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THE MACROECONOMICS OF FERTILITY IN SMALL OPEN ECONOMIES: A TEST OF THE BECKER-BARRO MODEL FOR THE NETHERLANDS AND NEW ZEALAND*

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Abstract

Becker and Barro (1988) formulated a theoretical model which identified a range of macroeconomic variables which can temporarily or permanently affect fertility in small open economies. While they suggested that their model provided a plausible explanation for the large shifts in fertility in western economies during this century, no formal econometric investigation was carried out. This paper tests the Becker-Barro model with relevant data which covers most of the 20th century for two small open economies, namely The Netherlands and New Zealand. The results show that government subsidies for having children have a strongly positive effect on fertility, while the provision of public pensions has a strongly negative effect. The degree of intergenerational altruism appears to have been declining. Moreover, there is some - albeit weak - support for the hypothesis that real interest rates positively influence fertility. The empirical analysis of the Dutch data is generally more conclusive than the analysis of the New Zealand data.

Keywords: dynastic utility; altruism; fertility; social security; real interest rates
JEL Classification Numbers: H55, J13, N30

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1. Introduction

The last decade has seen a revival of interest in theoretical models of long-run economic growth and in the empirical verification of these models. The papers by Romer (1986) and Lucas (1988) provided the initial impetus, while the textbook by Barro and Sala-i-Martin (1995) provides a good overview of the accomplishments of the new research programme. At the same time, a renewed interest in the economic determinants of population growth emerged, with the book by Razin and Sadka (1995) being representative of the modern approach to population economics.

These two trends are clearly related. The two driving forces of the steady-state rate of growth of output in the standard neoclassical model - technological change and population growth - were both treated as exogenous in this model (see Solow 1956). The recent attempts to endogenise technological change naturally aroused a similar interest in endogenising population growth.

The idea that population growth responds to economic development goes back to the classical theory of Malthus (1798). However, Malthus' pessimistic prediction that economic growth would lead to higher population growth, which - through decreasing returns and fixed resources - would put a brake on further development, was contradicted by the observation that the countries in which the standard of living rose rapidly this century exhibited a long-run trend of declining fertility. The failure of the Malthusian model was partly responsible for the convention of treating population as exogenous in economic growth modelling, until the ideas and the tools became available to explain the decline in fertility as incomes rose.

The basic idea had already been made clear by Leibenstein (1957) and Becker (1960), namely that there are investment and consumption aspects to having children and that therefore the standard neoclassical microeconomic theory could be applied to this situation. Thus, declining fertility can be explained by the positive effect of a higher income on the demand for children being outweighed by the negative effect of a higher price of having children, where the latter is primarily due to the increasing wages and job opportunities for women. Moreover, the declining child mortality resulting from the higher standard of living would lead, for a given demand for children, to a lower desired number of births.

A related idea, that there can be a substitution between quality and quantity in the demand for children, became fruitful to explain that lower fertility tends to be associated with higher investment in the children's education, as expounded by e.g. Becker and Lewis (1973) and Willis (1973). This idea then provided a clear feedback effect from population growth to economic growth, as investment in human capital is one of the main engines of growth. Thus, any complete economic theory of development needs to treat productivity growth and population growth as jointly endogenous in a framework in which behaviour follows neoclassical micro foundations.

The tools for this modern approach emerged from the widespread application of intertemporal optimisation techniques to long-run economic decision making problems and the development of overlapping generations models, following the classic paper by Samuelson (1958). As Becker (1992) noted in a survey of the relationship between fertility and the economy, the overlapping generations approach is a natural way to model the economic aspects of population change. The notion that children are the adults of the future is also a fundamental idea for dynamic modelling in demography.

It matters greatly in such a context how generations interact and it can be fruitful to interpret some of these interactions as intergenerational trade, with laws and social norms having evolved to represent the interests of the children (Becker and Murphy 1988). The suggestion that parental concern for their children's well being can be formally represented by a parental utility function for which the utility of children is one argument, is a final core aspect of the new economic theory of fertility, following early applications such as Barro (1974). Parental altruism in a overlapping generations framework generates a so-called dynastic utility function. The idea that a dynastic head determines a unique path of fertility, consumption and work decisions of all descendants may seem far-fetched, but, all else being equal, it can be shown that in such models children have no incentive to deviate from the optimal path determined by their forebears, i.e. there is time-consistency.

Becker and Barro (1988) were the first to combine these ideas and techniques into a reformulation of the economic theory of fertility. Their paper did not concern itself with the production-side of the economy, which implied that wages and interest rates had to be treated as exogenous. Their model would therefore be most applicable to regions or small open economies where interest rate differentials are absent - or vanish through capital mobility - and each region or country takes the long-run real interest rate as given. However, wages are considered in the model to be determined separately in each economy because of an assumed immobility of labour. In this case, a persisting inter-regional or inter-country wage differential can then contribute to an observed spatial variation in fertility, at least for some time.[1]

A subsequent paper, Barro and Becker (1989), made the production side explicit and described therefore a complete model of economic growth with endogenous fertility. By being agnostic about factor mobility or trade, this second paper followed in the Solow (1956) and Cass (1965) tradition of modelling the closed economy. Becker, Murphy and Tamura (1990) provided a further refinement in which both the quantity and the quality of children are variables of choice. The resulting model exhibits multiple equilibria and can

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[1] The spatial differences in wages could be due to differences in production technologies, non-constant returns to scale or different tax regimes.

be useful to explain how certain economies may remain trapped in a Malthusian state of poverty, high fertility and low human capital investments, while others are able to reach a path of high economic growth, low fertility and high investments in education.[2]

In terms of empirical work, the new economic theories of population growth point primarily to the same types of influences on fertility as did the earlier static models. Important economic variables are family incomes, real wages - particularly of women, public subsidies for child rearing and education, old age pensions and health expenditures. The dynamic formulation generated an important role for two additional variables, namely the real interest rate and the extent of parental altruism.

The long-run level of consumption in the Becker-Barro type model can be shown to be independent of the interest rate. In contrast, higher interest rates lead to consumption growth in the conventional intertemporal optimisation models. The key to the difference is the assumption of altruism in the Becker-Barro model. This leads to a first-order condition for the optimal consumption path such that an increase in the interest rate, which relaxes the intertemporal budget constraint, makes parents decide to increase the number of offspring, but leaves consumption per child the same, ceteris paribus. Similarly, an increase in the weight of future generations in the dynastic utility function has no long-run effect on consumption per capita but increases fertility also.

Thus, as will be elaborated in the next section, these dynamic models suggest that fertility will rise due to an increase in the real interest rate or in the degree of altruism. However, the study of fertility has led to a vast multi-disciplinary literature in the social sciences and to many students of fertility, a role for interest rates may seem rather incredulous when compared with traditional determinants such as infant mortality, contraceptive techniques, social norms (including those affecting altruism) and more conventional economic variables as listed above. Yet, the role of interest rates is a proposition which can be tested empirically.[3]

Becker and Barro (1988:18-20) provided only a casual verification of this proposition. They noted that the low fertility in Western economies during the 1960s and 1970s coincided with low international real interest rates, expansion of social security programmes and high economic growth. Conversely, they predicted a rise in fertility in these economies in the 1990s due to an expected increase in real interest rates, a slowing down in social security payments and a continuation of the lower economic growth observed since the early 1980s. Fertility did indeed increase somewhat, or declined to a lesser extent, in many developed countries in the late 1980s and early 1990s.

