CHANGING BIRTH RATES IN DEVELOPING AMERICA: NEW YORK STATE, 1840–1875

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THE theory of the demographic transition is generally accepted in its broad outlines, but we still have much to learn about the transition in our own history. The impressive fact is that empirically there is agreement that our society, like many others, has changed from high birth rates and high death rates to low ones without our being able to say just when these changes occurred or why. One of the difficulties is that transition theory emerged as an empirical statement, and we are still working at a close articulation with sociological theory. In general, however, we account for the facts of transition in population in terms of changes in social structure and in culture.[1]

One way to put this is that we conceive of the demographic transition as one aspect of the broader transition in culture and social structure which is called the industrial revolution.

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[1] Petersen, William: POPULATION. New York, Macmillan Co., 1961. For the American case, see Mayer, Kurt: Fertility Changes and Population Forecasts, *Social Research,* 1959, 26: 347–366.

Birth rates were supposed to be lower in cities than in rural areas because cities led in the cultural change to "rational" controls. Then the normal modes of cultural diffusion could account for the spread of a new family pattern throughout the society.

Difficulties arise in the American case, however, when more diligent study of available materials demonstrates a significant decline in the rural birth rate at an early date and even a decline in areas which are not considered "urban" by any standard definition. Part of the long decline in birth rates is analyzed in this paper by using fertility ratios for the period from 1840 to 1875 in New York State.[2]

The year 1840 is often taken as dating the beginning of the industrial revolution for the nation.[3] By that time New York had 2.5 million inhabitants of which nearly a fifth lived in incorporated cities. By 1875 there were 4.7 million New Yorkers, and Bogue calculates that the state had become 50 per cent urbanized by 1870, preceded only by Massachusetts and Rhode Island. In 1950 it was still one of the most highly urbanized of all the states.[4] While the censuses used in this study were chosen largely because of the type of data readily available, the period from 1840 to 1875 in New York is an appropriate one for the study of transition theory.

To illustrate the problem of deriving urban and rural birth rates we review some of the national data provided by Grabill, Kiser and Whelpton[5] for the period from 1800 to 1840. Similar data for New York State from 1840 to 1875 will then give a rough comparison for the later period.

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[2] Although fertility ratios derived from census data are not the same as annual birth rates obtained from registration, they are often used as indexes of birth rates when the latter are unobtainable. Speaking carefully, then, we are discussing fertility ratios only in this paper and are using them as approximate indexes of birth rates.

[3] For example, see Mayer: *op. cit.*, p. 356; also Whelpton, P. K.: Industrial Development and Population Growth, *Social Forces*, 1928, 6: 458–67, 629–38.

[4] Bogue, Donald J.: THE POPULATION OF THE UNITED STATES. Glencoe, Illinois, The Free Press, 1959, p. 68.

[5] Grabill, Wilson H., Kiser, Clyde V. and Whelpton, Pascal K.: *The Fertility of American Women*. New York, John Wiley & Sons, 1958, pp. 16–19.

The national birth rate began to decline at least by 1810, earlier in New England. The Middle Atlantic states are representative of the high birth levels of settled regions in this period, and of their decline. By 1840 the fertility ratios there were only three quarters of the level of 1810. During this period urban birth rates in the Middle Atlantic states were about 70 per cent of rural birth rates, a continuation of a differential that can be seen in New York throughout most of the eighteenth century.[6] Urban and rural birth rates in this region decline in nearly equal percentages from 1810 to 1840.

During the thirty-five years from 1840–1875, the fertility ratio for the state of New York dropped from 666 to 463. City and rural ratios for the state for this period are presented in Table 1. Because of differences in definitions, the data in this table are only vaguely an extension of the 1800–1840 time series.[7] From 1840 to 1875 the population of the state nearly doubled, and the population of incorporated cities increased more than five fold. The resultant population in 1875 is nearly evenly divided between city and non-city, whereas the ratio had been one to four in 1840.[8] The important fact to note is that for the state the differentials in fertility nearly disappear. The city birth rate had been only 80 per cent of the non-city rate in 1840, but in 1875 it was 96 per cent. Both rates fell, but the rural rate fell faster.[9] In 1875 non-city birth rates had dropped to 68 per cent of 1840 levels, while city birth rates were 82 per cent of 1840.

If each city is compared with the rest of its county (in Table 1), it is not always true that a city has a lower fertility level than its surrounding area, though usually it is. Also of interest

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[6] Jaffee, A. J.: Differential Fertility in the White Population in Early America, *Journal of Heredity*, 1940, 31: 407–411.

[7] There are different age intervals for women and different definitions of "urban." Here we use only incorporated cities.

