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FERTILITY AND THE PERSONAL EXEMPTION: COMMENT

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ABSTRACT

One of the most commonly cited studies on the effect of child subsidies on fertility, Whittington, Alm, and Peters (1990), claimed a large positive effect of child tax benefits on fertility using time series methods. We revisit this question in light of recent increases in child tax benefits by replicating this earlier study and extending the analysis. We discuss two strong assumptions that were implicitly made in the original analysis and show that the earlier results vanish if either assumption fails to hold. Even if these assumptions hold, we show that the Whittington et al. results are not robust to more general measures of child tax benefits. While we do not find evidence that child tax benefits affect the level of fertility, we find some evidence that they affect fertility timing.

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1 Introduction

Standard economic theory tells us that the demand for children is influenced by the cost of raising children. Holding other things constant, a decrease in the cost of raising children should lead to an increase in the demand for children. As shown in Figure 1, the average value of the U.S. child tax subsidy adjusted for inflation has increased from under $850 in 1980 to more than $2,000 in 2005.[1] The U.S.D.A. estimates that annual expenditures on children range from $7,580 to $16,970 depending on the age of the child and household income (Lino, 2007); thus, the $1,150 real increase in child tax benefits can be thought of as a 7 to 15 percent discount on the cost of raising children. How much of an effect (if any) did this reduction in the cost of raising children have on fertility?

Whittington, Alm, and Peters (1990) were the first to seriously estimate the responsiveness of fertility to child tax benefit changes. Their analysis of time series data from 1913 to 1984 suggests that the U.S. fertility rate is very responsive to child tax benefits. They estimate that a $100 increase (in 2005 dollars) in the tax value of the personal exemption would increase the general fertility rate by 2.1 to 4.2 births (a 3.2 to 6.5 percent increase).[2]

While the sign of the estimated effect is not unexpected, the strong and robust magnitude of the Whittington et al. (1990) estimate is surprising. If a $100 increase in annual child tax benefits could increase fertility by 3.2 to 6.5 percent, should we have expected a 32 to 65 percent increase in the U.S. fertility rate in response to the $1,000 Child Tax Credit, holding all other factors constant?[3]

Since Whittington et al. (1990), a handful of empirical studies have estimated a fertility response from changes in child tax benefits or other child subsidies. One set of papers uses

[1] The details regarding the calculation of the average per-child tax subsidy are given in the Appendix.

[2] Whittington, Alm, and Peters report their results in 1967 dollars. Their estimates of the effect of the value of the personal exemption in 1967 dollars on the general fertility rate range from 0.121 to 0.236. Converting the dollar amounts to 2005 dollars using the CPI-U, we find that their estimates range from 0.021 to 0.042.

[3] From 1997 (the year the Child Tax Credit was passed) to 2005, the general fertility rate in the United States increased by 4.9 percent. Note however that eligibility restrictions and interactions in the tax code make the $1,000 Child Tax Credit worth much less than this amount on average. From 1997 to 2005, the average child subsidy increased by approximately $550 in real terms.

similar aggregate time-series or pooled time-series methods to examine the long-run effect of child tax benefits on fertility (e.g. Zhang et al. (1994), Gauthier and Hatzius (1997), Huang (2002)). These studies generally find that fertility responds to tax benefits, though the estimated responses are smaller than that found by Whittington et al.

Another set of studies uses individual data and finds mixed results as to whether financial incentives influence fertility in the short run. While Whittington (1992) finds evidence in the PSID that tax benefits strongly influence family size in the United States, Baughman and Dickert-Conlin (2003) find that the largest estimated fertility response to Earned Income Tax Credit (EITC) expansions in the 1990s (for married non-white women) was less than half the magnitude reported in Whittington et al. and many subpopulations display no economically significant response. Similarly, Laroque and Salanie (2005) find evidence of only a small effect on fertility in France, despite the generosity of French child subsidies.

Milligan (2005) reports fertility response estimates of a similar magnitude as Whittington et al. (1990) using data from Quebec. However, it is likely this large fertility effect is in part due to the temporary nature of the Quebec subsidy program; Parent and Wang (2007) show that women may have had children earlier in order to claim the subsidy with no change in their completed fertility. Most recently, Cohen, Dehejia and Romanov (2007) find strong effects of financial incentives on fertility among low-income populations in Israel.

Despite the lack of agreement in the literature, Whittington et al. (1990) is cited by an increasing number of publications (many in non-economics journals) as evidence of a strong link between child tax benefits and fertility. In this paper, we revisit and extend the analysis in Whittington et al. along two dimensions. First, we update the data series with 21 additional years of data and broader measures of child tax benefits. While Whittington et al.'s analysis was limited to the real tax value of the personal exemption, we incorporate the child tax credit (CTC) and the earned income tax credit (EITC) in our measure of child subsidies. As illustrated in Figure 1, these additional components of child tax benefits grew in importance over the last two decades and account for much of the significant growth in the value of the average child tax subsidy; currently, they make up more than half of the total subsidy available to families with children. Extending and updating the data series allows us to develop more precise estimates of the relationship between fertility and child tax benefits and reexamine the relationship in light of recent increases in these subsidies.

Second, we also revisit the model specification and estimation procedure from the original paper. We focus on two assumptions necessary for the validity of the original model. The first implicit assumption is that there is a long-run relationship between the general fertility rate and child tax benefits. If this assumption is violated, running the regression in levels is not justified. The second assumption is that the general fertility rate does not Granger-cause any of the explanatory variables. If this assumption is violated, autocorrelation correction via feasible generalized least squares (FGLS) will produce inconsistent estimators.

We show that even if both these strong assumptions hold, the results of Whittington et al. (1990) are specific only to the personal exemption series and are not robust to broader measures of tax subsidies. Because a tax subsidy in the form of a child tax credit should affect fertility in the same way as a tax subsidy from the personal exemption, this finding casts doubt on the model specification in Whittington et al. We also investigate the implications of relaxing either assumption for the conclusions of Whittington et al. Again we find that the updated data and more general measures of tax subsidies do not produce a robust, statistically significant relationship with the general fertility rate.

We also examine the short-run effects of child tax benefits on the general fertility rate by estimating the models in first differences. We find evidence that child tax benefits increase fertility with a two-year lag. However, the total short-run effect is not statistically different from zero. These results suggest that tax benefits may influence the timing of fertility but not the overall level.

The paper is organized as follows. Section 2 describes the estimation methods used to replicate the original Whittington et al. results. In Section 3 we update the data and report our new results. Section 4 concludes. Details on the data reconstruction are relegated to the

Appendix.

2 1913-1984: Data and Replication

Whittington et al. (1990) regressed the general fertility rate from 1913 to 1984 on a set of explanatory variables that they argued would affect fertility: male and asset income, unemployment, infant mortality, immigration, female wage, and binary variables for World War II and the availability of the birth control pill. The dependent variable is the general fertility rate, defined as the number of births per thousand women age 15-44. While some of the series were reported in the appendix of the published paper, others have been lost since the paper's publication. We reconstructed the missing series using the footnotes and references in Whittington et al.

Table 1 reports summary statistics of the reconstructed series and those reported in Whittington et al. (1990). It is clear that there are small differences between the two datasets, even for some series that were copied directly from the Whittington et al. appendix. In fact, of those series for which we obtained original data (general fertility rate, personal exemption, male and asset income, and female wage), only the personal exemption series exactly matches the reported moments. The other series are either different than the series used to report the summary statistics or some error was made in computing the mean and standard deviation.[4] The unemployment, infant mortality, and immigration series that we constructed quite accurately match the reported moments.

The primary variable of interest for Whittington et al. (1990) is the real tax value of the personal exemption for dependents. Today, the personal exemption is only one of several child subsidy provisions in the federal tax code accounting for about one-third to one-half of the total child subsidy. However, for the 1913-1984 period considered in Whittington

[4]Brigitte Madrian generously gave us access to a 1991 letter she received from Leslie Whittington in which the full male and asset income series used in Whittington et al. (1990) is reported. According to this letter, the average female wage index values for 1972 and 1919 were typos. However, correcting these typos leads to greater discrepancies between both the reported moments and the replication results, so we use the series as reported in Whittington et al. in the replication analysis.

et al., the personal exemption was the primary source of the implicit child subsidy, never accounting for less than 90 percent of the total child subsidy. The statutory value of the personal exemption for dependents changed only nine times between 1913 and 1984; however, its real tax value fluctuates substantially due to changes in marginal tax rates and the price index.

