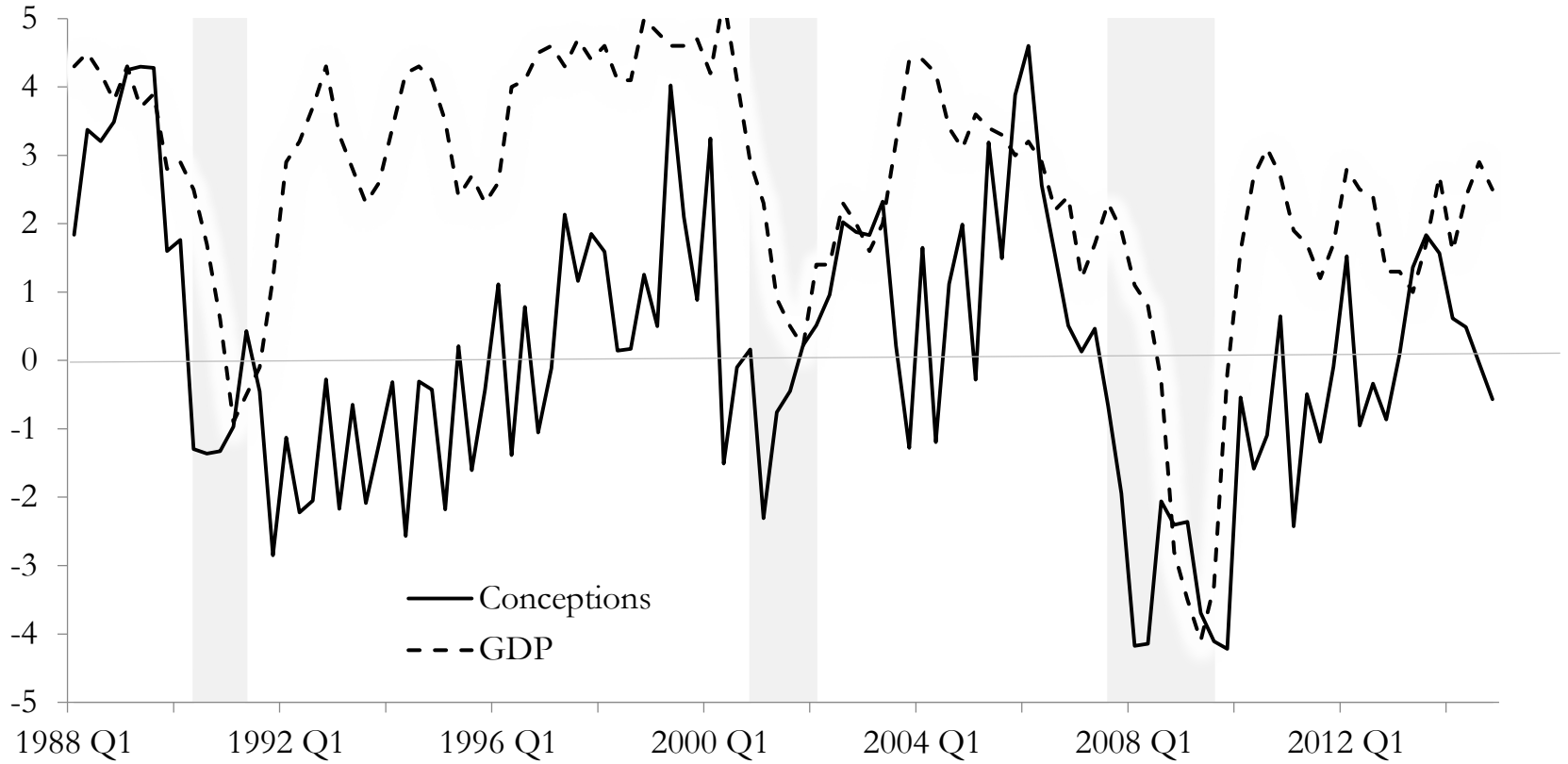
Notes: Both variables are annual growth rates, reported quarterly. The table presents the simple correlations over the given period at different lags of the conceptions variable, where the lags are in terms of quarters.

Table 4: Granger Causality

		Lags Included in the Regression Equations				
Period	Sample Size	1	2	3	4	5
(1) 1988-2012	108	0.88	0.93	0.86	0.23	**0.11**
(2) Recession 1st 4 Qtr	12	0.17	0.34	0.13	0.02**	**0.07***
(3) Non-recession years	85	**0.45**	0.46	0.53	0.56	0.63
Optimal lags						
(4) 1988-2012	108				**0.05****	
(5) Recession years	24					**0.005*****
Asymmetry						
(6) 1988-2012	108					0.05**
(7) Recession years	24					0.00***

