Fertility Is a Leading Economic Indicator

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Abstract

Many papers show that aggregate fertility is pro-cyclical over the business cycle. 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 recessions in the United States, the growth rate for conceptions begins to fall several quarters prior to economic decline. Our findings suggest that fertility behavior is more forward-looking and sensitive to changes in short -run expectations about the economy than previously thought.

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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). This would not have come as a surprise to most researchers studying fertility; a large literature across the social sciences has explored the relationship between fertility and the business cycle, with most studies concluding that fertility is pro-cyclical.[1]

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

In this article, we document changes in aggregate fertility at 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 United States to investigate whether changes in total conceptions preceded the Great Recession and other recent economic downturns. The data allow us to identify a new business-cycle fact: the growth rate of fertility declines prior to economic downturns and the decline occurs several quarters *before* recessions begin. This pattern holds in the United States 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 observe 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 consider changes in conceptions at the *end* of recessions; however, there the pattern is more complicated.

[1] Examples include Adsera (2004, 2011), Adsera and Menendez (2011), Currie and Schwandt (2014), Galbraith and Thomas (1941), Yule (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.

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.

Large literatures in economics consider fertility and, separately, the onset of recessions. The business-cycle fact we establish generates a novel connection between these topics and as such it does not fit neatly into any one area of prior work. Instead, our finding has implications for multiple lines of research.

Regarding research on the cyclicality of fertility, our paper makes several contributions. We note that despite hundreds of studies, scholars have not noticed the patterns we document here and indeed recent, careful papers suggest that the patterns we find are unlikely to exist. For example, in an excellent and well-cited overview of fertility and the business cycle, Sobotka, Skirbekk, and Philipov (2011) write that during a recession "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." Our results show that fertility behavior in the U.S. over the last three decades has been much more forward-looking and quick to respond than this statement implies.

Our findings also suggest that the choice of economic measure is important, especially for studies using high-frequency data, which are likely to become increasingly prevalent given the growing availability of high-quality economic and fertility data. In particular, unemployment is the most commonly used measure of economic performance in the fertility literature, and its use could be problematic because unemployment lags the business cycle—an issue we discuss below. Additionally, some work on the relationship between fertility and economic factors has acknowledged that measures of fertility could partially be driven by abortions and miscarriages (e.g., Dettling and Kearney, 2014). Our discussion of that possibility for our results suggests that conceptions are the driving factor.

Our findings also imply that fertility responds to expectations about the *future*. Some prior work has considered the relationship between fertility and economic conditions across generations (Becker and Barro, 1988); some has explored how long-term economic growth affects long-term fertility trends (Chatterjee and Vogl, 2016); and some has considered how a woman's long-term economic prospects interact with contraception use and early fertility (Bailey, 2010; Goldin and Katz, 2002; Kearney and Levine, 2014). None

of this research focuses on *near-future* economic conditions. In his seminal study, Becker (1960) argues that the lengthy "production time" for creating babies means that their production should be relatively unresponsive to short-term fluctuations.[2] Our work suggests in fact a high level of sensitivity to near-future events.

From a more macro-economic perspective, our paper relates to the growing body of research connecting changes in family composition to macroeconomic conditions. See Doepke and Tertilt (2016) and Greenwood et al. (forthcoming) for two recent reviews. Work in this area typically does not focus on business cycle dynamics, with the (very notable) exception of considering how family composition may affect jobless recoveries.[3] Our findings suggest that the *onset* of recessions also should be considered. Relatedly, prior work has found that recessions can have long-term effects on many economic outcomes (like wages, for example); we note that the fertility effects also appear to be quite persistent, a conclusion supported by several other papers (Currie and Schwandt, 2014; Chatterjee and Vogl, 2016; Huttunen and Kellokumpu, 2016). This fact represents an arguably under-appreciated channel by which the impact of a recession can persist, indeed for generations.

Finally, identifying and anticipating the onset of recessions is itself one of the most important topics of study in macroeconomics. In discussing several variables as forecasters, Sims (2012) notes that "measures of financial distress are important, and (economists) have been sifting through candidates for measuring them better." However, the performance of such indicators has come under question, and Frankel and Saravelos (2012) conclude that "a consistent theme of the most recent literature is that the leading indicators that most frequently appeared in earlier reviews are not statistically significant indicators of crisis incidence." Essentially

[2] Specifically, he writes, "It takes about 10 months on the average to produce a pregnancy and this period combined with a nine-month pregnancy period gives a total average construction period of nineteen months. This period is sufficiently long to reduce the impact on the demand for children of temporary movements in income" (page 227). When calculating the cyclicality of fertility (in tables 4 and 5), he brings births forward one year, so that cyclicality is estimated based on conditions contemporaneous to the time of conception.

[3] Greenwood et al. (2005) consider the interaction between baby booms and busts and the macro-economy. Also, see Jones and Schoonbroodt (2016). We focus on shorter-run movements. In the longer term, demographic shifts could alter the very nature of the business cycle. Jaimovich and Siu (2009) and Lugauer (2012) show that economies with a relatively younger labor force experience larger economic fluctuations. The quick reduction in conceptions and the potentially related changes in housing and durable goods purchases at the beginning of recessions represents one way in which this empirical relationship might manifest itself.

all of the many indicators considered concern financial and other macroeconomic variables (for further discussion of recent papers, see Ng and Wright, 2013; Frankel and Saravelos, 2012; and Gades Rivas and Perez-Quiros, 2015). While employing measures of macroeconomic and financial conditions to predict economic crises is natural, our work raises the question of whether non-traditional indicators—like conceptions—might be used for the purpose of forecasting.

Conceptions have a unique appeal in that the occurrence of conceptions is ubiquitous across human societies, including times and places where other leading indicators and even measures of output are highly flawed or unavailable (for example, in developing economies, cf. Henderson, Storyegard, and Weil, 2012). Further, for recent U.S. recessions, we show that conceptions fall coincident with or even prior to declines in other well-known indicators such as consumer confidence and durables purchases. Given that many births are unplanned, that planned births face uncertain timing, and that these other indicators may also reflect forward-looking behavior, the relative performance of conceptions is surprising.

A challenge for using conceptions as a leading economic indicator is that our measure is based on births, so there is a built-in 9-month lag in the time series we construct (longer, in fact, as birth certificate data are not immediately available after a birth occurs). At the end of the paper, we explore one possibility for tracking conceptions in near-real time: the use of scanner data on retail purchases related to fertility and pregnancy. This is a proof-of-concept exercise, and better proxies for conceptions may be found in the future. We also think the increased availability of "big data" will lead to the discovery of many useful indicators and predictors (such as other measures of demographic change, social media use, or internet search patterns) to use in tandem with traditional economic indicators.

The importance of the birth patterns explored in the following pages goes beyond the potential to help predict future economic crises. Our results could provide some insight into key questions about business cycles; for example, whether the nature of business cycles has evolved over time, and how recessions unfold. The almost prescient decline in fertility at the onset of the last three recessions is evidence that people react rapidly to changing economic conditions in even their most personal choices, such as whether or not to conceive a child.

II. Evidence on Conceptions and Recessions

II.A. Graphical Evidence

We begin with graphical 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 set 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 III.B. The data include the infant's month of birth, and a clinical estimate of gestation in weeks, which we use to estimate a month of conception.

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: $\frac{c_t - c_{t-4}}{c_{t-4}}$, where c represents conceptions and t represents the date of each quarterly observation.[4] We work with annual growth rates, rather than quarterly, because of the seasonality present in conceptions. This measure fits with the preferred method of investigating fertility and recessions advocated in Sobotka, Skirbekk, and Philipov (2011); see their discussion on page 269. Below we consider both other measures of birth rates and other ways to account for the seasonality; our conclusions are robust to these changes.

We analyze 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—something we discuss in more detail below. The United States 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, 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

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

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 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. Using GDP also 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.[5] We use quarterly data, as this is the most frequent GDP data available.[6] We then use the annual growth rate in this measure to side-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. We consider alternate detrending techniques and results in levels below.

In Figure 1, we plot the annual growth rate in births (solid line) against 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.[7] The figure also shows an absence of "false positives" where large drops in conceptions occur away from any recessions. 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%

[5] Data are from BEA NIPA Table 1.11.1. We list the data sources in the references. 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.

[6] We also aggregate the conceptions data to quarterly, even though it is possible to construct monthly conception rates using the birth certificate data. Appendix Figure 1 shows the time series of monthly growth rates in conceptions.

[7] In fact, the absolute number of conceptions begins to decline before any of the recessions begin. Our use of an annual growth rate somewhat obscures this fact 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. Figure 5 presents results that control for seasonality directly, and the anticipatory drop in the *level* of conceptions is clearer. Also, see Appendix Figure 1.

decline). Further, the decline in conceptions leads the corresponding decline in GDP for each of the three recessions.[8]

Next, we look at the three recessions individually. We start with the Great Recession because it was such a significant economic event, and then briefly discuss the other two smaller 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). We think it is fair to say that in late 2007 many experts were 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 December, as later determined by the NBER, and by this time, conceptions had already been in 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.[9] 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, 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 Figure 2 is the same as in Figure 1, but zooming in highlights the anticipatory nature of conceptions. 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 the growth rate of 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

[8] We also have used the demographic information that is available in the birth certificate data to reproduce Figure 1 by mother's age, by marital status, and by whether the mother was born in the United States. The growth rate of conceptions falls before each recession for all groups.

