Time cost, relative income and fertility in Canada
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Abstract. A regression model which combines both the time cost and relative income
hypotheses is estimated using Canadian data. The results indicate that the influence of relative income is greater in the case of fertility and the effect of time cost
grows in this order of births. Some policy implications are derived.

1. Introduction

Economists have offered two hypotheses to explain the observed negative associa-
tion between income and fertility. One hypothesis explains falling fertility as a
result of a rising cost (shadow price) of children (Becker 1965; Schultz 1974) and
the other ascribes it to rising material aspirations relative to income (Easterlin 1975).
While both explanations emanate from a price theoretic framework the former
(the price model) is conditioned on the assumption of invariant tastes while the latter
the (relative income model) involves changes in tastes over time and among families.
Although the two hypotheses appeared to be at competing ends initially, the proponents of the two have eventually recognized that the two
hypotheses are rather complementary (Easterlin et al. 1985; Willis 1987; see
Abeyinghe 1990 for a review).

The empirical testing of the two hypotheses with aggregate data has been
scornfully hampered by a lack of theoretically suitable data. Sometimes the problem
is that data are not available for comparable and satisfactory time spans. As a
result, empirical work is carried out mostly with poor proxies which have often pro-
duced ambiguous results. Moreover, for example, has suggested a population ratio
to proxy relative income. Abeyinghe (1991) has shown that it is a poor proxy for
relative income. Similarly, Easterlin's unemployment biased proxy for relative in-
come has also not been satisfactorily tested (Ruttan and Higgs 1984). The results of Abey-
inghe (1991) shows that the proxies for relative income have to be based on income

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The problem of data requirements for the price model has been greatly simplified by a model proposed by Butz and Ward (1979). This model requires the income of males (not the full income suggested by Becker 1960) and the female wage rate. The latter represents the time cost (a portion of the shadow price) of having children. An uneasy aspect of the Butz and Ward model is that it also requires the employment ratio of wives as an explanatory variable of fertility. This brings back an old question to causality between fertility and female labor force participation.

The main objective of this paper is to cast the price model (a Butz and Ward variant) and the relative income model into a single empirical model and analyze Canadian fertility. Far too little work has been done in this area with Canadian data mainly due to data problems. In this analysis we also examine the labor force participation (LFP) of married women.

2. The model

In developed countries, especially during the post World War II period, observed completed fertility is determined mostly by desired fertility (Wachter 1975; Easterlin et al. 1980). We assume, therefore, that a demand model is sufficient to explain the variations in fertility in Canada during the last four decades. As mentioned in the introduction the model we use is a combination of the relative income and price models.

Easterlin has proposed to measure relative income by taking the ratio of income of young men to that of their parents. The parental income measures the level of material well-being to which the young adults have become accustomed before their marriage. This variable represents the desired standard of living of the young adults contemplate for themselves. A fall in own income relative to parental income is expected to lower fertility and increase the labor force participation of married women. The major explanatory variables of the price model proposed by Butz and Ward (1979) are the male income and female wage rate.

The combined price and relative income model for aggregate data can be written as

\[ \ln F_t = \beta_0 + \beta_1 \ln Y^m - \beta_3 \ln Y^P - \beta_5 \ln W^f + \epsilon_t, \]

where \( F_t \) is fertility, \( Y^m \) is income of young men, \( Y^P \) is income of male parents, \( W^f \) is female wage rate, and \( t \) is the time subscript.

Since the same set of explanatory variables are believed to explain labor force participation rate of married women (LFP) we also analyze the model

\[ \ln L_t = \delta_0 - \delta_1 \ln Y^m + \delta_2 \ln Y^P + \delta_3 \ln W^f + \epsilon_t. \]

The models (1) and (2) are presented with the expected signs attached to the elasticity coefficients.

Ideally \( Y^m \) and \( Y^P \) should represent the life-time resources (or permanent incomes) of the young and parental cohorts. The paucity of data, however, prevents us estimating such an ideal model. Even if the discounted present value of the two income streams it used for \( Y^m \) and \( Y^P \) the current income receives the largest weight (a weight of one) while future incomes would be heavily
deflated if the discount factor is large. Moreover, at an aggregate level \( Y^m \) and \( Y^P \) are average incomes which are, therefore, free from transitory fluctuations in income.

