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What Factors Influence Twin, Triplet and Higher Order Birth Rates?

A Cross-Sectional State Study, 1995-1997

I. INTRODUCTION

The growing incidence of multiple pregnancies has become a public health concern for many reasons. First, there is a heightened risk to the mother and child. Second, multiple birth infants are less likely to survive the first year of life, they are born earlier and smaller than singletons, and if they do survive they are more likely to develop life-long disabilities. "Accordingly, multiple births are exerting growing influence over important indicators of infant health such as low birth-weight and pre-term birth rates" (Joyce Martin and Melissa Park, 1999).

Although twin births constitute only approximately 2% of all births, multiples risk for low birth weight is seven times greater than among singletons. Twins account for 17% of all low birth weight infants and approximately 12% of all infant deaths (MMWR, 1997). Nine of 10 triplets were born pre-term compared with 1 of 10 singleton births. The average triplet weighed approximately 3 lbs. 12 oz. at birth, whereas the average singleton birth weighs 7 lbs. 6 oz. The low birth weight, pre-term delivery and a number of other complications associated with triplet births contributes to a part of the explanation why triplets are 12 times more likely to die during their first year, in other words, 93.7 triplet infant deaths compared with 7.8 singleton infant deaths per 1,000 live births (Martin, MacDorman, Mathews, 1997).

Twin, triplet and other higher order multiple births have climbed at an unparalleled rate over the last two decades. Twin birth rates have risen 52 percent since 1980, from 68,339 to 104,137 births in 1997, and the number of triplet and other higher order births skyrocketed 404 percent, compared to singleton births, which have increased only 6 percent since 1980(Martin and Park, 1999). Although twin births encompass the vast majority of multiples, the rapid rise in the number of triplets and higher order births has increased the interest in triplets and possibly improved the ability of studying triplet trends independently. The focus of this study is the increasing trend of multiple births, 1995 to 1997, among the 50 states and the District of Columbia and the factors that may influence these rates.

This study separately addresses the relationship of state-specific twin birth rates and triplet/ higher order multiple birth rates and factors that may influence these rates. Presumably, the need for two separate regressions is because of the large differences between twin and triplet birth rate trends and outcomes. Overall, a more accurate picture of multiple births will be developed by estimating the two groups separately due to the fact that the magnitude of twin births is so large compared to the occurrence of triplets. Triplet births comprise about 92% of all higher order multiple births, which include quadruplets, quintuplets and other higher multiples therefore for succinctness triplet/+ will be used to represent this group.

This paper seeks to determine the factors that contribute to the variation and occurrence of multiple births. Many studies have found a direct relationship between the increasing maternal age and the likelihood of a multiple birth. This is also true for the increase use of fertility enhancing drugs. Special attention was paid to the use of assisted reproductive technology and how the increase in such procedures can affect the outcome of multiple birth rates.

These state specific increases in twins and triplet/+ births are important because these high- risk births contribute disproportionately to health care costs and may negatively affect maternal and infant health outcomes. Health-care organizations, public health agencies, researchers and policymakers can use this study's findings in evaluating and planning programs related to multiple births and infant health.

The next section explains in detail the theoretical relationship that was modeled and the expected relationships between the independent and dependent variables. Section III reviews the literature on twin and triplet birth trends and demonstrates the correlation and contributions of insights to this paper. The data and empirical methodology are explained in depth in section IV. Section V details the findings of the estimated models and addresses the tests for multicollinearity and heteroskedasticity and the resolutions. The conclusions and an in-depth interpretation of the estimated models are discussed in section VI.

II. Theory

The theoretical relationship between the rate of multiple births and factors that may contribute to the variation of multiple births was modeled. The variables are clearly defined below. As noted, twins and triplets were estimated separately because the number of twin births is much larger. The magnitude of twins is so large compared to triplets that the outcome of a joint model would not depict as clear a picture of triplet trends. Also, each model was estimated with two proxy variables to represent the theoretical variable for technology. This will be explained later in this section. Therefore, the relationship between twin birth rates and various independent variables can be empirically modeled as follows:

$$TWINPS_i = B_0 + B_1\ AGE_i + B_2\ RACE_i + B_3\ EDUC_i + B_4\ MARST_i + B_5\ PRELF_i + B_6\ ABORTL_i + B_7 TECHNOLOGY_i + \varepsilon_I$$