[9] 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.

magnitude of the decline is also 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 that year.[10] 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 (so that the 1990 recession was also followed by a "baby-less" recovery). The anticipatory drop in conceptions shown in Figure 2, before the most recent recession, is observed in these prior recessions as well.

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 typically employed with GDP data.[11] 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, leaving only movements at business cycle frequencies (similar to the seasonal filtering just discussed).[12] 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

[10] GDP growth does not turn negative because (as discussed earlier) we are using annual growth rather than quarterly.
[11] We use the X11 procedure to estimate the seasonal components. The Census Bureau developed the X11 seasonal adjustment method, and it is among oldest and most widely used techniques. The basic idea is to estimate the trend at each point by the moving average of a symmetric window of the data, and then the trend and seasonal parts can be separated. As with the BEA GDP adjustment, the X11 procedure may not eliminate all forms of seasonality.
[12] Business cycle filtering removes long run trends, such as an on-going decline in birth rates. However, our variables actually 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. We used a band-pass filter that also removes high-frequency movements, e.g., seasonality.

growth rate in conceptions break downward prior to each recession and turn negative before GDP does. We also looked at this relationship between the growth rates in levels using the Hodrick-Prescott (HP) filter (Hodrick and Prescott 1997), obtaining similar results.[13]

Our analysis to this point has used GDP as our measure of the strength of the economy. However, much of the previous literature uses employment measures, arguing that changes in employment are most salient for families (and potential families). In Figure 7 we plot conceptions against the unemployment rate. Following the literature, we simply use the basic, unadjusted unemployment rate, but four-quarter differences produce similar results (as reported in Appendix Figure 2). 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 far below prior-year values. The large decline in conceptions comes before the large increase in unemployment. The other two recessions again display the same pattern—conception growth starts to fall before unemployment starts to rise. Changes to aggregate employment tend to lag the cycle, whereas conceptions lead.

II.B. Statistical Evidence

Figures 1-7 graphically show that conceptions decline prior to recessions. Here we quantify the relationship through a few simple statistics. Table 2 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 2 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

[13] We first logged both series and then applied the HP filter with a smoothing parameter of 1600.

correlation is actually 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 three rows break the correlations out for each recession. 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 2 demonstrate that the correlations outside of the recession time periods behave differently. Row 6 reports the correlations, dropping the observations beginning one quarter before the recession through two quarters after. Compared to row 1, these non-recession periods have lower correlations at 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. 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 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 3 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.[14] Letting GDP_t denote the growth rate of GDP at date t, C_t denote conception growth, and e_t capture unexplained shocks to GDP growth, the relevant estimation equation is:

$$GDP_t = \alpha_1 GDP_{t-1} + \beta_1 C_{t-1} + \beta_2 C_{t-2} + \ldots + \beta_k C_{t-k} + e_t \qquad (1)$$

$$H_0: \beta_1 = \beta_2 = \ldots \beta_k = 0$$

The null is then that past conception growth rates (lags 1 to k) do not "Granger cause" GDP growth, and the stars in Table 3 indicate whether the null can be rejected with the indicated levels of certainty.

Row 1 of Table 3 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 (k=5) in the regression equation. When using the entire sample, the null of no Granger causality cannot be rejected at the 10% level in any of these five model specifications.

However, the 'asymmetric' nature of the correlations over the cycle (as documented in Table 2) makes 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 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 3 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 five 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

[14] 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 of Granger causality would look stronger.

specified number.[15] 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.

A large literature (e.g., considering how oil prices effect the economy as in Kilian and Vigfusson, 2011; Hatemi-J, 2012; Herrera, Lagalo, and Wada, 2015; and Hamilton, 2011) has encountered a potential 'asymmetry' similar to what we see with conceptions. Following this literature, we test for the presence of an asymmetric 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 or negative conception growth affect GDP differently (or asymmetrically). The new variable is added into Equation (1). Rows 6 and 7 of Table 4 report the Granger causality test on conceptions and the new variable (the lags up to 5 periods). In addition, 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 new variables have a statistically significant effect. 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 2 and 3 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 is not entirely surprising. The decline in births after the Great Recession has been noted by others (cf. Johnson, 2016). And, researchers have spent considerable effort

[15] Time series models are often selected to minimize the AIC. The AIC is similar in spirit to the inverse of an adjusted R^2, but with a larger penalty for each additional parameter to be estimated. 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 alternative Schwarz Bayesian Criteria would suggest different specifications, as would an adjusted R^2.

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 7, this anticipation does not, however, appear to be an entirely satisfactory answer. While unemployment was persistently high after the Great 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. Using cohort-level data (which are more naturally suited to this question than the data we use here) Currie and Schwandt (2014) provide evidence that short-term effects of unemployment on fertility can be quite persistent even for younger women. 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 evidence (Daniels et al., 2015) that use of long-acting reversible contraception grew dramatically in the years around the Great Recession.

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 eventual) success. Thus, if many couples at the end of a recession begin efforts to conceive, this may appear gradually in the data. If, however, 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 2 suggests that the decline in fertility continued more than a year after the most recent economic recovery began, a sufficiently long period that it is doubtful that typical time-to-conception delays could be the sole driving force, but such delays could still be part of the story.

Finally, we have replicated the analysis from Tables 2 and 3 using state level data. Although aggregate business cycle fluctuations drive much of the state variation, there exist differences in the timing

and severity of business cycles across states for us to exploit. To conduct the analysis, we use the restricted-access versions of the Natality Detail Files, which include the mother's state of residence, to construct a panel of quarterly state-by-state conception growth rates. State-level output (GSP, or gross state product) time series are available quarterly only for recent years. Therefore, the state GSP analysis only covers the Great Recession.[16] Appendix Tables 1 and 2 report the results. Similar to our results based on national output, state-level output is correlated with conceptions at a one- to two-quarter lag during the Great Recession, conceptions "Granger cause" fluctuations in output at the state level, and the recession periods drive these findings. The results using state fixed effects in Appendix Table 2 also help us rule out that the national decline in fertility prior to a recession came from a single state or group of states, which may have entered into a recession before the rest of the country.

III. Understanding the Forward-Looking Nature of Conceptions

III.A. Comparisons to Other Leading 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 those of other activities that are known to be 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 focus on these two alternate indicators for brevity, but we have considered others; doing so generally confirms the results shown here.[17]

[16] Since the GSP data only covers the Great Recession, we also show results using unemployment as our measure of the economy. As an economic indicator, unemployment can lag the business cycle, but state-by-state unemployment rates are available quarterly throughout our time frame. Consistent with previous results, state-level conception growth and unemployment are more correlated in recessionary periods than in recoveries, and lags of conception growth are more highly correlated with unemployment than contemporaneous measures during recessions.

[17] A few are worth highlighting. Oil prices increased 5-fold during our period of study, but with large swings that sometimes coincided with the business cycle. Housing prices, too, climbed during this era; however, the growth of prices in the Case-Shiller index fell at the beginning of the 1990 recession and collapsed during the Great Recession (but not the 2001 recession). We also have compared conceptions to the Consumer Sentiment Index and the uncertainty measures of Baker, Bloom, and Davis (2016) and Jurado, Luvvigson, and Ng (2015). Conception growth declines at the

Figure 8 plots the growth rate in conceptions against the consumer confidence index. The index is based on a monthly survey of households' 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 9 plots 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 with or even anticipates these two indicators, for each of the last three recessions. Each figure plots the two trends on separate axes (with conception growth on the left), as the magnitude of the variations differ.[18] In Figure 8, the fall in conception growth does actually appear to precede the decline in confidence prior to the Great Recession. Conceptions also turn negative slightly before consumer confidence prior to the 1990 recession, as well as before the 2001 recession.

The drop in conceptions preceding the Great Recession happens at about the same time or slightly before the drop in durables purchases in Figure 9. Conception growth moves closely with durables for the 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. Moreover, our results for fertility show that 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 end. This continued uncertainty may be another factor contributing to the slow rebound in conceptions at the end of recessions.

[18] 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).

uncertainty that people feel heading into recessions is reflected in not only their responses to surveys or their purchasing decisions, but in a major decision like whether to have a child. One could perhaps also interpret the results here as suggesting that conceptions could form the basis of an economic indicator useful for forecasting purposes—something we consider further below.

III.B. 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. 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 fetal deaths explain most of the fertility pattern, then that would suggest another channel altogether—one that is driven by physiological factors (perhaps induced by stress) rather than by a conscious decision about fertility.

We consider fetal deaths and abortions in turn. Fetal deaths at less 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. Miscarriages may provide a quantitatively important channel because 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 been identified as risk factors for miscarriage in early pregnancy (Atik, Hepworth-Jones, and Doyle, 2010).[19]

[19] Another possibility is that stress could affect conceptions by affecting sexual behaviors (by causing people to have more or less sex) or by affecting the probability of conception conditional on sex. While we are not able to test this, either explanation would still mean that future economic conditions are having real effects with timing that is consistent with our results.