Fertility is conventionally measured by the Total Fertility Rate (TFR) which is the synthetic number of children which a woman would bear if she followed throughout her

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[2] Becker (1992: 195-199) provides a non-technical description of this model.

[3] Alternatively, the link between the interest rate and fertility can be studied by means of simulation with an overlapping generations model. An example is Blomquist and Wijkander (1994).

life the present age-specific birthrates. The increase in the TFR in some Western economies in recent years may be partly the result of shifts in the timing and spacing of births. The rapid increase in female labour force participation has led to many women postponing having children until their mid 30s and beyond, so that the recently observed increase in births may be a "catching up" effect of large cohorts of women in late reproductive age groups. Changes in behaviour would be best gauged by considering completed fertility, i.e. the actual fertility experience of a cohort at the end of the reproductive life phase, but the outcomes for young women today are of course not yet known for several decades. For example, Olsen (1994) showed that in the United States the younger cohorts did not increase their fertility in the late 1980s (at a time of higher real interest rates) and he expects a continued decline of completed fertility in that country.

Yet it is easy to find a number of small open economies in which fertility rates stopped their decline or actually increased during the second half of the 1980s, when real interest rates in these countries increased sharply. Examples are Sweden, The Netherlands and New Zealand. Another notable observation is the continued decline of fertility in Japan in the mid 1990s. Fertility is in this country now below that of many other industrialised economies and real interest rates are in fact also very low.

The purpose of this paper is to provide a more formal empirical verification of the original Becker and Barro (1988) model by means of a near-century of data for two small open economies, The Netherlands and New Zealand. There have been many studies of fertility using primarily post-Word War II time-series or cross-section data. Studies encompassing the greater part of a century are less common due to data problems, but Tzannatos and Symons (1989) estimated regression models of fertility behaviour in Britain since 1860. In contrast to the approach adopted in the present paper, their model assumed static optimisation of household utility on a period-by-period basis and the real interest rate was assumed constant over time.

The next section uses the original model to derive an equation for econometric estimation. Section 3 discusses the data and describes the movement of some of the variables of interest throughout the 20th century. The results of econometric modelling are reported in section 4. Section 5 draws some general conclusions.

2. The theoretical model

We will first outline the key features of the Becker and Barro (1988) model. For expository purposes, we will consider a simplified version. Of course, the essential features required for the specification of the empirical model are maintained.

Consider an economy in which agents live through two phases: childhood and adulthood. Parents allocate resources to children in three ways: by devoting time and money to the children's consumption, by leaving bequests and by investing in their human capital. All assets, including human capital, yield the same rate of return. The prevailing real rate of return available to adults of generation i is r_i (i = 0, 1, ...). Since the country or region under consideration is assumed to be a small open economy, r_i is exogenous. Let h_i represent the human capital of an adult of generation i and b_i the bequest which these adults received from their parents. Each adult i works a given time and earns an income w_i.[4] The income w_i is determined by the reward for effort e_i and the return on human capital. Thus,

$$(1) \qquad w_i = e_i + (1 + r_i)\, h_i \qquad\qquad i = 0, 1, \ldots$$

Adults spend their labour earnings and their bequests on their own consumption, on their children's consumption and education, and on leaving these children with a bequest. The adult of generation i has n_i children and the rearing of each child costs β_i, excluding the investment in the child's education. The total cost of raising n_i children to adulthood is n_i $(\beta_i + h_{i+1})$.[5] Consequently, the budget constraint for each adult of generation i is:

$$(2) \qquad e_i + (1 + r_i)(h_i + b_i) = c_i + n_i(\beta_i + h_{i+1}) + n_i b_{i+1} \qquad i = 0, 1, \ldots$$

where b_i refers to the bequest which was passed on by a parent of generation i-1 to each adult of generation i (i = 1, ...; h_0 and b_0 are exogenous). The allocation of income between own consumption and expenditure on children depends on the motive for having children. Following Becker and Barro (1988), the concern of parents for their children is their expected future well being in adulthood. The direct impact of the presence of children on parents' utility is neutral. Hence, parents are altruistic and the utility function of a parent of generation 0 is assumed to satisfy

$$(3) \qquad U_0 = v(c_0) + a(n_0)\, n_0\, U_1$$

The term $v(c_0)$ represents the utility flowing from the adult's own consumption, n_0 is the number of his or her children and U_1 represents the utility of each one of these children when they reach adulthood. The utility level which adults obtain is a weighted sum of the utility of their own consumption and the aggregate total utility of their children with $a(n_0)$ representing a weight factor. This weight factor can depend on the number of children. Equation (3) is a recursive relationship which can be easily rewritten into a so-called dynastic utility function in which the utility of the head of the dynasty is expressed as a weighted sum of the utility of consumption of this head and all descendants. This dynastic utility function is

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[4] It is possible to make the allocation of time endogenous, but we do not consider this issue here.

[5] There are therefore no economies of scale in raising children.

(4) $$U_0 = \sum_{i=0}^{\infty} A_i N_i v(c_i)$$

where $A_0 = N_0 = 1$, $A_i = \prod_{j=0}^{i-1} a(n_j)$ and $N_i = \prod_{j=0}^{i-1} n_j$ for i = 1,2, ... Here, N_i is obviously the size of the total population of generation i. It is plausible that an adult will attach more weight to own consumption than to the consumption of children, let alone subsequent generations. The declining weights should also be such that the infinite sum U_0 of equation (4) converges. It is therefore assumed that

(5) $$a(n_i) = \alpha\, n_i^{-\varepsilon}$$

with $0 < \alpha < 1$ and $0 < \varepsilon < 1$.

Moreover, the utility function is assumed to have decreasing marginal utility with a constant elasticity. Hence

(6) $$v(c_i) = \gamma\, c_i^{\sigma}$$

with $0 < \sigma < 1$. Substituting (5) and (6) in the dynastic utility function (4) yields

(7) $$U_0 = \sum_{i=0}^{\infty} \gamma \alpha^i N_i^{1-\varepsilon} c_i^{\sigma}$$

Taking into account expectations of the path of rewards for labour effort e_i, interest rates r_i and child rearing costs β_i, the head of a "dynasty" maximises the utility function (7) subject to the budget constraints (2) and a given initial human capital endowment h_0 and bequest b_0.

Because we do not specify the mechanism to distinguish between human capital and bequest capital transfers (both yield the same return), the two types can be aggregated into $k_i = h_i + b_i$ and the optimal path must satisfy the following condition that the present value of all resources is equal to the present value of all expenditures:

(8) $$k_0 + \sum_{i=0}^{\infty} \delta_i N_i e_i = \sum_{i=0}^{\infty} \delta_i (N_i c_i + N_{i+1} \beta_i),$$

where the discount factor $\delta_i = \prod_{j=0}^{i} (1 + r_j)^{-1}$. The optimisation of (7) takes place with respect to both c_i (i = 0, 1, ...) and N_i (i = 1, 2, ...) and yields a path of optimal consumption c_i and fertility n_i (= N_{i+1}/N_i) decisions with the Lagrange multiplier method.

The second order conditions for maximisation require the additional conditions on the parameters that $1 - \varepsilon > \sigma$ and that $1 + r_{i+1} > n_i$. The former condition follows from inspection of the effect on U_0 of a increase in population, fully compensated by a reduction in consumption per capita such that aggregate consumption in that generation remains constant. For there to be any population growth at all, this effect should be positive, implying that $1 - \varepsilon - \sigma > 0$. The latter condition is the standard requirement that the return to capital exceeds the population growth rate.