$TWINPS_i$: Number of individuals born as twins per 1,000 live births, 1995-1997
AGE_i: Percentage of females per state age 35-54, 1999
$RACE_i$: Percent of the total white population per state for 1996
$EDUC_i$: Educational attainment of percent of females 25 years +, 1999
$MARST_i$: Percent of married females per state age 15 and over
$PRELF_i$: Percentage of religious fundamentalists per state
$ABORTL_i$: Dummy variable representing the state laws on abortion (strict laws = 1, otherwise = 0)

$TECHNOLOGY_i$: Theoretical variable for TECHNOLOGY
TRIPLSi: Dependent variable for models 3 and 4. The number of individuals born as triplets, quadruplets, quintuplets and other higher order multiples per 1,000 live births per state, 1995-1997
ε: Error term

The relationship between triplet/+ birth rates and various independent variables can be empirically modeled the same as above with TRIPLSi replacing $TWINPS_i$. Also, ε, in the above model is an error term and β's are parameters of the model.

First, the dependent variable for models 1 and 2, $TWINPS_i$, is defined as the number of individuals born as twins per 1,000 live births per state, 1995-1997. $TRIPLPS_i$, the dependent variable for models 3 and 4 is defined as the number of individuals born as triplets, quadruplets, quintuplets and other higher order multiples per 1,000 live births per state, 1995-1997. The independent variables used are the same for each of the two models estimated and are explained in the following section and the hypotheses are listed in Table 1 located at the end of the text.

AGE_i is the variable chosen to depict the percentage of females per state 35 to 54 years of age for 1999. The variable was chosen because of the increase occurrence of multiple births among women age 35 and over. The expected sign of the variable's coefficient is positive. This can be explained by the study by Martin and Park, 1999. The overall trends of twin and triplet/+ births have occurred with greater significance amongst women age 35 to 49. As women either prolong pregnancy or decide to have a child at an older age the likelihood of multiple births greatly increases. This may be due to the increase in age, a female's eggs are more likely to be less healthy than at a younger age, and to the increase use of assisted reproductive technology.

The second independent variable chosen is RACE. This denotes the percent of the total white population per state for 1996. The variable was chosen because of the higher occurrence of multiple births within the white population. Therefore, the expected coefficients sign would be positive. Hence, if the percent of total white population per state were to increase the multiple births, twin and triplet/+, would increase for that state. The hypothesis can be attributed to the case study by Martin and Park. Studies have shown that the white population has experienced the majority of occurrence of multiple births. This may be contributed to the greater number of white females employed, educated and of a higher income level relative to the omitted races. Females that are employed and/or educated may forgo having children earlier in their life and decide later in life to have a child. This theory corresponds to the age hypothesis. Secondly, the higher income level may signify that a female is educated and has worked as a professional and has decided to prolong child bearing until later in life or the higher income may allow females to engage in assisted reproductive technology. These two can affect the multiple birth probability. Also, higher income earning individuals are more likely to be able to afford expensive procedures for fertility treatments.

Another independent variable is EDUC which represents the educational attainment of percent of females 25 years and over per state in 1999. The educational attainment groups chosen include percent with a bachelor's degree and more degrees. These two specific categories were chosen because of the projected increase in occurrence of multiple births with higher educated females. The expected sign of the coefficient on the education variable is positive. As a female pursues a bachelor's or advanced degree such as a masters or doctorate, childbirth is probably delayed. The time and effort required to attain an advanced degree may hinder one's decision to bear a child during that time. The trade-off of attaining a higher degree is the possibility of prolonging children bearing. Educational attainment may also contribute to a higher income level. The more advanced degree, such as a doctorate, is synonymous with a higher earning profession. The education level incorporates the income effect on the probability of multiples. This is one of the reasons why income was not included in this study. Race, education and income were somewhat redundant. Therefore, income was legitimately omitted.

The fourth variable is MARST, which is the percent of married females per state age 15 and over. The significance of this variable is correlated to the higher occurrence of multiple births with married women, according to Martin, MacDorman and Mathews Triplet births: trends and outcomes, 1971-1994(January 1997). Married couples may be more willing and financially capable of investing in fertility treatments, which increase the chances of multiple births. Married couples will generally have higher incomes compared to unmarried couples. This is primarily true with two income families. Secondly, married couples may be more likely to continue having children even as the mother's age increases which will also increase the likelihood of multiple births. Therefore, the expected sign of this variable's coefficient is positive. As the percent of married couples per state increases the number of multiple births per state will increase.