We begin with a simple back-of-the-envelope calculation. A miscarriage rate of 20 percent would imply that there are 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 about 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.[20] 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).[21] 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 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 in New York State over this period. 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.

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. There is no meaningful increase in this growth rate before either the 2001 or the 2007 recession. We interpret these data with caution

[20] We did explore using the National Survey of Family Growth, which has retrospective information on fetal deaths for women age 15-44. Even when combining data from surveys between 1995 and 2010, the sample size was still too small to be able to distinguish meaningful changes in the miscarriage rate from noise at a quarterly frequency. The CDC publishes annual national-level data for fetal deaths, although unlike the data we present 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).

[21] 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.

because they come from a subset of one state, and because fetal deaths are under-reported.[22] Nevertheless, the data provide no evidence of an increase in miscarriages leading up to recessions that is anywhere near the magnitude required to explain a significant portion of the observed decrease in births. As an additional check, we used the birth certificate data to construct the time series in the sex ratio. Because male fetuses are known to be more vulnerable to adverse conditions in utero (Catalano et al., 2005), if our results are driven by stress-induced miscarriages, we might also see a lower male/female sex ratio heading into recessions. We found no evidence of this. Overall, data on miscarriages, patterns in the gender composition of birth, and an appeal to the basic magnitude of our fertility drop all indicate that the fall in pre-recession births is likely not driven by miscarriages.

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 4 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.

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.

Moreover, a quick look at the magnitudes in the table indicates that abortion is unlikely to play a quantitatively important role. Abortions increased by 3,000 from 2007 to 2008—while births fell by nearly

[22] 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.

70,000 (NVSS, 2015). Even a tenfold increase in the number of abortions beyond what is reported in Table 4 would fail to account for most of the decline we identify. The cyclical patterns we observe are driven by conceptions and not abortions or miscarriages.

IV. Discussion

This paper shows that conceptions fall before recessions begin, and that conceptions compare well with or even outperform other economic indicators in anticipating recessions. In their 2011 survey of the literature, Sobotka, Skirbekk, and Philipov (2011) characterize the relationship between fertility and the business cycle as one in which fertility responds to changes in GDP or unemployment with a lag (or in a few exceptional cases, concurrently). How can we reconcile our finding that changes in conceptions *lead* the business cycle with this large body of research? We think there are three issues. First, we note that the majority of the work cited by Sobotka, Skirbekk, and Philipov uses data aggregated to the annual level. While in many cases this is due to a lack of data at a higher frequency, the result is that one would struggle to identify the relationship we document here (unless one did so by implication, as was the case with the New York Times article mentioned in the introduction). We show this in Appendix Figure 3, where we replicate our own results using annual rather than quarterly data. For all three recessions, the annual time series conceals the anticipatory nature of conceptions—in fact, for the first and third recessions, conception growth appears to be at relative highs right before the recessions begin. The problem is even worse if one were to use data on births rather than conceptions.[23]

Second, this literature spans several decades, or even centuries. Taking this evidence as a whole, we agree with Sobotka, Skirbekk, and Philipov's assessment that fertility has historically fallen after economic downturns are already underway. In fact, when we extend our own analysis back to the late 1960s, we do not

[23] 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 unanticipated" (page 2159), but this finding for white teenagers in North Carolina appears hard to reconcile with our evidence based on millions of births across the country. 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).

observe that declines in conceptions precede the four recessions between 1968 and 1988 (though the quality of the birth certificate data is also lower during this period). The anticipatory nature of fertility may have become more pronounced in recent recessions, so that we are documenting a newly-emerging business cycle fact. Indeed, a number of studies find that the relationship between fertility and other socioeconomic phenomena changed during the 1970s/early 1980s (Ahn and Mira, 2002; Billari and Kohler, 2004; D'Addio and d'Ercole, 2005; Macunovich, 1996; Adsera, 2004; Myers, forthcoming).[24] 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, and labor market institutions. Further, the recessions we focus on may have affected some economic outcomes (e.g., labor productivity) in ways different from older recessions (Ng & Wright, 2013); the explanation may thus depend upon the nature of modern recessions themselves.

Third, many studies in this literature consider employment as a measure of the health of the economy (e.g., Ahn and Mira, 2002; Noguera, Golsch, and Steinhage, 2002; Adsera, 2004; Adsera, 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. Figure 7 illustrates this possibility by plotting unemployment against the conception growth rate. 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, particularly when using high frequency data, is that other outcomes beyond employment at the time of conception should be considered as measures of economic activity. Further, future work on fertility and outcomes specific to employment should take into account the potentially confounding effects of anticipatory changes in fertility.

[24] See in particular Figures 12 and 13 in D'Addio and d'Ercole (2005) and the discussion in Section 4 of Adsera (2004).

Finally, our results raise the question: could conceptions be used in practice as an indicator to forecast economic downturns? An obvious challenge is that conceptions are difficult to measure in real time, even compared to other indicators like consumer confidence or durables purchases. Using the measure we have constructed here, changes in conceptions would not be observable for at least nine months after they occurred, and even more in reality, given lags in the availability of the birth certificate data. One possible option is to use consumer purchases of goods that are especially likely to be bought (or not bought) by those who are attempting to conceive or who are newly pregnant. These purchases are tracked with high frequency by retail firms using scanner technology and might therefore be used to track conceptions in near-real time.

We explored this possibility using Nielsen Retail Scanner Data from 2006 to 2012, which provides weekly purchasing volumes for products by universal product code (UPC), for over 35,000 retail stores.[25] This period includes the Great Recession but few pre-recession observations. There are over 2.6 million UPCs, grouped into over 1,100 product categories. We selected data from the following product categories: ovulation and fertility test kits, pregnancy test kits, contraception, multivitamins (which includes prenatal vitamins), other vitamins, pads, and tampons. The latter two are included as women's menstrual cycles are affected by both pregnancy and by the use of some methods of contraception.

We pursued two strategies. First, we calculated the average number of daily purchases in each category, by quarter, from 2006 to 2012. We then created annual growth rates (for each quarter, using the same method as for conceptions) and compared the trends over time. Using this method, the product category that appeared to track conceptions most closely was ovulation and fertility test kits (which averaged approximately 200-250 thousand purchases per quarter). Appendix Figure 4 shows the results. Note that while the growth rate in ovulation kit purchases was still positive as the Great Recession began (it was a growing market at the time), both series trend downward from 2007 to 2009. The series are also closely linked at the end of the sample, with the growth rate of ovulation kit purchases reaching a peak in the fourth quarter of 2011, one quarter before conceptions peak.

[25] The data were accessed via an agreement between the University of Notre Dame and the Marketing Data Center at The University of Chicago Booth School of Business.

Our second strategy was to consider purchases in these same categories, but with a more statistical approach for identifying which items best predict conception growth. Specifically, following the method developed in Belloni et al. (2012), we employed a Lasso technique, letting the Lasso estimation identify whether the growth rates of several fertility-related items could predict contemporaneous changes in conception.[26] We then took variables selected by the Lasso (i.e., given non-zero coefficients in the Lasso estimation) and produced fitted values of conception growth from an OLS regression of conception growth on the selected variables: a post-Lasso estimate. The Lasso estimator selected only two variables for inclusion and both are somewhat unexpected: growth in tampons and growth in non-multi-vitamins. Further, the post-Lasso OLS regression gave a positive coefficient to tampon growth. If conceptions drop, one might expect more menstruating (non-pregnant) women rather than fewer, and thus growth, rather than decline, in tampon purchases. The data instead show both dropping together before the Great Recession. One possibility is that some women avoided pregnancies by using methods such as long-acting-reversible contraception that prevented both births and menstruation, but we are unaware of evidence of a spike in the use of such methods in mid-2007 (although their popularity increased greatly during the recession overall, as mentioned earlier).[27]

Given these caveats, the post-Lasso estimate is plotted along with actual conception growth in Appendix Figure 5 and its fit is remarkably good. Notably, both trends begin with small positive values and both become negative in the third quarter of 2007. Both then stay negative every quarter until the fourth quarter of 2010, when both become positive again.[28]

[26] The Lasso technique calculates regression coefficients by minimizing the standard sum-of-squared-errors plus a penalty term equal to the (weighted) sum of the absolute values of the included coefficients. The weights and penalties are determined by the data as proposed in Belloni et al. (2012). The variables included were the growth rates of the following: contraception purchases, pregnancy tests, ovulation kits, menstrual pads, multivitamins, and non-multi-vitamins. Including a more aggressive set of candidate controls (e.g., including levels, or lagged rates) typically produced similar results, although sometimes no variables were selected.

[27] Of course, another possibility is that tampon and vitamin purchases respond to or even predict business cycle fluctuations directly, absent any relationship to conceptions. The Lasso technique described here could be used to identify other products or product categories that have this feature.

[28] The post-Lasso OLS regression produces an R-squared (on 2 covariates) of 0.48; these two covariates explain half the variation in conception growth. There are 24 quarterly observations, and the adjusted-R-squared is 0.43.