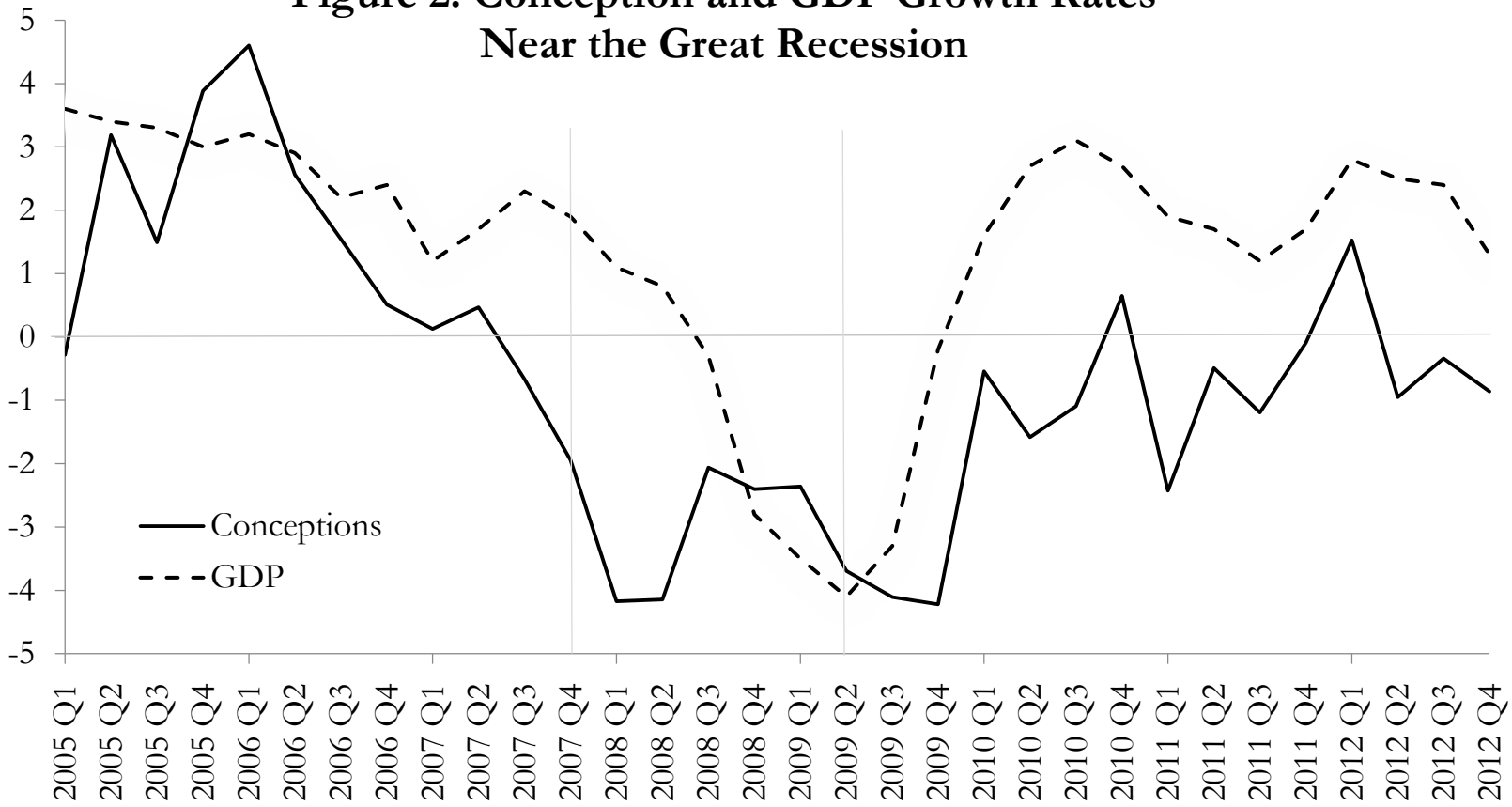
Notes: This table reports the probability of exceeding the chi-squared statistic of a Wald test of the hypothesis test that none of the conception lags are statistically significant in a regression of GDP growth on lags of GDP and lags of conception growth. Stars denote significance at the * 10% ** 5% and *** 1% level. Bold indicates the lowest AIC.

Figure 1: Conception and GDP Growth Rates



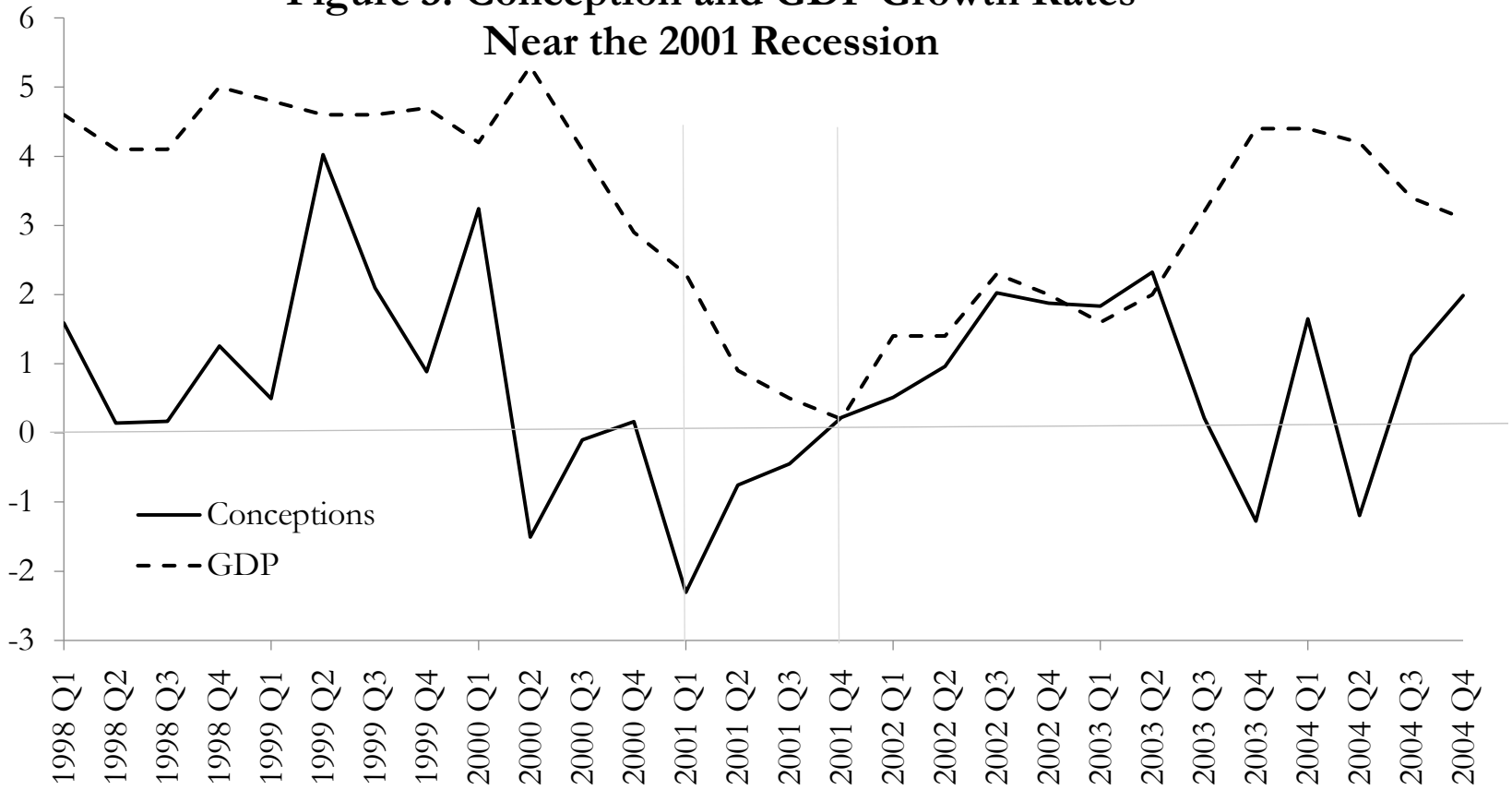
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The shaded areas indicate NBER dated recessions.