The next variable chosen was PRELF to measure the percentage of religious fundamentalists in a state. Fundamentalist affiliates include Churches of Christ, Church of God, Latter-Day Saints, Nazarene, Free Methodists, Mennonites, Seventh Day Adventists, Southern Baptists, Pentecostal Holiness, and Lutheran –Missouri Synod. Percentages are for all members, including full members, their children and the estimated number of other regular participants who are not considered as communicant, confirmed or full members. This may be directly correlated to an increase or decrease occurrence of multiples. The cultural and moral attitudes may differ greatly from state to state and this may affect the number of multiples born within each state. The expected sign on the variable's coefficient is an ambiguous sign, as the percentage of religious fundamentalists in a state increases, the number of multiple births could decrease or increase in that state. First, fundamentalists may not believe in fertility treatments, which increase the occurrence of multiple births. The church that they belong to may not approve of interfering with the natural phenomenon of fertility, which will hinder their involvement in assisted reproductive technologies. On the other hand, fundamentalists may be more focused on the family, hence more children. Also, they may not believe in any form of birth control, which will increase the probability of the mother becoming pregnant. The mother may have more children and may continue to have children later in life. This will increase the probability of multiples.

The next variable is a dummy variable representing the state laws on abortion. The abortion laws were divided between two categories, states with strict laws, and the omitted variable, states with less strict laws. This categorization is strictly subjective to this study and created for the purpose of this paper. Some presumptions were made to make this task a little more manageable. For the purpose of this study the presumption on the definition of viability was created. Viability is not clearly defined within all statutory definitions of a legal abortion. Therefore, a viable fetus is defined as a fetus that has reached 24 weeks. States that define an abortion as legal only when termination of the pregnancy is necessary to preserve the life and health of mother, or if continuation of pregnancy would result in death or injury to mother, are included in the Strict category. This is the included dummy variable, ABORTL. Less Strict states define legal abortion as abortions that are performed before viability, 24 weeks, with little or no restrictions, or if pregnancy is the result of rape or incest. Restrictions include but not limited to consent of one or more medical doctors, consent of woman, spouse, or both, procedure performed by licensed physician, and during 2^{nd} trimester abortion must be performed in a hospital. The inclusion of this variable was due to the incidence of abortions per state according to statutory law and the effect on the number of live multiple births in that state. The expected sign of the coefficient on ABORTL, (states with stricter laws = 1), will be positive. States that have stricter laws on what is deemed a legal abortion will positively affect the number of multiple births. Mothers will not be able to abort or selectively reduce the number of fetuses unless her life and health are in danger.

The last variable in the model is the theoretical variable for TECHNOLOGY. Two proxy variables were used and were tested separately to capture the effect of each empirical proxy. First, ARPD, is a dummy variable where 1,000 or more Assisted Reproductive Technology (ART) procedures performed per state in 1998 equals one. The omitted variable, equal to zero, when less than 1000 procedures were performed. The dummy variable was included because of the increasing trend in the use of ART procedures and the greater chance of a multiple birth when ART is used. The actual number of ART procedures reported was used. The next proxy technology variable, ARTC, is the number of ART clinics per state, 1996. The expected signs for each of these technology variables are positive. The increase in the number of ART clinics, and procedures performed would increase the incidence of multiple births. To increase the women's chance of success with fertility treatments more eggs are inserted, additional cycles of drugs are performed to increase the number of eggs that can be fertilized. The cycles are expensive and straining on a women's health, therefore, success is highly anticipated. These all increase the chance of multiple births.

The hypotheses of the independent variables coefficients are located in Table 1. The next section discusses the literature on twins and triplet trends and the correlations to this paper.

III. Literature Review

The report, Trends in Twin and Triplet Births: 1980-1997 by Martin and Park, 1999 was an important contributor to the bulk of this paper. The report discusses the growth rates of multiple births within several different socioeconomic groups. Race, and age of the mother was one area of study. According to the report, the rapid growth of triplets and higher order multiple births for women in their thirties was up 400 percent and up 1,000 percent for women in their forties. These factors provided insights to selecting the explanatory variables used in the study set forth in this paper. Also, the rapid growth in multiples is a public health concern due to the severity of risk involved when having multiple births. The literature was quite helpful in providing background information and important state-specific data on multiple births.

IV. **<u>Data and Empirical Methodology</u>**

This section briefly describes the empirical model used to test the influence of several independent variables on the dependent variables, twins and triplet/+ births for the years 1995 to 1997. Cross-sectional data was collected for each U.S. state and the District of Columbia. Therefore, the total number of observations is 51. The state data was collected for the time period ranging from 1995 to 1999 approximately. Each variable' source and methodology is explained in detail below.