[8] If we use 1940 definitions, the state was 50 per cent urban by 1870. See p. 2.

[9] The number of immigrants in New York State during this period is both an asset and a liability, statistically speaking. They are present in large numbers

(continued on page 164)

	1840	1855	1865	1875
Albany (1686)	594	505	459	473
Cohoes (1869)				352
Rest of Albany Co.	711	549	516	481
Binghamton (1867)				399
Rest of Broome				481
Auburn (1848)		512	415	417
Rest of Cayuga		532	448	425
Elmira (1864)			433	420
Rest of Chemung			488	487
Hudson (1785)	548	504	452	389
Rest of Columbia	623	521	461	461
Poughkeepsie (1854)		489	453	410
Rest of Dutchess		499	465	458
Buffalo (1832)	666	618	622	502
Rest of Erie	741	680	674	566
Watertown (1869)				356
Rest of Jefferson				431
Brooklyn (1834)	603	501	495	480
Rest of Kings	717	402	571	504
Rochester (1834)	633	568	511	455
Rest of Monroe	689	562	526	477
New York (1653)	540	462	463	441
Lockport (1865)				403
Rest of Niagara				509
Rome (1870)				403
Utica (1832)	519	478	433	398
Rest of Oneida	660	547	487	446
Syracuse (1847)		564	517	456
Rest of Onondaga		547	506	471
Newburgh (1865)				453
Rest of Orange				496
Oswego (1848)		619	564	486
Rest of Oswego		629	523	453
Long Island City (1870)				570
Rest of Queens				440
Troy (1816)	533	512	462	426
Rest of Rensselaer	652	539	526	499
Ogdensburg (1868)				464
Rest of St. Lawrence				488
Schenectady (1798)	554	502	448	462
Rest of Schenectady	706	596	515	497
Kingston (1872)				531
Rest of Ulster				562
Yonkers (1872)				466
Rest of Westchester				447
New York State	666	539	496	463
All Cities	556	491	482	454
Rest of State	697	568	506	472
	POPULATION			
New York State	2,428,921	3,466,212	3,827,818	4,698,958
All Cities	465,640	1,144,287	1,404,864	2,209,310
Rest of State	1,963,281	2,321,925	2,422,954	2,489,648

Table 1. Fertility ratios for cities and rural areas.

is the fact that New York City (Manhattan only at that time) is below the level of all cities in all four censuses, while Brooklyn, then the second city in size, is above in all four—and Buffalo, the third city, is well above but dropping rapidly. Buffalo is above the rural areas of the state in all three later censuses, but below the rural part of Erie County.

In view of the rapid growth of city population from less than half a million to over two million, the falling city birth rate can be viewed as a fulfillment of expectations as these people adjust to industrial and commercial life in larger and more complex aggregations. But what about the rural birth rate, which falls faster? Rural population increased only moderately, since the farming areas were mostly settled by 1840. Was the urban birth rate maintained at a higher than "normal" level by the influx of immigrants? Did the urban birth rate decline in the eighteenth century, to be followed by the rural birth rate in the nineteenth century?

II

These and similar questions cannot be answered by the data of Table 1. Nor would a county analysis be of enough assistance. Instead we go to the smallest political units in the expectation of greater homogeneity within units. Using some 900 townships and cities[10] we can examine the relation between declining birth rates and rural-urban differences.

The method of analysis involves abandoning political defini-

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from 1855 to 1875 and their impact on birth rates is well known, but fertility ratios cannot differentiate between native and foreign populations in these censuses.

	Total Population	*Native Population*	*Foreign Population*	
1840	2,428,921			
1845	2,604,495	2,206,921	397,574	15.3%
1850	3,097,394	2,441,465	655,929	21.2
1855	3,466,212	2,546,193	920,019	26.5
1860	3,880,735	2,879,455	1,001,280	25.8
1865	3,831,777	2,907,525	920,293	24.0
1870	4,382,759	3,244,406	1,138,353	26.0
1875	4,698,958	3,503,300	1,195,658	25.4

[10] The number of units increased as a result of subdividing townships in newly settled areas and carving out cities from townships. There were 840 units in 1840, and an additional 125 by 1875.

tions of cities (incorporation) and census definitions of urban (size). In place of these, we take density and heterogeneity from Louis Wirth's definition of urbanism[11] and consider each township and city in the state as being more or less urbanized according to where it falls in the array of all townships and cities. Then, differences between political units become differences of degree, making possible more complex statistical analysis.

