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Author(s): T. Paul Schultz
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Changing World Prices, Women's Wages, and the Fertility Transition: Sweden, 1860–1910

T. Paul Schultz

Yale University

This paper identifies demand-induced changes in the price of women's time as a factor determining the fertility transition. Changes in world prices of grains and animal products in the 1880s affected the composition of Swedish output and labor demands. The increase in the price of butter relative to grains improved women's wages relative to men's and contributed thereby to the decline in fertility. When child mortality, urbanization, and the real wages of men are held constant, aggregate county-level data for a 50-year period, 1860–1910, suggest that this exogenous appreciation in the value of women's time relative to men's explains a quarter of the concurrent decline in Swedish fertility.

Economic explanations for the historical fertility decline in the West generally assume that the price of children has increased relative to other goods and that, in the view of parents, some of these other goods substitute for having many children. Moreover, this substitution by parents away from a large family because of the price change must be sufficiently strong to offset the tendency conjectured by Adam Smith (1776) and Thomas Malthus (1798) for fertility, or at least a woman's surviving offspring, to increase with real wages and rising standards of living. To argue that a change in the relative price of children has "explained" the secular trend in fertility, the price

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change must come from outside the family or household sector; namely, it must be exogenous to parents and be independent of their preferences and behavior.[1] To give this economic interpretation more content, a market-dictated change in price must be specified that is reasonably linked to the rising price of children and to the consequent fertility transition.

It is widely conjectured that an important element in the rising opportunity cost of children is the market value of women's time relative both to market goods and services and to the market value of men's time (Becker 1960; Mincer 1963). Most empirical evidence assembled in support of the hypothesis that the rising value of women's wage opportunities contributes to the secular decline in fertility is based on cross-sectional correlations, where women's wage opportunities are either proxied at the individual level by women's education or measured at the aggregate level by the regional wage rate, holding constant in both cases men's wages, income, or education and a variety of other possible fertility determinants, such as the level of child mortality (Knodel 1979; Schultz 1981). In the first case, there are many noneconomic interpretations for the cross-sectional association between women's education and their fertility, and a deeper analysis is called for to indicate whether this association is predominantly a reflection of economic attributes of more educated consumers and producers. In the second case, the aggregate wage received by working women is influenced by the number and type of women seeking work and their conditions of work. Women's wages may be depressed (elevated) by their increased (decreased) aggregate labor supply and net migration, as well as by their selective characteristics.[2] If women

[1] Consequently, it is not possible to draw cause and effect inferences from the observation that parents who have fewer children also do other things, such as invest more resources in the education of each child; nor is it possible to say that their values regarding children are different. Both fertility and these other responses may be independently or jointly affected by an exogenous third factor, and thus the correlation between these family responses may not be observed in other circumstances.

[2] For example, women's wages may be relatively high in an area because the area's natural resources and the prices for its output favor the employment of a relatively large number of female workers in, e.g., dairying, food processing, or textile manufacturing. These resources and relative prices would represent the derived *demand* side of the labor market, and their change over time could be attributable to technological change, institutional evolution, discovery of new resources, and possibly long-run climatic change. Alternatively, women's wages could be relatively high as a consequence of other factors that induced relatively few women to participate in the market labor force or that encouraged a predominantly female emigration from the region. These labor *supply* effects could provide a second explanation for why working women would receive relatively high wages. Alternatively, where women participate in the labor force more frequently and steadily over their life cycle, they accumulate labor market experiences that are more similar to those of men, and consequently women's wages rise relative to men's. In either case, the endogenous shifts in labor supply should be

enter jobs where investment in market skills and on-the-job training becomes important, their observed wages over their employment (life) cycle may deviate systematically from a static concept of marginal productivity, or the average opportunity value of all women's time may differ from the wage accepted by working women (Smith and Ward 1985).

To distinguish between the supply and demand determinants of wage rates, information is needed on a force outside the local economy and society that autonomously causes relative prices or technological possibilities to change in a quantifiable manner, thereby affecting only the aggregate derived demand for female labor relative to that for male labor. Any ensuing variation in relative wages for women and men thus identified may then be treated as demand induced and independent of labor supply behavior. The crux of the economic demand hypothesis is that the output-price-driven changes in the structure of production explain women's historically changing economic and domestic roles, with fertility adapting to these economically modified opportunities.[3] As an alternative explanation, the fertility transition may be seen as a series of changes in individual supply behavior induced by changes in culture (Coale 1973; Mosk 1983) or by the secularization of society (Lockridge 1983), changes that simultaneously alter reproductive goals and encourage women to engage in lifetime labor market commitments, with the incidental on-the-job training effect of raising the market wages of women relative to men. This paper argues that exogenous international price changes promoted change in fertility and women's labor market roles in Sweden, and these accurately monitored inducements for the composition of output and labor demands to change can be confidently treated as exogenous to the Swedish society. If the empirical case for Sweden is

somehow netted out of wage changes if one is to obtain a satisfactory test of the economic explanation of the fertility transition, which posits that exogenous shifts in demand cause the rising value of women's time relative to men's.

[3] Snell (1981) describes gradual changes in women's roles in England in the eighteenth century as induced by shifts in the relative prices of dairy products vs. food grains (similar to the shifts to be described below), with repercussions on marriage patterns and possibly fertility. "The historical determinants of women's economic and domestic roles would appear to be located primarily in the seemingly autonomous changes in the structure of the economy, rather than in shifts of social attitudes" (p. 436). Men and women were of course both employed in the production of food grains and dairy products, but they are assumed to be imperfect substitutes for each other and women are hypothesized to exhibit a comparative advantage in dairying. Child labor may also be a close substitute for female labor in some productive activities. Coincident movements in wages of women and children might then weaken the inverse relationship anticipated here between women's wages and fertility since higher child wages would presumably encourage larger families. Unfortunately, I have not found any wage series for children in Sweden to explore these issues, which were suggested by Peter Lindert.

persuasive, that this price development contributed to the onset of the fertility transition, it may help to explain the common timing of the fertility transition in many other northern European countries that confronted similar problems of domestic economic adjustment to the same shift in world agricultural prices in the latter half of the nineteenth century (e.g., Ankarloo 1979; Matthiessen 1983).

The Economic and Demographic Setting

From about 1750 to 1850 the price of grains in Europe increased relative to agricultural wages (Slicher van Bath 1963). This development encouraged the extension of cultivated areas, investment in agricultural infrastructure, consolidation of landholdings, and technological change in Sweden (Thomas 1941) as it did elsewhere in Europe. For example, the real wage paid to men for day labor during the summer harvest season stagnated from 1732 to about 1850 in Sweden (App. table A1). From 1851–55 to 1876–80 freer trade in agricultural goods contributed to a fourfold increase in Swedish grain exports, with oats accounting for 90 percent of these exports by the end of the period (Fridlizius 1957, table 13). But with the European grain crisis of the 1880s, Swedish grain exports collapsed and were only one-tenth their former level by 1900, while butter exports increased fourfold, replacing grains as a proportion of total exports (Fridlizius 1957, table 64). This redeployment of agricultural resources was induced largely by the decline in the world price of grains relative to the price of butter and other animal products. Protection measures adopted by Sweden did not insulate the domestic economy from this price shock. In the 1860s and 1870s more than half of Sweden's national income from agriculture was generated by the production of crops rather than livestock or dairying, whereas the share of crops had fallen to 30 percent by 1906–10 (Thomas 1941, table 22). The primary cause for the realignment in world relative prices was the opening up of fertile new lands in the midwestern United States and the Russian steppes, combined with the declining cost of transportation from these regions to European markets.