Figure 2: Conception and GDP Growth Rates Near the Great Recession



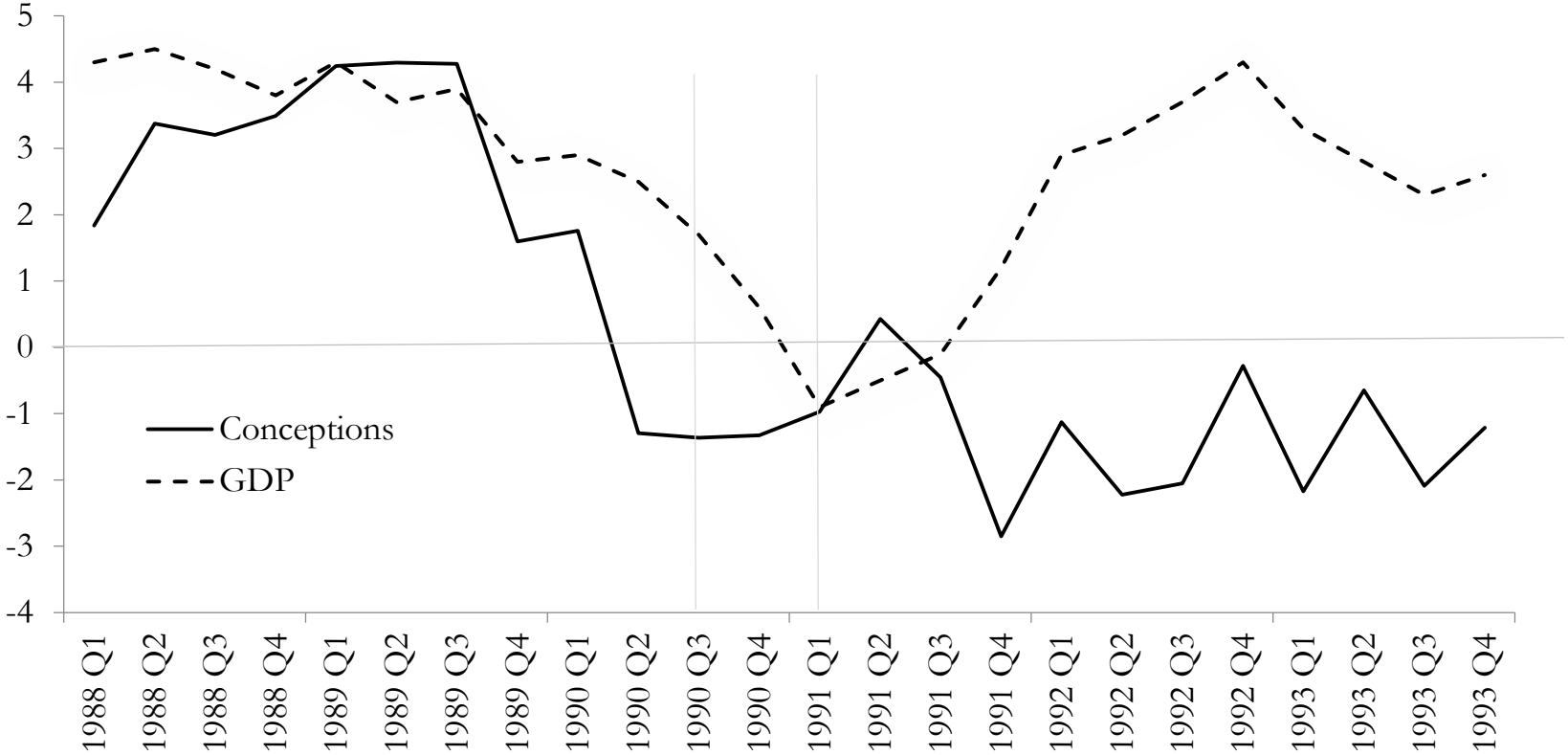
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (2007 Q4) and end (2009 Q2) of the recession.

Figure 3: Conception and GDP Growth Rates Near the 2001 Recession



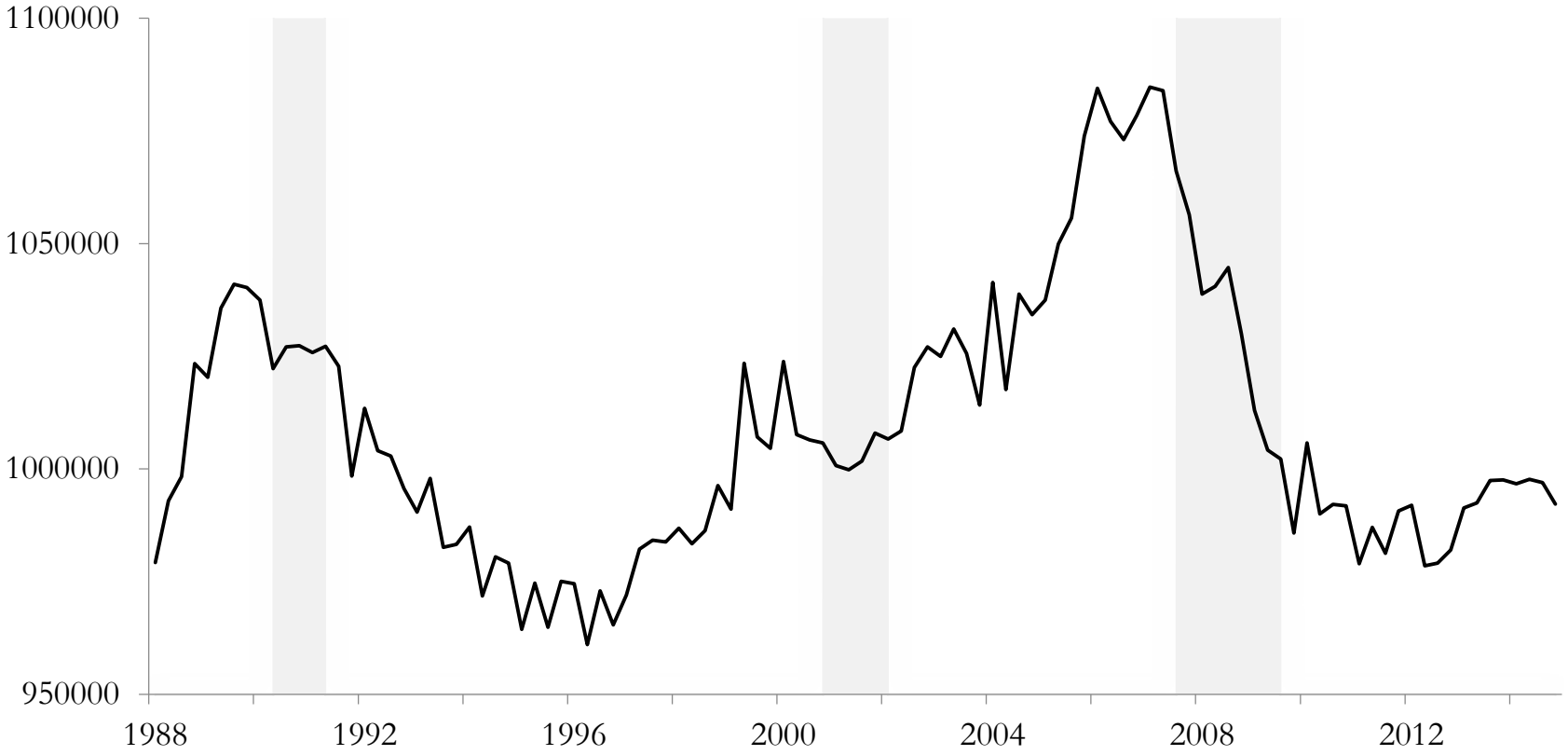
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (2001 Q1) and end (2001 Q4) of the recession.