We view this as an exploratory exercise. Our aim is not to identify the most effective strategy for tracking conceptions in real time, but rather to provide proof-of-concept evidence that data on consumer purchases might be used to do so.[29] In addition to addressing the lag for observing conceptions, this approach also could help track conceptions in settings where other leading indicators are less well-measured, such as in developing countries. This exercise also illustrates an important implication of our paper: quantifiable phenomena beyond standard financial and economic measures have enormous potential for refining our ability to measure, anticipate, and understand recessions and related economic behavior.

V. Conclusion

In this paper, we use high-frequency data from birth certificates in the U.S. to document a new business cycle fact: the growth rate of conceptions declines prior to economic downturns and the decline occurs several quarters *before* recessions begin. Our measure of conceptions is constructed using live births; we present evidence suggesting that our results are indeed driven by changes in conceptions and not by changes in abortion or miscarriage. Conceptions compare well with or even outperform other economic indicators in anticipating recessions.

Our paper focuses on the U.S. 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 across countries, the pro-cyclical behavior of fertility has been found in many settings. Whether the particular anticipatory behavior we identify here holds in other countries, we cannot say. If not, then fertility patterns may point to reasons why business cycles unfold differently, depending on time and place.

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

[29] We also explored the possibility of using historical data on internet searches for terms related to pregnancy or conception. We found that some terms did seem to be correlated with conceptions ("pregnancy" or "trying to conceive"), but other similar searches ("pregnant" or "have a baby") did not. We also found that values in google-trends data on internet searches appeared to change over time, even when the period of study was held constant, raising issues of replicability. We concluded that this strategy also has potential for the future, but that the scanner data has more predictive content at this time.

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 economic circumstances. 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. This is not to say that studies of contemporaneous or lagged economic circumstances are of diminished 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 Chatterjee 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.

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 for characterizing the conceptions themselves. The dynamic aspects of fertility decisions regarding the near-future are too seldom studied, and the remarkably prescient nature of fertility has been sorely underappreciated in quantitative research.

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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 United States 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 U.S. government bails out General Motors and Chrysler (Christian Science Monitor, 2013).

Table 2: Correlations between Conception Growth and GDP Growth

Period	Sample Size	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)
(1) 1988-2014	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: Variables are annual growth rates, reported quarterly. Each row presents the simple correlations over the given period using different lags of the conceptions variable, where the lags are in terms of quarters. Row 6 drops the dates from one quarter before the recession to two quarters after; row 7 uses the 12 quarters of data after each of the three recessions. The first quarter of 1988 is not included. The sample size is the number of observations used for the contemporaneous correlation.

Table 3: Granger Causality

		Lags Included in the Regression Equations				
Period	Sample Size	1	2	3	4	5
(1) 1988-2014	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) 1988-2014	108				**0.05****	
(5) Recession years	24					**0.005*****
Asymmetry						
(6) 1988-2014	108					0.05**
(7) Recession years	24					0.00***

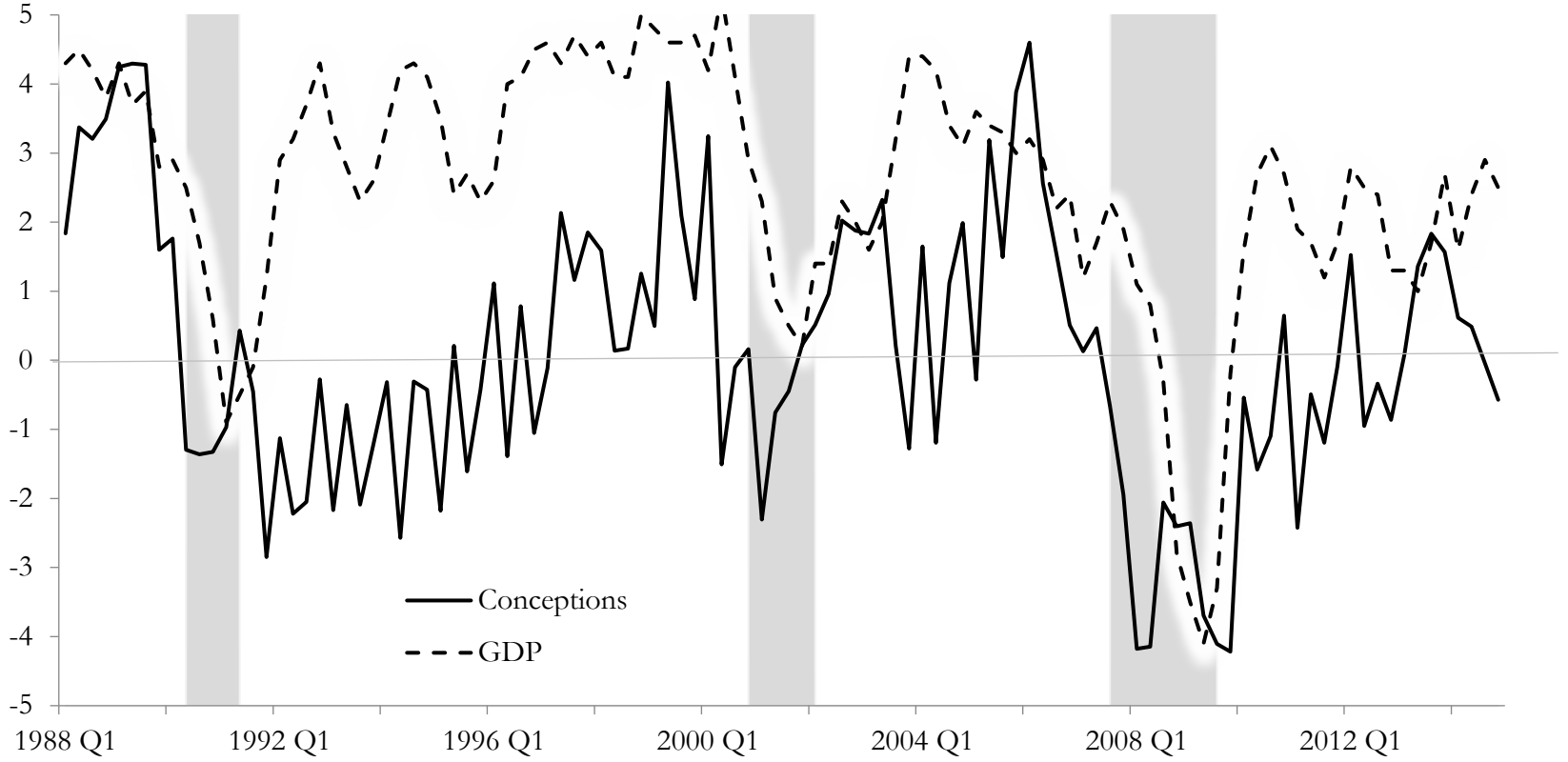
Notes: This table reports the probability of exceeding the chi-squared statistic of a Wald test of the hypothesis test that none of the conception lags are statistically significant in a regression of GDP growth on lags of GDP and lags of conception growth. Stars denote significance at the * 10% ** 5%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

Table 4: 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	

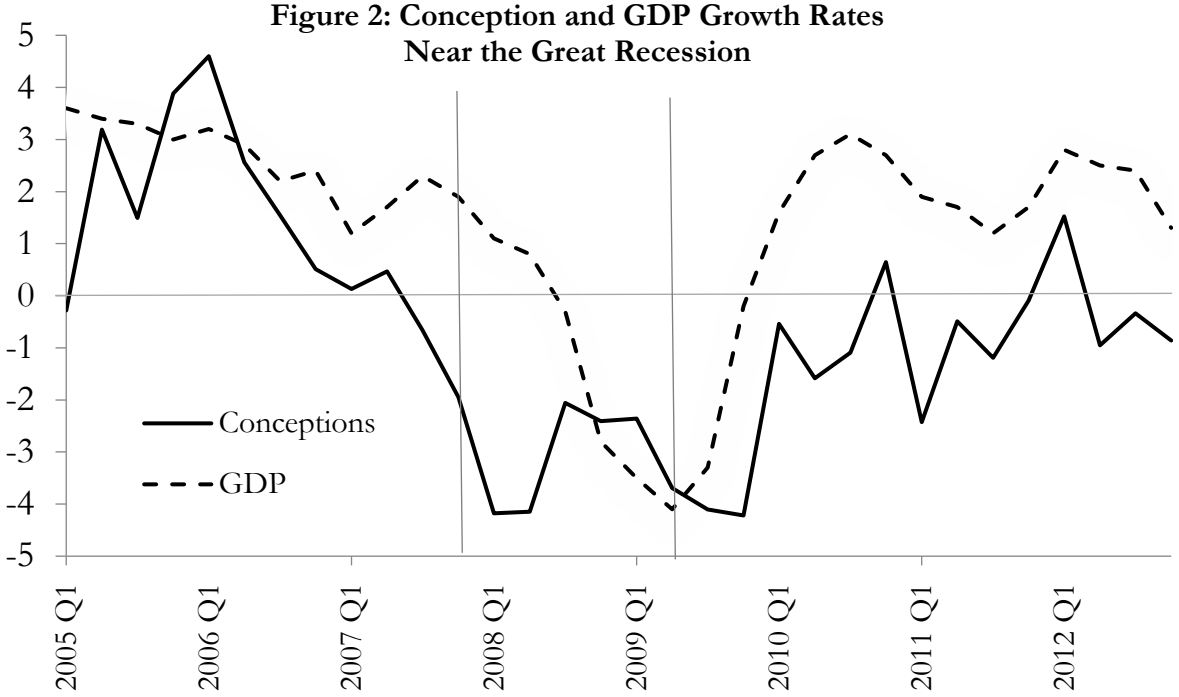
Source: Jones and Jerman (2014). The abortion rate is abortions per 1000 women ages 15-44 as of July 1st each year. The abortion ratio is abortions per 100 pregnancies ending in abortion or live birth, for each year; the ratio is based on birth during the 12-month period starting July of that year. Interpolations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