Most of the data come from the state censuses of 1855, 1865 and 1875, with some data from the federal census of 1840. Birth rates are measured by fertility ratios (number of children under 5 per thousand women aged 15–44).[12] Density was calculated for each political unit, using area data published by the Bureau of the Census in 1940.[13] Heterogeneity was determined by the per cent of the population foreign born.[14] Per cent born in New York State and born in the county were also tried as measures of heterogeneity, but without as significant results. Other useful indexes of urbanization and industrialization which could be derived from the three state censuses were the value of the land and the average value of dwellings.[15] Value of land in the nineteenth century was ex-

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[11] Urbanism as a Way of Life, *American Journal of Sociology*, 1938, 44: 1.

[12] White population only was used for 1840, and the number of women aged 40–44 was estimated as half the number reported 40–49.

Fertility ratios undoubtedly vary through time in minor civil divisions because of changes in age composition. For rural townships the total population is usually under two thousand, and age changes in any one township are often substantial. However, these fluctuations in fertility ratios do not appear to affect the analysis when many townships are grouped together.

[13] AREAS OF THE UNITED STATES, 1940. Washington, G.P.O., 1942. Shifting political boundaries made necessary some estimation of areas, but the error is small.

[14] Actually in a study of fertility we reverse Wirth when we use per cent of foreign (or native) as a measure of heterogeneity. We expect birth rates to rise (not fall) with high percentages of foreign born.

[15] Value of land was calculated from the reported cash value of farms divided by the number of improved acres. Value of dwellings was also given, together with the number of units reporting; we converted these into averages. Each variable was recomputed for each census.

The statistical treatment involved transferring ratios and averages to punch cards with two columns for each variable. For example, fertility ratios were transformed by the formula $X = F.R. - 250/10$. After sorting, all machine work was done on the IBM 402. Rates reported are translations of averages arrived at from the two column sorts back to corresponding original rates.

pected to correlate with the nearness of cities and the availability of transportation for access to markets. Value of dwelling should be high where economic conditions are good or where there is pressure of population on available housing.

Data for fertility ratios and density are available for 1840 and for the three state censuses, but nativity, value of land and value of dwelling could not be computed for 1840.

III

When these townships are arranged in arrays for each variable, some interesting patterns emerge. The decline in the fertility ratio for the state from 666 in 1840 to 463 in 1875 is accompanied by a smaller deviation of townships from the mean. In this respect the state as a whole became more homogeneous.

Although the density of population for the state as a whole naturally increased during this period, there is relatively little change in the frequency distribution. The mode for density stays the same, but there are more townships filling in the long upper tail and the departure of some cities becomes extreme. Considered from the perspective of the frequency distribution, most of the population increase came in a small number of places where density became quite high.

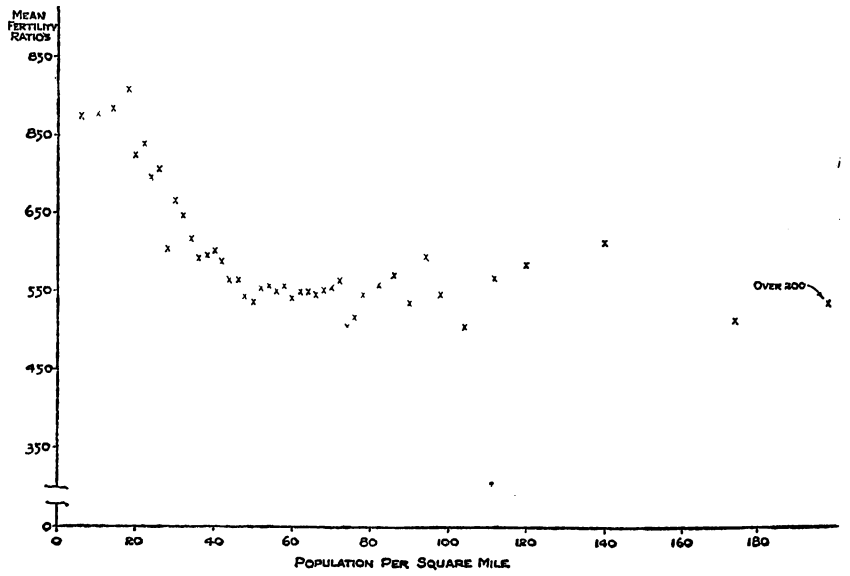
Changes in the distribution of townships by nativity are minor except in the reduction of very high percentages of foreign born in a few places in 1855. In 1875 no town had less than 55 per cent native, but in 1855 there were eighteen, with one having less than 30 per cent native (many of whom were probably native children of foreign parents).

In this twenty year period the average value of land in these townships naturally increased. The mode of distribution increased from $45 to $60 per acre, and there was greater deviation from the mode in 1875. Similarly the average value of dwellings increased in the three censuses, and the deviation increased substantially.