Figure 4: Conception and GDP Growth Rates Near the 1990 Recession



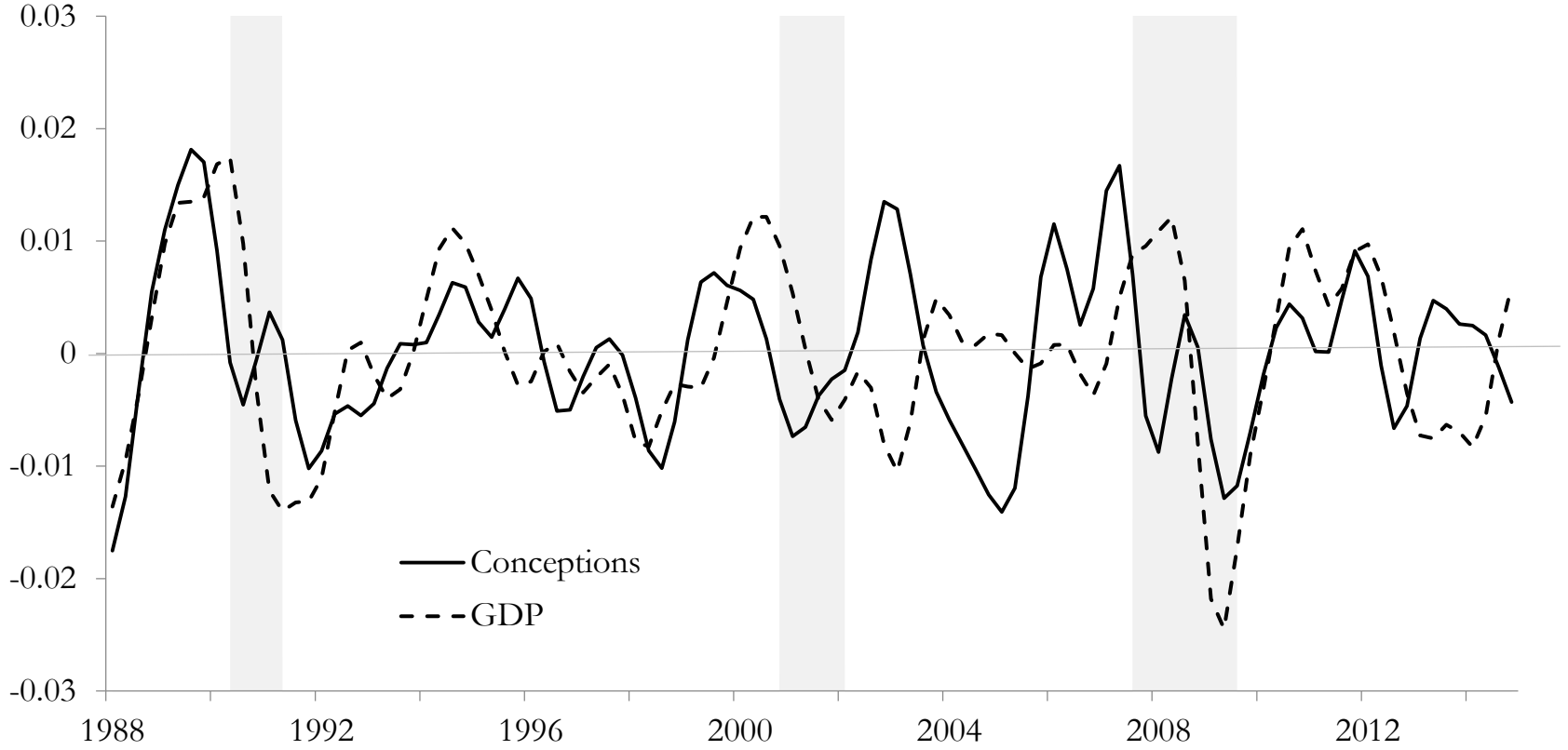
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (1990 Q3) and end (1991 Q1) of the recession.

Figure 5: Conceptions (seasonally adjusted) and NBER Recessions



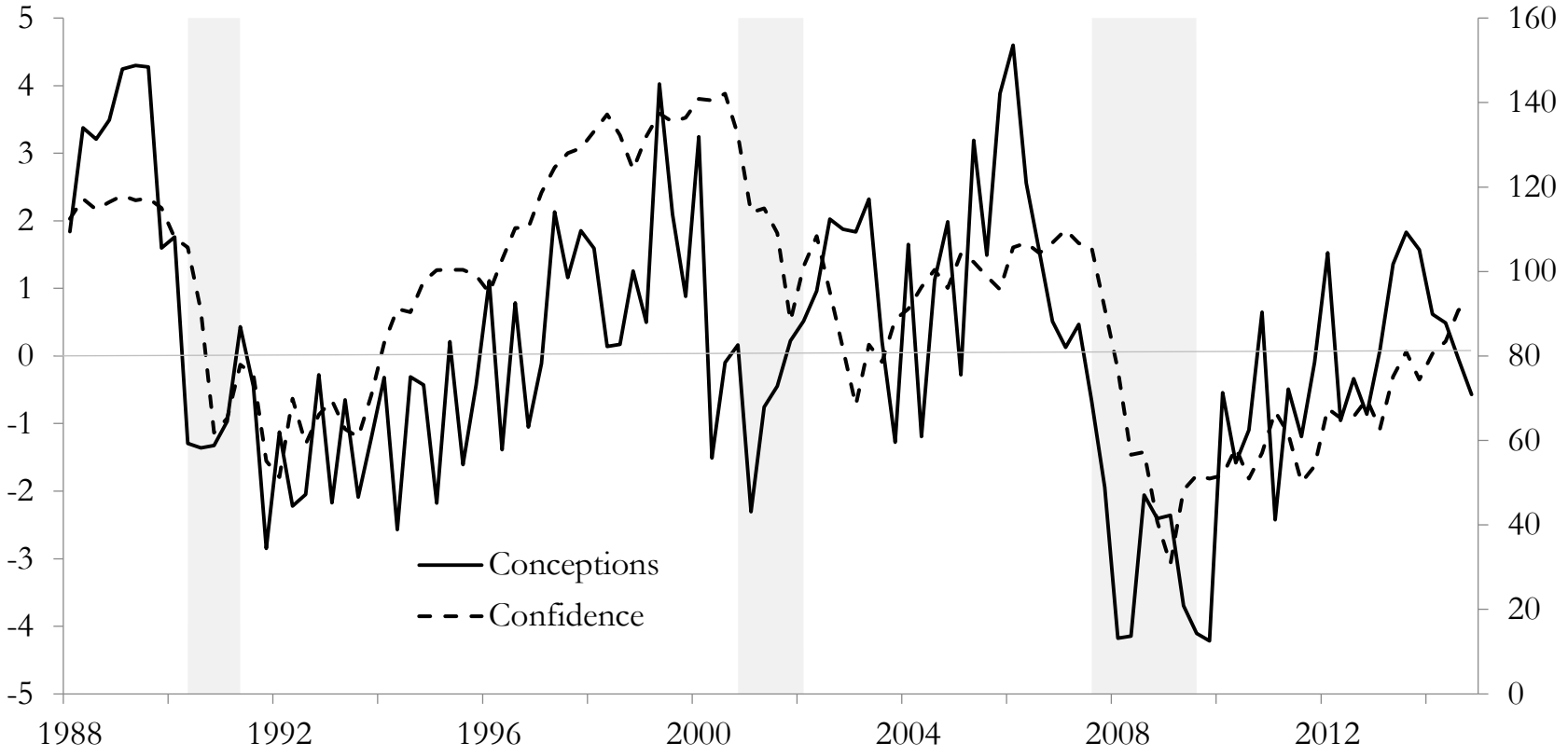
Notes: The figure shows the number of conceptions each quarter, after seasonal adjustment. The data comes from the Natality Detail Files. The shaded areas indicate NBER dated recessions.