Technological change reinforced these pressures of world relative prices to encourage the reallocation of production from grain to animal husbandry. Improvements in livestock breeding facilitated a doubling of milk yields per cow and increased butterfat percentages in the last quarter of the century (Lindahl, Dahlgren, and Kock 1937). The efficiency with which milk was processed into butter and cheese also increased, through the improvement in separator technology pioneered in Lund. Refrigerated transportation also widened the market for Sweden's dairy and animal products.

Dairying and milk processing were "women's work" in Sweden, as they often are in other societies (Snell 1981). The production of grains and root crops, on the other hand, placed greater demands on male labor, and integrated beef and pork production probably also employed mainly male labor. The hypothesis tested later in this paper is that price movements that raised the profitability of butter production relative to grain production should have been associated with improvements in women's agricultural wages relative to men's, other things being equal.

At the other extreme of the employment continuum, forestry and sawmills hired almost exclusively male workers.[4] Although data are scarce on employment in this sector, Swedish output grew rapidly in the latter half of the century. By 1861–65, exports of boards and planks had equaled in value Sweden's traditional exports of iron and thereafter increased fourfold before subsiding at the turn of the century. With high wages but few jobs for women, the nothern tier of counties that relied heavily on forestry may have resembled isolated mining communities, which have been shown to exhibit unusually high levels of fertility in Europe and America (Haines 1979).

In the industrial labor force women were concentrated in textiles and food processing. The 1920 census, the first to distinguish the industrial distribution of the labor force by sex, reported that three-fourths of the women employed in industry worked in these two sectors, which accounted for 28 percent of the entire industrial labor force.[5] Wage series in these two sectors show that women's wages were between 60 and 67 percent of those received by males. By contrast, day agricultural wages for women were as low as 50 percent of male wages in 1870–74 (see table 1), when oats exports were still expanding, but they had increased to 61 percent of male wage levels by the start of World War I. Annual cash contracts for labor, referred to as agricultural servants, experienced an even sharper rise of one-half in the wage level for women relative to men; female servant cash wages were 42 percent of male servant wages in 1870–74 but had reached 63 percent of male levels by 1910–14 (table 1). Given the greater need for year-round labor to tend livestock and perform dairy functions, it is also not surprising to note that the premium paid for casual day

[4] According to the 1920 census, women represented only 1 percent of the industrial workers in lumbering (Thomas 1941, table 43).

[5] In the 1920 census, women accounted for 31 percent of the industrial labor force in food processing, while their share in textiles was 76 percent (Thomas 1941, table 43). Wages for women relative to men did not change notably in textiles from the start of the series in 1865 to 1914. In food products women's hourly wage increased from 60 percent of male levels in 1890 to 65 percent in 1914 (Bagge, Lundberg, and Svennilson 1933, vol. 1, table 18).

TABLE 1

DEMOGRAPHIC INDICATORS, RELATIVE PRICES, AND WAGES: SWEDEN, 1850–1920

YEARS	TOTAL FERTILITY RATE*	CHILD MORTALITY RATE†	MARITAL FERTILITY RATE‡	PROPORTION MARRIED§	PROPORTION OF POPULATION URBAN‖	PRICE INDEX:# 1860 = 100 Butter to Rye	Pork to Rye	Summer Male Day Wage to Rye	FEMALE TO MALE DAY WAGE**	FEMALE TO MALE SERVANT WAGE††
1850–54	4,273	N.A.	8,703	.491	.101	85	88	72	N.A.	N.A
1860–64	4,582	.252	9,021	.508	.113	100	100	100	55.2	44.3
1870–74	4,488	.207	9,000	.499	.129	110	105	109	49.5	42.0
1880–84	4,341	.232	8,835	.491	.151	126	112	117	54.2	43.2
1890–94	4,094	.200	8,364	.489	.188	143	124	152	58.9	49.4
1900–1904	3,906	.179	7,794	.501	.215	154	139	195	59.3	54.5
1910–14	3,311	.120	6,693	.495	.252	143	137	220	60.9	63.0
1920–24	2,577	.101	5,279	.494	.296	N.A.	N.A.	N.A.	63.3	66.8

NOTE.—N.A. = not available.

* The total fertility rate is the sum of the seven female age-specific birthrates (15–19, etc.) times 5 (years), and it is lagged 1 year, i.e., 1851–55, etc. (Hofsten and Lundström 1976, tables 2.2, 6.2–6.7).

† Child mortality from birth to age 10 is calculated around 1861, 1871, etc., as the product of county survival rates: $CMR = 1 - (1 - {}_1m_0)(1 - {}_4m_1)^4(1 - {}_9m_5)^5$ (Hofsten and Lundström 1976, tables 7.1–7.7).

‡ Number of legitimate live births per thousand married women aged 15–44, times 30, to give it a similar dimension to the total fertility rate (Hofsten and Lundström 1976, tables 2.3, 6.17).

§ Crude indicator of proportion of women 15–44 married, defined as the total fertility rate divided by the marital fertility rate. The illegitimate birthrate per unmarried woman in this period varied little from 38 to 41 per thousand per year (Hofsten and Lundström 1976, table 6.19).

‖ Urban proportion of the population is that which is in towns at start of period, from Statistika Centralbyran (1955, vol. 1, tables A.5, A.7).

Relative price indexes from Jorberg (1972), vol. 1, app., pp. 222–29. Unweighted average of country reports for the whole country.

** Wages of day workers in agriculture averaged for summer and winter seasons. Annual summaries of agricultural statistics series from Bagge et al. (1933) for national total, vol. 2, table 170. The first available years are 1865–69 (vol. 2, app., tables 205, 207 for counties).

†† Cash wages of agricultural servant annual employees. Annual summaries from Bagge et al. (1933) for national total, vol. 2, table 170. The first available years are 1865–69.

labor during the summer grain harvest diminished relative to the wages paid to day labor during the winter season.[6] All of these developments in the structure of wages in agriculture mirror the increased opportunity value of women's time, particularly in year-round employment associated with dairying.

Technical rationalization and mechanization of Swedish agriculture after 1850 reduced the demand for tenants, servants, day laborers, and other categories of hired help. But the movement of landless workers from agriculture to the cities and, after 1860, the upsurge in emigration, mainly to the United States, also reduced the supply of agricultural labor. Wages of male day labor deflated by the price of the principal food grain, rye, doubled from 1870 to 1914, while cash wages of male servants increased even more rapidly (Bagge et al. 1933; Jorberg 1972). The Swedish population had managed to adapt to the dislocating effects of the changing relative values the world economy attached to its exports of grains and animal products, principally butter. This adjustment in the mix of agricultural production occurred at a time of large-scale emigration and of increasing urbanization and industrialization (Karlstrom 1980; Mosher 1980). How did these different but intertwined developments affect the level of fertility in Sweden?