Let us now consider the first order condition with respect to consumption. The optimal path must satisfy constraint (8) so that the effect of a small change in c_i on c_{i+1} (all else being equal) should be such that

$$\text{(9)} \qquad \frac{dc_{i+1}}{dc_i} = -\frac{\delta_i N_i}{\delta_{i+1} N_{i+1}} = -\frac{1 + r_{i+1}}{n_i} \qquad i = 0,\ 1,\ \ldots$$

Moreover, because along the optimal path $\frac{dc_{i+1}}{dc_i} = -\frac{\partial U_0}{\partial c_i} \Big/ \frac{\partial U_0}{\partial c_{i+1}}$, we can take the partial derivatives of (7) and substitute (9) to yield

$$\text{(10)} \qquad \frac{c_{i+1}}{c_i} = \left[\alpha(1 + r_{i+1})\right]^{\frac{1}{1-\sigma}} \left[n_i\right]^{\frac{-\varepsilon}{1-\sigma}} \qquad i = 0,\ 1,\ \ldots$$

Given that ε and σ are both between zero and one, we see that the rate of growth of consumption per capita along the optimal path is positively related to the degree of altruism towards future generations and the real rate of return to capital. However, consumption growth per capita is inversely related to fertility. Moreover, because $\varepsilon < 1 - \sigma$, the negative impact of an increase in fertility on the rate of growth of per capita consumption is relatively inelastic. This is consistent with the empirical evidence on the macroeconomic inverse relationship between growth in income per head and population growth (see e.g. Brander and Dowrick, 1994).

The second set of first order conditions result from differentiation with respect to N_i. These conditions are somewhat less easy to derive, but they yield (see also Becker and Barro 1988, pp. 8-9):

$$\text{(11)} \qquad v(c_i)[1 - \varepsilon - \sigma] = v'(c_i)[\beta_{i-1}(1 + r_i) - e_i] \qquad i = 1,\ 2,\ \ldots$$

The left hand side measures the marginal utility benefit of an additional adult in generation i, leaving aggregate consumption of that generation fixed (this can be derived from (7)). The right hand side measures the net utility cost of the additional adult in generation i (i.e. leading to additional child rearing costs in generation i-1, but generating additional labour effort reward e_i). Hence, equation (11) states that on the optimal path the population is allocated across generations such that for each generation marginal benefit equal marginal cost. When the explicit form of the utility function is substituted in (11), we can solve for c_i:

$$(12) \qquad c_i = \frac{\sigma[\beta_{i-1}(1+r_i)-e_i]}{1-\varepsilon-\sigma} \qquad i = 0, 1, \ldots$$

This equation suggests that the level of consumption along the optimal path is positively related to the net cost of child rearing.[6] The higher consumption is made possible by lower fertility (see equation 10), which is the optimal response to a higher net cost of child rearing. Combining (12) and (10) gives the explicit solution for fertility

$$(13) \qquad n_i = \left[\frac{\beta_i(1+r_{i+1})-e_{i+1}}{\beta_{i-1}(1+r_i)-e_i}\right]^{-\frac{1-\sigma}{\varepsilon}} [\alpha(1+r_{i+1})]^{\frac{1}{\varepsilon}} \qquad i = 0, 1, \ldots$$

This equation shows that the only variables which have an effect on the long-run steady-state level of fertility are the degree of altruism and the real interest rate. Both affect the steady-state level of fertility positively. The term in the first set of brackets represents the growth factor of the net cost of child rearing (excluding human capital investment). An increase in this growth factor decreases fertility. Of course, if the net real cost of child rearing was constant over time but at some stage changed to a different level, equation (13) shows that such a change would only have a temporary effect on fertility.

With the optimal values of consumption and fertility given in equations (12) and (13) respectively, the optimal transfer of wealth from adults to children (through human capital investments and bequests) can be found by rewriting (2) and using that $k_i = h_i + b_i$:

$$(14) \qquad k_{i+1} = \frac{e_i + (1+r_i)k_i - c_i}{n_i} - \beta_i$$

For any given k_0 and constant values of the labour effort reward, interest rate and child rearing cost, the adjustment to the steady state takes only one generation.

Equation (13) forms the basis of the empirical work. Given that we will use annual observations, it is assumed that each agent evaluates the desired number of children annually and that fertility control is effective. Because there is no gender distinction in the model, the desired offspring n_t of each representative adult agent is

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[6] Hence a value for β_{-1} must be specified.

empirically equivalent to the population's net reproduction rate at time t, and will be approximated in this paper by half the observed TFR_t.[7]

The time for children to reach the reproductive adulthood phase is T years.[8] If we take the model literally, the fertility decision at time t is based on the interest rate of time t+T expected at time t and the expected growth in the net cost of child rearing between time t and time t+T. We will therefore consider the expected annual compound growth rate of the real net cost of child rearing, g_t^e. This variable is defined by

$$(15) \quad \left(1+g_t^e\right)^T = \left[\frac{\beta_t\left(1+r_{t+T}\right)-e_{t+T}}{\beta_{t-T}(1+r_t)-e_t}\right] \qquad t = 0,\ 1,\ \ldots$$

Similarly, the expected real annual compound interest rate is defined by

$$(16) \quad \left(1+r_t^e\right)^T = 1+r_{t+T} \qquad t = 0,\ 1,\ \ldots$$

Replacing i by t and 1 by T in the time subscripts of equation (13), substituting (15) and (16) and taking the natural logarithm of both sides, gives the following linear equation:

$$(17) \quad \log TFR_t = \left[\log 2 + \frac{\log\alpha}{\varepsilon}\right] - \frac{(1-\sigma)T}{\varepsilon}g_t^e + \frac{T}{\varepsilon}r_t^e \qquad t = 0,\ 1,\ \ldots$$

Estimation of this equation will clearly depend on how expectations are related to the observed interest rates, price levels and other macroeconomic conditions. The variable g_t^e in equation (17) lumps together all the economic factors which affect the growth in the net cost of raising the optimal number of descendants.

Because declining child mortality implies that fewer births are required to obtain a certain number of adults in the next generation, growth in child survival probabilities lowers g_t^e temporarily and therefore raises fertility temporarily. Becker and Barro (1988) argue that this conclusion does not necessarily contradict the demographic transition theory. This theory states that declining child mortality reduces the number of births required for achieving a target number of adult offspring and that therefore declines in mortality should be followed by declines in fertility. In the current model, a decline in

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[7] Since infanticides are not permitted or acceptable in most societies, it is almost impossible for a specific individual to adjust the optimal number of children downward after, say, an exogenous upward shock in the cost of child rearing, if all these children would already have been born (except when children die before reaching adulthood or are adopting out). However, at the aggregate level there is assumed to be sufficient flexibility for downward adjustment of the TFR because fertility decisions can be spread over many years.

[8] The maximum age-specific fertility in many developed countries are observed in the 25-29 age group, for example in Australia, New Zealand, Canada, Norway, Sweden, France, Germany (see e.g. Statistics New Zealand, *Demographic Trends 1989*, Table B.4). T is therefore likely to be around 27 years in these countries.

mortality to a lower steady-state level temporarily raises fertility, although the steady-state fertility rate will be eventually lower (because the desired number of adult offspring remains unaffected).