Figure 6: Deviatons from Trend Growth Conceptions and GDP - CF Filtered



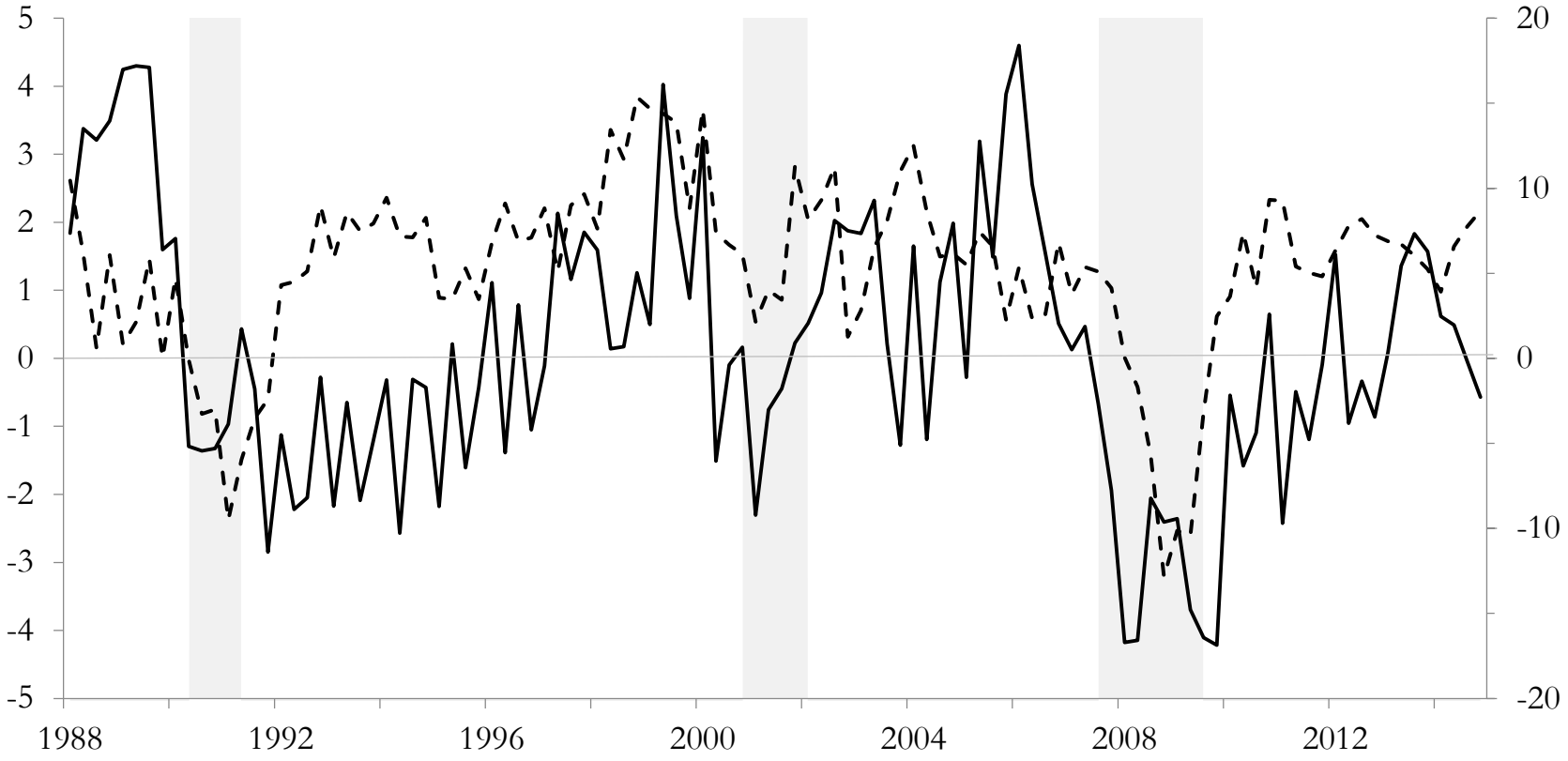
Notes: The figure shows the deviations from trend growth rates for conceptions and GDP. The data comes from the Natality Detail Files and the BEA. The shaded areas indicate NBER dated recessions.