The data analyzed to consider this question relate to the 25 counties of Sweden and the city of Stockholm for six decadal cross sections from 1860–64 to 1910–14 (see fig. 1). National demographic price and wage series are summarized in table 1. In this half century the Swedish total fertility rate decreased by 28 percent after increasing somewhat in the 1860s and 1870s. Cohort data constructed for women born between 1840 and 1890 indicate that cumulative fertility decreased by 43 percent across these birth cohorts (Hofsten and Lundström 1976, table 2.2). Mortality among children up to age 10 continued its secular decline, falling in this 50-year period by 52 percent, though not without increasing as in 1880–84. The marital fertility rate followed much the same path as the total fertility rate, declining by 26 percent from 1860 to 1910. Thus dramatic changes in marriage patterns were apparently not responsible for the noted national trends in total fertility rates, although beneath the national figures regional changes in marriage patterns may have responded to different economic and demographic conditions.

The objective of the empirical analysis is to test three hypotheses: (1) Do changing local prices of basic traded agricultural commodities help to explain the cross-sectional variation and temporal changes in

[6] The summer day wage for males was 53 percent more than the winter day wage in 1870 but only 34 percent greater by 1915 (Bagge et al. 1933, vol. 1).

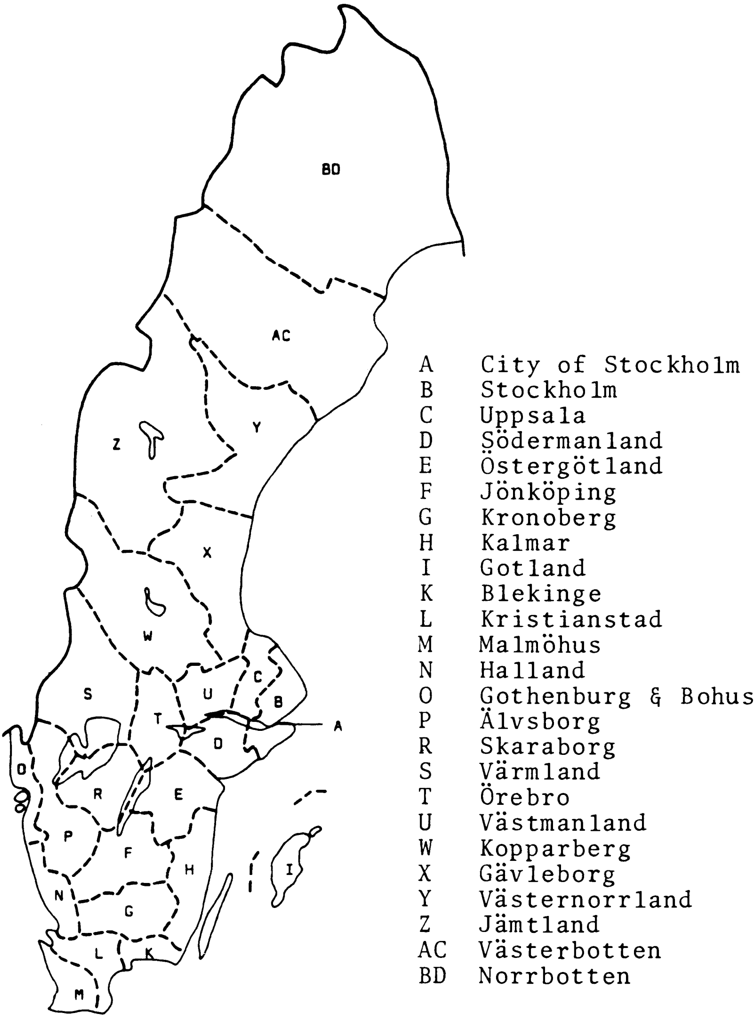

Fig. 1.—Division of Sweden into counties (source: Hofsten and Lundström 1976, fig. 6.1).

male and female wages in Sweden? (2) Do women's and men's wages exhibit the anticipated association with total and age-specific fertility rates, controlling for child mortality, urbanization, and the rising general standard of living? (3) Given the likelihood that factors other than shifts in the demand for labor influenced the observed wages of men and women in agriculture (i.e., supply responses via migration, differential female labor force participation, cumulative labor market experience), do time-series variations in commodity prices, plus the smaller interregional variations in prices, provide a satisfactory instrument to estimate without simultaneous equation bias the demand determinants of fertility operating through male and female wages? This final step in the analysis is a severe, but nonetheless appropriate, test of the gist of the demand hypothesis, which assigns importance to exogenous variation in market prices and thereby to changes in sex-specific wage rates in governing the historical fertility decline in the West. More specifically, the study seeks to answer the question whether the identified demand-induced increase in women's wages relative to men's is a quantitatively important factor explaining the decrease in Swedish total fertility rates.

Empirical Results

The regressions in table 2 report the linear ordinary least squares (OLS) relationships between three groups of conditioning variables and three dependent variables: (1) the total fertility rate, (2) the wage rate for male agricultural day labor, and (3) the female agricultural wage rate relative to the male. The first set of regressions includes as explanatory variables only the relative price of the main categories of agricultural outputs: the price of butter relative to rye, the price of pork relative to rye, and a dummy variable equal to one when the pork price is not locally reported as a basis for settling tax obligations in the county.[7] A higher relative price of butter is associated with a higher male wage level, a higher female-to-male wage ratio, and a lower fertility rate, as hypothesized. Pork prices relative to rye are associated with higher male wages, lower female to male wages, and

[7] Seven of the 25 counties did not report pork prices throughout the period 1860–1910. These counties were regionally grouped in the north (AC, W, Y) and the south (K, L, M, N) (see fig. 1). The dummy variable for these regions denotes the irrelevance of pork prices to production in regions where pork is economically unimportant. One county also does not report butter or rye prices in this period (K, or Blekinge) for no obvious reason; perhaps the historical records of the government tax settlement prices were destroyed. Regardless, the price of butter relative to rye for this coastal county is "imputed" as an unweighted average of those reported by the neighboring counties of Kristianstad and Kalmar. These relative price series are 5-year averages from Jorberg (1972, 2:357–72). The addition of other grain prices, such as for oats, barley, and wheat, added little explanatory power since all grain prices are highly correlated. Adding other price series for, e.g, beef, cows, and pinewood did not appear to change the relationships noted here but required the estimation of additional, more inclusive dummy variables for counties with missing price variables. Butter and rye are the most universally reported prices. Virtually all price series tend to vary less across counties during the last half of the nineteenth century as transportation improved and local markets became more integrated. For example, the cross-county coefficient of variation for the price of rye decreased from .12 in 1860–64 to .07 in 1910–14, butter from .08 to .06, pork from .19 to .15, and male day wages in agriculture from .24 to .16 (Jorberg 1972, 2:222–29).

higher fertility. The same pattern holds for those regions in the south and north where the production of pork is sufficiently uncommon that pork is not an accepted basis for settling government tax obligations.