Similarly, increases in public subsidies for having children (through social welfare payments or tax rebates, paid for by the children when they have become adults) lower g_t^e temporarily and increase fertility temporarily. This can be seen by considering a decline in β_1 offset by an identical increase in e_{i+1} in equation (13). A growth in social security payments to adults - such as old age pensions - has temporarily the opposite effect, i.e. it lowers fertility.[9]

Finally, an important consideration is the opportunity cost of time. Technological change leads to a growth in the real value of a unit of time. Because the rearing of children is a time-intensive activity, a higher opportunity cost of time increases the real cost of child rearing. Thus, the process of technical change itself leads to a positive value of g_t^e. Consequently, the country or region with the faster technical change-induced productivity growth has the lower steady-state fertility rate.

When equation (17) is estimated for different economies, differences between corresponding coefficients of the regression models can be interpreted in terms of preference differences with respect to intergenerational altruism and the intertemporal allocation of consumption. Differences in expectations formation between the countries may also affect the results. Moreover, if the long-term secular decline in fertility this century is the result of less intergenerational altruism, a deterministic trend will also be present.

3. Fertility and long-run macroeconomic trends

Given that the theory of fertility outlined in the previous section is concerned with long-run adjustments of fertility across generations, empirical support may be found in observing long-run changes in fertility in response to changing macroeconomic and demographic conditions in open economies.

In terms of the Becker and Barro (1988) model, the long-run decline in fertility this century can be explained by growth in social security and the slowing down of declines in child mortality. The long-run steady state level itself may have also been declining if technological change accelerated, if intergenerational altruism became less pronounced and if real interest rates were on a downward trend (see the discussion of interest rate trends below). The post-war baby boom was, with this interpretation, a transitional adjustment to the lower long-run steady-state fertility level, following less than steady-state fertility during World War II.

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[9] The reason for this is that we can interpret such a transfer as an increase in e_i and an identical decrease in e_{i+1} (see equation (13)). This raises the growth in the net child rearing cost.

For both The Netherlands and New Zealand we collected data which span most of the 20th century. For the Netherlands, all statistics but the fertility rate were conveniently available from a computer database (Statistics Netherlands, 1994). Statistics Netherlands also provided the TFR time series. For New Zealand, constructing the required series was a rather cumbersome undertaking which required a wide variety of sources, but most statistics originated from official Department of Statistics publications.[10] Dutch data were generally available from 1901 to 1993 and New Zealand data from 1912 to 1990.

Figure 1 displays the movement of the TFR this century in both countries. Many developed countries have experienced similar long-run movements in fertility this century and the comparison of The Netherlands and New Zealand provides a striking example. Both countries experienced a steady decline in fertility from the beginning of the 20th century until World War II, but with an accelerated decline during World War I and a sharp catching up in 1920 and 1921. Fertility before World War II was lower in New Zealand than in The Netherlands. Despite active involvement of New Zealand troops in Europe and Asia, the German occupation of The Netherlands in World War II undoubtedly disrupted family formation patterns more so than in the former country. Hence, the post-World War II baby boom was far more pronounced in The Netherlands. Removing the effect of this war, fertility in both countries exhibited an upward trend from 1940 with a peak in 1961. However, fertility in New Zealand had become at that time an average of 1.104 children per woman greater than in The Netherlands. The subsequent decline took place in both countries at roughly the same pace, leading to a minimum fertility this century of 1.92 and 1.47 respectively and in the same year (1983). Since then, fertility increased in both countries to reach a modest peak of 1.62 in The Netherlands in 1990 and of 2.20 in New Zealand in 1993 (not shown in the figure).

The most recent increase in fertility is usually explained in demographic terms by the later and lesser-spaced child bearing by women of the large 1960s cohorts. This phenomenon, in turn, is related to the rapid growth in female labour force participation. In addition, the econometric evidence reported in the next section suggests that changes in social security payments, and possibly higher real interest rates, have also contributed to the higher fertility.

Figure 1 about here

A demographic factor which may influence fertility is child mortality. We noted in the previous section that a lower steady-state rate of mortality will lead in the Becker-Barro model to lower steady-state fertility, but declines in mortality to a lower level would temporarily increase fertility (by reducing the expected cost of rearing a certain number of

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[10] A separate report on the sources of the New Zealand data is available upon request from the authors.

surviving children). Figure 2 shows that the probability of survival to age 15 increased notably in The Netherlands and New Zealand during the first half of the century, but levelled off in the second half of the century. The model suggests therefore that the decline in child mortality would have temporarily led to higher fertility followed by a decline in fertility to a lower steady-state level.

Another demographic factor which may influence fertility is the marriage propensity. This variable is displayed in Figure 2b. The figure shows that the two countries exhibit similar trends and fluctuations in the marriage propensity. The marriage rate has been affected by both World Wars and by cohort effects (such as the marriages of postwar babyboomers during the 1970s). Much of the post-1970 downward trend in both countries is due to *de facto* unions replacing *de jure* marriages. A statistical series of actual cohabitations would therefore have been preferred to test an effect of cohabitation on fertility, but such a series was not available.

Figure 2 about here

The conventional economic explanation for declining fertility is the price effect of the long-run growth in real earnings on the demand for children (the increasing opportunity cost of time) outweighing the income effect. The long-run increase in real earnings is displayed in Figure 3, which exhibits real national income (net national product at factor cost) per person of working ages.[11] For both countries, nominal data were deflated to prices of the base year 1983 and the New Zealand series was subsequently converted into 1983 Dutch guilders by means of the purchasing power parity exchange rate published in the Penn World Table (see Summers and Heston 1991). The 1983 actual exchange rate was 1.88 guilders for one NZ dollar, but a higher price level in The Netherlands implied a PPP exchange rate of 2.31 guilders per dollar.

In terms of purchasing power, earnings per person of working age tended to be somewhat higher in New Zealand than in The Netherlands, except from about 1926 to 1932 and 1978-1979. The gap was the largest in the early 1950s, so that it is not surprising that the immigration quota for Dutch citizens in New Zealand was easily filled at that time, while actual immigration since the mid 1970s from this source has been less than the permitted quota. If we interpret real income per adult of working age as an indicator of productivity, the acceleration of productivity growth until the late 1960s would have had in the Becker-Barro model a downward effect on fertility. The deceleration of productivity growth subsequently would have put upward pressure on fertility.

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[11] The population of working ages is equal to the population aged 15 to 60 in New Zealand and 15 to 65 in The Netherlands.

Figure 3 about here

Figure 4 provides evidence regarding the changes in social security payments. Again, the real amounts for the two countries (in 1983 prices) have been made comparable through the use of the 1983 PPP exchange rate. The introduction of such payments, the timing of major changes in policies and the real amounts paid out show a striking similarity between the two countries. This is an example of a significant diffusion of social policy initiatives across developed economies.

Figure 4a shows that universal child subsidy payments (the family benefit) were introduced in the Netherlands in 1941 and in New Zealand in 1946.[12] The amount paid in New Zealand was initially higher in real terms and the absence of indexing - with erosion of the real benefit followed by one-off nominal increases - is clear. The real subsidy paid to parents of Dutch children grew fairly steadily until 1980. However, parents of Dutch and New Zealand children received on average a similar family benefit in real terms.

The introduction and rapid growth of child support payments in the early post-war period would have encouraged higher fertility in both countries. In The Netherlands, the real value of the payments grew until the mid 1970s. Since then, the family benefit has fluctuated around the equivalent of 1000 guilders per child per year in New Zealand and 1600 guilders in The Netherlands.[13]

Figure 4 about here

Social security payments to elderly grew rapidly in The Netherlands since their introduction in 1947 until 1980 (Figure 4b).[14] Payments to elderly New Zealanders were similar in real terms until 1960. The acceleration of the real welfare payments to the elderly did not commence in the latter country until the 1970s, when a universal pension called National Superannuation was introduced in 1975. Real payments in recent years are lower.