Figure 1: Conception and GDP Growth Rates



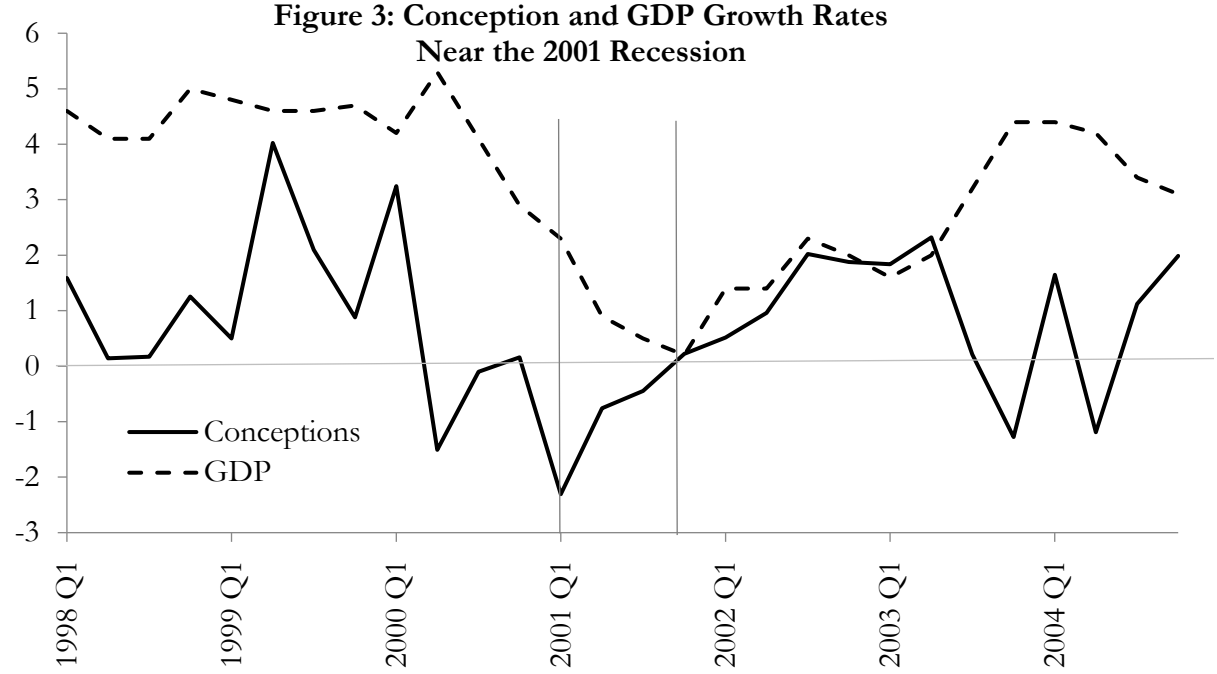
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The shaded areas indicate NBER dated recessions.

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



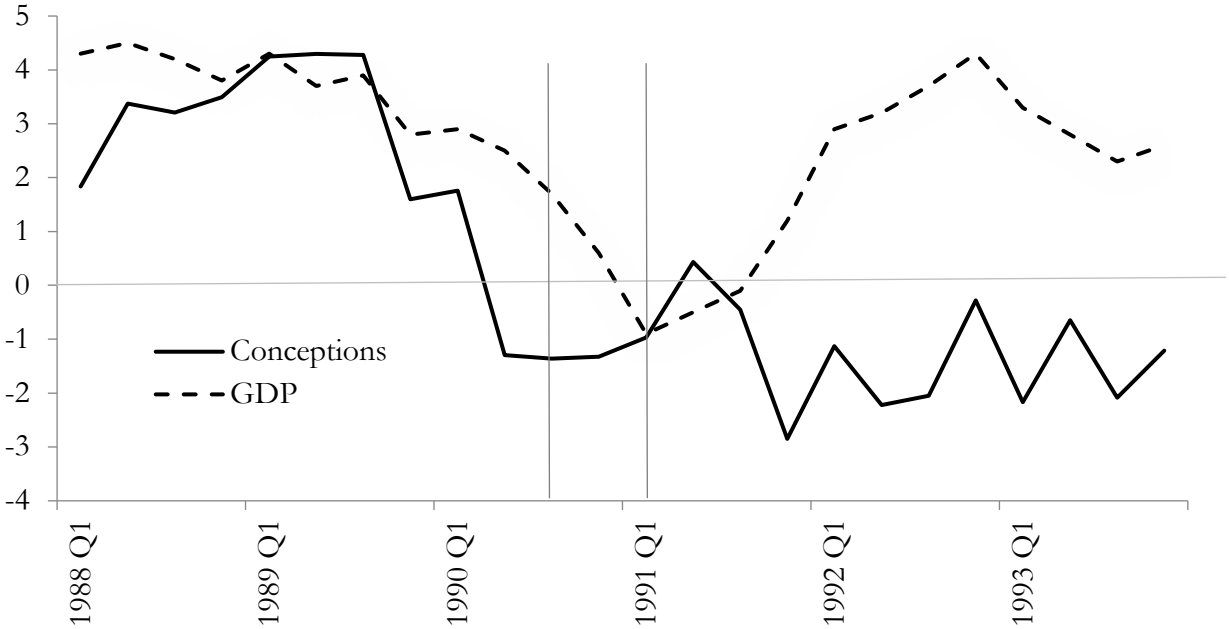
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (2007 Q4) and end (2009 Q2) of the recession.

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



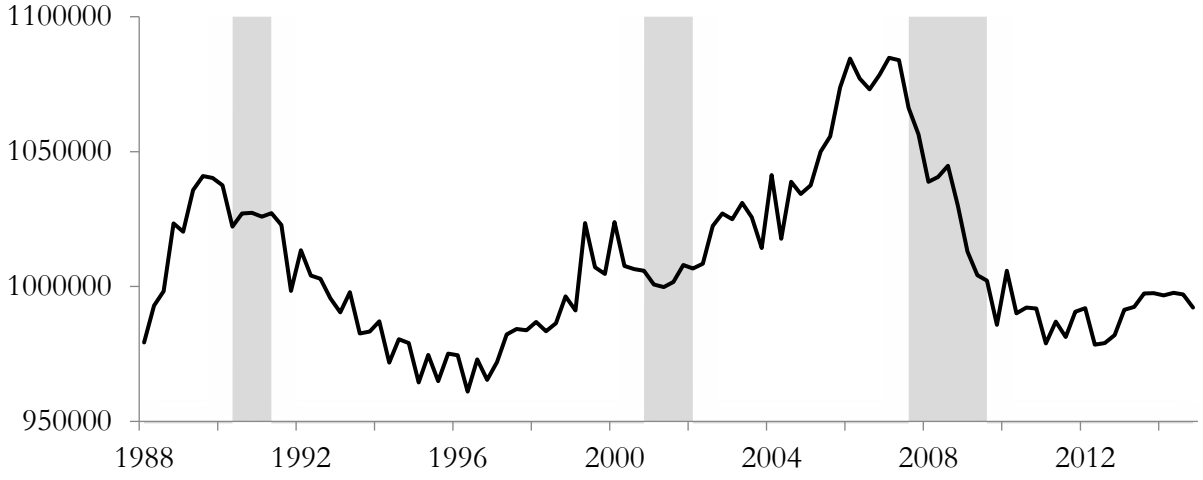
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (2001 Q1) and end (2001 Q4) of the recession.