For a preliminary understanding of the relationship between

fertility ratios and the other variables, the cards are sorted for an independent variable (density, for example) and then a mean fertility ratio is derived for each level of density. (See Fig. 1 for a representative example.) Upon inspection, it is noted that mean fertility ratios are related to density, and inversely, as expected. Approximately the same results are obtained when the cards are sorted for value of land or value of dwellings. Nativity is only moderately related to fertility ratios and these tend to be lower in the towns that have the more native populations. The statistical treatment of these relationships involved difficulties, however. Most of them are curvilinear. More important, population data are often imperfect for correlation analysis in that the distributions are skewed.[16] So the interrelation of these various factors and their effect on birth rates was studied by analysis of variance. We are seeking

Fig. 1. Mean fertility ratios by density, 1855.



(Between ten and forty townships are represented in each of the means in Fig. 1. Below a density of 20 per square mile and above 80 there is some grouping to keep to the minimum for means.)

[16] See Hagood, Margaret J. and Price, Daniel O.: STATISTICS FOR SOCIOLOGISTS. New York, Henry Holt & Co., 1952, pp. 351–355.

to discover how much of the variance from the general mean can be allocated to each of the independent variables. Another way of stating this is, "Analysis of variance provides a procedure for testing the significance of the differences among a set of means in which every combination of means is considered simultaneously."[17]

In a series of tables two variables were used in combination, e.g., density and nativity; the cards were divided as evenly as possible into four groups for each variable, resulting in a sixteen cell table with means of fertility ratios. It was not possible to arrive at uniform numbers within cells, however, and it was not possible to continue the analysis of variance with a three-way sort. Instead, the analysis was attempted with various two-by-two combinations of the four variables.

IV

As we have defined urbanization for this study in terms of density, heterogeneity, value of land or value of dwellings, the analysis of variance indicates a very tight and significant relationship in each of the census years between the degree of urbanization and the level of the fertility ratio. Probably the most important combination of variables in influencing fertility means is population density and per cent of the population that is native. Tables 2, 3 and 4 provide the detail for 1855, 1865 and 1875, and they will be discussed in common because of similarities.

In these three similar tables the row totals at the right

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[17] Dornbush, Sanford M. and Schmid, Calvin F.: *A Primer of Social Statistics.* New York, McGraw-Hill Book Co., Inc., 1955, p. 223. The methods used were adapted from Wert, James E., Neidt, Charles O. and Ahmann, J. Stanley, *Statistical Methods in Educational and Psychological Research.* New York, Appleton-Century-Crofts, Inc., 1954. I should also credit an assist from my colleague, Dr. John A. Finger.

In interpreting the results when analysis of variance is used, due attention should be given to the fact that this method was developed for experimental situations. Its use in observational studies is still not fully explored; especially is this true for the distributions obtained in this study. Note the careful qualifications of Hagood and Price, *op. cit.,* (p. 382), but also note their hope that experimentation with the method will continue.

reveal differences in mean fertility ratios according to variations in per cent native. In all three, birth rates are lowest in the towns with the most native populations, and the differences between rows are not linear, or progressive. Thus, in Table 4 the means range downward (increasingly native) from 520 to 479, 466 and 459, with the greatest difference between 520 and 479. Note also that in 1855 (Table 2) the most native towns have birth rates a little higher than the two middling categories, a reflection of the curvilinear relationships seen above. Reading down the table, in each of the columns we can see that birth rates nearly always are lower for more native communities over a range of densities. For example in 1875

Table 2. Mean fertility ratios in 1855 by density and nativity.

Per Cent Born in U. S.	Population per Square Mile				
	0–37	38–49	50–69	70 and Over	Row Totals
0–80	843	689	600	572	631
n	30	20	37	107	194
81–87	671	595	542	534	575
n	43	37	70	62	212
88–93	677	547	527	517	573
n	71	79	66	42	258
94–100	631	575	552	570	587
n	72	80	58	10	220
Column Totals	684	579	550	551	590
n	216	216	231	221	884

Analysis of Variance*

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Density	3	26,326	31,881	10,627	117
Nativity	3	4,547	10,102	3,367	37.2
Interaction	9	11,038	5,483	609	6.72
Within	868	78,689		90.6	
Total	883	120,600			

$F^{.01}_{8-1000} = 3.80$ $F^{.01}_{9-1000} = 2.43$

* Computations for analysis of variance were done in punch-card units. (See Footnote 16). Authorities differ on the proper denominator for F ratios. Here we follow McNemar, Quinn: Psychological Statistics. New York, John Wiley & Sons, Inc., 1955, p. 306.