Thus the trends in real social security payments to the elderly are similar to those made to children: rapid post-war growth as the welfare state grew in importance, with the subsequent dismantling of the welfare state to a more "targeted to needs" approach commencing in the 1980s. The effects on fertility of the changes in old age security payments would have been the opposite of those resulting from child welfare payments.

Figure 5 shows the fluctuations in the real interest rate. Data limitations implied that measurement of these series was far from ideal. For the Dutch case, use was made of

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[12] Means-tested child welfare payments were available in New Zealand from 1927 to 1945 and since 1985. These are included. In both countries, direct income-tax relief was generally not taken into account.

[13] In New Zealand, the family benefit payable to all parents was abolished on October 1, 1986 and replaced by a targeted benefit for low income families.

[14] The data actually also include payments to widows and orphans.

the yield on Dutch government consols, while for the New Zealand case only a series of the average rate of interest on new mortgages was available. The conversion to a real interest rate was based on the actual CPI index rather than a measure of expected inflation.

Figure 5 about here

There is a significant correlation between the real interest rates of the two countries at the 1 percent level, although the correlation coefficient is relatively small (0.49). Nonetheless, the data satisfy at least a necessary condition for the small open economy assumption to be valid. The average New Zealand real interest rate over the 1912-1990 period was 0.87 percentage points higher than the Dutch real interest rate. This is consistent with the notion that New Zealand has had to offer a premium to attract sufficient foreign capital. The theoretical model of section 2 suggests that this may have been a contributing factor to the average level of fertility having been higher in the latter country, but to disentangle such an effect for other potential influences requires the use of econometric models. The next section describes the results of some rather straightforward model specifications.

4. Regression equations

A substantial literature has emerged during the last decade concerning the appropriate specification and interpretation of long-run economic relationships (see Engle and Granger 1991 for an overview). Many macroeconomic time series have stochastic trends. The correlations which are detected in regression models which relate such variables are likely to be spurious and the conventional statistical inference inappropriate.

The first step in specifying the regression equations is therefore to consider the statistical properties of the individual series. The unit root tests which have been developed to test for non-stationarity have had a major impact on econometric practice (e.g. Engle and Granger 1987). Essentially, such tests regress a variable on its own lagged values and when the hypothesis that the coefficient of the first lag is one (a unit root) cannot be rejected, the series is considered non-stationary.

Two popular test procedures for the presence of unit roots are the Augmented Dickey-Fuller test and the Phillips-Perron test.[15] These tests consider the estimated coefficients of the following equation:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t$$

The following hypotheses are tested regarding these coefficients:

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[15] A textbook outline of these procedures can be found e.g. in Davidson and MacKinnon (1993), Chapter 20.

H.1: $\alpha_1 = 0$
H.2: $\alpha_1 = 0, \alpha_2 = 0$
H.3: $\alpha_1 = 0, \alpha_2 = 0, \alpha_0 = 0$
H.4: $\alpha_1 = 0, \alpha_0 = 0$ (given $\alpha_2 = 0$)

The interpretation of these tests is as follows. H.1 tests for the presence of a unit root, irrespective of whether there is a deterministic drift (non-zero constant) or trend (non-zero coefficient of time t). H.2 tests for a unit root without a deterministic trend. H.3 tests for a unit root without a trend or drift. H.4 tests for a unit root without drift given that it is assumed that a deterministic trend is absent.

The Augmented Dickey-Fuller test requires the choice of the lag length p and assumes an autoregressive data generating process for the time series Y_t. The Phillips-Perron test does not include the lag terms (i.e. $p = 0$), but uses a non-parametric correction of the test statistics. When there is uncertainty regarding the ARMA structure of the time series, the Phillips-Perron unit root test is preferred. However, in this case a truncation lag parameter needs to be chosen to compute the correction factor. The statistical results below were derived with SHAZAM (White 1993). This program sets the parameter equal to the highest significant lag from either the autocorrelation function or the partial autocorrelation function from the first differenced series.

The results of the unit root tests are reported in Table 1. Conclusions are drawn only where all test statistics suggest the same. The first point to note is that where conclusions can be drawn, the conclusions for both countries are the same. The graphs described in the previous section demonstrated a remarkable similarity in the long-run movement of the corresponding time series. This is confirmed statistically by the results of Table 1.

As equation (17) indicated, the regression models will have the natural logarithm of the fertility rate as the dependent variable. Table 1 shows that LOGNTFR and LOGZTFR are both integrated of order one, i.e. I(1), since they are difference-stationary (which is confirmed by the Phillips-Perron tests on the differenced series DLOGNTFR and DLOGZTFR).

Table 1 about here

However, Table 1 shows that the real interest rate series in The Netherlands is stationary, while the one for New Zealand is also possibly stationary (as confirmed by H.4, but particularly the statistic for H.3 is too low). Given the plausibility of a stationary real interest rate, the only source of the stochastic trend in the fertility series must be, according to equation (17), the variables affecting the growth in the real net cost of child rearing (assuming additive stochastic disturbances in the true model are stationary). Table

1 shows that there is indeed evidence of stochastic trends in variables such as real income per person of working age (in The Netherlands) and social security for the aged (in both countries). In other cases, the test statistics are equivocal.

It appears that the variables which could potentially affect the total fertility rate are a mixture of I(0) and I(1) variables. The cointegration framework is therefore not fully applicable, but it is possible that a linear combination of the I(1) variables is stationary. The residuals of the regression model are then also stationary. In this case, the OLS estimator is shown to be "superconsistent" (e.g. Stock 1987). However, the use of t-ratios for the usual hypothesis testing regarding the influence of specific variables is not appropriate. Formal procedures which generate t-ratios with normal limits are available (see Engle and Yoo 1990). Here we will simply identify relatively large t-ratios as evidence of some influence of variables in models in level form when the residuals are stationary and then test such effects by proceeding to estimate models in difference form.

Additionally, our strategy is to fit the same models to both countries and not to seek "best fit" models for each individually. This implies that insignificant variables are not excluded (and the likelihood of specification bias is therefore reduced) and the dynamics are kept simple. This will facilitate the extraction of a limited set of rather robust results. Table 2 shows the results of estimation of equation (17) in level form. The top half of the Table substitutes for g_t^e actual current growth rates of variables which may be expected to affect the real cost of child rearing. The bottom half of the table uses the levels of these variables and basically assumes that we are agnostic about the exact way in which these variables influence the expected growth in the cost of child rearing.

Table 2 about here

The regression models fit very well, particularly in the case of The Netherlands, but - as was to be expected - all four equations exhibit significant autocorrelation. The Durbin-Watson statistic is less than the critical lower bound in all cases. However, in the two equations for The Netherlands, the DW statistic is close to one and the Phillips-Perron tests of the stationarity of the residuals in the OLS regression are close to the critical values (and in fact exceed these in the case of the t-ratio test).

Re-estimation with a correction for first-order autocorrelation (not reported in Table 2) removes the problem in the equations for the Netherlands and shows that the variables having OLS t-ratios of 3.5 or more are significant after the correction has been made. For New Zealand, the results are rather more fragile.

Table 2 suggests a positive influence of the interest rate on fertility in the bottom half of the table, but not in the top half. However, even in the case of the largest t-ratio (2.34) the coefficient becomes insignificant at the conventional levels when a correction for positive autocorrelation is introduced. The evidence to support the hypothesis that the real interest rate has had a positive influence on fertility is therefore rather weak.