The second set of regressions adds as explanatory variables the earliest data on the location of employment opportunities outside of agriculture that might have had an effect on both the overall level of wages and the ratio of female wages to male wages. As we noted earlier, women were disproportionately employed in textiles and food processing, and both industries were geographically concentrated in a few counties.[8] Specifically, the percentage of a county's labor force in textiles and food processing in 1896 and the percentage in forestry in 1910 are the variables added to the second set of regressions in table 2. As anticipated, forestry bids up the level of male agricultural wages, depresses female-to-male wage ratios, and is associated with higher overall fertility. Industries with predominantly female employment are associated with higher female relative wages and lower fertility, but these industries are not statistically significantly related to male wage levels.

The final set of regressions in table 2 adds the urban proportion of the population and the child mortality rate from birth through age 10. As with the location of textile and food processing industries, it might be argued that urbanization is facilitated by the geographic distribution of industrial investment and of investment opportunities in agriculture, which should themselves respond to the local level and structure of wages. It is common to regard such a lagged feedback response of urbanization and industrialization to the wage structure as of secondary importance compared with the direct effect of urbanization and industrialization as determinants of wage and price levels.[9]

[8] Textiles were concentrated in counties M, O, P, A, and E and food processing in A, O, and M (see fig. 1 and Thomas et al. 1941). The location of rivers as a source of power is attributed a role in the placement of textile factories in this period and may therefore have been independent of the local conditions of labor supply (Heckscher 1954).

[9] A relevant exception to this approach is the work of Goldin and Sokoloff (1982), who hypothesize that textiles developed in the northeastern United States *in response* to the relatively low female (and child) wages in that region in the early nineteenth century. If low female wages influenced the location of textile investments in Sweden in this period, we might expect to see a negative sign for the coefficient on textiles and food processing (or biased downward) in the equations explaining female to male wages and male wage levels. One could also suspect that internal migration from rural to urban areas and then abroad affected wages and governed the rate of urbanization. The unbalanced sex ratio of migration among counties and overseas illustrates how the changing economic opportunities for men and women in Sweden were in flux in this period (Thomas 1941). Future work should explore the origins of this migration process as jointly determined with marriage patterns and marital fertility. Haines (1979) speculates on some of these interlinkages.

TABLE 2

REGRESSIONS OF TOTAL FERTILITY RATES, MALE REAL WAGE RATE, AND FEMALE-TO-MALE WAGE RATIO ON RELATIVE PRICES AND CONDITIONS

Explanatory Variable	Total Fertility Rate (1)	Male Real Wage Rate (2)	Female-to-Male Wage Rate (3)	Total Fertility Rate (4)	Male Real Wage Rate (5)	Female-to-Male Wage Rate (6)	Total Fertility Rate (7)	Male Real Wage Rate (8)	Female-to-Male Wage rate (9)	Explanatory Variable: Mean [Standard Deviation] (10)
Price of butter relative to rye	−125 (8.74)	.799 (6.50)	.495 (2.28)	−81.5 (5.52)	1.06 (8.29)	.272 (1.40)	−45.9 (3.32)	.814 (6.51)	.193 (.98)	17.5 [3.21]
Price of pork relative to rye	88.6 (3.49)	1.57 (7.21)	−.695 (2.28)	3.33 (.12)	1.10 (4.74)	−.250 (.71)	37.5 (1.57)	.856 (3.98)	−.349 (1.03)	7.23 [4.87]
No pork prices available (= 1)	1,186 (4.43)	16.0 (6.03)	−7.15 (2.22)	345 (1.23)	10.8 (4.50)	−2.88 (.78)	610 (2.58)	8.76 (3.94)	−4.34 (1.24)	.280 [.451]
Forestry employment percentage, 1910	...	...	...	28.7 (2.46)	.594 (5.94)	−.037 (.24)	28.3 (2.78)	.610 (6.63)	.0091 (.06)	3.39 [3.95]

Textile and food processing employment percentage, 1896	...	...	...	−45.7 (4.26)	.126 (1.37)	.337 (2.39)	−21.0 (1.83)	.0687 (.66)	.667 (4.08)	4.42 [4.32]
Proportion of population urban	...	...	...	...	...	...	−1,431 (5.57)	6.78 (2.92)	−7.24 (1.99)	.160 [.192]
Child mortality rate through age 10	...	...	...	...	...	...	3,844 6.21	−31.3 (5.61)	−26.1 (2.98)	.198 [.0653]
Intercept	5,444 (19.9)	−12.4 (5.27)	54.1 (16.4)	5,639 (21.9)	−14.6 (6.58)	52.2 (15.4)	4,055 (12.5)	−2.74 (.93)	59.4 (12.9)	...
R^2	.3854	.5331	.0622	.5016	.6256	.1066	.6353	.6939	.2281	...
Dependent variable:										
Mean	4,227	17.4	55.7	...	...	...	...	...	...	...
Standard deviation	635	6.26	6.19							

NOTE.—Absolute values of *t*-ratios are in parentheses beneath regression coefficients. Sample size = 150.

However, fertility is widely observed to be lower in urban than in rural populations in Sweden as elsewhere, and it is not possible in Sweden to measure the rural-urban differences in relative prices of child support and in child wage opportunities that might help to account for rural-urban differences in fertility. The relative prices of agricultural commodities could also differ systematically between urban and rural areas, such as butter's having a higher price relative to rye in urban than in rural areas.[10] Including urbanization as a predetermined variable affecting wages may thus reduce the apparent effect of commodity prices and proxy unmeasured changes in relative prices, incomes, and work environment that contributed in urban areas to the adoption of a smaller family size goal.

It is common to view child mortality as determined by the local economic environment and a region's health technology, but this view neglects the possibility that causation may flow in the opposite direction. In other words, the level of fertility may itself have a direct effect on child mortality, and factors omitted from this study could also be partially responsible for the levels of both fertility and mortality.[11] Consequently, some proportion of the positive covariation anticipated between child mortality and fertility may be due to omitted factors that affect fertility and thereby influence child mortality or that influence both by unspecified mechanisms. For these reasons, fertility and wages are first treated as a function of only the least controversial determinants, namely, the relative commodity prices. Then the list of explanatory variables is augmented to include industrial structure, urbanization, and child mortality. Pooling six decadal observations for 25 county areas of Sweden assumes independence of observations, and consequently the estimates reported here do not exploit the

[10] My attention was drawn to this possibility by members of a seminar at the Economic History Institute at the University of Lund in October 1983. Such a regional pattern in commodity prices could be attributed to higher urban incomes in conjunction with the greater income elasticity of demand for butter and animal products compared with that for food grains. These differences in local consumption patterns might affect relative prices if transportation costs remained significant for more perishable animal products. Urbanization may, therefore, account for some of the simple association between higher butter prices and lower fertility if the urbanization process were both instigating the movement in relative commodity prices and motivating the secular decline in fertility by increasing omitted child price variables.