Per Cent Born in U. S.	Population per Square Mile				
	0–37	38–49	50–69	70 and Over	Row Totals
0–82	717	622	578	535	584
n	35	25	44	110	214
83–88	598	500	500	489	517
n	44	46	65	63	218
89–93	555	481	480	439	493
n	59	61	58	41	219
94–99	498	462	448	489	474
n	88	104	47	17	256
Column Totals	566	491	499	502	515
n	226	236	214	231	907

Analysis of Variance

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Density	3	8,159	14,016	4,672	56.6
Nativity	3	15,572	21,429	7,143	86.6
Interaction	9	9,403	3,546	394.0	4.78
Within	891	73,499		82.5	
Total	906	106,633			

Table 3. Mean fertility ratios in 1865 by density and nativity.

(Table 4) birth rates drop from 667 to 551, 526 and 491 in towns of lowest density (column 1) and from 511 to 468, 450 and 443 in towns of above average density (column 3). In each year, however, in the towns of greatest density (column 4) birth rates rise in the most native communities. In general, though, at given levels of density there are differences in fertility ratios with differences in nativity.

Similarly, the column totals show a lower birth rate in towns with greater density, though not uniformly. Reading across the tables we can see birth rates become lower as density is greater whether nativity is high or low.[18]

[18] In passing it should be noted that most of these density levels are not high. The middle of the table comes at a density of 50 persons per square mile; so, many of these townships in column 3 are merely fully settled agricultural regions with a sprinkling of villages. Many of the cities have densities in hundreds per square mile, and New York had more than 28,000 per square mile in 1855 and over 47,000 in 1875. These, of course, are included in the fourth column of the table. In cor-

(continued on page 172)

Per Cent Born in U. S.	Population per Square Mile				
	0–37	38–49	50–73	74 and Over	Row Totals
0–82	667	543	511	479	520
n	30	36	54	113	233
83–88	551	464	468	448	479
n	50	50	76	66	242
89–93	526	438	450	412	466
n	69	57	61	31	218
94–99	491	440	443	436	459
n	85	90	38	14	232
Column Totals	537	460	469	458	481
n	234	238	229	224	925

Analysis of Variance

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Density	3	9,792	15,435	5,145	71.3
Nativity	3	5,302	10,945	3,648	50.5
Interaction	9	7,565	1,922	214	2.96
Within	909	65,589		72.2	
Total	924	88,248			

Table 4. Mean fertility ratios in 1875 by density and nativity.

The advantage of analysis of variance is that we do not have to follow each row or each column in order to discover whether density or nativity is significantly related to differences in fertility. Nor do we have to apply a test of significance to the differences between pairs of means in these tables. The analysis of variance makes one test appropriate to discover the significance of density, or nativity, in the whole table, and their interaction.[19]

The null hypothesis may be stated in the following manner, "The means of fertility ratios do not vary in towns of different density of population." Clearly the F ratios show that this can be rejected as they are far above 3.80 required at the one per

relation analysis most of the incorporated cities would have to be thrown out of the density table; the alternative would be an excessive weight for them because of extreme skewness.

[19] Because of the differences of numbers in the cells, the means had to be adjusted, the results of which are given at the bottom of each table.

cent level. Then, one can substitute nativity for density in the null hypothesis, and the same conclusions apply.

Since interaction is the lack of consistency in the variation of means in the sixteen cells of the table with the marginal means (or with each other), the null hypothesis for interaction is stated as, "The means of fertility ratios for different percentages of nativity vary consistently in different degrees of density." Or, "The means of fertility ratios for different degrees of density vary consistently in different percentages of nativity." In all three tables this hypothesis is also rejected since interaction has an F ratio above 2.43 required at the one per cent level. One illustration is the fact that fertility ratios drop more rapidly in areas of low density than in areas of high density. When interaction is present, we must be on guard in our interpretation of the main effects.

Instead of stating the null hypothesis in this negative manner and then rejecting it, one can state the positive hypothesis, more meaningful for many readers. With significant F ratios, we can say that fertility ratios in townships and cities are significantly different when the per cent of the population which is native varies. Inspection of the table shows that the more native towns have the lower fertility ratios. However, we should recognize that no statistical test of linearity has been applied here. Similarly, fertility ratios vary with differences in the density of population. It is also true that in low density areas birth rates decrease with changes in per cent native, and the same statement can be made about high density areas. Fertility ratios are related to differences in density, and to differences in nativity, and there is a lack of consistency in the variations of the means.