Figure 7: Conceptions Growth Rate and Consumer Confidence



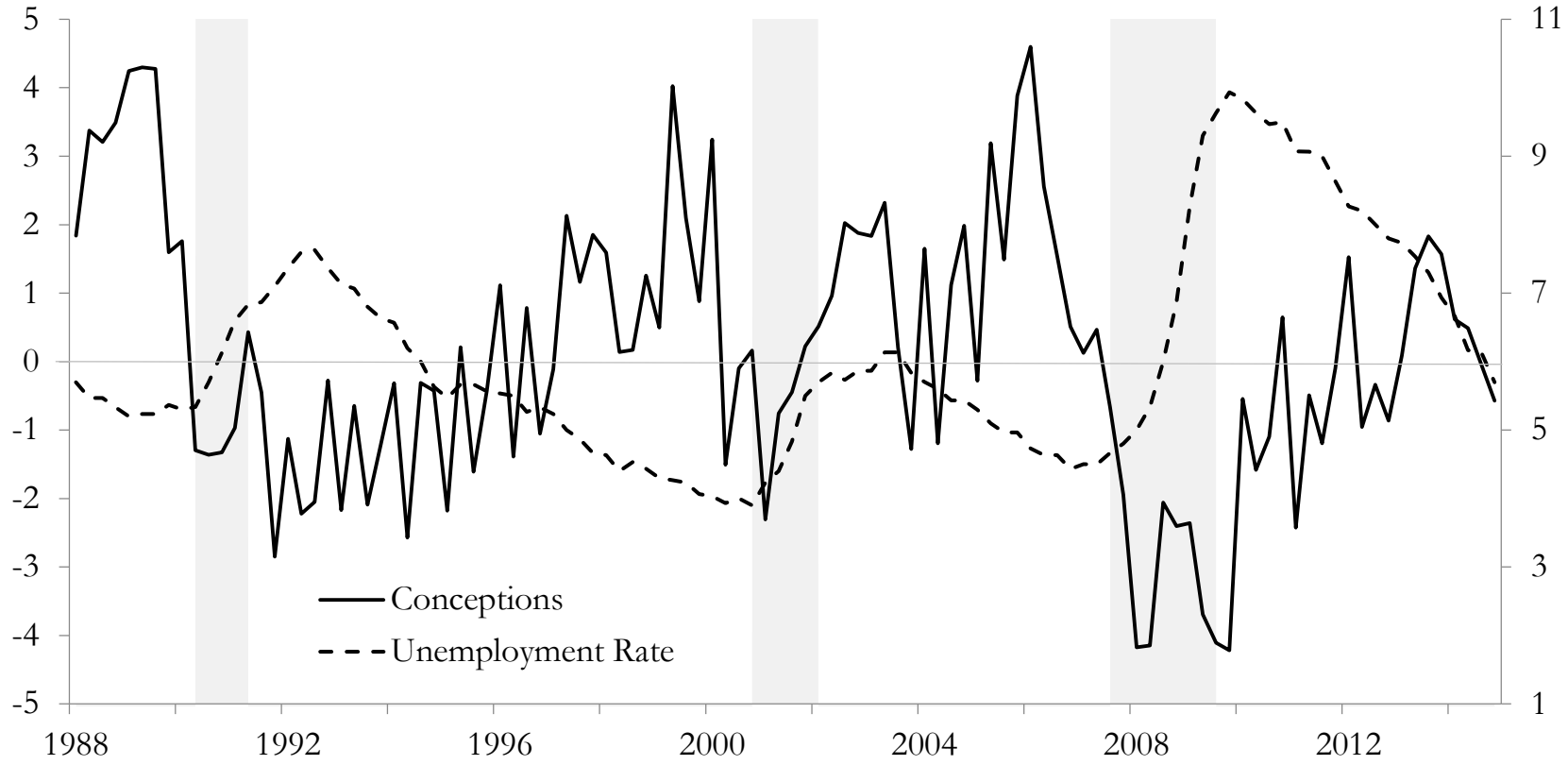
Notes: The figure shows the growth rate of conceptions over the preceding year, alongside the consumer confidence index. The shaded areas indicate NBER dated recessions.

Figure 8: Conceptions and Durables Growth Rates



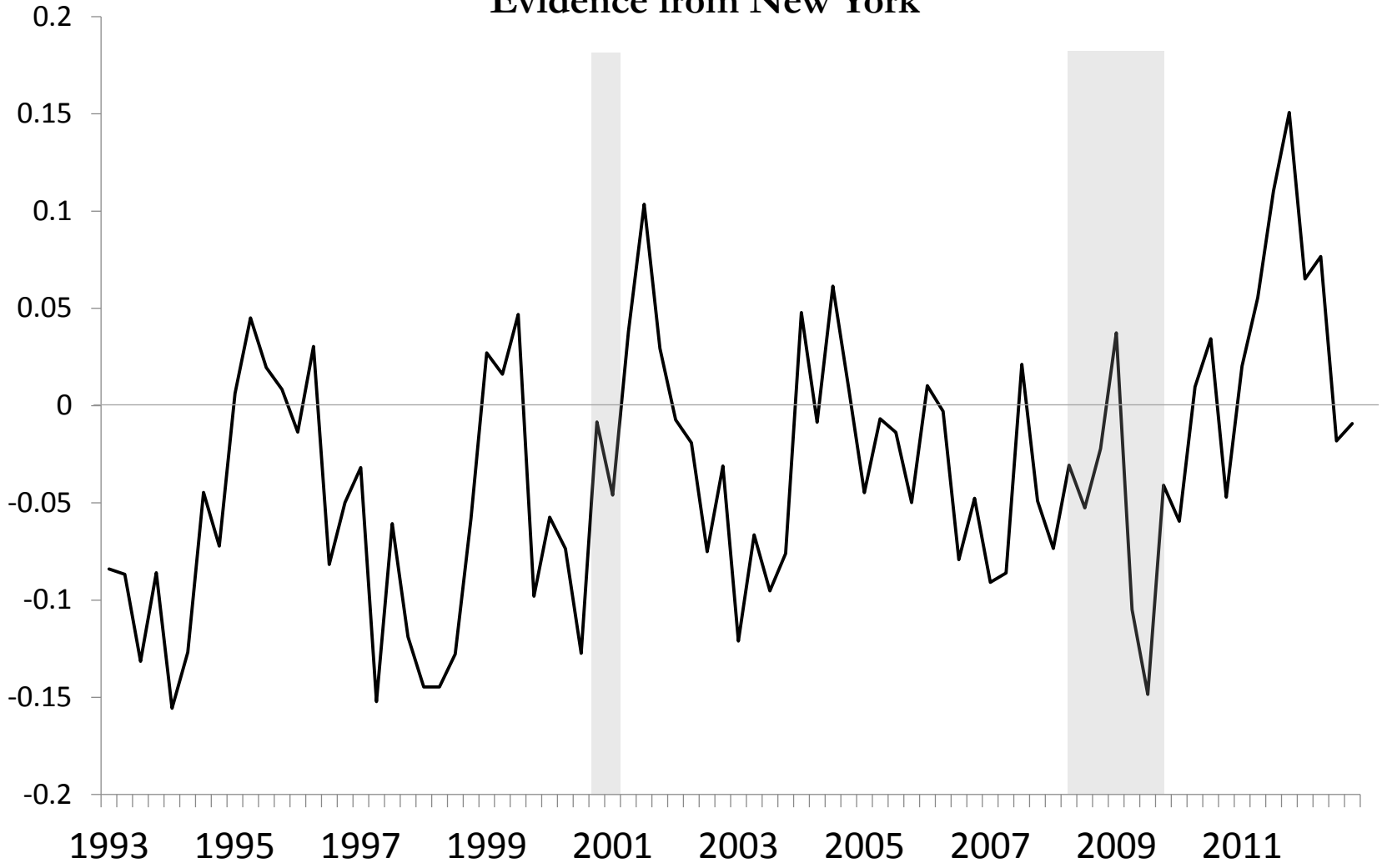
Notes: The figure shows the growth rate of conceptions and consumer durable goods purchases over the preceding year, reported quarterly. The shaded areas indicate NBER dated recessions.