[11] Long-standing regional differences in mortality in Sweden are documented back to the early eighteenth century (Heckscher 1954; Utterstrom 1965) and stressed by Sundbärg (1907) in his compilation of data (see table A2). Eastern Sweden reported substantially higher mortality, particularly among children, than did western (and southern) Sweden. Both Sundbärg and Utterstrom attribute the higher fertility of eastern Sweden to earlier marriage, more universal incidence of marriage, and higher rates of illegitimacy. Portions of the less densely settled northern counties reported relatively low mortality, just as the city of Stockholm until 1914 reported the highest mortality levels in the country.

likely covariance structure in the disturbances. Alternative error-component estimators for data in this form might, therefore, alter our hypothesis tests and standard errors, though not necessarily affect point estimates.[12]

The total fertility rate and the seven age-specific birthrates that sum up to (one-fifth) the total fertility rate are each regressed on the child mortality and urbanization variables and on the predicted values of the male wage and female-to-male wage ratio obtained from the first-stage regressions (2) and (3) in table 2. These instrumental variable estimates of the effects on fertility of the male wage level and wages of women relative to men are identified in table 3 by the minimal exclusion restriction of the commodity price series, whereas those in table 4 are overidentified by the further inclusion of the industrial composition of the labor force, as well as urbanization and child mortality in the first-stage regressions. These instrumental variable estimates of demand effects of wages are statistically consistent if the instruments—the commodity prices and industrial structure variables—are uncorrelated with the statistical error in the fertility equation. The inconsistent OLS estimates of the fertility equations, where women's wages are likely to reflect labor supply responses also, are reported for comparison in Appendix table A3.

Child mortality is significantly associated with total fertility and with all age-specific fertility rates from age 20 to age 39 in tables 3 and 4. The proportion of the population living in urban areas is associated with lower fertility among women over age 25, but, interestingly, the birthrate among teenagers is higher in urban areas, suggesting earlier marriage or at least earlier childbearing. The real wage rate for males in agriculture is not related to the overall level of total fertility, but it is significantly associated statistically with the age pattern of childbearing. A higher male real wage is associated with higher birthrates among younger women (aged 15–29) and lower birthrates among older women (aged 35–49). If these estimates measure the real wage effect on the life-cycle process of family formation, then higher male wages accelerate entry into marriage and childbearing but do not significantly raise completed fertility, as approximated here by the period total fertility rate. A rise in wages does, however, shorten the period between generations and thereby accelerates slightly the rate of population growth. The standard Malthusian hypothesis that increases in real wages contribute to earlier marriage appears to be

[12] Within-region (i.e., fixed-effect) estimators or first-differenced specifications of the model would not be attractive, however, since they neglect informative patterns of persistent cross-sectional variation in fertility levels and economic and demographic conditions. For example, differences in the extent of forestry activities persist as do the higher levels of fertility in the northern counties that depended on this industry.

TABLE 3

Instrumental Variable Estimates of the Determinants of Fertility Based Only on Commodity Prices: Sweden, 1860–1910

Explanatory Variable	Total Fertility Rate	Age-specific Birthrates							Explanatory Variable: Mean [Standard Deviation]
		15–19	20–24	25–29	30–34	35–39	40–44	45–49	
Child mortality	4,137	−7.11	87.4	207	243	175	107	13.8	.198
through age 10	(2.85)	(1.12)	(3.10)	(3.96)	(3.14)	(2.25)	(1.79)	(.88)	[.0653]
Proportion of population	−1,887	7.79	−12.9	−74.4	−105	−104	−76	−13.1	.160
urban	(3.82)	(3.58)	(1.34)	(4.16)	(3.99)	(3.90)	(3.72)	(2.57)	[.192]
Summer male day wage	−.804	.716	2.73	1.25	−.773	−1.83	−1.73	−.535	17.4
relative to rye prices*	(.04)	(8.46)	(7.31)	(1.80)	(.75)	(1.77)	(2.17)	(2.57)	[6.26]
Female day wage relative	−130.1	.0306	−2.05	−4.93	−6.85	−6.32	−4.59	−1.24	55.7
to male wage*	(2.40)	(.13)	(1.94)	(2.52)	(2.37)	(2.17)	(2.05)	(2.12)	[6.19]
Intercept	10,960	−1.51	162	424	580	551	382	93.6	...
	(3.57)	(.11)	(2.72)	(3.82)	(3.53)	(3.34)	(3.01)	(2.81)	
F-ratio statistic	10.1	34.9	14.3	10.8	12.2	12.5	12.5	8.91	...
Dependent variable:									
Mean	4,227	12.5	111	200	216	185	105	15.6	...
Standard deviation	635	5.89	21.1	26.1	34.7	36.5	28.1	6.40	...

Note.—Absolute values of asymptotic *t*-ratios are in parentheses beneath regression coefficients. Sample size = 150.
* Endogenous wage variables are identified by relative commodity prices (regressions [2] and [3], table 2).

TABLE 4

INSTRUMENTAL VARIABLE ESTIMATES OF THE DETERMINANTS OF FERTILITY BASED ON ALL AVAILABLE INSTRUMENTS: SWEDEN, 1860–1910

Explanatory Variable	Total Fertility Rate	Age-specific Birthrates						
		15–19	20–24	25–29	30–34	35–39	40–44	45–49
Child mortality through age 10	3,124	18.9	163	196	172	71.1	15.6	−11.5
	(2.23)	(2.02)	(4.03)	(3.52)	(2.45)	(.92)	(.25)	(.72)
Proportion of population urban	−2,148	3.69	−31.8	−88.4	−116	−108	−76.4	−13.2
	(6.27)	(1.62)	(3.22)	(6.51)	(6.81)	(5.70)	(5.03)	(3.39)
Summer male day wage relative to rye price*	2.78	.924	3.56	1.56	−.863	−2.07	−1.98	−.577
	(.20)	(9.87)	(8.83)	(2.80)	(1.23)	(2.68)	(3.18)	(3.61)
Female day wage relative to male wage*	−66.9	−.0515	−1.55	−2.94	−2.99	−2.95	−2.26	−.633
	(3.13)	(.36)	(2.52)	(3.47)	(2.82)	(2.51)	(2.39)	(2.60)
Intercept	7,630	−5.03	108	312	382	389	275	65.3
	(5.18)	(.51)	(2.55)	(5.34)	(5.21)	(4.79)	(4.20)	(3.89)
F-ratio statistic	23.2	45.8	28.5	24.0	30.7	26.0	23.2	16.7

NOTE.—Absolute values of asymptotic *t*-ratios are in parentheses beneath regression coefficients. Sample size = 150. See table 3 for variable means and standard deviations.
* Endogenous wage variables are identified by relative commodity prices, industrial compositions, urbanization, and child mortality (regressions [8] and [9], table 2).

confirmed by these Swedish data, just as Heckscher (1954) noted that marriage rates in Sweden responded sensitively to the harvest cycle and Ohlin (1955) observed that opening up new frontier lands increased wages in Scandinavia, attracted immigrants, and raised fertility. Of greater novelty is the finding that the Swedish population in this period was able to restrain fertility within marriage to compensate fully for the pattern of earlier marriage and childbearing that occurred in high-wage areas.