In comparing city and non-city fertility ratios (p. 4), the influence of higher birth rates of immigrants on city rates was noted. With this analysis of variance, it becomes clear that while birth rates of foreign born are higher than those of natives, both birth rates are also affected by density. If we could separate fertility ratios by nativity, it seems quite clear that

Per Cent Born in U. S.	Cash Value of Farms per Improved Acre				
	0–$53	$54–$71	$72–$95	$96 and Over	Row Totals
0–82	648	547	473	485	521
n	42	33	51	103	229
83–88	532	486	468	451	479
n	44	56	70	72	242
89–93	519	458	439	437	466
n	60	58	56	44	218
94–99	489	446	434	413	459
n	86	91	43	10	230
Column Totals	534	473	455	462	481
n	232	238	220	229	919

Analysis of Variance

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Value of Land	3	8,869	12,756	4,252	57.1
Nativity	3	5,381	9,268	3,089	41.5
Interaction	9	6,432	2,545	282.8	3.80
Within	903	67,303		74.5	
Total	918	87,985			

Table 5. Mean fertility ratios in 1875 by value of land and nativity.

foreign born as well as native born have the lowest birth rates in the most urbanized (greatest density) communities.

The analysis of variance in Tables 2, 3 and 4 is illustrative of a cross section analysis which stands up in most any two-by-two combination of these variables. Among many analyses carried out we can select one combining value of land and nativity for 1875 (See Table 5), and a very similar pattern emerges. Fertility ratios are lower in the more native communities (reading down the row totals 521, 479, 466 and 459) and they are also lower in communities with high land values (534, 473, 455, 462). The higher rate for this last column can be traced back to a difference in the top row (lowest nativity) where fertility ratios rise again in communities of highest land value. In the other three nativity rows the direction of change is consistent. Here again the F ratios for both value of land and nativity are significant and interaction is also significant.

It may be argued that density and value of land must be so closely related as to mean practically the same thing. Indeed, they were selected as being different indexes of urbanization and industrialization, but they were recognized as being imperfect measures in the sense that they were not analytically defined by the census takers for these purposes. What is more, they are derived by different methods; value of land represents the sum of cash value of farms divided by the number of improved acres in a township or city. Some communities have little farm land left; some have great areas of unimproved land. Nonetheless, when value of land is plotted against density, a clear relationship emerges, which increases from 1855 to 1875 but is not a perfect correlation.

A better way to discover the extent to which fertility ratios

Table 6. Mean fertility ratios in 1875 by density and value of land.

Cash Value of Farms per Improved Acre	Population per Square Mile				
	0–37	38–49	50–73	74 and Over	Row Totals
0–$53	549	497	529	483	534
n	153	57	19	3	232
$54–$71	507	455	464	497	473
n	61	107	57	13	238
$72–$95	543	445	459	442	455
n	12	55	90	63	220
$96 and Over	526	411	470	460	462
n	8	17	63	141	229
Column Totals	537	460	469	458	481
n	234	236	229	220	919

Analysis of Variance*

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Density	3	9,837	3,398	1,133	13.7
Value of Land	3	8,868	2,429	809.7	9.77
Interaction	9	−5,568	871	96.78	1.17
Within	903	74,848		82.9	
Total	918	87,985			

* A negative sums of squares seems impossible, but it is arithmetically possible with the methods used. Note that the negative sums of squares for interaction disappears in the adjusting of means for unequal n's in the cells.

are affected by density and value of land is to arrange an analysis of variance for these two variables in combination as in Table 6. In this new combination the row and column totals are the same as in Tables 4 and 5, but the means in the sixteen cells are different. Fertility ratios are lower in communities of greater density and of higher land value, but the extent to which the general pattern is followed in each row or each column is less than in previous tables. The degree of relationship between the two variables is also revealed in the lumping of n's at the corners of the table and within rows and columns. Yet the analysis of variance proves that fertility is significantly affected by density and by value of land. Each is an appropriate variable to study differences in birth rates, even in combination. The F ratio for interaction, however, falls below the five per cent level. In such cases the table could be reworked putting sums of squares for interaction back into

Table 7. Mean fertility ratios in 1865 by value of land and value of dwellings.

Average Value of Dwellings	Cash Value of Farms per Improved Acre				
	0–$41	$42–$56	$57–$77	$78 and Over	Row Totals
0–$419	580	554	596	684	577
n	118	66	18	7	209
$420–$579	486	482	501	541	495
n	36	74	57	21	188
$580–$819	515	459	464	514	479
n	14	47	84	51	196
$820 and Over	430	494	448	487	477
n	2	14	46	122	184
Column Totals	553	501	482	507	509
n	170	201	205	201	777

Analysis of Variance

	DOF	Sums of Squares		Mean Squares	F Ratios
		Unadjusted	Adjusted		
Value of Land	3	4,963	2,316	772	9.09
Value of Dwellings	3	13,559	10,912	3,637	42.9
Interaction	9	−1,335	1,312	145.8	1.72
Within	761	64,587		84.9	
Total	776	82,044			

Within variance. This has not been done because 871 added to *Within* would not change the results significantly.