More robust results are found with respect to the deterministic trend and the social security variables. The downward trend can be explained in terms of the Becker-Barro model as a decline in the parameter α, which measures the degree of altruism with respect to the descendants. The results therefore suggest that adults have become less altruistic (or, in an alternative interpretation, more myopic). We also see that the introduction of "family benefit" payments to parents led to increasing fertility, while the introduction of social security for the aged led to lower fertility. These results reinforce earlier findings by e.g. Swidler (1986) for the USA, or those reported in the survey by Cigno (1992). It should be noted, however, that such evidence may be consistent with fertility theories which incorporate parental altruism as well as those in which fertility is driven by self-interest (Cigno 1992, p. 181).

The effect of real income on fertility is rather inconclusive. In levels there appears to be a possibly negative effect of real income on fertility in The Netherlands, but a significantly positive effect in New Zealand. In growth rate terms, fertility appears to have been higher in The Netherlands at times of higher per capita income growth. This is a rather surprising result since the growth in real income would imply a growth in the real cost of child rearing, which includes a time cost. There is also a causality issue due to the effect of birth rates on per capita income growth, but generally we would expect fertility and economic growth to be inversely correlated (see also e.g. Brander and Dowrick 1994).

Table 2 suggests that an increasing marriage propensity in the population increases the fertility rate in The Netherlands. The coefficient of NUPTRT plays no role in the case of New Zealand. The time series of fertility in Figure 1 suggest that fertility was postponed towards the end of the two World Wars, with a “catching up” effect immediately after the war. The marriage rate series behave similarly, but the effect becomes more noticeable in the error correction models discussed below. Alternative models with dummy variables for the World Wars add little to the specification when NUPTRT is included, but “pick up” the effect of the wars when it is not.

Table 3 provides additional tests of the various influences on fertility by reporting simple error correction models (ECMs), that is, models with variables in first differences and their lags plus the lagged residual of the regression in levels as the error correction term. The latter variable should have a negative coefficient. Given that the level-form equations do not strongly suggest co-integration and given the relatively large number of variables, no extensive search was attempted of the optimal lag length. A maximum lag length of one year was imposed.

Table 3 about here

Because the equations of Table 3 are based on differenced variables (except for the error correction term), the constants now signal the linear trend in the original series and the constants are indeed both negative and significant in the case of The Netherlands. A negative long-run trend was also detected by Tzannatos and Symons (1989). In the present context, it suggests a growing myopia or less concern for future generations, as mentioned earlier.

Given the corresponding number of observations and variables, the Durbin-Watson statistics are in the inconclusive range. As can be expected, the fit of the ECMs is not very close, but somewhat better in the case of The Netherlands. Because the New Zealand data were derived from a number of different sources and the construction of the time series involved several assumptions with the respect to the linking of data sources, the New Zealand data may be considered less reliable. This, in turn, may explain the relatively better performance of the ECMs for The Netherlands.

The regressions show once again that fertility is positively affected by the marriage propensity. Conversely, the growth in single person households and *de facto* unions in recent decades has contributed to the decline in fertility. However, real income per person of working age and the real interest rate are not significant in the Table 3 regression models.

The earlier detected positive effect of the family benefit on fertility in Table 2 is reinforced by Table 3, although the t statistics are not significant in the New Zealand case. Similarly, the introduction of social security for the aged has had a negative effect on fertility in The Netherlands. Finally, the error correction term has the expected sign in the case of The Netherlands, and is also statistically significant.

While of similar magnitude, the parameter estimates in the models discussed so far differ markedly between The Netherlands and New Zealand. If the same processes are driving fertility in these two small open economies, a natural question is what the performance would be of a model which pools the data of the two countries. Here we estimated the cross-section heteroscedastic time-wise autoregressive model proposed by Kmenta (1986). Given that the two economies may be sensitive to similar international exogenous shocks, we also included the additional feature of contemporaneous correlation of the error terms in the two countries and estimated the resulting system by Generalised Least Squares. The results are reported in Table 4.

Table 4 about here

The results in this table reinforce the downward trend in fertility (reflecting a diminishing degree of intergenerational altruism in the Becker-Barro model), and the significant effect of social security payments. A higher marriage propensity increases, as expected, fertility. For the sake of brevity, models which include country effects in coefficients have not been included, but inspection of coefficients and standard errors in Tables 2 and 3 suggest that such country effects are generally significant. As noted in section 2, differences between corresponding coefficients of the regression models may be due to country differences in preferences or in expectations formation. Additionally, there may be country-specific phenomena affecting the growth in the net real cost of children, which we were unable to capture in our model.

5. Conclusions

In this paper we have tested whether the dynastic utility model of fertility behaviour introduced by Becker and Barro (1988) fitted the observed fluctuations in the long-run trends in fertility in The Netherlands and New Zealand.

The model suggested that fertility is influenced by variables which affect the real growth in child rearing costs, the degree of altruism of parents with respect to their children and subsequent generations, and the real interest rate. The results reported above provided support for the former two types of influences. A positive influence of the real interest rate could also be detected, but it was rather fragile in the specifications considered in this paper.

However, the results do highlight the impact of social security payments on fertility. The regression models suggest that the introduction of a substantial subsidy to families just after World War II boosted fertility significantly. This occurred at a time when fertility was increasing in any case to catch up from the low level of fertility during the war. The regression result shed some light on why, for example, the large subsidies available at present to parents in France do indeed coincide with a level of fertility which generates two-thirds of the natural increase in the entire European Union.[16] Birth rates in Scandinavia, which also have generous family support, have also increased during the last decade.

Similarly, the growth in old age social security has reduced fertility. Conversely, the current trend in many developed countries to reduce the present value of the transfers to the aged in response to the fiscal consequences of the aging of the population, may lead to an increase in fertility.

While the results in this paper provide some support for the posited Becker-Barro framework, they are not very conclusive with respect to detecting a positive effect of the real interest rate. Furthermore, the strong effects of social security payments which we described in this paper, had already found support in earlier empirical work (see e.g. Cigno 1992) and can be also explained by alternative behavioural models. Consequently, much remains to be done in extending this type of modelling to a wider range of

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[16] See "Europe's Population Shrinking", *The Economist*, November 9 1996, p. 74.

countries, a careful consideration of the intertemporal dynamics and by taking into account a wider range of influences on the intertemporal budget constraint.

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ANNEX

Variable names referred to in the text and the tables have been constructed by the following conventions:

N at the start of a variable name refers to The Netherlands
Z at the start of a variable name refers to New Zealand
D at the start of a variable name refers to taking first differences
LOG at the start of a variable name refers to taking the natural logarithm

The variable names are:

TFR: The total fertility rate.
SURVPB: The probability of survival to age 15
NUPTRT: The number of marriages per 1000 of the population
RYPW: Real income per person of working age
CHLDSS: The average annual amount of social security payments to children per recipient
AGEDSS: Public average annual old age pension paid per recipient
RI: The real interest rate
EC: The residual of the cointegration regression

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Figure 1 The Total Fertility Rate