Following Whittington et al. (1990) we estimate the following reduced form equation for the period 1913 to 1984:

$$\begin{aligned}\text{General Fertility Rate}_t = \beta_0 &+ \beta_1 \text{Personal Exemption}_t + \beta_2 \text{Male and Asset Income}_t \\ &+ \beta_3 \text{Unemployment}_t + \beta_4 \text{Infant Mortality}_t + \beta_5 \text{Immigration}_t \\ &+ \beta_6 \text{Female Wage}_t + \beta_7 \text{Pill}_t + \beta_8 \text{WW2}_t + \beta_9 \text{Time Trend}_t + \epsilon_t.\end{aligned} \tag{1}$$

Whittington et al. (1990) estimate equation (1) by FGLS because of concerns about (first-order) serial correlation. Further details on the estimation approach are not included in the original paper. We report the original estimates of the primary specification as reported in Whittington et al. as Model (1) in Table 2. Next, we report the regular OLS estimates using the replicated data with Newey-West standard errors as Model (2) in Table 2. Finally, we report the results using Prais-Winsten FGLS (with a single iteration) and the replicated data as Model (3) in Table 2. Model (3) closely replicates the original Model (1) results.[5] The estimated coefficient on the tax value of the personal exemption is very close to the reported value in Whittington et al. In addition, the remaining coefficient estimates are also similar to Whittington et al.'s results.[6]

Two key assumptions are necessary for the specification of Equation (1) and the FGLS

[5]At first glance, there appears to be a substantial discrepancy between Model (3) and Model (1), as measured by the R^2. In GLS estimation R^2 is not well defined, so it is unclear what definition was used by Whittington et al. Using the total sum of squares from the original OLS regression and the sum of squared residuals from Model (3) yields an R^2 of 0.919. While this technique does not give an accurate description of the fit of Model (3), it does represents a plausible method that may have been used to arrive at their reported R^2 of 0.916.

[6]We experimented with various estimation and iteration schemes and this provided the closest results. Slight differences in the data (including the series that were obtained from the paper itself) and potential differences in details of the estimation procedure likely explain deviations from the original results.

estimation procedure used in Whittington et al. (1990).[7] First, in order to express the regression in levels, Equation (1) must represent a long-run equilibrium relationship between the general fertility rate and the explanatory variables (Assumption 1). This assumption is of paramount importance in the present application because the series are highly persistent. We conducted unit-root tests on the series in Equation (1) and found that the only series where we could reject the unit-root null hypothesis at a size of 10% was the unemployment rate and even this series exhibited a high degree of persistence.[8] We describe these results to emphasize the high degree of persistence in these series without taking a stand as to whether or not they have an exact unit root. If there does not exist a long-run relationship then a regression in levels, such as Equation (1), would be inappropriate and likely to produce spurious results.[9] In fact, Wooldridge (2009), a well-known undergraduate econometric textbook, uses Whittington et al. as an example of a spurious regression.

Second, in order to use FGLS to correct for autocorrelation in the error term, the so-called "common factor" restrictions must hold in a more general autoregressive distributed lag model. McGuirk and Spanos (2009) show that these restrictions hold if and only if the general fertility rate does not Granger-cause any of the right-hand side variables (Assumption 2). If this assumption does not hold, then the OLS and FGLS estimators will be inconsistent.

[7]We take as given that a single-equation analysis is appropriate. Discussion of the feasibility of this assumption is beyond the scope of this paper.

[8]We conducted the unit-root tests of Harvey, Leybourne and Taylor (2009) and Carrion-I-Silvestre, Kim, and Perron (2009) on the updated data. The tests of Harvey, Leybourne and Taylor (2009) are constructed to accommodate uncertainty over the nature of the initial condition or the presence of a linear time trend. The tests of Carrion-I-Silvestre, Kim, and Perron (2009) allow us to accommodate a structural break induced by the widespread availability of the birth-control pill. The autoregressive lag lengths were chosen by the variant of the modified Akaike information criterion (MAIC) described in Perron and Qu (2007).

[9]Recall that the so-called "spurious regression" problem is not confined to unit-root processes. Similar effects may arise even when the series are stationary (see, for example, Granger (2003), Granger, Hyung and Jeon (2001), Su (2008)).

3 1913-2005: Updated Data and Results

3.1 Updated Data

We construct an updated dataset with 21 additional years (1985-2005) of data. In so doing, we examined each of the reconstructed (1913-1984) series to determine whether a better source was available. We found more up-to-date sources for several of the data series and use these rather than the reconstructed series in the updated data. Details regarding the data construction are provided in the Appendix.

We follow the Whittington et al. (1990) methodology in calculating the value of the personal exemption as described in the Appendix. We also construct a measure of the total value of child tax benefits in the federal income tax, as recent tax changes have increased the relative importance of other child tax benefits. In addition to the tax value of the personal exemption, the total child subsidy series also includes the value of the child tax credit (CTC) and the earned income tax credit (EITC).

The child tax credit acts as a child subsidy in a similar manner as the personal exemption, providing tax benefits to parents with children. However, the EITC is a tax credit that both increases in value with the number of children and affects the after-tax wage of recipients. Therefore, the EITC could also affect fertility through its effect on the opportunity cost of time. However, theory and empirical evidence both suggest that the effect of the EITC on the opportunity cost of time is minimal.[10] Because the labor supply effect is weak in aggregate and the child tax benefits from the EITC are large, the EITC acts more like a child subsidy than a wage subsidy and we think it is appropriate to include the EITC in the measure of the total child subsidy. However, we also report results excluding the EITC from

[10]Theory suggests that the effect of the EITC on female labor supply is ambiguous except for single women not in the labor force where there is an unambiguous increase in the likelihood of labor force participation. The empirical literature finds that the EITC does increase the labor force participation of single women mothers (Meyer and Rosenbaum 2001). However, the EITC appears to reduce the labor force participation of married women (Eissa and Hoynes 2004). The reduction in labor force participation by married women to some extent offsets the increase in labor force participation by single women. In terms of hours of work, the empirical literature finds no significant effect of the EITC on aggregate female labor supply (Eissa and Hoynes 2006).

the total child subsidy series.

The average value of these credits is calculated by dividing the total federal tax expenditure on these credits by the number of children in the United States in each year. The summary statistics for the extended data are reported in Table 3.

3.2 Updated Results: Original Specification

Table 4 summarizes our first set of results. In Column (1), we report our replication of Whittington et al. (1990)'s main specification with one change – the typos in Whittington et al.'s series are corrected (see the discussion in footnote 4 and the Appendix). These results are reported in constant 1967 dollars and are calculated using data series from the years 1913-1984. For Columns (2) and later, we make an additional change: the value of the child tax subsidy, male income, and female wage are converted to constant 2005 dollars. The effect of changing the base year can be seen clearly in the coefficient on the tax subsidy: whereas our replication of Whittington et al. in Column (1) showed that $100 in tax benefits (in 1967 dollars) are associated with an increase in the general fertility rate of 9.9 births, the results in Column (2) show that the comparable change in the general fertility rate for $100 in tax benefits (in 2005 dollars) is 1.7 births. This value provides a benchmark against which results from our subsequent analyses can be measured.

Column (3) begins the analysis using our extended data series for 1913-2005. The results in Column (3) show that using updated data sources and extending the data through 2005 reduces but does not substantively change the key coefficient estimated in Whittington et al. (1990) (cf. Column (2)). However, the results are sensitive to the definition of tax benefits. In Column (4) we repeat the analysis including the child tax credit in the tax subsidy series. While the coefficient on the child tax subsidy variable has the same sign as in Column (2), it is less than half the size and no longer significant. In Column (5) we show that a similar conclusion holds when the EITC is added to the tax subsidy series. The main results of Whittington et al. are weaker but still present in the extended time horizon, but are not robust to more general measures of child tax benefits.

3.3 Updated Results: Relaxing Assumption 2

As we discussed above, the use of FGLS requires that the general fertility rate does not Granger-cause any of the explanatory variables. In other words, for FGLS to be valid, one would have to argue that the general fertility rate would not be useful in predicting future values of any of the explanatory variables. This assumption seems unlikely to be true. For example, one might argue that a high fertility rate would induce a higher return to capital due to the increased supply of workers, resulting in lower wages. The assumption that the general fertility rate does not Granger-cause any of the explanatory would then be violated.

If we relax this assumption, the appropriate model specification would be Equation (1) augmented with a lagged value of the general fertility rate and a lagged value of each of the explanatory variables. This is the simplest case of an autoregressive distributed lag (ADL) model (see Hendry, Pagan, and Sargan (1984) for a general overview). The class of ADL models is appealing for two reasons: first, as just discussed it is the appropriate model if we relax Assumption 2; second, as pointed out in Whittington et al. (1990), there are several reasons to believe that a fertility response from changes in covariates may occur with a lag. The birth of a child will lag the decision to have a child by at least nine months and frequently longer, and therefore the relevant variable in analyzing fertility in year t may be the covariate's value in year $t-1$. Covariates in time t may have little influence on fertility in year t.[11]

Moreover, there is a reason to believe that the fertility response from changes in child tax benefits may be even more delayed. While a fertility response would not likely be observed until at least one year after a change to child tax benefits, it takes some time for taxpayers to learn that a tax change has taken place. Changes to the tax code are often made while the tax year is well underway. Individuals are not likely to learn about tax changes until they

[11] Immigration by women of childbearing age is an exception since some women may be pregnant at the time of immigration.

do their taxes (by April of the following year). While this may have an immediate effect on the decision to have a child, the actual birth is then realized with a delay. Therefore, while a single lag may be appropriate for the other regressors, the real value of child tax benefits should enter the fertility equation with at least two lags. That is, we posit that a tax policy change in year t may not affect the decision to have children until at least year $t+1$ and thus would not affect the total fertility rate until at least year $t+2$.