The fourth variable, average value of dwellings, also shows up as being significant when combined with nativity. These tables are not reproduced here as they are so much like the other ones. To reduce repetition and to increase comparisons, average value of dwellings is combined with value of land in Table 7 for 1865. A correlation coefficient of .61 was found for these two variables for 1855. Yet, in Table 7 each is seen to have a significant relationship to variations in fertility, and separately. Interaction, however, is not significant.

Thus far it appears that if we define urbanization by the variables of density, value of land, and value of dwellings it is definitely related to the level of the birth rate, and this relationship is always inverse. The larger the proportion of foreign born, the higher is the birth rate; so city birth rates were probably higher than they otherwise would have been.

V

As against this cross section analysis, what do we expect over time? It depends upon what stage we conceive New York to have reached by 1840. One hypothesis is that communities of high density in the early period should undergo the greatest drop in birth rates. Almost the opposite is that communities of high density, say in 1840, had already passed through a period of falling birth rates, and in the period after 1840 the greatest change should appear in communities of low density, or of changing density. Consistent with the latter is the fact noted by Grabill, Kiser, and Whelpton that "after 1810 the decline in fertility ratios of the rural population more than kept pace with those of the urban population."[20]

A rigorous horizontal analysis is not possible because of changes in political boundaries. New townships are created from old ones in areas of newer settlement, and cities are carved

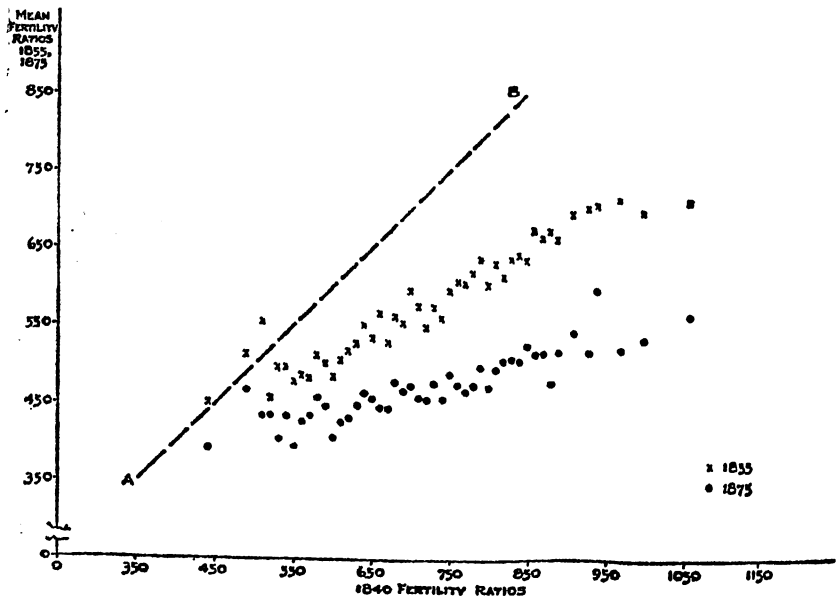
[20] *Op. cit.*, p. 16.

out of townships as they grow and become incorporated. If we excluded all towns with changing boundaries or areas, we would not have a true representation of the state. It is precisely the growing areas we are interested in, not the static ones alone. However, let us see what horizontal analysis can reveal.

First, we take all townships and cities for which we have fertility ratios in 1840, 1855, and 1875, sort them by 1840 fertility, and derive means of 1855 and 1875 fertility. The result is Fig. 2. If no change had occurred, then all means would have fallen on line A B; but 1855 fertility ratios were lower than those of 1840, and 1875 ratios were lower still. In addition the greatest change occurs where 1840 fertility was highest. One could almost find a point in the lower left of the figure around which these lines are turning.

Changing density is another way to approach this problem. We can divide the cards at the median density for 1840 and for

Fig. 2. Mean fertility ratios in 1855 and 1875 by 1840 fertility ratios.



(At least ten townships are in each mean. The bulk of townships in 1840 fall between 500 and 900 in fertility ratios; above and below these levels, townships have been grouped to maintain the minimum number in each mean.)