Data presented in this study for the two population models is defined, tabulated and provided from various sources and will be explained in depth. First, the dependent variable for models 1 and 2, $TWINPS_i$, , is defined as the number of individuals born as twins per 1,000 live births per state, 1995-1997. $TRIPLPS_i$, the dependent variable for models 3 and 4 is defined as the number of individuals born as triplets, quadruplets, quintuplets and other higher order multiples per 1,000 live births per state, 1995-1997.

The data was provided in the National Vital Statistics Reports vol. 47, number 24 page15, 1999. Triplet/+ was used because triplets comprise approximately 93% of all higher order multiple births. Twins and triplet/+ were estimated separately because of the greater magnitude of twin births compared to triplet/+. Multiple births are defined as twin, triplet, quadruplet, quintuplet and other higher order births.

The independent variables used are the same for each model developed. AGE_i is the variable chosen to depict the percentage of females per state 35 to 54 years of age for 1999. The data is provided by the U.S. Census Bureau, Census 2000 Summary File, Table: Sex by Age Distribution. The variable was formulated by totaling the number of potential fertile women, age 14 to 54, per state and dividing this by the total number of females age 35 to 54.

The second independent variable chosen is RACE. This denotes the percent of total white population per state for 1996. The data is provided in The State and Metropolitan Area Data Book, Table A-5 page 6.

Education, EDUC, will be measured as the percentage of females age 25 years and over with a bachelor's and more advanced degrees, 1999 per state. The data is provided from the U.S. Census Bureau, Census 2000 Summary File, Table P37. The data was formulated by dividing the total number of females with a bachelor's or higher degrees by the total population of females per state age 25 and over.

The marriage variable, MAST, is the percent of females married per state age 15 and over, 1999. The variable was measured by dividing the total population of females age 15 and over by the number of now married females per state, 1999. Now married category is defined by the U.S. Census as "all people whose current marriage has not ended by widowhood or divorce. This category includes people defined as separated." The data is provided from the U.S. Census Bureau, Census 2000 Summary File, Table P18.

The next variable chosen was PRELF to measure the percentage of religious fundamentalists in a state. Fundamentalist affiliates include Churches of Christ, Church of God, Latter-Day Saints, Nazarene, Free Methodists, Mennonites, Seventh Day Adventists, Southern Baptists, Pentecostal Holiness, and Lutheran –Missouri Synod. Percentages are for all members, including full members, their children and the estimated number of other regular participants who are not considered as communicant, confirmed or full members. The data was collected from Does AFDC-UP Encourage Two-parent Families? Winkler (1995), which was compiled originally from Quinn et al.(1982), based on a definition previously used by Morgan and Meier (1980) and Feigenbaum, Karoly, and Levy (1988).

The next variable, ABORTL, is a dummy variable representing the state laws on abortion. The abortion laws were divided between two categories, states with strict laws, and the omitted variable, states with less strict laws. These were defined thoroughly in section II. The data of state laws was compiled from the National Survey of State Laws Table 21 pages 277-307.

The last variable in the model is the theoretical variable for TECHNOLOGY. Two proxy variables were used and were tested separately to capture the effect of each empirical proxy. First, ARPD, is a dummy variable where 1,000 or more Assisted Reproductive Technology (ART) procedures performed per state in 1998 equals one. The omitted variable, equal to zero, when less than 1000 procedures were performed.

The data was compiled for each state and all ART procedures that were reported for 1998. The actual number of ART procedures reported was used. The next proxy technology variable, ARTC, is the number of ART clinics per state, 1996. This data was provided from the CDC study, Use of Assisted Reproductive Technology, United States, 1996 and 1998 ,page 3-4, 2002.

The means and standard deviations of the variables derived are available in Table 2 at the end of the paper. The mean of Triplets/+, TRIPLS, was 1.4379 per 1,000 live births versus the mean for twins, 25.761 per 1,000 live births. This reinforces the statement made earlier about the greater magnitude of twin births compared to triplets/+. The results of the estimated models will be explored more thoroughly in the following section.

V. Findings

The following twins and triplet/+ models were estimated two different times using ordinary least squares. Each model was estimated twice using the two empirical proxy variables for TECHNOLGY and the basic estimated regressions are listed in Table 3.