To accommodate all of these concerns we consider ADL models with a lagged dependent variable, one to four lags in the chosen tax subsidy series, and one lag in the other explanatory variables. The parameter of interest is the long-run coefficient associated with the measure of tax benefits. To generate estimates of the long-run coefficient and their associated standard errors we used the transformation of Bewley (1979) as advocated by Pesaran and Shin (1999). It is important to note that the estimates of the long-run coefficients and their standard errors are not invalidated in the case where the explanatory variables are either $I(1)$, $I(0)$ or mutually cointegrated. Consequently, the results of the unit-root tests mentioned previously are no cause for concern. Finally, we reserve the first five observations for the construction of lagged variables so that the various model specifications are directly comparable.

The estimated long-run coefficient for each tax subsidy series and each model are reported in Table 5. Panel A of Table 5 uses the updated data for the 1913-1984 period while Panel B uses the updated data for the full 1913-2005 period. Each cell reports the long-run coefficient from a separate regression where the model number indicates the number of lags in the tax subsidy series. We include the results for three different measures of child tax benefits: the personal exemption only; the personal exemption combined with the child tax credit; and the personal exemption, the child tax credit and the EITC. During the 1913-1984 period, the child tax credit was not available so this measure is excluded.

Restricting to the pre-1984 data, we find large positive estimates of the long-run coefficient. These estimates are not statistically significant once more than two lags of the child tax subsidy series are included. When the time period is extended to 2005, the estimates of the long-run coefficient drop in magnitude substantially, particularly when more than two lags of the child tax subsidy series are included or alternative measures of the child tax subsidy are considered. Only one of the twelve estimates is statistically significant at the 10 percent level.

With up to four lags in the tax subsidy series and up to two lags in all other explanatory variables there are more than 1,200 potential model specifications. For each model we calculated the Bayesian information criterion (BIC). The BIC has been shown to perform well as a model-selection criterion in ADL models (see, for example, Pesaran and Shin (1999) or Panoplou and Pittis (2004)). Of the ten models which produced the smallest values for the BIC, the long-run coefficient is rarely significant for broad measures of the child tax subsidy.[12]

3.4 Short-Run Effects: Relaxing Assumption 1

Now that we have discussed the implications of relaxing Assumption 2, let us reconsider Assumption 1. Suppose there does not exist a long-run relationship. If this is the case, the Whittington et al. (1990) results are driven by the high persistence of the variables in the model rather than a meaningful, long-run relationship between these variables. However, this does not preclude the possibility that there may be a short-run relationship between tax benefits and fertility. Specifically, the value of the child tax benefits may affect the timing of fertility rather than the equilibrium value of fertility.

To estimate the short-run effect, we consider a regression similar to Equation (1), except using differenced variables. Table 6 summarizes the results from these regressions. Column (1) displays the results for differenced variables over the time period originally considered in Whittington et al. (1990) using the replication dataset converted to 2005 dollars. Surpris-

[12] Five of ten specifications yield long-run coefficients that are statistically significant at the 10 percent level when child tax benefits are limited to the personal exemption, three of ten specifications yield statistically significant long-run coefficients when child tax benefits include the child tax credit, and there are zero statistically significant long-run coefficients when child tax benefits include the child tax credit and the EITC.

ingly, the coefficient on the tax subsidy flips sign and decreases in magnitude. In Column (2), we run the same specification but utilize the extended data series. Columns (3) and (4) show the results for the other two child tax subsidy measures. Across all four models, the estimated short-run effect is negative.

We also explore whether the short-run effect changes when additional lags of the child tax subsidy are included. Table 7 reports the results from a regression of the differenced total fertility rate on varying number of lags of the child tax subsidy. The child tax subsidy variable specified here includes all three components of the child tax subsidy: the personal examption, the child tax credit and the EITC. The current and lagged values of all other controls are included in the estimations although the estimated coefficients are not reported. Table 7 also reports the measure of the estimated total short-run effect of tax benefits, equal to the sum of the coefficients of all lagged child tax subsidy variables, with standard errors.

The results in Table 7 suggest that there is a statistically significant short-run effect of changes in child tax benefits on changes in fertility with two lags. However, the estimated *total* short-run effect across the four specifications are small and statistically insignificant, ranging from -0.004 to 0.010. The point estimates suggest that a $100 increase in the real value of child tax benefits in 2005 dollars is associated with an increase of approximately 0 to 1 birth. The magnitude of this total effect is much smaller than the magnitude of the Whittington et al. (1990) estimate of 1.7 births as calculated in Table 4, Column (2), and is statistically insignificant across all specifications.

These results suggest that, in the short run, tax benefits may affect the timing of births but we find only weak evidence for an overall response of fertility to tax benefits. Our estimates of the total effect are small and generally positive, but statistically insignificant.

4 Conclusion

The effect of tax policy on fertility rates is often neglected in the literature on federal tax policy, even though child tax benefits are large and have recently grown in importance. One of the most cited studies on this topic, Whittington et al. (1990), estimates a very large fertility rate response to the tax value of the dependent exemption. We have updated their analysis by incorporating 21 additional years of data along with more general measures of tax benefits for having children. We find in our updated analysis that the results of Whittington et al. are not robust to more general measures of child tax benefits.

We have also clarified two key assumptions that the analysis of Whittington et al. (1990) rests upon. First, to justify the use of FGLS autocorrelation correction, one must assume that the general fertility rate does not Granger-cause any of the explanatory variables. We show that if this assumption does not hold, there is no evidence for a robust long-run relationship between fertility and child tax subsidies. Second, to justify running the regression in levels, one must assume that there is a long-run relationship between the variables. If this assumption does not hold, we show that there is some evidence that child tax benefits affect the timing of births, but find no evidence of any lasting fertility effects. Even if one assumes that both of these strong assumptions hold, using updated data, we show that the Whittington et al. single-equation model does not continue to yield a large robust relationship between child tax subsidies and the general fertility rate.

References

Barro, Robert J., and Chaipat Sahasakul. 1983. "Measuring the Average Marginal Tax Rate from the Individual Income Tax." *Journal of Business,* 56(4): 419–452.

Barro, Robert J., and Chaipat Sahasakul. 1986. "Average Marginal Tax Rates from Social Security and the Individual Income Tax." *Journal of Business,* 59(4): 555–566.

Baughman, Reagan, and Stacy Dickert-Conlin. 2003. "Did Expanding the EITC Promote Motherhood?" *American Economic Review,* 93(2): 247–251.

Bewley, Ronald A. 1979. "The Direct Estimation of the Equilibrium Response in a Linear Dynamic Model." *Economics Letters,* 3, 357–361.

Cohen, Alma, Rajeev Dehejia, and Dmitri Romanov. 2007. "Do Financial Incentives Affect Fertility?" National Bureau of Economic Research.

Eissa, Nada, and Hilary Hoynes. 2004. "Taxes and the Labor Market Participation of Married Couples: The Earned Income Tax Credit" *Journal of Public Economics,* 88, 1931–1958.

Eissa, Nada, and Hillary Hoynes. 2006. "Behavioral Responses to Taxes: Lessons from the EITC and Labor Supply" In *Tax Policy and the Economy,* ed. James M. Poterba, vol. 20 MIT Press. pp. 74–110.

Gauthier, Anne H., and Jan Hatzius. 1997. "Family Benefits and Fertility: An Econometric Analysis." *Population Studies,* 51(3): 295–306.

Granger, Clive W. J. 2003. "Spurious Regressions in Econometrics" In *A Companion to Theoretical Econometrics,* ed. Badi H. Baltagi Blackwell Publishing Ltd. pp. 557–561.

Granger, Clive W. J., Namwon Hyung, and Yongil Jeon. 2001. "Spurious Regressions with Stationary Series" *Applied Economics,* 33, 899–904.

Harvey, David I., Stephen J. Leybourne, and Robert A. M. Taylor. 2009. "Unit Root Testing in Practice: Dealing with Uncertainty Over the Trend and Initial Condition" *Econometric Theory,* 25(3): 587–636.

Hendry, David F., Adrian R. Pagan, and J. Denis Sargan. 1984. "Dynamic Specification" In *Handbook of Econometrics,* ed. Z. Griliches and M.D. Intriligator Elsevier Science Publishers. pp. 1023–1100.

Huang, Jr-Tsung. 2002. "Personal Tax Exemption: The Effect on Fertility in Taiwan." *Developing Economies,* XL(1): 32–48.

Josep Lluís Carrion-i Silvestre, Dukpa Kim, and Pierre Perron. 2009. "GLS-Based Unit Root Tests with Multiple Structural Breaks Under Both the Null and the Alternative Hypotheses" *Econometric Theory,* 25(6): 1754–1792.

Kurian, George Thomas. 2001. *Datapedia of the United States: 1790-2005.* Lanham, Maryland: Bernan Press.

Laroque, Guy, and Bernard Salanie. 2005. "Does Fertility Respond to Financial Incentives?" *CEPR Discussion Paper,* 5007.