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



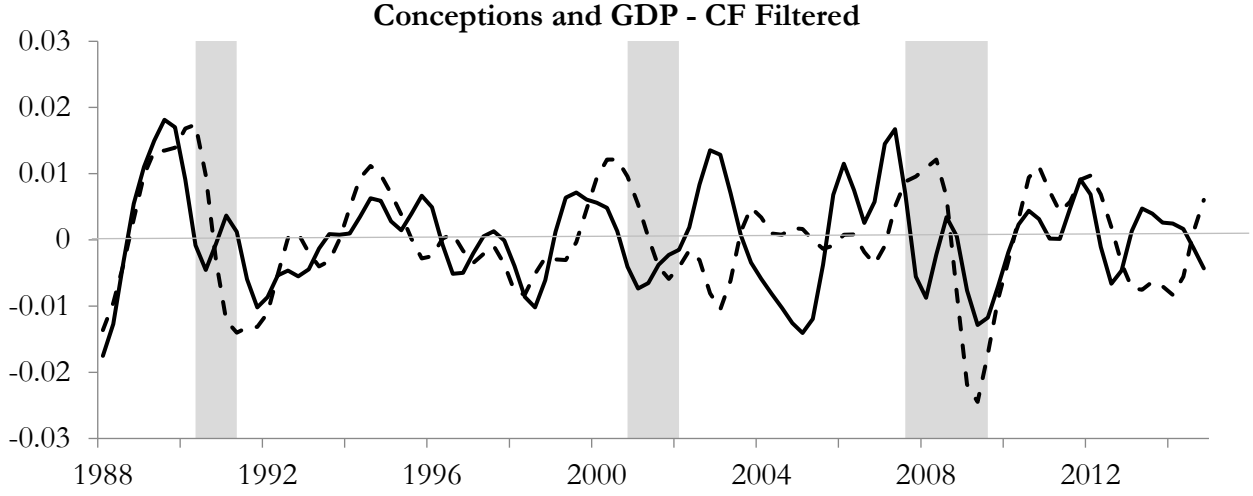
Notes: The figure shows the growth rate of conceptions and GDP over the preceding year, reported quarterly. The data comes from the Natality Detail Files and the BEA. The vertical lines indicate the beginning (1990 Q3) and end (1991 Q1) of the recession.

Figure 5: Conceptions (seasonally adjusted) and NBER Recessions



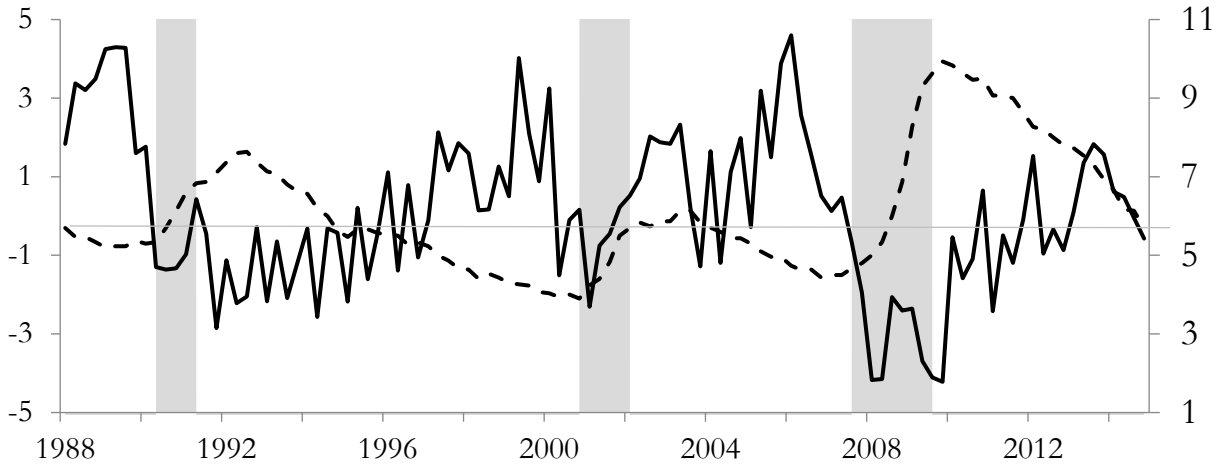
Notes: The figure shows the number of conceptions each quarter, after seasonal adjustment. The data comes from the Natality Detail Files. The shaded areas indicate NBER dated recessions.

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



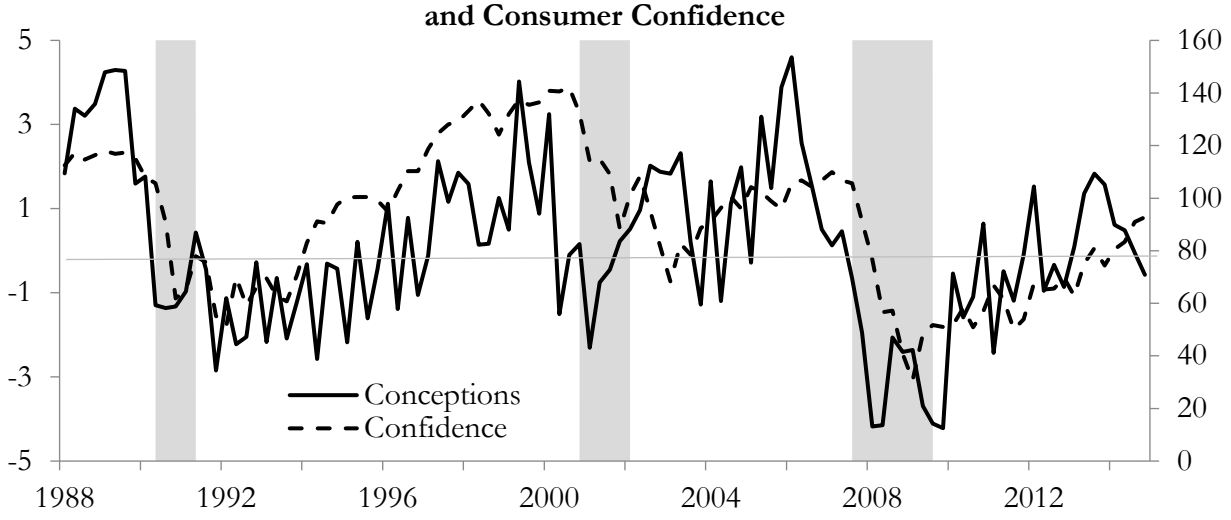
Notes: The figure shows the quarterly deviations from trend growth rates for conceptions (solid line) and GDP (dashed line). The data comes from the Natality Detail Files and the BEA. The deviations from trend were calculated using the CF filter. The shaded areas indicate NBER dated recessions.

Figure 7: Conceptions Growth Rate and Unemployment



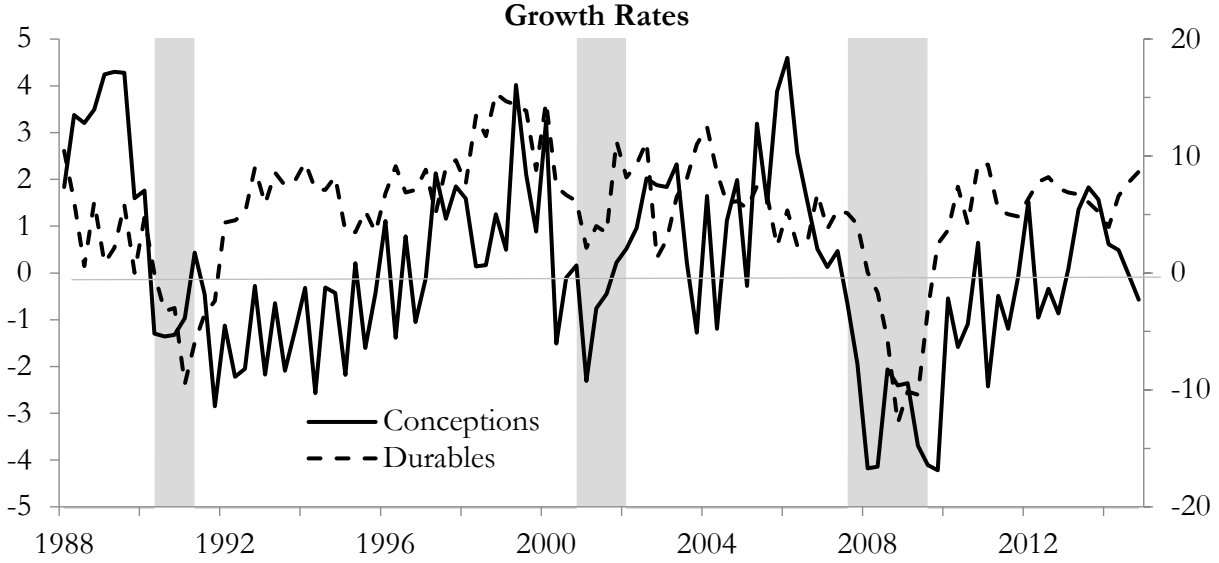
Notes: The figure shows the growth rate of conceptions (solid line, left axis), alongside the unemployment rate (dashed line, right axis), both reported quarterly. The shaded areas indicate NBER dated recessions.