In the standard formulation of the relative income model the two income variables appear as a ratio \( Y^m / Y^P \) which implies that the income elasticities with respect to own income and parental income are the same in magnitude. As we shall see later this may not be a reasonable assumption to make.

3. Data

A major portion of this research had to be devoted to construct and compile data. Even with such efforts our analysis had to be restricted to the period since 1951 because of the lack of income data prior to this period. A detailed data appendix is available from the author upon request.

The most suitable fertility measure would be the completed fertility rate (CFR). The CFR used in this study is an estimate of the completed cohort fertility rate per 1000 women whose mean age at fertility is 27 years at the reporting year. Figure 1 depicts the movements of the CFR and the total fertility rate (TFR). As the figure shows the TFR has amplified the general fertility level during the baby boom period. This is mainly because the TFR as well as the age specific fertility rates are sensitive to the timing of births. We have, however, chosen the age specific fertility rates \( F_{15-24} \), \( F_{25-34} \), and \( F_{35-44} \) for analysis. The CFR was available (in Vital Statistics published by Statistics Canada) only until 1980 while the other rates were available until 1986.

Figure 1 also shows the labor force participation rate (LFP) of married women. This series records a strong and steady increase since the early 1950's. It is interesting to note that fertility declined during a period (till 1940's) in which the LFP of married women remained very low. The LFP series shows an upward
shift in mid 1970's. This is due to a change in the definition and measurement of labor force participation in the Canadian Labor Force Survey. To account for this change we used a dummy variable in our regression models. The sharp peak observed in 1984 was replaced with the mean of 1983 and 1985 values.

The explanatory variables are graphed in Fig. 2. The income of young men is represented by two series, Ye and Ye. The former is the average real income of male heads of families who are below 25 years of age and the latter is the average real income of those who are below 35. Ye is used only in the analysis of F1.2 series while Ye is used with all other dependent variables. The parental income is represented by the average real income of male heads of families who are in the age group 45 - 54. This is also the income category and by Easterlin (1980) to represent parental income. The income data are from the "Income Distributions" survey published by Statistics Canada.

The female real wage rate is proxied by the average real weekly salaries of female clerks. The female real income in 1980's which is a result of the recession that hit Canada during this period. In contrast, female wages have continued to rise though at a slower rate.

All these series except fertility, were available until 1988. The nominal income and wage data were converted to real values by dividing CPI (1970 = 100). After this study was completed we encountered a study by Hyatt and Milne (1991) who have tested the Box-Ward model using Canadian data. They have constructed income and female wage data partly on the basis of Taxation Statistics of Revenue Canada. It would be more informative to repeat our exercise with their data. We did not attempt this as we did not have access to income data by age group. It should be noted, however, that Hyatt and Milne have constructed the female hourly wage rate by dividing annual female income by average number of hours worked per week multiplied by 52. We also resorted to this method initially, but observed that the total number of hours worked per year is not equal to the average number of hours worked per week times 52. Furthermore, they have used the female employment ratio to proxy the employment ratio of married women. We also tried this, but found that the results in the two series are not comparable.

4. Empirical analysis

Engle and Granger (1987) have shown that when OLS regressions involve non-stationary variables, they produce inconsistent estimates unless the regression variables are co integrated. Moreover, non-stationary regressions often tend to reject the null hypothesis of no relationship even if it is true. On the other hand, a finding that a linear combination of a set of individually nonstationary variables is stationary is strong support for the underlying economic theory. Another useful aspect of co integrated variables is that measurement error do not affect cointegration so long as the measurement errors are stationary.

Since a co integrated regression produces stationary residuals the Engle-Granger (EG) approach to testing for cointegration is to test for unit roots in the residual series. Table 1 reports the results of the Dickey-Fuller test for cointegration based on the residuals of regressions of the form (3) and (2).

<table>
<thead>
<tr>
<th>Table 1. Dickey-Fuller test for cointegration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cointegrating variables</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>F1,2 and</td>
</tr>
<tr>
<td>(i) (Y_{e}, W_{e})</td>
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<tr>
<td>(i) (Y_{e}, W_{e})</td>
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<tr>
<td>(i) (Y_{e}, W_{e})</td>
</tr>
</tbody>
</table>

\(X_{t}\) : Autocorrelations at lag 1 to 5.

\(FR\) : Fertility Rate.