The level of female to male wages exerts a depressing effect on birthrates at all ages except among teenagers. This effect is spread quite evenly over the childbearing years, suggesting that the labor market opportunities of women do not simply delay entry of women into marriage, as assumed by Kussmaul (1981) for early modern England, but may also exert a moderating effect on fertility that might be difficult to deduce by traditional demographic methods, which focus on parity-specific control as a deviation from "natural fertility" (Coale 1973).

Table 4 reports the preferred estimates; these are not qualitatively different from those in table 3, although the inclusion of the industrial composition of the labor force, urbanization, and child mortality in the list of instruments used to estimate the wage variables tends to reduce the magnitude of the coefficients on the female to male wage and child mortality variables and also to improve the precision of these estimates.[13] If one translates the child mortality coefficient into an estimate of the partial adjustment of births to a child death, the estimates in table 4 imply a replacement ratio of .65. Thus, about two-thirds of the increase in population growth caused by the rapid decline in child mortality in this half century appears to have been offset by a compensating decline in fertility, but since the replacement rates were larger for birthrates of younger women, one may assume that expectations as well as realized child mortality may have influenced the observed pattern of Swedish fertility.[14]

Table 5 simulates the implications of the estimates from tables 3 and 4 for the actual changes in the explanatory variables (from table

[13] Table 2 shows that this augmented list of instruments accounts for nearly four times the variance in the female-to-male wage ratio and a third more of the variance in the male wage level. This improved explanatory power of the instruments may account for the greater precision of the estimates of the coefficient on the female-to-male wage ratio in the fertility equations reported in table 4 compared with those in table 3.

[14] A derivative of births with respect to child deaths under age 10 is calculated as $dF/dD = b/(F + bCM)$, where b is the coefficient estimated for the child mortality rate, F is the sample mean of the fertility rate, and CM is the sample mean of the child mortality rate (i.e., 0.198) (Lee and Schultz 1982). Thus the replacement ratio for the total fertility rate from table 4 is $0.645 = 3{,}124/[4{,}227 + 3{,}124(0.198)]$. For the first six age-specific birthrates the replacement rates fall from 1.16, 1.14, 0.82, 0.69, and 0.36 to 0.14.

TABLE 5

SOURCES OF PREDICTED AND ACTUAL CHANGE IN FERTILITY

Change in Fertility Predicted Based on Actual Change in National Level of Explanatory Variable (Table 1)	Total Fertility Rate		Age-specific Birthrates—Derived from Table 4						
	Derived from Table 3	Derived from Table 4	15–19	20–24	25–29	30–34	35–39	40–44	45–49
Female-to-male wage ratio (5.7)	−740	−381	−.3	−8.8	−16.8	−17.0	−16.8	−12.9	−3.6
Male real wage rate (14.2)	−11	39	13.1	50.5	22.0	−12.2	−29.4	−28.1	−.9
Child mortality (−.132)	−546	−412	−2.5	−21.5	−25.9	−22.7	−9.4	−2.1	1.5
Percentage of population urban (.139)	−262	−299	.5	−4.4	−12.3	−16.1	−15.0	−10.6	−1.8
Total fertility rate in 1860–64	4,582	4,582	8.9	105	208	240	208	127	19.6
Total fertility rate in 1910–14	3,311	3,311	19.5	113	163	158	130	69.2	8.1
Actual change	−1,271	−1,271	10.6	8	−45	−82	−78	−57.8	−11.5
Predicted change	−1,559	−1,053	10.8	15.8	33	−68	−70.6	−53.7	−4.8
Predicted-to-actual ratio	1.23	.83	1.02	1.96	.76	.83	.91	.93	.42

1) and compares these predicted changes in fertility with the actual changes occurring over the half century studied. The estimates in table 3 overpredict the decline in the total fertility rate by 23 percent, while the estimates in table 4 underpredict the decline by 14 percent. The preferred estimates from table 4 overpredict changes in age-specific birthrates for the young, for whom fertility rates increased in this period, and underpredict slightly the fertility declines after age 25. Since the same explanatory variables are included in each of the fertility regressions, the sum of the age-specific coefficients on any explanatory variable is equal to one-fifth of that variable's coefficient in the total fertility rate equation. A consistent adding-up of predicted effects is therefore maintained.[15]

The effect of these four explanatory variables on marital fertility and the proportion married is explored tentatively in a final set of estimates. Since marital fertility rates are available only from 1870, the analysis is limited to 1870–1910. The dependent variables are the total fertility rate, as before, the marital fertility rate, and a proportion married equal to the ratio of total fertility to marital fertility (see table 1 for definitions). This residually constructed proportion married also captures changes in illegitimate birthrates (which were relatively constant in this period) and in the age composition of married women that are ignored in the reported marital fertility rate.

The marital fertility regressions are shown in table 6, first in linear form as before and then with the three dependent variables in logarithmic form. This logarithmic specification facilitates the decomposition of the effect of explanatory variables on the total fertility rate presented in the third portion of table 6. Child mortality exerts its effect on the total fertility rate mainly (93 percent) through depressing marital fertility, implying that the fertility response is occurring through hedging and replacement behavior within marriage, and not by anticipations that influence the age at marriage as observed in Taiwan and Korea (Schultz 1980; Lee and Schultz 1982). Urbanization also exerts 85 percent of its effect on fertility through depressing marital fertility rates. Male wages appear to increase the proportion married, as was surmised from the male wage effect on the age-

[15] Alternatives to age-specific birthrates to summarize the age schedule of fertility should also be investigated. Breckenridge (1983) proposed such a three-parameter representation of the age schedule of fertility and fit these parameters to the Swedish data at the county level for the same decadal intervals analyzed here. Using the IV specification of the model in table 4, urbanization and the male real wage rate are positively associated with the woman's fertility level parameter (β_i). The female relative to male wage and urbanization are associated with later ages of childbearing ($\beta_{i.T}$) given the level, whereas child mortality and male wages are associated with childbearing at young ages.