Lebergott, Stanley. 1964. *Manpower in economic growth; the American record since 1800.* New York, McGraw-Hill.

Lino, Mark. 2007. "Expenditures on Children by Families, 2006" U.S. Department of Agriculture, Center for Nutrition Policy and Promotion.

Martin, Joyce A., Brady E. Hamilton, Paul D. Sutton, Stephanie J. Ventura, Fay Menacker, and Martha L. Munson. 2005. *Births: Final Data for 2003.* vol. 54 U.S. Vital Statistics.

McGuirk, Anya, and Aris Spanos. 2009. "Revisiting Error-Autocorrelation Correction: Common Factor Restrictions and Granger Non-Causality" *Oxford Bulletin of Economics and Statistics,* 71(2): 273–294.

Meyer, Bruce D., and Dan T. Rosenbaum. 2001. "Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers" *Quarterly Journal of Economics,* CXVI, 1063–1114.

Milligan, Kevin. 2005. "Subsidizing the Stork: New Evidence on Tax Incentives and Fertility." *Review of Economics and Statistics,* 87(3): 539–555.

Panopoulou, Ekaterini, and Nikitas Pittis. 2004. "A comparison of autoregressive distributed lag and dynamic OLS cointegration estimators in the case of a serially correlated cointegration error" *Econometrics Journal,* 7, 585–617.

Parent, Daniel, and Ling Wang. 2007. "Tax Incentives and Fertility in Canada: quantum vs tempo effects" *Canadian Journal of Economics,* 40(2): 371–400.

Perron, Pierre, and Zhongjun Qu. 2007. "A Simple Modification to Improve the Finite Sample Properties of Ng and Perron's Unit Root Tests" *Economic Letters,* 94, 12–19.

Pesaran, M. Hashem, and Yongcheol Shin. 1999. "An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis" In *Econometrics and Economic Theory in the 20th Century,* ed. Steinar Strom Cambridge university Press. pp. 371–413.

Stephenson, E. Frank. 1998. "Average Marginal Tax Rates Revisited." *Journal of Monetary Economics,* 41, 389–409.

Su, Jen-Je. 2008. "A Note on Spurious Regressions Between Stationary Series" *Applied Economics Letters,* 15, 1225–1230.

U.S. Census Bureau. 1975. *Historical Statistics of the United States: Colonial Times to 1970.* Bicentennial ed. Washington, D.C.

U.S. Census Bureau. 2003. *Statistical Abstract of the United States: 2003.* 122 ed. Washington, DC. Mini-Historical Series, http://www.census.gov/compendia/statab/hist_stats.html.

U.S. Census Bureau. 2006. *Historical Statistics of the United States: Millenial Edition.* Online ed. Cambridge University Press.

Whittington, Leslie A. 1992. "Taxes and the Family: The Impact of the Tax Exemption for Dependents on Marital Fertility" *Demography,* 29(2): 215–226.

Whittington, Leslie A., James Alm, and H. Elizabeth Peters. 1990. "Fertility and the Personal Exemption: Implicit Pronatalist Policy in the United States." *American Economic Review,* 80(3): 545–556.

Wooldridge, Jeffrey M. 2009. *Introductory Econometrics: A Modern Approach.* 4th ed. Thomson South-Western.

Zhang, Junsen, Jason Quan, and Peter van Meerbergen. 1994. "The Effect of Tax-Transfer Policies on Fertility in Canada, 1921-88." *The Journal of Human Resources,* 29(1): 181–201.

Figure 1: General Fertility Rate and Real Average Per Child Tax Subsidy

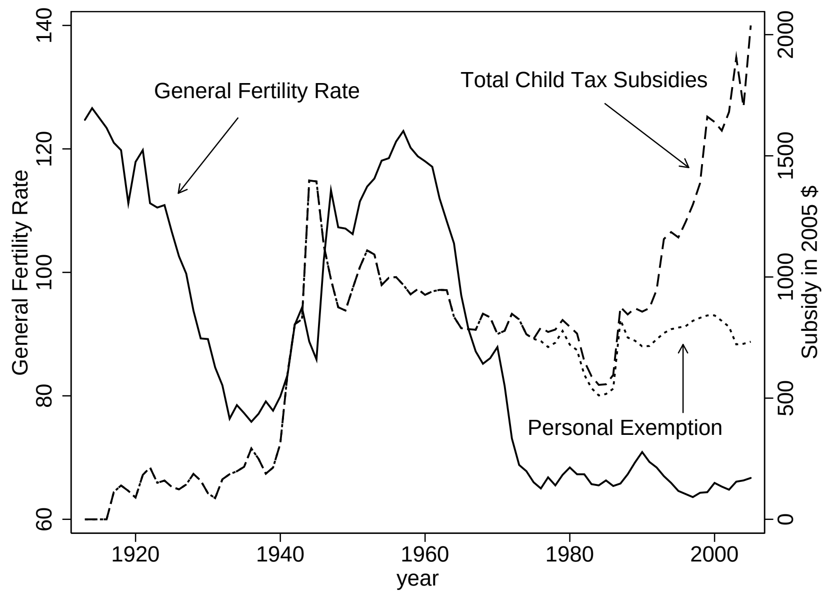


Table 1: Summary Statistics, 1913–1984

Variable	Obs.	Replicated Data Mean	Replicated Data Std. Dev.	Whittington et al. Mean	Whittington et al. Std. Dev.
General Fertility Rate	72	95.6	19.81	95.5	19.64
Personal Exemption	72	100.4	65.88	100.4	65.88
Male and Asset Income	72	7,467.38	2,926.06	7,466.37	2,982.78
Unemployment	72	0.071	0.054	0.071	0.053
Infant Mortality	72	43.02	26.84	43.02	26.84
Immigration	72	0.003	0.0036	0.003	0.0035
Female Wage	72	1.35	0.585	1.22	0.532
Pill	72	0.306	0.464	0.305	0.464
WW II	72	0.069	0.256	0.069	0.256
Time Trend	72	36.5	20.93	36.5	20.92

Variables expressed in constant 1967 dollars.

Table 2: Comparison of Estimation Results

Variable	(1) Whittington et al.	(2) OLS	(3) Prais-Winsten
Personal Exemption	0.121	0.178	0.116
	(0.0446)**	(0.0977)	(0.0449)**
Male and Asset Income	-0.0004	0.0035	0.0007
	(0.0027)	(0.0031)	(0.0025)
Unemployment	-73.43	-68.12	-68.19
	(34.20)**	(25.818)*	(34.004)**
Infant Mortality	0.083	0.393	0.0351
	(0.255)	(0.321)	(0.251)
Immigration	774.24	964.13	760.71
	(311.31)**	(329.44)**	(304.98)**
Female Wage	5.647	15.427	5.629
	(15.686)	(5.286)**	(5.036)
Pill	-10.856	-25.383	-12.014
	(6.126)*	(11.961)*	(6.028)*
WW II	-17.223	-29.419	-17.863
	(4.989)**	(8.057)**	(4.854)**
Time Trend	-0.539	-0.843	-0.741
	(0.538)	(0.543)	(0.510)
Intercept	102.979	55.944	104.130
	(24.666)**	(25.831)*	(23.368)**
Observations	72	72	72
R^2	0.916	0.829	0.749

Standard errors in parentheses.

Variables expressed in constant 1967 dollars.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Model (1) reports the regression results from the Whittington et al. paper.

Model (2) OLS estimates with Newey-West standard errors.

Model (3) Prais-Winsten FGLS estimation with a single iteration.

Table 3: Summary Statistics, 1913–2005

Variable	Obs.	Mean	Std. Dev.	Min	Max
General Fertility Rate	93	88.9	21.4	63.6	126.6
Personal Exemption	93	625.9	347.9	0	1398
Personal Exemption + CTC	93	661.1	384.8	0	1501
Personal Exemption + CTC + EITC	93	741.7	479.1	0	2038
Male & Asset Income	93	31,287	11,681	17,043	50,169
Unemployment	93	0.068	0.048	0.012	0.249
Infant Mortality	93	35.15	27.77	6.7	101
Immigration	93	0.00351	0.00257	0.00028	0.01505
Female Wage	93	7.59	3.34	2.14	12.93
Pill	93	0.462	0.501	0	1
WW II	93	0.054	0.227	0	1

Variables expressed in constant 2005 dollars.