\(LFPR\) : Labor force participation rate of married women. Significance at 10% level. Critical values for \(T = 50\) are from Engle and Yoo (1987).
Table 2. FM estimates of selected regressions

<table>
<thead>
<tr>
<th>Term</th>
<th>FM1</th>
<th>FM2</th>
<th>TFR</th>
<th>CFR</th>
<th>LFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>13.020</td>
<td>14.332</td>
<td>17.434</td>
<td>14.074</td>
<td>-5.653</td>
</tr>
<tr>
<td>(3.70)</td>
<td>(3.62)</td>
<td>(3.71)</td>
<td>(4.90)</td>
<td>(2.12)</td>
<td>(-2.85)</td>
</tr>
<tr>
<td>w</td>
<td>0.483</td>
<td>0.283</td>
<td>0.440</td>
<td>0.360</td>
<td>-0.008</td>
</tr>
<tr>
<td>(1.67)</td>
<td>(1.07)</td>
<td>(2.21)</td>
<td>(2.12)</td>
<td>(0.51)</td>
<td></td>
</tr>
<tr>
<td>$\beta_{w}$</td>
<td>-1.160</td>
<td>-0.976</td>
<td>-1.679</td>
<td>-1.997</td>
<td>0.216</td>
</tr>
<tr>
<td>(4.52)</td>
<td>(4.28)</td>
<td>(1.58)</td>
<td>(1.31)</td>
<td>(0.71)</td>
<td></td>
</tr>
<tr>
<td>$\beta_{f}$</td>
<td>-0.371</td>
<td>-0.653</td>
<td>-0.649</td>
<td>-0.649</td>
<td>1.733</td>
</tr>
<tr>
<td>(1.24)</td>
<td>(1.06)</td>
<td>(0.84)</td>
<td>(0.90)</td>
<td>(0.19)</td>
<td></td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.91</td>
<td>0.94</td>
<td>0.96</td>
<td>0.96</td>
<td>0.97</td>
</tr>
</tbody>
</table>

All variables are in logarithms. Parenthetical values are ratios. See notes to Table 1 for abbreviations.

Combines $w$ and $y$ into a single variable. This amounts to imposing a restriction of the form

$$\beta = \beta_{f} \beta_{w}$$

thereby reducing regression (1) to

$$\ln F = \beta_{f} \ln Y + \beta_{w} \ln W + \epsilon.$$  (3)

If $k = 1$, then the relative income is simply the ratio of the two income series. This is the procedure that Easterlin (1980) has adopted. The regression results of Table 2, however, suggest that parental income plays a more important role than own income. This implies $k > 1$.

To choose a value for $k$ we ran a large number of regressions by choosing different values for $k: 1 \leq k \leq 5$. The upper limit corresponds to the coefficient ratio $\beta_{f}/\beta_{w}$ of the CFR regression given in Table 2. We observed that as $k$ increases the relative income elasticity increases and wage elasticity falls in magnitude and finally yields results similar to that of Table 2. Although not strictly applicable, we also carried out an FM test on these restricted results. Since Hansen's program did not offer the flexibility of introducing a dummy variable in LFP regressions we pre-adjusted the series by subtracting 3.2 from the values since 1975. This figure was arrived at by regressing LPPR on $t, t^2, t^3$ and a dummy.

Table 2 reports the estimated elasticity coefficients from the combined model. The results show that the effect of parental income on relative income is much stronger than that of own income. The female wage rate, however, has the wrong sign in three cases. So does $w$ in FM2 equation.

The main problem with the results in Table 2 is multicollinearity. All these explanatory variables are income variables with upward trends. A solution to the multicollinearity problem is to resort to the relative income formulation which
female wage rate has a relatively greater influence on the timing of births and relative income (parental) income in particular, on completed fertility. A com-
prehensive predictive analysis of the effect of a large number of variables on completed fer-
tility and timing of fertility is found in Cigno and Ermisch (1989).

Relative income shows a negative sign in $F_{5}$. As for the LFP of married women, both Tables 2 and 3 and show that the female wage rate is the most important determinant among the three. The difference in $k$ required for fertility and LFP indicates that own income and parental income do not influence fertility and LFP in a symmetric way.