TABLE 6

POOLED CROSS-COUNTY REGRESSIONS ON TOTAL FERTILITY RATE, TOTAL MARITAL FERTILITY RATE, AND PROPORTION MARRIED: SWEDEN, 1870–1910

Explanatory Variable	Linear: Total Fertility Rate	Linear: Proportion Married Residual	Linear: Total Marital Fertility Rate	Logarithmic: Total Fertility Rate	Logarithmic: Proportion Married Residual	Logarithmic: Total Marital Fertility Rate	Proportionate Changes*: Total Fertility Rate	Proportionate Changes*: Proportion Married Residual	Proportionate Changes*: Total Marital Fertility Rate	Explanatory Variable: Mean [Standard Deviation]
Summer male day wage relative to rye price*	24.4	.174	−1.52	.00483	.0111	−.00623	1.00	2.29	−1.29	18.62
	(1.63)	(6.61)	(1.26)	(1.56)	(6.74)	(1.55)				[6.20]
Child mortality through age 10	6,915	1.73	375	1.63	.118	1.51	1.00	.07	.93	.1860
	(4.12)	(.58)	(2.77)	(4.70)	(.64)	(3.34)				[.0591]
Proportion of population urban	−2,337	−1.38	−123	−.626	−.0920	−.534	1.00	.15	.85	.1661
	(4.77)	(1.59)	(3.11)	(6.19)	(1.71)	(4.06)				[.196]
Female day wage relative to male wage*	−11,550	5.48	−839	−2.30	.309	−2.61	1.00	−.13	1.13	.5608
	(2.05)	(.55)	(1.85)	(1.98)	(.50)	(1.73)				[.0636]
Intercept	9,265	9.19	718	9.32	2.36	6.96	...	...	...	...
	(2.84)	(1.59)	(2.72)	(13.8)	(6.58)	(7.92)				
F-ratio statistic	11.65	14.25	8.57	17.04	14.79	12.35	...	...	...	...
Dependent variable:										
Mean	4,142	15.6	268	8.32	2.74	5.57	...	...	...	...
Standard deviation	649	1.69	48.1	.159	.106	.191				

NOTE.—Absolute value of asymptotic *t*-ratio is in parentheses beneath regression coefficient. Sample size = 120.
* Endogenous wage variables are identified by relative commodity prices, industrial compositions, urbanization, and child mortality (regressions [8] and [9], table 2).

specific birthrates. The female-to-male wage ratio affects only marital birthrates, confirming the earlier inference that relatively higher wage opportunities for women do not only deter their early marriage, but rather also reduce their later reproductive performance, perhaps by means of relatively uniform practice of traditional methods of birth control throughout marriage.

Conclusion

In many high-income countries the wage received by women relative to that received by men has increased in the last 100 years (Schultz 1981, table 7.3). Economists hypothesize that this aspect of modern economic growth increases the opportunity cost of children and may be a contributing factor to the secular decline in fertility. But this trend in female to male wages may itself be caused by women's employment and human capital investment choices, which have evolved simultaneously with the reduction in reproductive goals. The problem addressed in this paper is how to identify the aggregate demand and technologically induced effects on male and female wages that can then be examined as an exogenous price of women's time to help explain cross-sectional and time-series variation in fertility.

The approach adopted here is to estimate how the abrupt worldwide change in the relative prices of grains and animal products that occurred in the 1880s filtered through the largely agricultural Swedish economy to affect the labor market. An effort was also made to hold constant real male wages, child mortality, and urbanization, all of which were changing rapidly in the period 1860–1910.

Specifically, the disappearance of exports of Swedish oats and the rapid growth in exports of butter from 1870 to 1900 can be traced to the decline in the price of cereals relative to livestock products. It is hypothesized by English historians that earlier swings in the price of livestock products relative to grains (from the sixteenth to the eighteenth centuries) contributed to swings in the relative employment of women in farm service, with repercussions on their age at marriage and hence aggregate fertility (Kussmaul 1981; R. Smith 1981). The late nineteenth-century improvement in the price of butter relative to grains may have analogously contributed to an improvement in women's wages in Sweden relative to men's and thus to a more rapid decline in fertility than would otherwise have occurred in Sweden. Other developments may have worked in the opposite direction. The northern counties of Sweden were involved in a rapid expansion of exports of timber from the 1860s to 1900, and the predominance of male workers in lumbering provides an explanation for the persistently high fertility in some of these areas until well into the twentieth century. Conversely, a few southern and eastern counties developed textile and food-processing industries that provided employment for 76 percent of the female industrial labor force in 1920. These geographic patterns in location of industry are assumed here to be exogenous to the fertility determination process, dictated primarily by natural resource endowments, transportation, and early river power for mechanization.

The first stage in the analysis confirms that where the price of butter relative to rye (the basic food grain in Sweden) was higher, female to male wages were higher and fertility lower. The reverse was true for areas where pork prices were relatively high. Local industrial employment in forestry is associated with higher male wages; conversely, greater employment in textile and food processing is linked to higher female to male wages. The second stage in the analysis reports instrumental variable estimates, implying that a quarter of the decline in the Swedish total fertility rate from 1860 to 1910 can be explained by the 10 percent rise in the female-to-male wage ratio. Another quarter is associated each with the 50 percent reduction in child mortality and with the increase in urban share of the population to one-quarter. The doubling of real wages paid to male day workers in agriculture is not associated with a change in total fertility rates but is estimated to contribute to earlier marriage and higher fertility among women under age 30 and, consequently, to lower fertility among women older than 30. Cohort data would be needed to examine the underlying dynamics of the family formation process during this period, an analysis beyond the scope of this paper. When the real wages of men, child mortality, and urbanization are held constant, the aggregate county-level data for this 50-year period in Sweden suggest that the appreciating value of women's time relative to men's played an important role in the Swedish fertility transition.

Appendix

Table A1 summarizes long-term trends in prices, wages, and derived measures of relative wages and prices in Sweden. Table A2 defines the regional administrative units used in the empirical analysis and shown in figure 1. The regional codes are also indicated for the wage series by Bagge et al. (1933), the price series by Jörberg (1972), and the demographic groupings by Sundbärg (1907). The primary purpose of this Appendix is to restate the estimation issues that arise in the paper and to indicate the source and likely direction of the bias in estimating the effect of female wages on fertility by ordinary least squares (OLS). The asymptotically unbiased instrumental variable (IV) estimates provided in the paper are then briefly contrasted with the inconsistent OLS estimates reported below.

County demand for female labor is assumed to depend on the wages of females and males, a vector of prices of alternative agricultural outputs and inputs (P_A) for which male and female labor have different comparative

TABLE A1

Average Price Levels and Number of Swedish Counties (in Parentheses) Reporting Prices for Selected Commodities and Years

	1732	1758	1815	1860	1913
Commodity:					
Grains:					
Rye	.45 (19)	1.11 (28)	7.50 (30)	8.89 (30)	9.63 (30)
Wheat	.68 (11)	1.52 (13)	9.84 (13)	13.2 (24)	11.2 (23)
Barley	.41 (27)	.97 (28)	5.17 (30)	7.75 (30)	8.29 (30)
Livestock products:					
Butter	.06 (21)	.11 (23)	.83 (26)	1.26 (29)	2.01 (29)
Pork	.04 (16)	.08 (17)	.55 (17)	.78 (20)	1.24 (22)
Beef	.02 (15)	.04 (10)	.29 (16)	.53 (18)	1.10 (19)
Lumber:					
Pinewood	.08 (2)	.16 (2)	.98 (29)	.53 (18)	1.10 (19)
Labor:					
Day wages male summer/harvest	.07 (10)	.09 (20)	.68 (30)	1.07 (29)	2.74 (29)
Day wages of hand and two horses	.12 (8)	.17 (19)	1.61 (26)	2.89 (27)	6.65 (27)
Maximum number of regions	27	28	30	30	30
	Derived Measures of Price Levels and Real Wages				
Index of cost of living*	...	...	79	100	132
Real wage index for agricultural workers (20-year average)†	100	85	86	97	165
Implicit real agricultural daily wage‡	...	...	86	107	208
Price of butter relative to rye	.13	.10	.11	.14	.21