Table 4: Comparison of Estimation Results in Levels

Variable	(1)	(2)	(3)	(4)	(5)
Personal Exemption	0.099	0.017	0.011		
	(0.044)**	(0.008)**	(0.006)*		
Personal Exemption + CTC				0.007	
				(0.005)	
Personal Exemption + CTC + EITC					0.005
					(0.004)
Male and Asset Income	-0.0003	-0.00005	-0.001	-0.001	-0.001
	(0.003)	(0.0004)	(0.0005)***	(0.0005)***	(0.0005)**
Unemployment	-68.019	-68.019	-86.711	-80.939	-84.576
	(33.684)**	(33.684)**	(25.079)***	(24.068)***	(24.254)***
Infant Mortality	-0.013	-0.013	0.057	-0.041	-0.086
	(0.247)	(0.247)	(0.157)	(0.141)	(0.139)
Immigration	698.917	698.917	1,079.458	989.809	979.596
	(299.761)**	(299.761)**	(297.470)***	(285.178)***	(288.937)***
Female Wage	16.545	2.829	4.137	3.847	4.257
	(14.129)	(2.416)	(2.349)*	(2.240)*	(2.240)*
Pill	-10.937	-10.937	-6.080	-5.332	-5.436
	(5.902)*	(5.902)*	(4.697)	(4.562)	(4.631)
WW II	-16.269	-16.269	-13.736	-11.689	-11.371
	(4.772)***	(4.772)***	(3.865)***	(3.653)***	(3.669)***
Time Trend	-0.969	-0.969	-0.527	-0.625	-0.718
	(0.590)	(0.590)	(0.348)	(0.346)*	(0.365)*
Constant	108.208	108.208	119.724	128.591	132.707
	(23.052)***	(23.052)***	(15.527)***	(13.919)***	(13.510)***
Observations	72	72	93	93	93
R^2	0.745	0.745	0.804	0.793	0.792

Standard errors in parentheses.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Model (1): Replication of Whittington et al. (1990) with typos corrected (see text).
Model (2): Model (1) with variables expressed in constant 2005 dollars.
Model (3): Model (2) with extended data series for sample period 1913-2005.
Model (4): Model (3) with child tax benefits defined by personal exemption and child tax credit.
Model (5): Model (3) with child tax benefits defined by personal exemption, child tax credit, and EITC.

Table 5: Autoregressive Distributed Lag Model Results

Panel A: 1913-1984 Data

Child Subsidy Measure	(1)	(2)	(3)	(4)
Personal Exemption	0.045	0.062	0.044	0.043
	(0.025)*	(0.030)**	(0.036)	(0.039)
Personal Exemption + EITC	0.046	0.064	0.044	0.042
	(0.027)*	(0.033)*	(0.039)	(0.043)

Panel B: 1913-2005 Data

Child Subsidy Measure	(1)	(2)	(3)	(4)
Personal Exemption	0.033	0.043	0.022	0.020
	(0.023)	(0.026)*	(0.033)	(0.037)
Personal Exemption + CTC	0.025	0.031	0.012	0.010
	(0.020)	(0.023)	(0.027)	(0.030)
Personal Exemption + CTC + EITC	0.014	0.017	0.003	0.002
	(0.017)	(0.018)	(0.021)	(0.022)

Standard errors in parentheses.
Variables expressed in constant 2005 dollars.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Each coefficient represents the estimated long-run coefficient of the child subsidy measure on the general fertility rate in an autoregressive distributed lag model with a lagged dependent variable and current and lagged values of all independent variables on the right-hand side. Only current values of Pill and World War II included. All analysis was done with the updated data series. Panel A child subsidy measures do not include the Child Tax Credit because it did not exist during the sample period. The column number signifies the number of lags of the child subsidy measure included in the model.

Table 6: Comparison of Estimation Results in First Differences

Variable	(1)	(2)	(3)	(4)
Personal Exemption	-0.014	-0.013		
	(0.006)**	(0.005)***		
Personal Exemption + CTC			-0.008	
			(0.004)*	
Personal Exemption + CTC + EITC				-0.007
				(0.004)*
Male and Asset Income	-0.001	-0.001	-0.001	-0.001
	(0.000)*	(0.000)	(0.000)	(0.000)
Unemployment	-20.985	-10.041	-8.391	-9.063
	(25.647)	(21.515)	(22.030)	(22.130)
Infant Mortality	-0.042	-0.072	-0.055	-0.053
	(0.178)	(0.157)	(0.159)	(0.159)
Immigration	68.878	198.098	191.007	195.459
	(182.199)	(195.021)	(200.214)	(201.176)
Female Wage	1.278	2.127	1.950	1.934
	(1.563)	(1.834)	(1.871)	(1.876)
Pill	-1.910	-0.688	-0.524	-0.447
	(1.113)*	(0.897)	(0.924)	(0.931)
WW II	5.138	4.703	3.629	3.483
	(2.441)**	(2.241)**	(2.229)	(2.227)
Constant	-0.618	-1.272	-1.177	-1.176
	(0.951)	(0.914)	(0.936)	(0.940)
Observations	71	92	92	92
R^2	0.203	0.145	0.108	0.104

Standard errors in parentheses.
Variables expressed in constant 2005 dollars.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Model (1): Replication of Whittington et al. (1990) performed in first differences.
Model (2): Model (1) with extended data series for sample period 1913-2005.
Model (3): Model (2) with child tax benefits defined by personal exemption and child tax credit.
Model (4): Model (2) with child tax benefits defined by personal exemption, child tax credit, and EITC.

Table 7: Short Run Effects of Child Tax Benefits on Fertility, 1913–2005

Variable	(1)	(2)	(3)	(4)
Δ Total Child Tax Subsidy	-0.004	-0.003	-0.003	-0.004
	(0.004)	(0.004)	(0.004)	(0.004)
Δ Total Child Tax Subsidy$_{t-1}$	0.001	-0.0002	0.0002	0.0002
	(0.004)	(0.004)	(0.004)	(0.004)
Δ Total Child Tax Subsidy$_{t-2}$		0.012	0.012	0.011
		(0.004)***	(0.004)***	(0.004)***
Δ Total Child Tax Subsidy$_{t-3}$			0.002	0.002
			(0.004)	(0.004)
Δ Total Child Tax Subsidy$_{t-4}$				-0.003
				(0.004)
Error Correction Term				
Measure of Total Effect	-0.004	0.008	0.010	0.007
	(0.007)	(0.008)	(0.010)	(0.011)
Error Correction Model	No	No	No	No
Observations	88	88	88	88
R^2	0.264	0.349	0.350	0.355

Standard errors in parentheses.
Variables expressed in constant 2005 dollars.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

All specifications include current and lagged values of all independent variables on the right-hand side. Only current values of Pill and World War II included. All analysis was done with the updated data series. Total Child Tax Subsidy defined by personal exemption, child tax credit, and EITC. The column number signifies the number of lags of the child subsidy measure included in the model.

Appendix

A Replication Data

The general fertility rate, value of the personal exemption, and the female wage series which was constructed by Whittington et al. (1990) to measure the real change in average female wages, were each reported in the paper's appendix. The introduction of the birth control pill and U.S. involvement in World War II are simple binary variables that equal one after 1963 for the birth control pill and between 1941-1945 for World War II.

Male and Asset Income

The male and asset income series is a measure of average family income less female earnings. While this series was not reported in the appendix of Whittington et al. (1990), it was recorded in a letter from Leslie Whittington to Brigitte Madrian. Whittington et al. derived these data for 1913-1948 from Historical Statistics Series D722-727 and D830-844 by calculating a male-to-average earnings ratio, and multiplying this by the average earnings. Years 1949-1955 were derived in the same manner, but used data from the CPS Series P-60 on median earnings. Years 1956-1984 are directly from CPS Series P-60. Nonwage income was obtained from the 1988 Economic Report of the President by subtracting Compensation from National Income, dividing by the population, and multiplying by average family size. The series is adjusted for inflation and is included as a measure of the income effect on fertility. The year to which the series is normalized is not reported.

Unemployment

Whittington et al. (1990) do not report their source for the annual national unemployment series. Unemployment rates for 1929 to 1984 are obtained from the Statistical Abstract of the United States: 2003, Mini-Historical Series HS-29 (U.S. Census Bureau 2003). Unemployment rates from 1913 to 1928 are obtained from Lebergott (1964) Table A-3. While there is overlap of certain years between the two sources of unemployment data, we found that this method gave us the best match of the mean and standard deviation reported in Whittington et al.

Infant Mortality

Infant mortality data from 1915 to 1984 are obtained from the Statistical Abstract of the United States Mini-Historical Series HS-13 (U.S. Census Bureau 2003) and measure the number of children who die before reaching their first birthday (excluding fetal deaths), per thousand children born. However, no data appears to be available before 1915 and Whittington et al. do not record the source or give any indication of what values they used for 1913 and 1914. Some studies cite an estimated infant mortality rate of 200 in the early 1700s and then use a linear extrapolation for years between 1700 and 1915. Because the measured infant mortality rate for 1915 is 99.9, it is likely that Whittington et al. simply used values of 100 for both 1913 and 1914. Doing so closely matches their reported mean and standard deviation.

Immigration

The immigration series is listed as the immigration of the at-risk group as a fraction of the resident at-risk group. We assume that the at-risk group is the age group 16-44.[13] We use the original source material as provided in the previous correspondence from Leslie Whittington. For 1913-1970, immigration by age is obtained from the Historical Statistics of the United States: Colonial Times to 1970 Series C 138-142, and population totals by age come from Series A 29-42 of the same volume (U.S. Census Bureau 1975). The source of the remaining data for 1971-1984 is listed as various years of the Statistical Abstract; we use the Historical

[13]Defining the at-risk group as females aged 16-44 requires making an assumption that the percent of immigrants that are female is uncorrelated with the percent of immigrants that are aged 16-44, and yields a series that does not match the reported moments in Whittington et al. (1990).