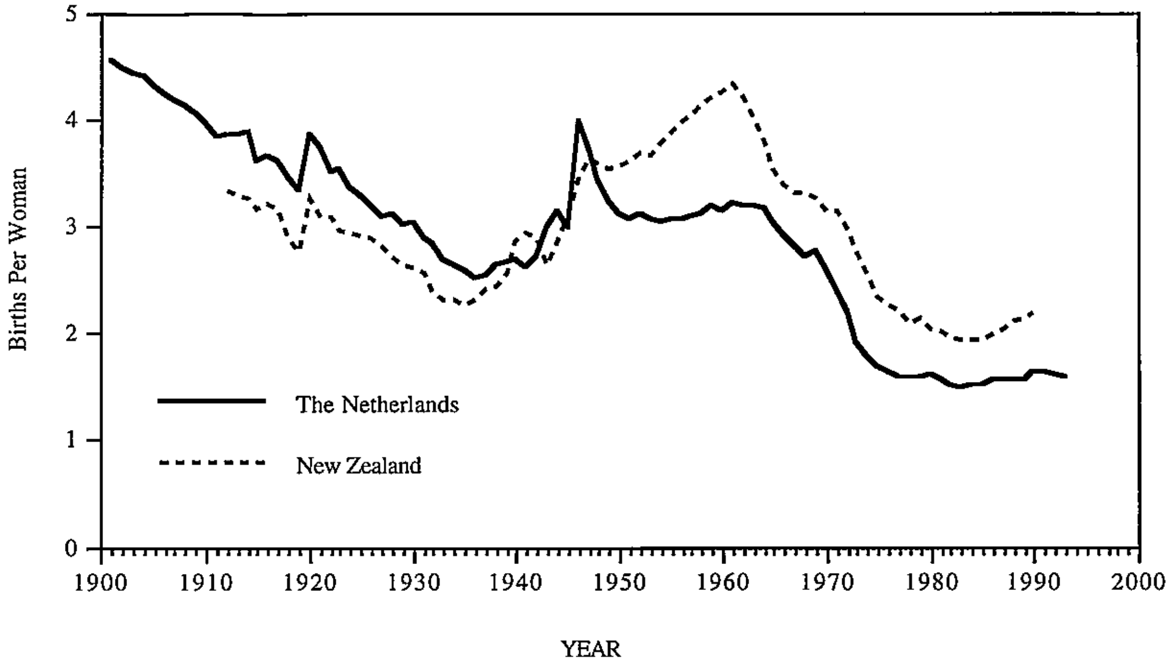
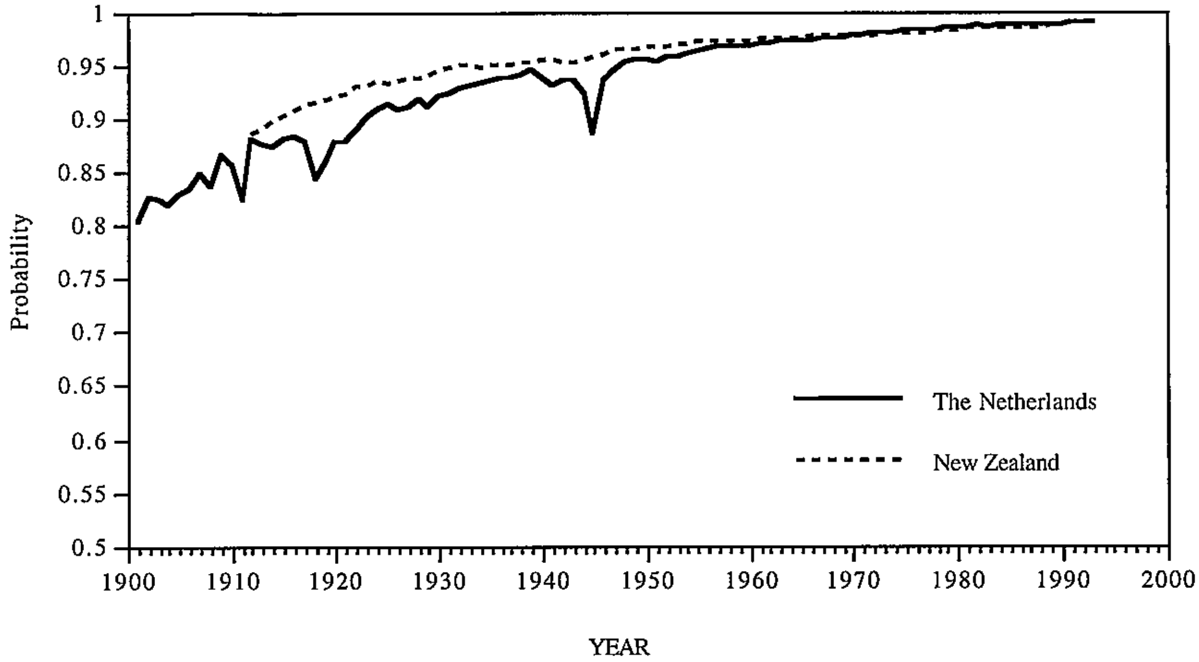
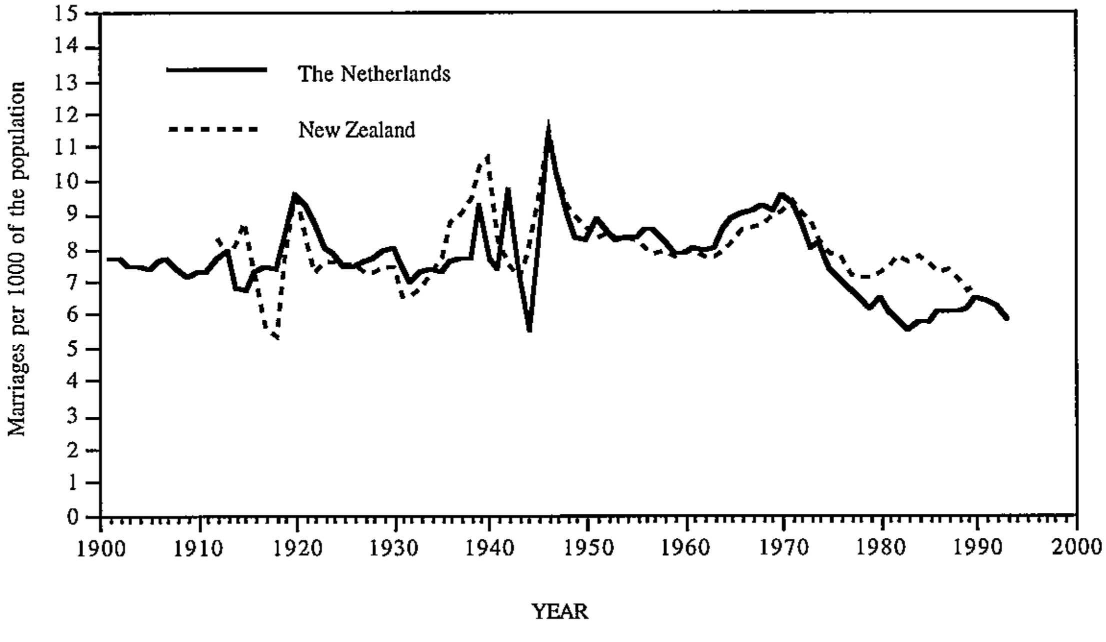