1875 and compute birth rates for 1840, 1855 and 1875 for each of the four cells (See Table 8). There were 349 townships in the lower half of the density ranges in both censuses; mean fertility ratios in these low-low communities declined from 762 to 497, a ratio of 100 to 49. Ninety-five communities changed from low density to high density, and their fertility ratios dropped from 769 to 483, a ratio of 100 to 45. Another 85 towns dropped from high to low density, and fertility ratios there dropped even more, from 675 to 408 (100 to 38). Finally 287 townships and cities were in the high-high group with a change in birth rates in these thirty-five years about the same in proportion as in the low-low group; the decline was from 653 to 446, or 100 to 49. By 1875 there were 125 political subdivisions not present in 1840. Of these 76 were of low density with fertility ratios averaging 577, a high for this table in 1875; 49 were in the high density group with fertility at 484.

Certainly there is some confirmation here of the proposition that communities of high density in 1840 had already passed through a period of falling birth rates. Low density areas in 1840 had higher birth rates and farther to fall, and they did fall rapidly, although in communities that stayed in the same density levels (low-low and high-high) the rate of change was about the same. An increase in density results in a greater de-

Table 8. Change of fertility by change of density, 1840–1875.

1840 Density	Low Density Mean Fertility Ratios			High Density Mean Fertility Ratios			Row Totals Mean Fertility Ratios		
	1840	1855	1875 n	1840	1855	1875 n	1840	1855	1875
Low Density	762	625	497 349	769	612	483 95	763	622	494
High Density	675	505	408 85	653	531	446 287	658	525	438
Column Totals	743	595	480	681	551	456			
New Towns, 1875			577 76			484 49			

1875 density.

crease in fertility, but the consequence of a decrease in density is the sharpest drop of the four. This is hard to interpret. Some towns lost population; in which case, if migration is selective by age, the fertility ratios could fall. There is reason to believe that most of these townships decreased in density because of incorporation of the more dense parts into new units, but the fertility ratio of 408 for these towns is well below the 577 and 484 for new units in 1875.

VI

We can return now to the questions raised in the introduction about the relation between the transition theory of the demographer and sociological theory. As one aspect of this we have examined urbanization and industrialization in New York State in the middle of the nineteenth century. By taking nine hundred minor civil divisions in the state, and by considering census variables as indicating different degrees of urbanization and industrialization, we have been able to complicate somewhat the usual urban-rural differentiations. In the statistical results we see density, per cent native, value of land, and value of dwellings as being significantly related to differences in the levels of fertility ratios in 1855, 1865 and 1875; any combination of these variables reveals the same general patterns. If these variables are indexes of urbanization, then fertility differences vary with degrees of urbanization.

Also some time studies showed birth rates in cities as falling more slowly than in rural areas (Table 1); but when birth rates are studied in relation to changing densities (Table 8), the differences are moderate. There is support for the hypothesis that urban rates fell earlier than 1840 (or even 1810), and that rural rates are following them in the period to 1875. Yet there is also support for the hypothesis that the rate of change in birth rates is fairly uniform throughout the state in spite of the fact that differentials exist at each census.

How, then, do we account for the fairly constant reduction in rural rates over such a long period. In the article cited

earlier, Kurt Mayer points out that rural birth rates were falling when there were few really urban centers in the nation. He sees the agricultural revolution as being important, and the industrial revolution as being significant nationally only after 1840. But why did American farm families adapt so rapidly to changing agricultural technology? Why did they accept the technology when other cultures are so resistant?

If we are to place transition theory more solidly into sociological theory (in our own history) perhaps it is time to reach beyond structural features into value theory. This does not mean that studies of urbanization are unimportant (they certainly are important if the data in this study are any test); rather it means that we should study more the culture within which a particular kind of urbanism emerged. Then we might find that changes in urban and in rural birth rates, rather than being responses to different cultural values, are differential responses to the same ones. This, of course, is another paper, but the implications for research can be suggested.

In his paper for the 1961 International Population Conference, Ronald Freedman argued that demographers at first failed to understand the baby-boom because of "a theoretical bias shared with sociologists" on the nature of urbanism.[21] One way to correct this bias has been suggested by William L. Kolb. His position was that urban sociology in the United States was culture-bound, that to understand our own history (not to mention the history of other societies) we have to recognize the dominant value orientation in a culture which permitted (or assisted) the growth of cities as we know them.[22]

Thus we could search for clues to the early decline in rural birth rates in the value orientation of these populations. In much of nineteenth century New York State, this leads back to New England. As others have done, Ralph Barton Perry claimed that the mentalities of puritan protestantism and eco-

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[21] "American Studies of Factors Affecting Fertility." (Mimeograph).

[22] The Structure and Social Functions of Cities, *Economic Development and Cultural Change*, (1954), 3: 30–46.

nomic capitalism were "congenial."[23] We might discover that a small family system was adopted along with the agricultural and the industrial revolution, because it was congenial with a preexisting mentality, a value orientation embedded in the culture.

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[23] PURITANISM AND DEMOCRACY. New York, The Vanguard Press, 1944.