Statistics of the United States: Millenium Edition Online (U.S. Census Bureau 2006).[14]

Reconstructed 1913-1984 Data Series

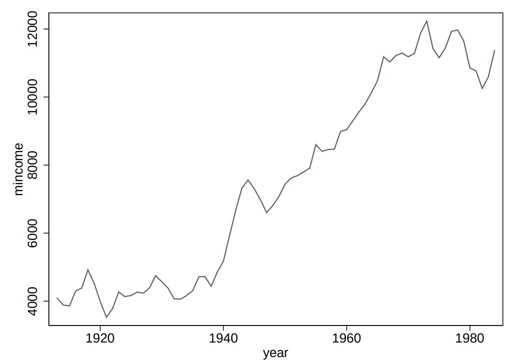
Year	Fertility Rate	Personal Exemption	Male & Asset Income	Unemploy-ment	Infant Mortality	Age 16-44 Immigration	Female Wage
1913	124.7	0	4,090	0.043	100.0	0.02086	0.461
1914	126.6	0	3,887	0.079	100.0	0.02043	0.458
1915	125.0	0	3,860	0.085	99.9	0.00504	0.467
1916	123.4	0	4,294	0.051	101.0	0.00450	0.492
1917	121.0	19.27	4,388	0.046	93.8	0.00434	0.503
1918	119.8	23.94	4,920	0.014	100.9	0.00157	0.554
1919	111.2	20.07	4,536	0.014	86.6	0.00197	0.548
1920	117.9	15.33	3,990	0.052	85.8	0.00608	0.627
1921	119.8	34.32	3,529	0.117	75.6	0.01141	0.657
1922	111.2	36.65	3,782	0.067	76.2	0.00403	0.681
1923	110.5	25.83	4,271	0.024	77.1	0.00723	0.720
1924	110.9	27.34	4,136	0.050	70.8	0.00948	0.738
1925	106.6	22.85	4,167	0.032	71.7	0.00389	0.712
1926	102.6	21.13	4,268	0.018	73.3	0.00410	0.713
1927	99.8	24.61	4,237	0.033	64.6	0.00450	0.717
1928	93.8	31.96	4,390	0.042	68.7	0.00403	0.747
1929	89.2	27.29	4,751	0.032	67.6	0.00359	0.737
1930	89.2	18.40	4,570	0.087	64.6	0.00301	0.738
1931	84.6	14.91	4,386	0.159	61.6	0.00113	0.735
1932	81.7	28.36	4,070	0.236	57.6	0.00038	0.702
1933	76.3	31.95	4,059	0.249	58.1	0.00025	0.786
1934	78.5	33.91	4,164	0.217	60.1	0.00031	0.972
1935	77.2	36.98	4,304	0.201	55.7	0.00037	0.959
1936	75.8	50.12	4,716	0.169	57.1	0.00038	0.928
1937	77.1	42.79	4,727	0.143	54.4	0.00055	0.981
1938	79.1	32.22	4,437	0.190	51.0	0.00075	0.988
1939	77.6	36.53	4,857	0.172	48.0	0.00086	1.000
1940	79.9	53.33	5,179	0.146	47.0	0.00070	1.043
1941	83.4	102.49	5,936	0.099	45.3	0.00048	1.084
1942	91.5	137.70	6,678	0.047	40.4	0.00027	1.147
1943	94.3	141.20	7,327	0.019	40.4	0.00023	1.278
1944	88.4	243.83	7,561	0.012	39.8	0.00028	1.351
1945	85.9	238.40	7,304	0.019	38.3	0.00038	1.358
1946	101.9	193.16	6,983	0.039	33.8	0.00129	1.359
1947	113.3	168.90	6,604	0.039	32.2	0.00152	1.368
1948	107.3	149.79	6,811	0.038	32.0	0.00167	1.405
1949	107.1	147.05	7,076	0.059	31.3	0.00183	1.323
1950	106.2	163.10	7,442	0.053	29.2	0.00225	1.239

[14]The ages for which data are available differ slightly over the years. The number of immigrants prior to 1918 was reported for 14-44 year olds. From 1940-1944, the reported age category was 16-45, and from 1971 onwards, 15-44 year-olds were reported. We do not attempt any correction for these differences.

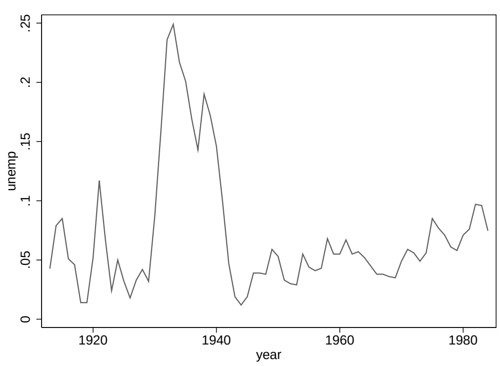
Year	Fertility Rate	Personal Exemption	Male & Asset Income	Unemploy-ment	Infant Mortality	Age 16-44 Immigration	Female Wage
1951	111.5	178.14	7,622	0.033	28.4	0.00179	1.235
1952	113.9	189.43	7,691	0.030	28.4	0.00235	1.287
1953	115.2	186.51	7,797	0.029	27.8	0.00162	1.423
1954	118.1	165.46	7,910	0.055	26.6	0.00198	1.404
1955	118.5	170.57	8,603	0.044	26.4	0.00227	1.661
1956	121.2	171.00	8,404	0.041	26.0	0.00299	1.669
1957	122.9	165.12	8,458	0.043	26.3	0.00299	1.729
1958	120.2	158.66	8,470	0.068	27.1	0.00231	1.746
1959	118.8	162.19	8,989	0.055	26.4	0.00232	1.765
1960	118.0	158.28	9,043	0.055	26.0	0.00237	1.776
1961	117.2	160.71	9,298	0.067	25.3	0.00236	1.739
1962	112.2	161.58	9,563	0.055	25.3	0.00247	1.777
1963	108.5	161.61	9,802	0.057	25.2	0.00263	1.812
1964	105.0	142.73	10,125	0.052	24.8	0.00244	1.855
1965	96.6	134.60	10,481	0.045	24.7	0.00243	1.903
1966	91.3	133.94	11,178	0.038	23.7	0.00240	1.859
1967	87.6	133.80	11,032	0.038	22.4	0.00258	1.918
1968	85.7	145.10	11,221	0.036	21.8	0.00321	1.979
1969	86.5	142.62	11,290	0.035	20.9	0.00253	2.063
1970	87.9	130.58	11,183	0.049	20.0	0.00261	2.064
1971	81.8	132.99	11,284	0.059	19.1	0.00262	2.057
1972	73.4	144.85	11,882	0.056	18.5	0.00268	2.094
1973	69.2	140.87	12,231	0.049	17.7	0.00269	2.061
1974	68.4	130.49	11,429	0.056	16.7	0.00259	2.034
1975	66.0	122.36	11,154	0.085	16.1	0.00245	2.103
1976	65.8	120.08	11,434	0.077	15.2	0.00247	2.170
1977	66.8	116.11	11,930	0.071	14.1	0.00277	2.187
1978	65.5	118.98	11,972	0.061	13.8	0.00363	2.277
1979	67.2	132.93	11,646	0.058	13.1	0.00274	2.206
1980	68.4	123.17	10,857	0.071	12.6	0.00310	2.136
1981	67.4	119.31	10,765	0.076	11.9	0.00342	2.106
1982	67.3	102.04	10,255	0.097	11.5	0.00339	2.173
1983	65.8	92.49	10,595	0.096	11.2	0.00324	2.216
1984	65.4	83.90	11,370	0.075	10.8	0.00309	2.240