Figure 8: Conceptions Growth Rate and Consumer Confidence



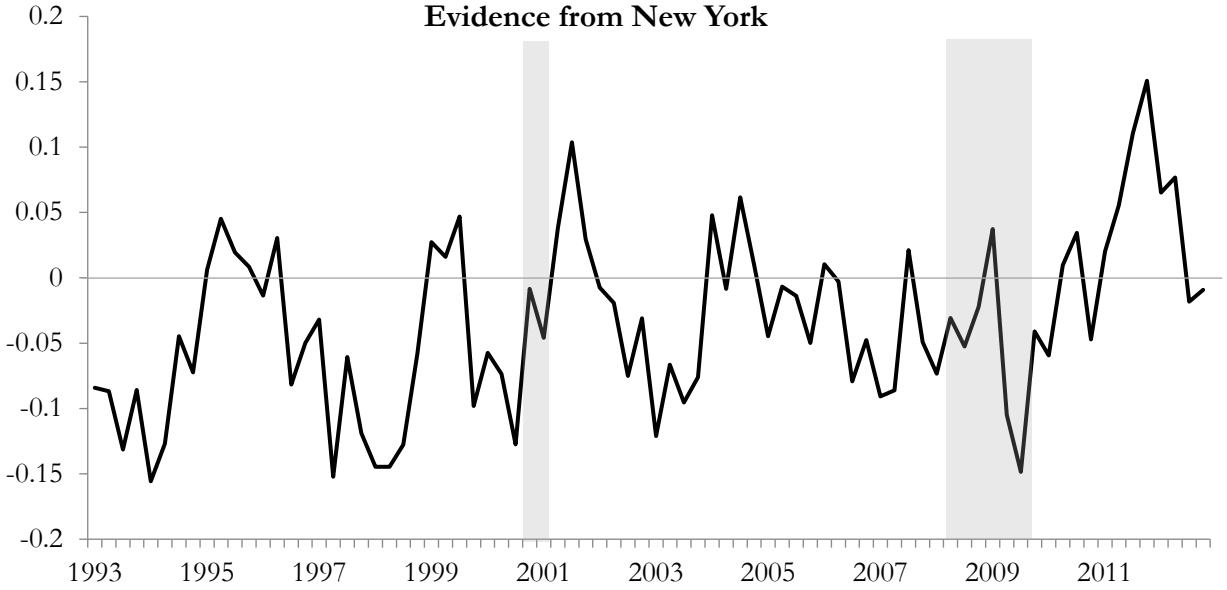
Notes: The figure shows the growth rate of conceptions over the preceding year, alongside the consumer confidence index, both reported quarterly. The shaded areas indicate NBER dated recessions.

Figure 9: 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 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 Table 1: Correlations Between Conception Growth and State-Level Economic Fluctuations

Panel A: Conceptions and State GDP

	Period	Sample Size	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)
(1)	2006-2014	1836	0.33	0.32	0.30	0.26	0.23	0.22
(2)	Recession 1st 4 Qtr	204	0.29	0.41	0.40	0.29	0.17	0.09
(3)	2007Q4 – 2009Q2	357	0.23	0.30	0.40	0.49	0.51	0.40
(4)	Non-recession years	1275	0.22	0.20	0.16	0.08	0.05	0.11
(5)	Post-Recession	612	0.42	0.33	0.28	0.27	0.23	0.19

Panel B: Conceptions and State Unemployment

	Period	Sample Size	(t)	(t-1)	(t-2)	(t-3)	(t-4)	(t-5)
(1)	1988-2014	5253	-0.26	-0.26	-0.23	-0.20	-0.16	-0.10
(2)	Recession 1st 4 Qtr	612	-0.14	-0.20	-0.22	-0.12	-0.06	-0.10
(3)	2007Q4 – 2009Q2	357	-0.23	-0.26	-0.36	-0.46	-0.51	-0.41
(4)	2001Q1 – 2001Q4	204	0.06	-0.04	-0.06	0.01	-0.04	-0.02
(5)	1990Q3 – 1991Q1	153	-0.35	-0.18	-0.17	-0.11	-0.14	-0.16
(6)	Non-recession years	4029	-0.06	-0.09	-0.06	-0.05	-0.07	-0.04
(7)	Post-Recession	1836	-0.25	-0.23	-0.19	-0.20	-0.20	-0.15

Notes: Variables are annual growth rates, reported quarterly. Panel A uses state-of-residence conception rates and state-level GSP data (including the District of Columbia). The change in growth rate is calculated from 2006 onwards, as state-level GSP data is not available at the quarterly level for earlier years. Panel B uses state-level unemployment data. The first quarter of 1988 is not included. The sample size is the number of observations used for the contemporaneous correlation. Each row presents the simple correlations over the given period using different lags of the conceptions variable, where the lags are in terms of quarters. Row 6 drops the dates from one quarter before the recession to two quarters after; row 7 uses the 12 quarters of data after each recession (36 quarter/year periods total).

Appendix Table 2: Granger Causality Using State-Level Data

Panel A: With State Level Data and State Fixed Effects

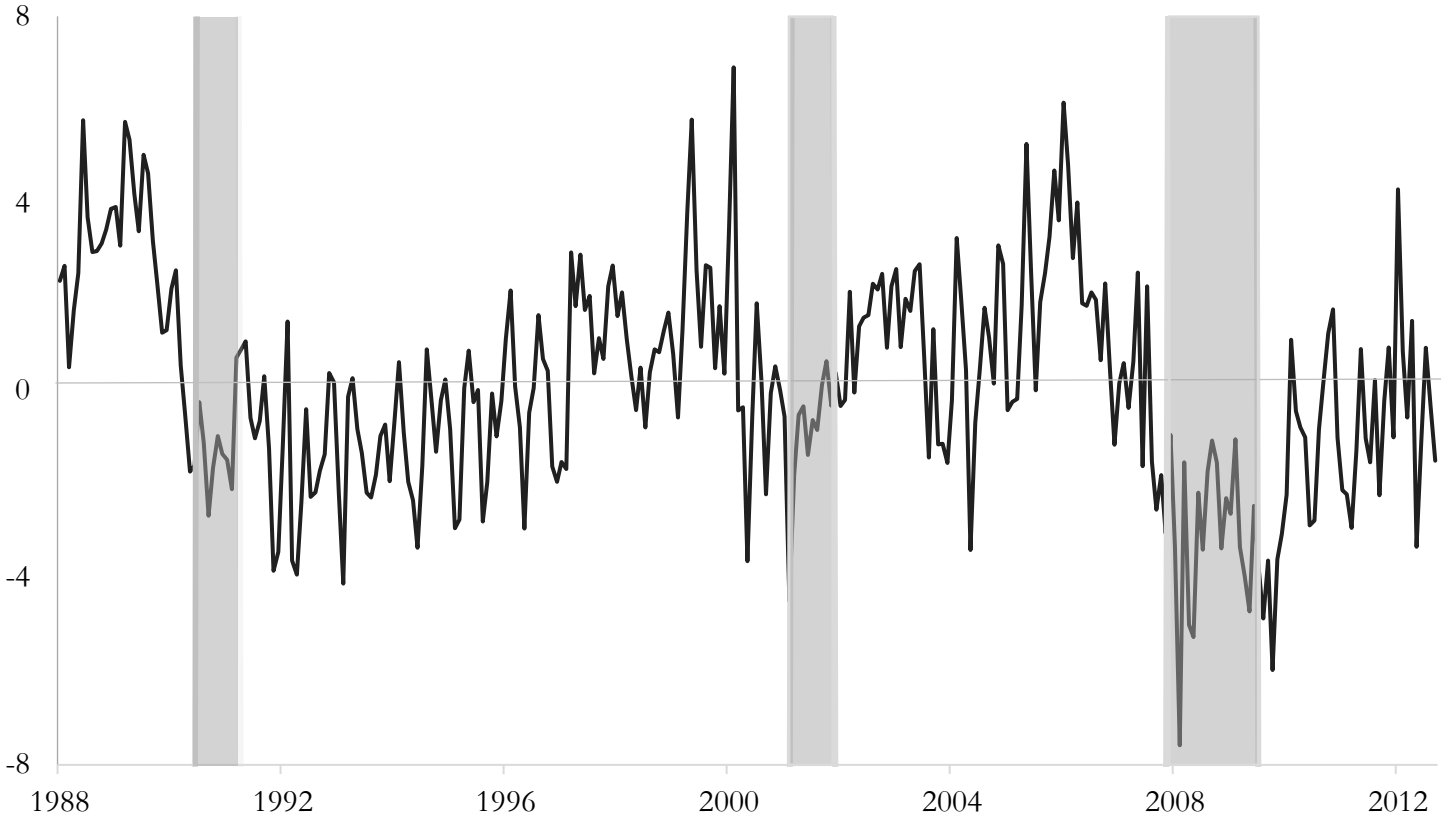
		Lags Included in the Regression Equations				
Period	Sample Size	1	2	3	4	5
(1) 1988-2014	1734	0.02	0.05	0.16	0.22	0.00
(2) Recession 1st 4 Qtr	204	0.00	0.00	0.00	0.00	0.00
(3) Non-recession years	1224	0.75	0.57	0.10	0.00	0.00

Panel B: With State Level Data and No State Fixed Effects

		Lags Included in the Regression Equations				
Period	Sample Size	1	2	3	4	5
(1) 1988-2014	1734	0.00	0.01	0.02	0.02	0.00
(2) Recession 1st 4 Qtr	204	0.00	0.00	0.00	0.00	0.00
(3) Non-recession years	1224	0.88	0.92	0.14	0.26	0.00