Figure 9: Conceptions Growth Rate and Unemployment



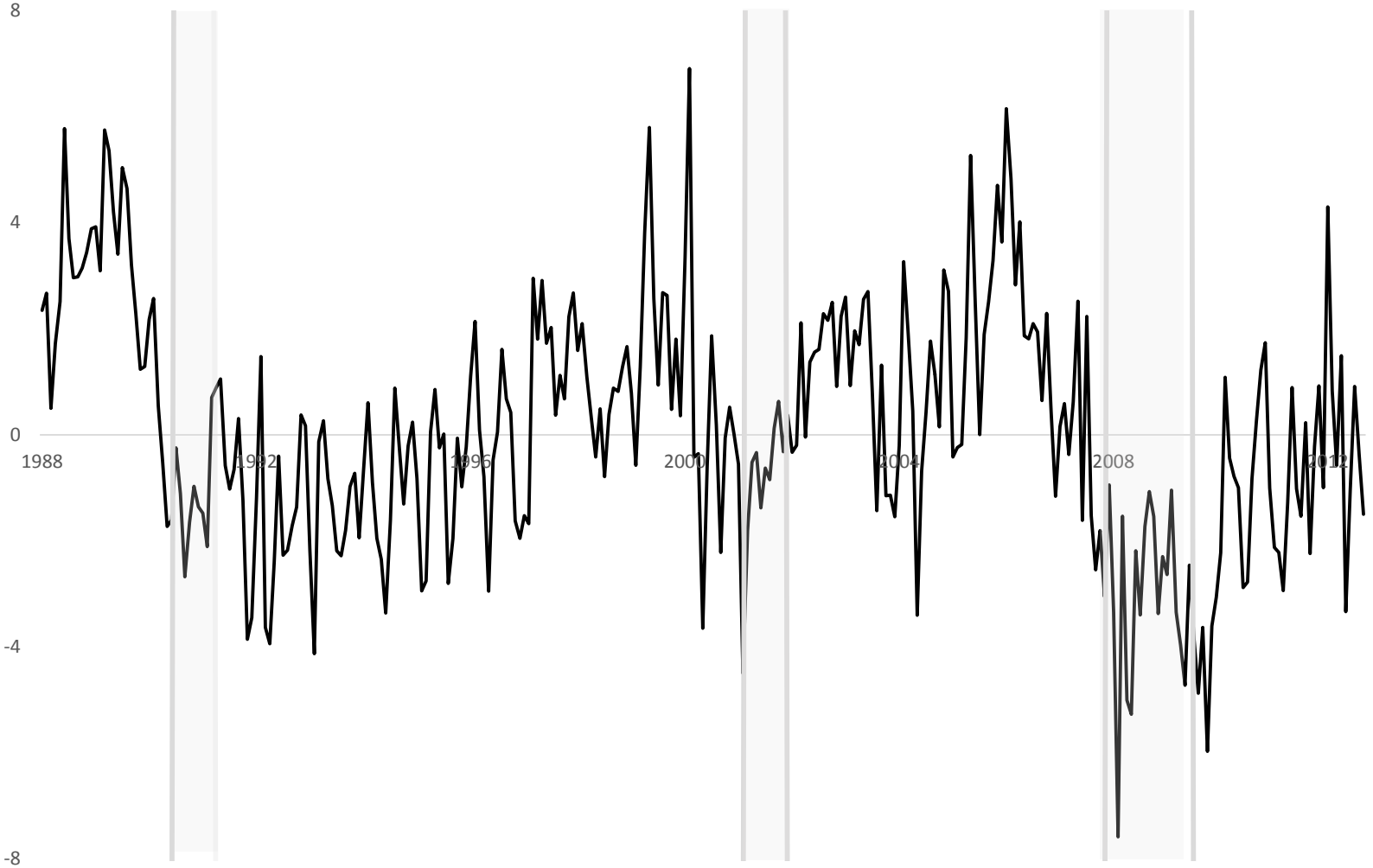
Notes: The figure shows the growth rate of conceptions, alongside the unemployment rate, both reported quarterly. The shaded areas indicate NBER dated recessions.