The evaluation of the quality of the regression model involves several steps. First, all the theoretically relevant variables have been included that were available and applicable. More data regarding specific fertility treatments would have been desirable, but the data was not available. Second, not all the signs on the estimated coefficients conform to the theories proposed. The marriage variable coefficient had a negative sign, meaning as the percentage of married females increases the twin or triplet rates decrease per 1,000 live births. The abortion coefficient also had a negative sign and this was not consistent with the proposed theory. Third, the R^2 and the adjusted R^2 were low, but not too low. This provides a piece of the information but there are other things to consider. The R^2 for twin model was .4125, which means that 41.25% of the variation in twin rates around its mean was explained by the regression, explanatory variables. The R^2 for the triplet model was even lower at .2690, meaning that only 26.9% of the variation in triplet rates around its mean was explained by the regression. This great difference between the two models' R^2 values may be due to the greater occurrence or larger magnitude of twin births and the low values may be contributed to the small occurrence of multiple births compared to all live births. Last, not much confidence can be placed in the estimated coefficients as a measure of the true, population, coefficient. Generally, most of the coefficients were not statistically different from zero, using the rule of thumb if $|\beta_1| > 2 * S.e.(\beta_1)$ we are 95% confident that β_1 is statistically different from zero. If true than this is a good indicator that there is a relationship between the independent and dependent variables. However, the coefficients on RACE and EDUC in models 1 and 2 were statistically significant at the 95% significance level. The values are located in Table 3.

Hypothesis tests were also performed for each of the estimated coefficients and the results are located in Table 1. Upper one-tailed tests were performed for all the coefficients except for the religion variable, where a two- tailed test was used. The level of significance was set at the 5% level and the degrees -of -freedom used was 40 instead of the calculated 43. The twin model results were not overwhelmingly surprising. The majority of the null hypotheses were not rejected, in other words, we failed to reject the null, except for RACE and EDUC variables where the null hypotheses were rejected. The triplet models exhibited very similar results. The null hypotheses were not rejected except with the technology variable, ARPD, where the null hypothesis was rejected.

However, the ARPD variable was not statistically significant as stated earlier. A special F test was performed to test the overall significance of the model using the 5% level of significance and 40 degrees of freedom for the denominator. The calculated F statistic for the twin model was 4.313 and the F critical was 2.25. The null hypothesis was rejected, meaning that the slope coefficients did not all jointly equal zero. The test was repeated for the triplet model and the F statistic was 2.26 and the F critical is 2.25. Since 2.26 is greater than 2.25, the null can be rejected at the 5% level of significance using the special F test. However, these values are so close that rejecting the null is unsettling. The overall significance of the regression is not very reliable. The results can also be found in the appendix.

No evidence of severe multicollinearity was found. The pair wise correlations were compared with the marker value of .8 there was no evidence of any strong multicollinearity. Second, the R^2 are not high but the t statistics are low. A high R^2 does indeed indicate the probability of severe multicollineariy, but a low R^2 does not disprove the presence of multicollinearity. Also, auxillary regressions were estimated to calculate the VIF's using an arbitrary value of $VIF(\beta) > 5$, if true than severe multicollinearity. Again, no evidence of severe multicollinearity was found with the VIF's. Park tests were performed for the two models to test for heteroskedasticity. The Z value chosen was total population of each state. There was no evidence of heteroskedasticity and we failed to reject the null hypothesis, no heteroskedasticity, for both models. Therefore, our OLS estimated models are the chosen regressions, however the majority of the estimated coefficients were not statistically significant, except for RACE and EDUC for the twin models, as stated previously. Data is located in Table 3.

VI. Extensions and Conclusions

The focus of this study is the increasing trend of multiple births, 1995 to 1997, among the 50 states and the District of Columbia and the factors that may influence these rates. This paper seeks to determine the factors that contribute to the variation and occurrence of multiple births. The four models were estimated using ordinary least squares. The overall estimated coefficients were not statistically significant, with the exception of RACE and EDUC for twin births, models 1 and 2, however the study was still viable. The dependent variables, twin rates and triplet/+, are fairly infrequent occurrences, comprising only 2% of all live births. The infrequency makes it more difficult to estimate a relationship between the independent and dependent variables. Also, individual – level data could be more significant and revealing, meaning the relationships between multiple birth occurrences and the independent variables may be masked at the aggregate state level. The study would probably be more significant if specific technology variables were included in addition to the two already included. For example, a study regarding specific fertility drugs and treatments and the occurrence of multiples and singleton births could be a continuation of this study.