Figure A-1: Replication Series 1913–1984

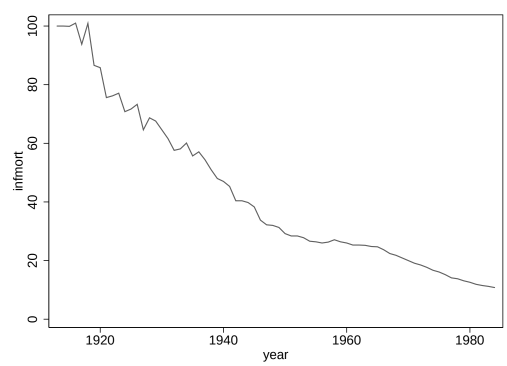
(a) Personal Exemption



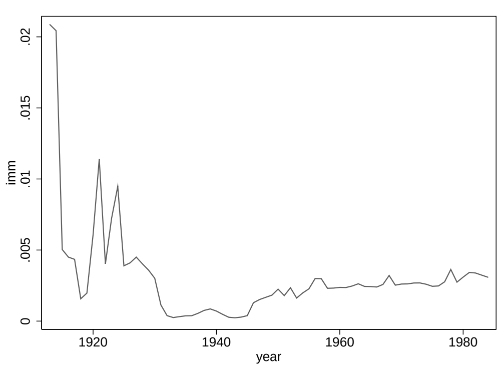
(b) Male and Asset Income



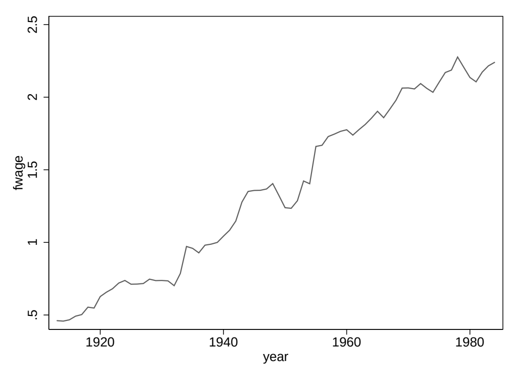
(c) Unemployment



(d) Infant Mortality



(e) Immigration



(f) Female Wage

B Extended and Updated Data

General Fertility Rate

For our extended data series, we use the general fertility rate in years 1913-1959 from the Datapedia of the United States (Kurian 2001) and years 1960-2005 from the National Vital Statistics Report (Martin et al. 2005). The general fertility rate series reported in the Datapedia match that reported in Whittington et al. (1990) in all but two years; however, the National Vital Statistics Report's general fertility rates differ slightly in several years. Since we believe the National Vital Statistics Report to have the most current and reliable fertility data, we use these data for all years they are available.

Child Tax Benefits

The value of the personal exemption for a parent claiming a child as a dependent is calculated by multiplying the statutory amount of the personal exemption by the marginal tax rate. From 1913 to 1916, there was no personal exemption for dependents. Starting in 1917, a personal exemption for dependents was introduced and set at $200, one fifth of the personal exemption for an individual. In 1944, the separate category for dependents was removed; the personal exemption for a dependent was equal to the personal exemption for the taxpayer or a spouse.[15]

Because the value of the personal exemption depends on the marginal tax rate, an average marginal tax rate for each year is needed. Whittington et al. (1990) use an arithmetic average marginal statutory income tax rate weighted by adjusted gross income that was first introduced by Barro and Sahasakul (1983) and then updated to include all years from 1916

[15]The personal exemption level series is commonly available. We used the series provided by the tax policy center, online at http://www.taxpolicycenter.org.

to 1983 in Barro and Sahasakul (1986).[16] Stephenson (1998) updated the series to 1994.[17] We use the Barro and Sahasakul methodology to extend the average marginal tax rate series to 2005 using data from the IRS Statistics of Income.[18] The IRS tables report the number of taxpayers and the amount of income at each marginal tax rate. Using this data, we take the arithmetic average weighted by AGI to update the Barro-Sahasakul statutory marginal tax rate series. Some of the AGI cells in the IRS data are negative and are dropped from the calculation.

The value of the personal exemption is not the only tax benefit for a parent claiming a child as a dependent. To calculate the total benefit, we add the tax value of the Earned Income Tax Credit (EITC) and the Child Tax Credit (CTC) to the value of the personal exemption. Unlike the additional personal exemption that can be claimed by nearly every taxpayer with a dependent child, the EITC can only be claimed by taxpayers in a specific income range. Thus, rather than calculate the tax value of these benefits for a taxpayer in the particular situation, we take the real value of all benefits from these tax provisions and divide by the number of children to produce an average benefit level. The value of the personal exemption and the total value of benefits are the same until the mid 1970's when these tax provisions are introduced. The tax expenditure on the EITC and CTC were gathered from the OMB *Analytical Perspectives, Budget of the United States Government* Tables 5-1 and 19-1 from various years.

Male and Asset Income

We construct a revised male and asset income data series, using more recently available data. From 1947-2005, male income data were obtained from the Historical Income Table P-

[16]As noted by Whittington et al., Barro and Sahasakul calculate the average marginal tax rate starting in 1916 because this is when the IRS statistics of income data become available. However, since between 1913 and 1916 the personal exemption for dependents was zero, no values for the value of the personal exemption series are missing.

[17]Stephenson notes that the average marginal tax rates reported by Barro and Sahasakul (1986) for 1981 and 1983 are slightly different than the values that he calculates. Stephenson attributes the difference to Barro and Sahasakul's use of preliminary statistics of income data.

[18]See http://www.irs.gov/pub/irs-soi/04in01tr.xls.

53 constructed by the U.S. Census Bureau.[19] Male income data before 1947 were constructed by estimating the equation

$$MaleIncome_t = \alpha_0 + \beta_0 MedianIncome_t + \epsilon_t \tag{A-1}$$

for years 1947-2005, and using these estimated coefficients to impute male income from median income prior to 1947[20]. The series that Whittington et al. (1990) used includes asset income, which was obtained from two additional sources: the Statistics of Income for years 1916-1936, and the National Income and Product Accounts for years 1929-2005. Finally, the series was adjusted to 2005 dollars.

Other Series

As in the unemployment series for replication, unemployment data after 1929 is obtained from the Bureau of Labor Statistics. The infant mortality series is also extended to 2005 using the same source as the replication data, the U.S. Census Bureau.

For years 1986-2005, the Department of Homeland Security publishes the number of immigrants by age and gender in the Yearbook of Immigration Statistics. These reports are available on the Department of Homeland Security's website.[21] These data were appended to the immigration data used for replication.

While the constructed female wage series was used for replication purposes, for our later analysis, we obtain female wages for 1973-2005 from the Economic Policy Institute and estimate a scaling factor which is applied to Whittington et al. (1990)'s series to fill in the values from 1913-1972.

[19]See http://www.census.gov/hhes/www/income/histinc/incpertoc.html.

[20]Median income from 1913-1960 is from Lebergott (1964). Using the overlapping years 1947-1960, a scaling factor was estimated and applied to the imputed male income series to make the transition between the two series smooth

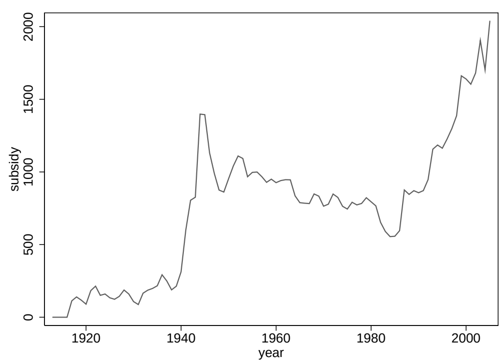
[21]See http://www.dhs.gov/ximgtn/statistics/publications/yearbook.shtm.

Complete 1913-2005 Data

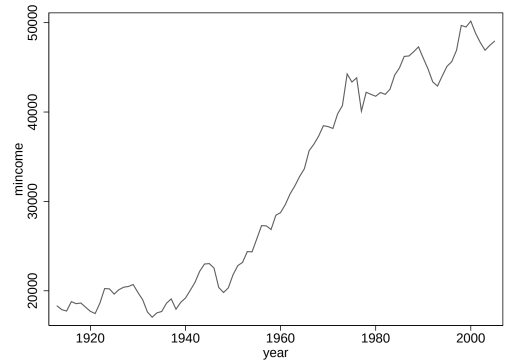
Year	Fertility Rate	Child Tax Benefits	Male Income	Unemploy-ment	Infant Mortality	Age 16-44 Immigration	Female Wage
1913	124.7	0	18,309.34	0.043	100.0	0.01455	2.159
1914	126.6	0	17,886.99	0.079	100.0	0.01505	2.145
1915	125.0	0	17,737.60	0.085	99.9	0.00459	2.187
1916	123.4	0	18,786.45	0.051	101.0	0.00374	2.304
1917	121.0	112.91	18,559.87	0.046	93.8	0.00376	2.356
1918	119.8	139.68	18,632.94	0.014	100.9	0.00142	2.594
1919	111.2	117.41	18,160.82	0.014	86.6	0.00169	2.562
1920	117.9	89.84	17,704.93	0.052	85.8	0.00543	2.936
1921	119.8	183.30	17,451.41	0.117	75.6	0.01062	3.077
1922	111.2	213.90	18,617.67	0.067	76.2	0.00436	3.189
1923	110.5	150.76	20,249.26	0.024	77.1	0.00626	3.372
1924	110.9	159.89	20,218.60	0.050	70.8	0.00800	3.456
1925	106.6	133.92	19,634.65	0.032	71.7	0.00364	3.334
1926	102.6	123.58	20,122.23	0.018	73.3	0.00379	3.339
1927	99.8	143.67	20,401.31	0.033	64.6	0.00398	3.358
1928	93.8	187.31	20,484.62	0.042	68.7	0.00388	3.498
1929	89.3	159.89	20,699.47	0.032	67.6	0.00369	3.451
1930	89.2	107.59	19,807.67	0.087	64.6	0.00324	3.456
1931	84.6	87.37	18,999.14	0.159	61.6	0.00137	3.442
1932	81.7	165.36	17,625.68	0.236	57.6	0.00049	3.287
1933	76.3	186.29	17,043.05	0.249	58.1	0.00031	3.681
1934	78.5	198.21	17,536.04	0.217	60.1	0.00038	4.552
1935	77.2	216.68	17,682.97	0.201	55.7	0.00046	4.491
1936	75.8	292.25	18,606.59	0.169	57.1	0.00047	4.346
1937	77.1	249.55	19,093.16	0.143	54.4	0.00064	4.594
1938	79.1	188.37	17,941.25	0.190	51.0	0.00087	4.627
1939	77.6	213.57	18,711.81	0.172	48.0	0.00093	4.683
1940	79.9	312.48	19,190.55	0.146	47.0	0.00077	4.884
1941	83.4	600.51	20,055.10	0.099	45.3	0.00054	5.076
1942	91.5	805.16	20,946.84	0.047	40.4	0.00032	5.371
1943	94.3	825.79	22,196.92	0.019	40.4	0.00028	5.985
1944	88.8	1,398.17	22,995.08	0.012	39.8	0.00035	6.327
1945	85.9	1,394.23	23,045.00	0.019	38.3	0.00051	6.359
1946	101.9	1,131.74	22,541.69	0.039	33.8	0.00199	6.364
1947	113.3	989.64	20,363.85	0.039	32.2	0.00198	6.406
1948	107.3	875.20	19,809.01	0.038	32.0	0.00207	6.580
1949	107.1	861.62	20,323.56	0.059	31.3	0.00214	6.196
1950	106.2	953.00	21,795.75	0.053	29.2	0.00239	5.802
1951	111.5	1,041.10	22,819.57	0.033	28.4	0.00189	5.783
1952	113.9	1,109.89	23,177.59	0.030	28.4	0.00255	6.027
1953	115.2	1,092.80	24,385.18	0.029	27.8	0.00189	6.664
1954	118.1	967.06	24,359.67	0.055	26.6	0.00219	6.575
1955	118.5	996.90	25,817.02	0.044	26.4	0.00245	7.778
1956	121.2	999.48	27,291.53	0.041	26.0	0.00315	7.816
1957	122.9	967.46	27,266.51	0.043	26.3	0.00321	8.097