Figure 10: Miscarriages and Recessions: Evidence from New York

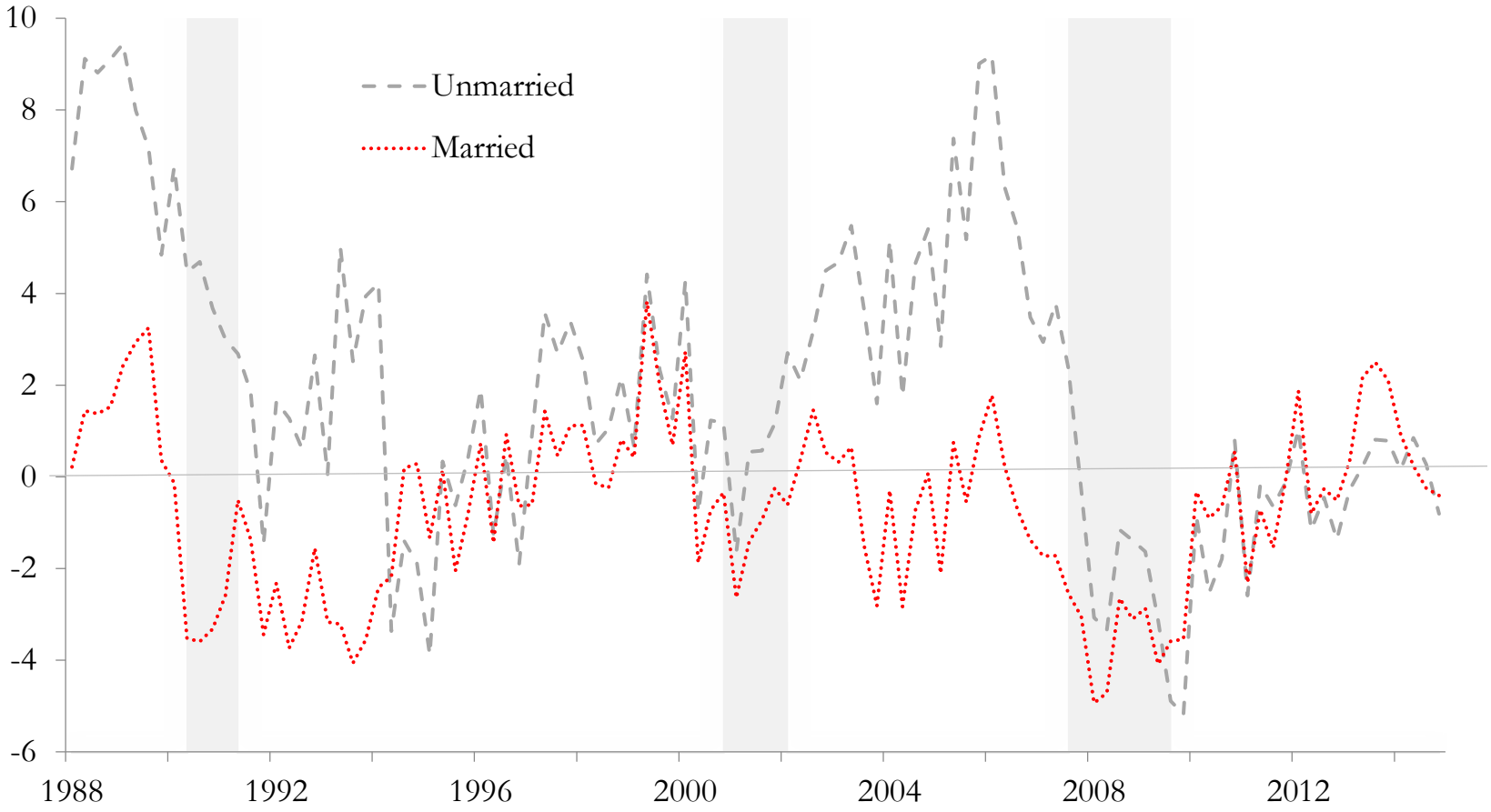


The picture shows the annual growth rate in quarterly miscarriages (fetal deaths of less than 12 weeks gestation) in New York State. The grey bars indicate recessions.

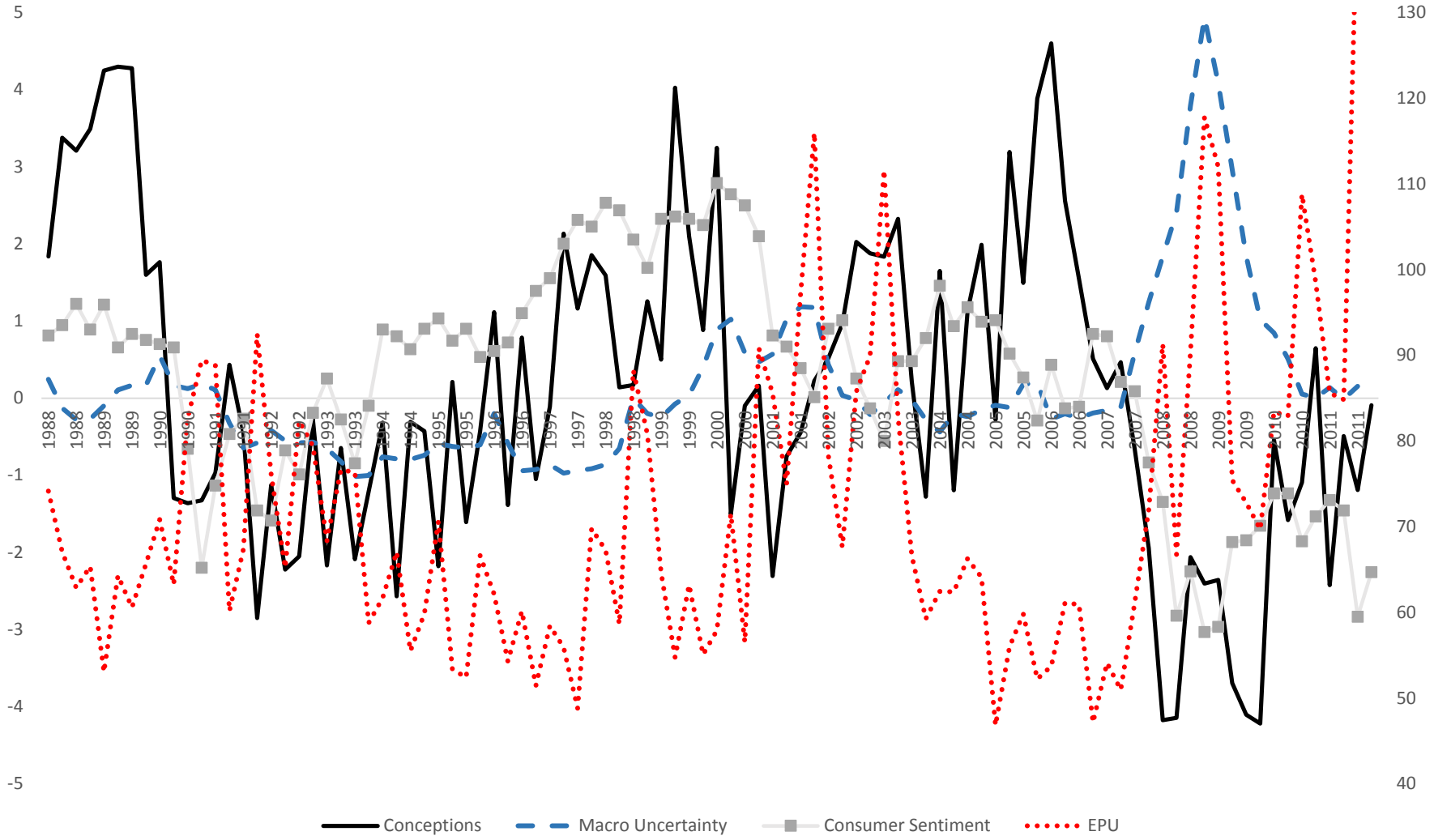
Appendix Figure 1: Using Monthly Conception Data



Appendix Figure 2: Conception Growth by Marital Status



Appendix Figure 3: Alternate Indicators & Measures of Uncertainty



Appendix Table 4: Conceptions- and Unemployment-Growth Rates all Years