Source.—Jorberg (1972), vol. 1, and various tables from vol. 2. Cost of living index from Myrdal (1933).
* Table XIX:11, p. 350, for 1815–20, 1860–64, 1910–14.
† Table XIX:8, p. 344, for 1735–54, 1755–74, 1805–24, 1855–74, 1895–1914.
‡ Calculated by dividing annual daily male wage above by cost of living index.

advantages, local natural resource endowments that account for the location of industrial employment (I) with a distinctly different female-to-male employment ratio (i.e., forestry, textiles, and food processing), and a modeling and measurement error:

$$L_d = d(w_f, w_m, P_A, I, e_1). \tag{A1}$$

County supply of female labor is also a function of female and male wages and a second error that probably contains many omitted price, home production, culture, and taste factors:

$$L_s = s(w_f, w_m, e_2). \tag{A2}$$

The local county wage for women is the one that equates their labor supply and demand. The reduced form for female wages then can be written

$$w_f = w_f(P_A, I, e_1, e_2). \tag{A3}$$

Male labor supply and demand are represented analogously with the reduced form for male wages also depending on P_A and I.

Our final interest attaches to the demand for children or a fertility equation:

$$F = f\left(\frac{w_f}{w_m}, w_m, X, e_3\right), \tag{A4}$$

where X represents fertility determinants other than wages, such as urbanization and child mortality, plus a fourth error encompassing omitted factors such as culturally mediated tastes. Note that the female wage is specified relative to the male wage to reduce the likely collinearity between wages of men and women.

The statistical problem with estimating the fertility equation (A4) directly is that its error will undoubtedly be correlated with that in the labor supply equation, and probably inversely, namely, $E(e_3e_2) < 0$. Consequently, observed wages will be correlated with e_3 and direct OLS estimates of equation (A4) will be inconsistent. In this paper, P_A and I are used as IVs to obtain consistent estimates of (A4) that are free of the simultaneous equations bias.

Since women's market labor supply tends to be relatively elastic (compared with men's) with respect to own wage, one expects demand shocks to elicit relatively larger compensating labor supply variations for women than for men (Schultz 1981; Killingsworth 1983). Therefore, OLS estimates of equation (A4) would likely understate the effect of women's wages on fertility compared with the IV estimates, whereas male wage effects might not be seriously biased by the endogenous labor supply behavior of men.

Table A3 reports inconsistent OLS estimates of equation (A4) to test our expectations. The female-to-male wage rate has no statistically significant effect on the total fertility rate according to these OLS estimates, though its association with fertility for ages 15–29 remains inverse and statistically significant at the 5 percent level of confidence. The OLS and IV estimates of the male wage effect are similar; they remain large and positive for fertility rates among women less than age 30 and negative for birthrates of women over age 40. The apparent effects of child mortality and urbanization are increased by the neglect of simultaneous equations bias. But primarily it is women's relative wage effects on fertility that are changed (reduced overall and shifted to the young ages) by neglect of the anticipated simultaneous equations bias. It is precisely this effect of female labor supply behavior concealing the magnitude of the fertility response to shifting demands for female labor that would have obscured from direct (OLS) view the time-series evidence that secularly rising female wages contributed to the Swedish fertility transition. To the extent that the uncompensated female labor supply own-wage effect outweighs the cross-price effect of husband's wages (J. Smith 1980), increased female labor force participation has reduced the observed increase in Swedish female relative wages.

TABLE A2

SWEDEN ADMINISTRATIVE AND REGIONAL CLASSIFICATIONS

County and Subareas	Regional Grouping	Codes from Wage Series, 1865–1914	Sundbärg's Grouping by Demography	Codes from Jorberg's Price Series, 1732–1914
Malmöhus		M	West	11
Kristianstad	III	L	West	10
Kristianstad	Skane			10a
Angelholm	(South)			10b
Simrishamn				10c
Blekinge		K	West	9
Kronoberg		G	West	6
Jönköping		F	West	5
Kalmar	II	H	West	7
Kalmar North	Smaland		Some East*	
Kalmar South	(Central		West	
Isle of Oland	East)		West	7a
Gotland, Isle		I	West	8

Halland		N	West	12
Göteborg and Bohus	IV Lake Region (Central West)	O	West	
Älvsborg		P	West	14
a. Älvsborg—North			West	
b. Älvsborg—South			West	
Skaraborg		R	West	15
Östergötland		E	East	4
Södermanland	I Stockholm Region (Central-East)	D	East	3
Stockholm		A + B weighted	East	1
a. Stad		A	East	
b. Other		B	East	
Uppsala		C	East	2
Orebro		T		17
South—Narke			East	17a
North—Norate (mining region)			West	17b
Västmanland		U	East	18
Värmland	V (Central to North)	S	West	16
Kopperberg		W	West*	19
Gävleborg		X	East	20
Jämtland		Z	East	22
Västernorrland		Y	North*	21
Västerbotten		AC	North	23
Norrbotten		BD	North	24

* Not entirely in one region, according to Sundbärg.

TABLE A3

ORDINARY LEAST SQUARES ESTIMATES OF DETERMINANTS OF FERTILITY: SWEDEN, 1860–1910

Explanatory Variable	Total Fertility Rate	Age-specific Birthrates						
		15–19	20–24	25–29	30–34	35–39	40–44	45–49
Child mortality	5,738	3.35	131	264	314	245	162	28.4
through age 10	(7.67)	(.53)	(4.90)	(8.33)	(8.22)	(5.82)	(4.94)	(3.52)
Urban proportion of	−2,568	6.59	−24.6	−98.3	−139	−137	−101	−20.0
population	(11.6)	(3.49)	(3.10)	(10.5)	(12.3)	(11.0)	(10.4)	(8.35)
Summer male day wage	8.12	.693	2.64	1.63	.188	−.595	−.699	−.227
relative to rye price	(2.53)	(11.4)	(10.3)	(5.35)	(.51)	(1.48)	(2.21)	(2.93)
Female day wage	−1.74	−.135	−.722	−.521	.0622	.374	.487	.108
relative to male wage	(.28)	(2.57)	(3.28)	(2.00)	(.20)	(1.08)	(1.80)	(1.64)
Intercept	3,285	6.22	83.4	164	169	148	74.3	11.1
	(767)	(1.17)	(5.45)	(9.06)	(7.75)	(6.17)	(3.95)	(2.39)
R^2	.515	.592	.441	.485	.579	.537	.520	.445
F-ratio statistic	38.5	652.6	28.6	34.1	49.7	42.0	39.3	29.0

NOTE.—Absolute values of *t*-ratios are in parentheses beneath regression coefficients.

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