5. Discussion

One important aspect of model (3) to consider is its longer term implications. Model (3) can be expressed in terms of growth rates as

$$F = \beta_1 Y^* - (\beta_2 k Y P^* + \beta_3 W),$$

where $X$ indicates the growth rate of the relevant variable. It is obvious from (4) that $F \approx 0$ only if $\beta_1 Y^* \approx (\beta_2 k Y P^* + \beta_3 W)$. On the other hand, if the three income variables grow at an identical rate $\gamma$, then

$$F = \beta_1 (1 - \gamma) Y^* + \beta_2 k Y P^* + \beta_3 W \gamma < 0 \text{ if } k \geq 1.$$  

Table 4. Average log growth rates

<table>
<thead>
<tr>
<th>Period</th>
<th>TFR</th>
<th>CFR</th>
<th>CFR_1</th>
<th>CFR_2</th>
<th>Y*</th>
<th>Y P*</th>
<th>W</th>
<th>LFP</th>
<th>LFP_1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951–59</td>
<td>1.5</td>
<td>0.4</td>
<td>−1.5</td>
<td>−1.8</td>
<td>3.2</td>
<td>2.8</td>
<td>3.0</td>
<td>5.9</td>
<td>5.7</td>
</tr>
<tr>
<td>1960–69</td>
<td>−4.9</td>
<td>−2.9</td>
<td>−2.7</td>
<td>−2.3</td>
<td>3.9</td>
<td>4.1</td>
<td>2.2</td>
<td>5.6</td>
<td>4.4</td>
</tr>
<tr>
<td>1970–79</td>
<td>−3.1</td>
<td>−3.1</td>
<td>−2.6</td>
<td>−2.9</td>
<td>3.1</td>
<td>3.1</td>
<td>2.5</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>1980–88</td>
<td>−0.8</td>
<td>−0.8</td>
<td>−0.7</td>
<td>−0.7</td>
<td>0.8</td>
<td>0.4</td>
<td>2.6</td>
<td>0.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

*For predicted values, subscript 1 refers to unrestricted model and subscript 2 to restricted model if $k = 1.3$.


Based on out-of-sample forecasts using actual input values.

Table 4 presents the average log growth rates of these variables. The predicted rates for LFP by unrestricted and restricted models almost coincided, therefore only one set is reported. The long-term predictive performance of CFR models is better than that of LFP model. One important exception is the prediction for 1941–59. During this period the three income variables have grown at roughly the same rate, 3%. Concurring with the implication in Eq. (5), the model predicts a negative growth for CFR whereas the actual growth was a positive 0.4%. Likewise, based on current trends in income growth the model predicts a continued fall in fertility. The model also makes a dismal prediction that fertility will eventually fall to zero unless the income of young males grow sufficiently faster than that of adults and females.

These results do not necessarily diminish the usefulness of the fertility model. It should be noted that when the income of different age groups grow at the same rate, the progressive nature of the income tax rates ensures that the after-tax income of young adult males grow faster than that of adults. Therefore, the use of after-
tax incomes and wage rates is likely to reverse the negative prediction for 1951–1959. Moreover, with the use of net incomes which properly account for the effect of taxes and other benefits such as child allowances, the "zero-fertility" implication of the model may become less relevant in practice. Clearly, to remove this counter-intuitive implication, the model needs to be reformulated. One way is to expand the model by adding more variables as is done in Ermisch (1988).

Another aspect to consider regarding model (1) or (3) is that whether the three income variables should be laged by one year. Such an argument is relevant because of the conception and gestation lags. Similar arguments may be made for model (2) as well. Re-estimation of models this way did not lead to radically different estimates. However, the analysis alone this line is worthwhile.

Finally, we also examined causality between fertility and labor force participa-
tion of married women by means of a Granger-causality test. We observed that an apparent causality between them disappears once the effect of the three in-
come variables is removed.

6. Conclusion

The results of this paper suggest that both the time cost (measured by female real wage rate) and relative income (measured by real income of young males relative to real income of a parental age group) are important determinants of completed
Inflation in Canada, relative income, however, exerts a greater influence on

plete fertility than does time cost. The effect of the latter seems to be more on

the timing of births. The falling levels relative in Canada have been a matter of some concern for

policy makers. The model analysed in the paper implies that for a positive growth in the relative income of

adults and females, the progressive tax system in place is likely to create the needed difference

in after-tax income growth rates. However, at current growth rates of income, the model predicts continued decline in fertility. Therefore, more direct policy measures such as proportionately more tax rebates, child care subsidies and child

allowances for additional children may be used to boost fertility.

References
Popul Econ 4:233–257
Wills RJ (1987) What have we learned from the economics of the family? Am Econ Rev 77:168–169

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