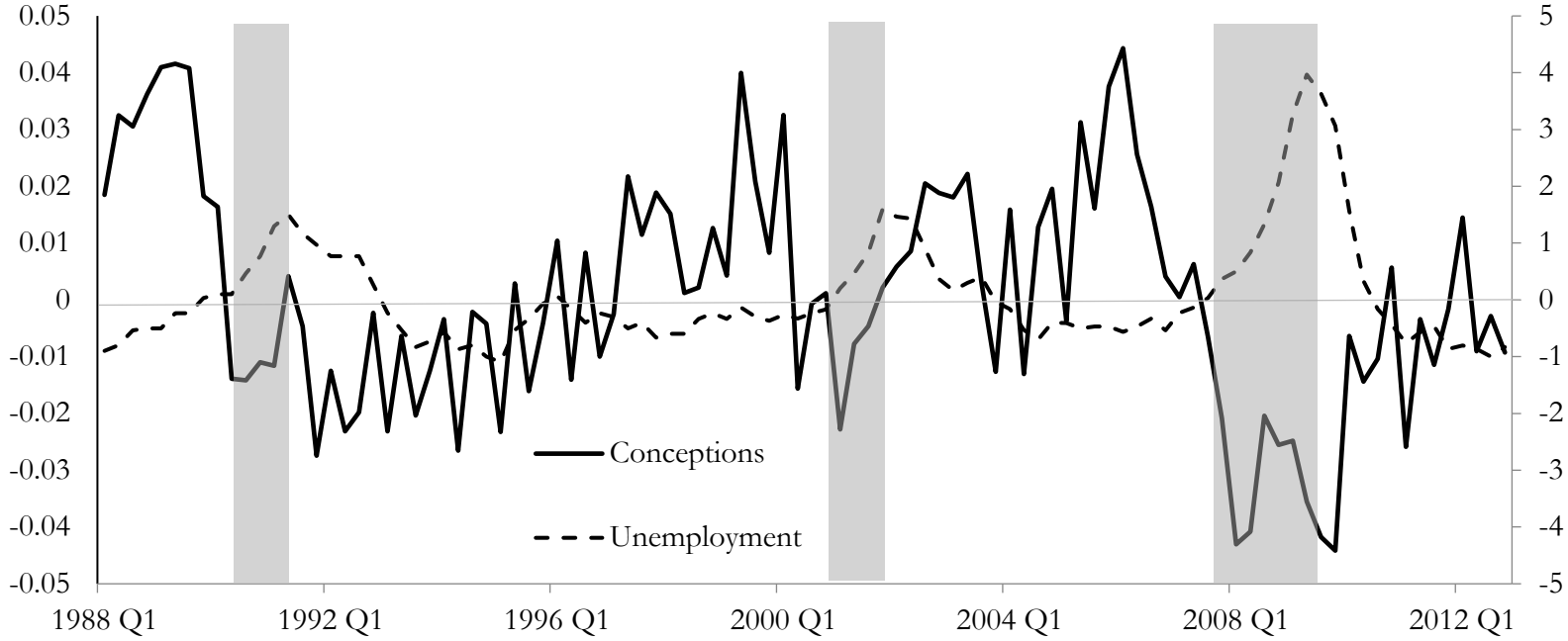
Notes: This table reports the probability of exceeding the chi-squared statistic of a Wald test of the hypothesis test that none of the conception lags are statistically significant in a regression of GSP growth on lags of GSP and lags of conception growth.

Appendix Figure 1: Conception Growth Rate, by Month



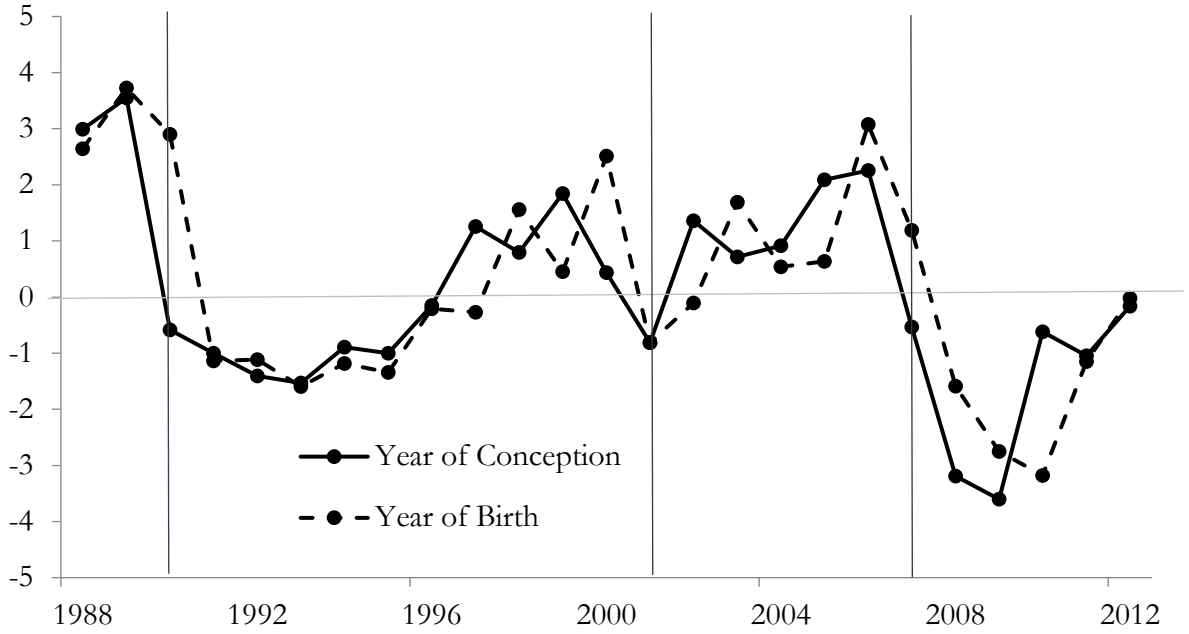
Notes: The figure shows the growth rate of conceptions reported monthly. The data comes from the Natality Detail Files. The shaded areas indicate NBER dated recessions.

Appendix Figure 2:
Conceptions Growth Rate and Changes in Unemployment



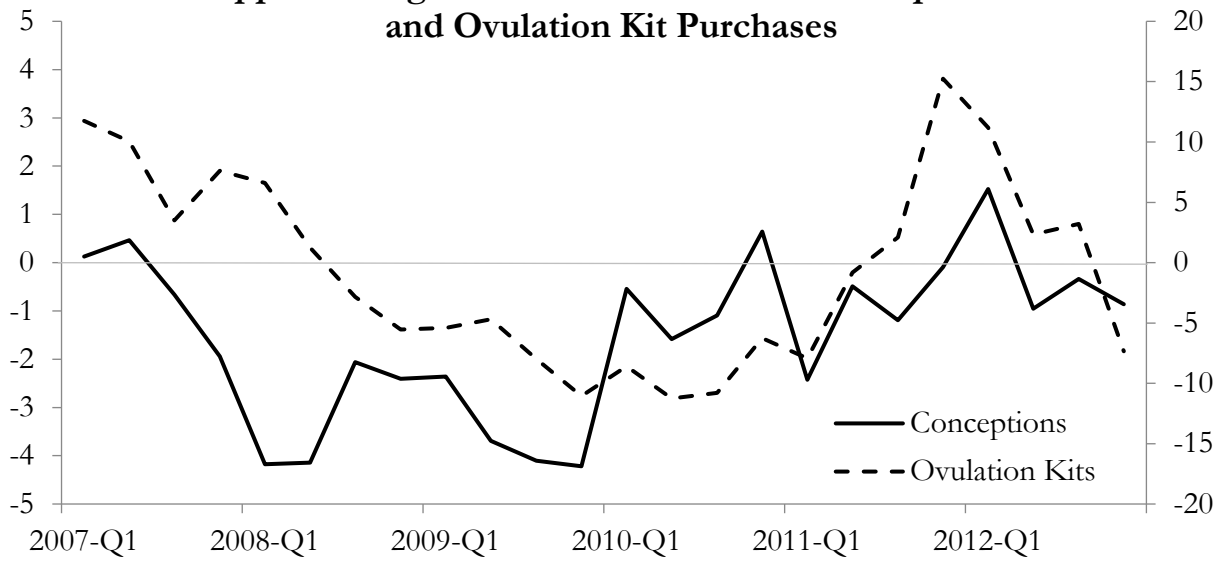
Notes: The figure shows the growth rate of conceptions (left axis) and the change in unemployment (right axis), both reported quarterly. The data comes from the Natality Detail Files and Bureau of Labor Statistics.

Appendix Figure 3:
Growth Rates in Conceptions and Births Using Annual Data



Notes: The figure shows the growth rate of conceptions and births over the preceding year, reported annually. The data comes from the Natality Detail Files. The vertical lines indicate the beginnings of NBER dated recessions.

Appendix Figure 4: Growth Rates for Conceptions and Ovulation Kit Purchases



Notes: This picture shows trends in the annual growth rates of conceptions (left axis) and purchases of ovulation kits (right axis), by quarter. The purchasing data are from The Nielsen Company (US), LLC and provided by the Marketing Data Center at The University of Chicago Booth School of Business. Data are from 2006-2012.

Appendix Figure 5: Using Scanner Data to Track Conceptions, Estimates from a Post-Lasso Model

Notes: The above picture plots two quarterly trends. The solid line is the growth rate of conceptions. The dashed line is from the expected level of conception growth based on an OLS regression of conception growth on the contemporaneous growth rates of (a) tampons and (b) non-multi-vitamins. These two goods were selected using a Lasso procedure outlined in Belloni, Chen, Chernozhukov, and Hansen (2012).