Table 1:

Hypotheses	Model 1	Model 2				
Variables	**TWINPSi**	**TWINPSi**				
TWIN MODELS	**Sign on Coefficients**		**Relative Test**	**Hypothesis**	**t-stat**	**Decision**
Independent:						
AGEi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**1.577**	Fail to reject H_o
RACEi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**2.52**	Reject H_o
EDUCi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**1.94**	Reject H_o
MARSTi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**-2.29**	Fail to reject H_o
PRELFi	**Ambiguous**	**Ambiguous**	**Two-tailed test**	H_o: $\beta = 0$ H_a: $\beta \neq 0$	**.449**	Fail to reject H_o
ABORTLi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**-1.88**	Fail to reject H_o
Technology:						
ARTCi	**Positive**	******	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**1.07**	Fail to reject H_o
ARPDi	******	**Positive**	**Uppper one-tailed test**	H_o: $\beta \leq 0$ H_a: $\beta > 0$	**1.23**	Fail to reject H_o
	Model 3	**Model 4**				
Triplet Models	**TRIPLSi**	**TRIPLSi**				
Independent:						
AGEi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**.0267**	Fail to reject H_o
RACEi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**1.54**	Fail to reject H_o
EDUCi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**1.47**	Fail to reject H_o
MARSTi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**-.798**	Fail to reject H_o
PRELFi	**Ambiguous**	**Ambiguous**	**Two-tailed test**	H_o: $C = 0$ H_a: $C \neq 0$	**-.687**	Fail to reject H_o
ABORTLi	**Positive**	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**-1.18**	Fail to reject H_o
ARTCi	**Positive**	******	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**1.39**	Fail to reject H_o
ARPDi	******	**Positive**	**Uppper one-tailed test**	H_o: $C \leq 0$ H_a: $C > 0$	**1.80**	Reject H_o

Table 2

Descriptive Statistics for Variables in Multiple Birth Equations

	Number	MEAN	Standard Deviation	VARIANCE	MINIMUM	MAXIMUM
Dependent Variables						
TWINS (TWINPS)	51	25.761	2.8856	8.3264	18.4	32.6
TRIPLETS (TRIPLS)	51	1.4379	0.63673	0.40543	0.397	3.236
Explanatory Variables						
AGE (AGE)	51	50.853	2.9791	8.875	39.4	56.53
RACE (RACE)	51	83.992	13.664	186.71	33.5	98.4
EDUCATION (EDUC)	51	22.746	4.5075	20.318	13.99	36.82
MARRIAGE (MARST)	51	54.936	3.9485	15.591	31.82	60.36
RELIGION (PRELF)	51	13.763	13.307	177.06	0.5	68.7
ABORTION DUMMY(ABORTL)	51	0.2549	0.44014	0.19373	0	1
TECHNOLOGY PROXY (ARTC)	51	5.6078	6.4717	41.883	0	35
TECHNOLOGY DUMMY(ARPD)	51	0.1177	0.3254	0.10588	0	1

Table 3: Regression Results

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Dependent:	**TWINPSi**	**TWINPSi**	**TRIPLSi**	**TRIPLSi**
Constant	20.182 (10.79)	20.875 (10.69)	1.054(2.657)	1.248(2.6)
Independent:	**Coefficient Est.**	**Coefficient Est.**	**Coefficient Est.**	**Coefficient Est.**
AGEi	0.219(.139)	.2205 (.1383)	.00091(.0342)	.00182(.0337)
RACEi	0.0857(.034)	.08399 (.03385)	.01286(.00837)	.01231(.00825)
EDUCi	0.1799(.09266)	0.1621 (.09359)	.03352(.0228)	.0271(.0228)
MARSTi	- 0.309 (.1353)	-.3099 (.1348)	-.02658(.0333)	-.02655(.0328)
PRELFi	0.0163(.036)	.013588 (.03585)	-.006148(.00895)	-.00687(.00873)
ABORTLi	– 1.59 (.8467)	-1.5174 (.8457)	-.2455(.0132)	-.219(.206)
Technology:				
ARTCi	0.0577 (.0538)		.01836(.0132)	
ARPDi		1.3217 (10.69)		.4725(.2627)
R^2	0.4125	0.4172	0.269	0.2897
Adjusted R^2	0.3169	0.3223	0.15	0.1741
F Statistic	4.313	4.397	2.26	2.505

Note: Standard errors are in parentheses

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