Year	Fertility Rate	Child Tax Benefits	Male Income	Unemploy-ment	Infant Mortality	Age 16-44 Immigration	Female Wage
1958	120.2	928.52	26,854.98	0.068	27.1	0.00271	8.176
1959	118.8	950.33	28,446.68	0.055	26.4	0.00269	8.265
1960	118.0	926.36	28,753.13	0.055	26.0	0.00274	8.317
1961	117.1	940.58	29,653.57	0.067	25.3	0.00269	8.144
1962	112.0	946.75	30,843.61	0.055	25.3	0.00277	8.322
1963	108.3	945.86	31,734.30	0.057	25.2	0.00298	8.485
1964	104.7	835.38	32,786.44	0.052	24.8	0.00289	8.687
1965	96.3	788.64	33,657.01	0.045	24.7	0.00289	8.912
1966	90.8	784.82	35,673.43	0.038	23.7	0.00281	8.706
1967	87.2	782.37	36,400.13	0.038	22.4	0.00303	8.982
1968	85.2	848.54	37,302.76	0.036	21.8	0.00375	9.268
1969	86.1	833.35	38,471.56	0.035	20.9	0.00284	9.661
1970	87.9	764.46	38,369.11	0.049	20.0	0.00286	9.666
1971	81.6	777.95	38,162.67	0.059	19.1	0.00284	9.633
1972	73.1	848.01	39,802.10	0.056	18.5	0.00291	9.806
1973	68.8	824.75	40,713.68	0.049	17.7	0.00291	9.951
1974	67.8	763.57	44,256.83	0.056	16.7	0.00280	9.730
1975	66.0	744.68	43,358.02	0.085	16.1	0.00264	9.773
1976	65.0	791.32	43,829.38	0.077	15.2	0.00269	9.869
1977	66.8	773.18	40,102.89	0.071	14.1	0.00297	9.856
1978	65.5	783.04	42,210.55	0.061	13.8	0.00384	10.103
1979	67.2	822.46	41,978.00	0.058	13.1	0.00290	10.346
1980	68.4	794.77	41,766.75	0.071	12.6	0.00329	10.322
1981	67.3	766.59	42,185.98	0.076	11.9	0.00363	10.248
1982	67.3	652.93	41,977.79	0.097	11.5	0.00356	10.275
1983	65.7	590.33	42,543.73	0.096	11.2	0.00331	10.414
1984	65.5	554.90	44,132.05	0.075	10.8	0.00318	10.514
1985	66.3	557.36	44,941.38	0.072	10.6	0.00329	10.573
1986	65.4	595.69	46,223.44	0.070	10.4	0.00334	10.844
1987	65.8	875.91	46,272.96	0.062	10.1	0.00336	11.126
1988	67.3	845.45	46,748.23	0.055	10.0	0.00354	11.229
1989	69.2	871.13	47,289.59	0.053	9.8	0.00646	11.220
1990	70.9	856.96	46,044.02	0.056	9.2	0.00891	11.251
1991	69.3	871.46	44,831.14	0.068	8.9	0.00760	11.299
1992	68.4	947.29	43,371.91	0.075	8.5	0.00530	11.389
1993	67.0	1,156.60	42,906.69	0.069	8.4	0.00518	11.514
1994	65.9	1,185.21	44,043.06	0.061	8.0	0.00453	11.420
1995	64.6	1,163.34	45,117.02	0.056	7.6	0.00397	11.347
1996	64.1	1,226.65	45,635.49	0.054	7.3	0.00517	11.394
1997	63.6	1,298.14	46,908.29	0.049	7.2	0.00449	11.682
1998	64.3	1,386.90	49,689.69	0.045	7.2	0.00364	11.969
1999	64.4	1,661.61	49,516.12	0.042	7.1	0.00357	12.076
2000	65.9	1,639.81	50,168.74	0.040	6.9	0.00505	12.325
2001	65.3	1,603.90	48,822.69	0.047	6.8	0.00653	12.589
2002	64.8	1,680.93	47,774.14	0.058	7.0	0.00631	12.906
2003	66.1	1,905.71	46,914.04	0.060	6.9	0.00406	12.929
2004	66.3	1,701.83	47,459.20	0.055	6.8	0.00568	12.912
2005	66.7	2,038.01	47,932.25	0.061	6.7	0.00663	12.816

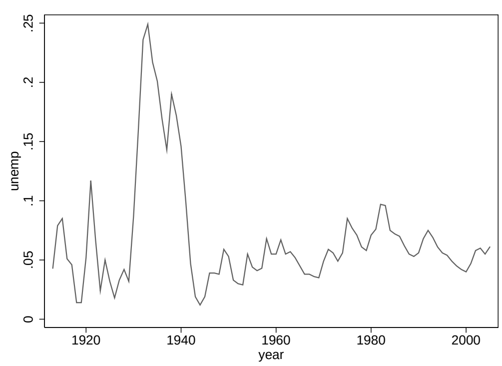
Figure B-1: Extended and Updated Series, 1913–2005



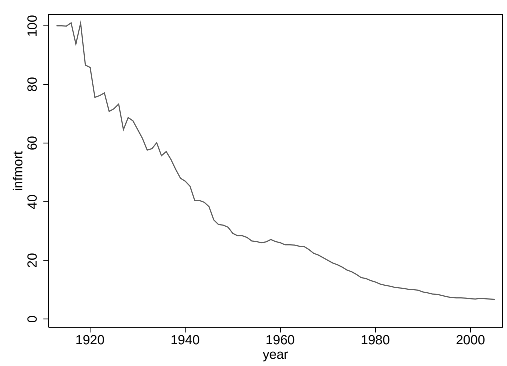
(a) Child Tax Subsidy



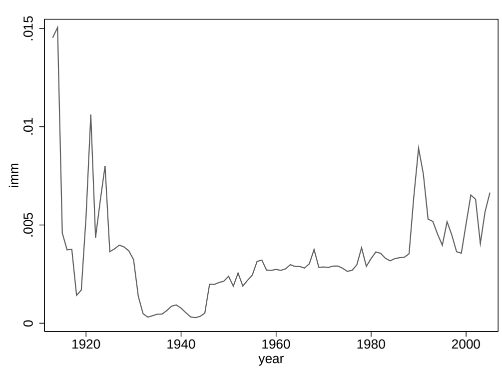
(b) Male and Asset Income



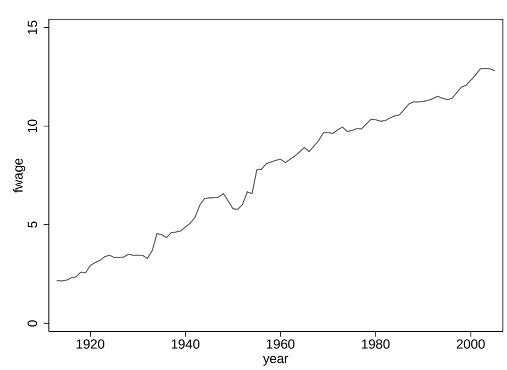
(c) Unemployment



(d) Infant Mortality



(e) Immigration



(f) Female Wage