Figure 2 Demographic influences: child mortality and the marriage rate



(a) The probability of survival to age 15



(b) The number of marriages per 1000 of the population

Figure 3 Real income per person of working age

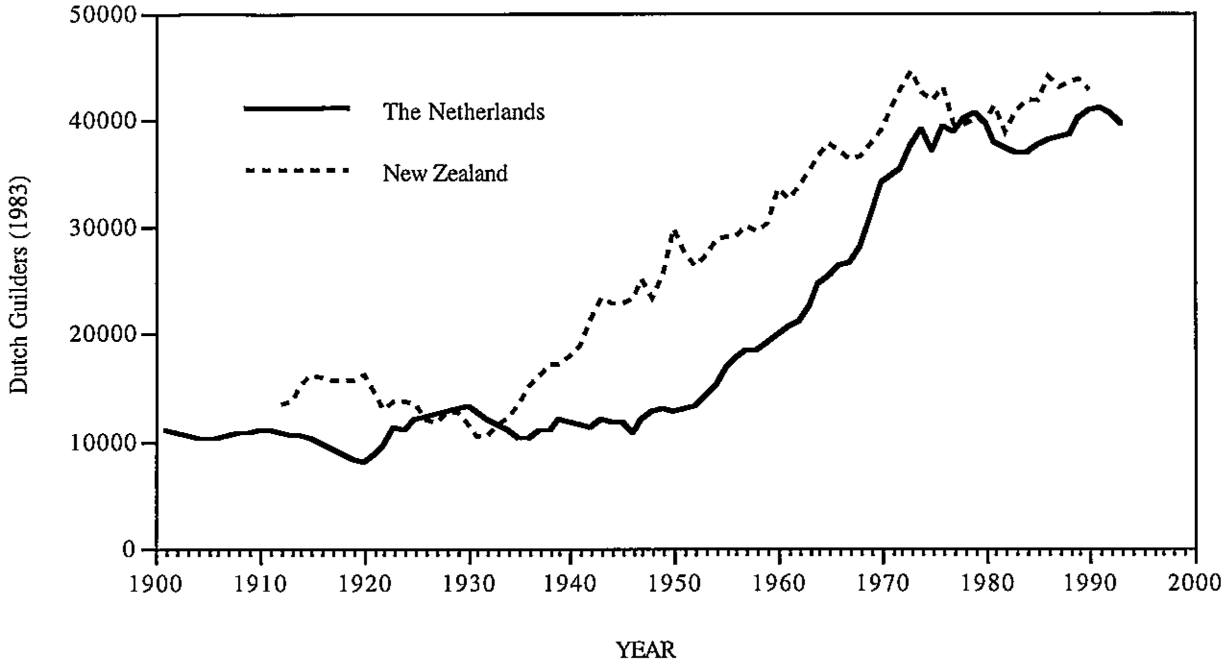
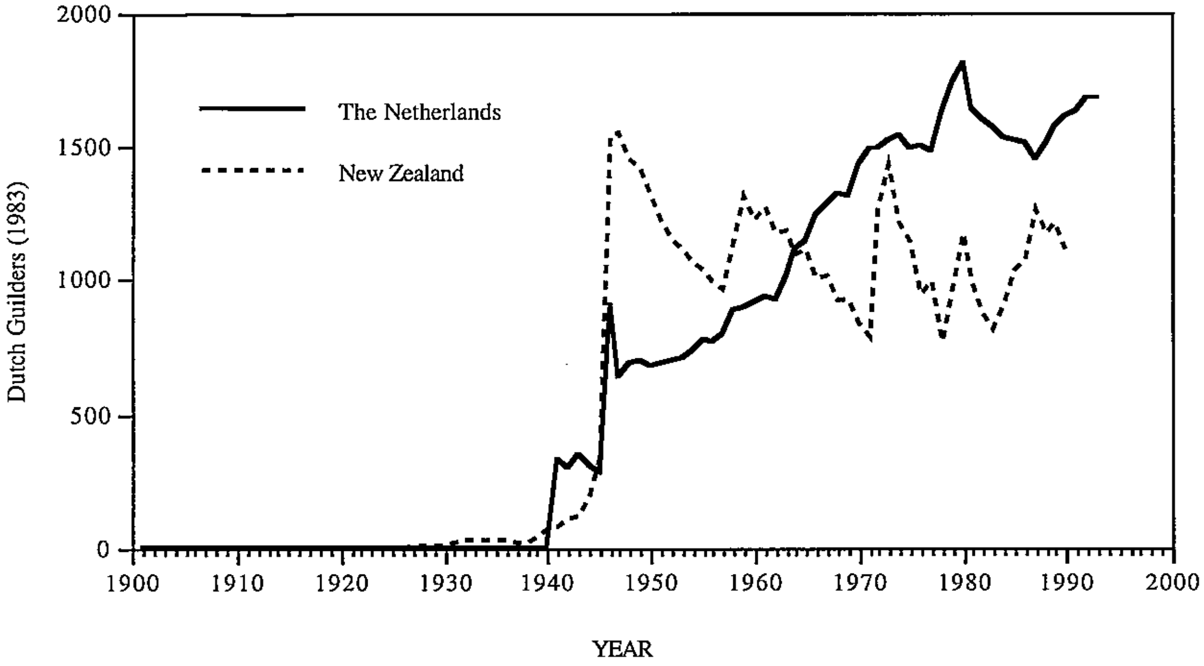
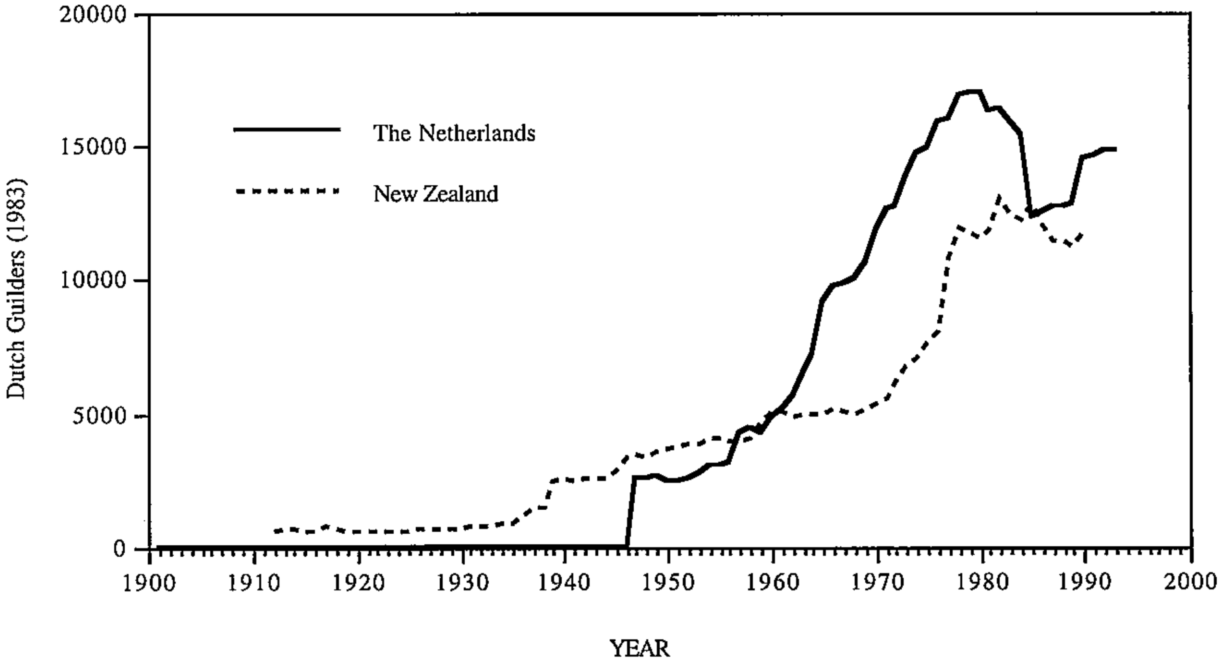


Figure 4 Social welfare payments to children and the aged



(a) The average annual amount of social security payments to children per recipient



(b) Public average annual old age pension paid per recipient

Figure 5 The real interest rate

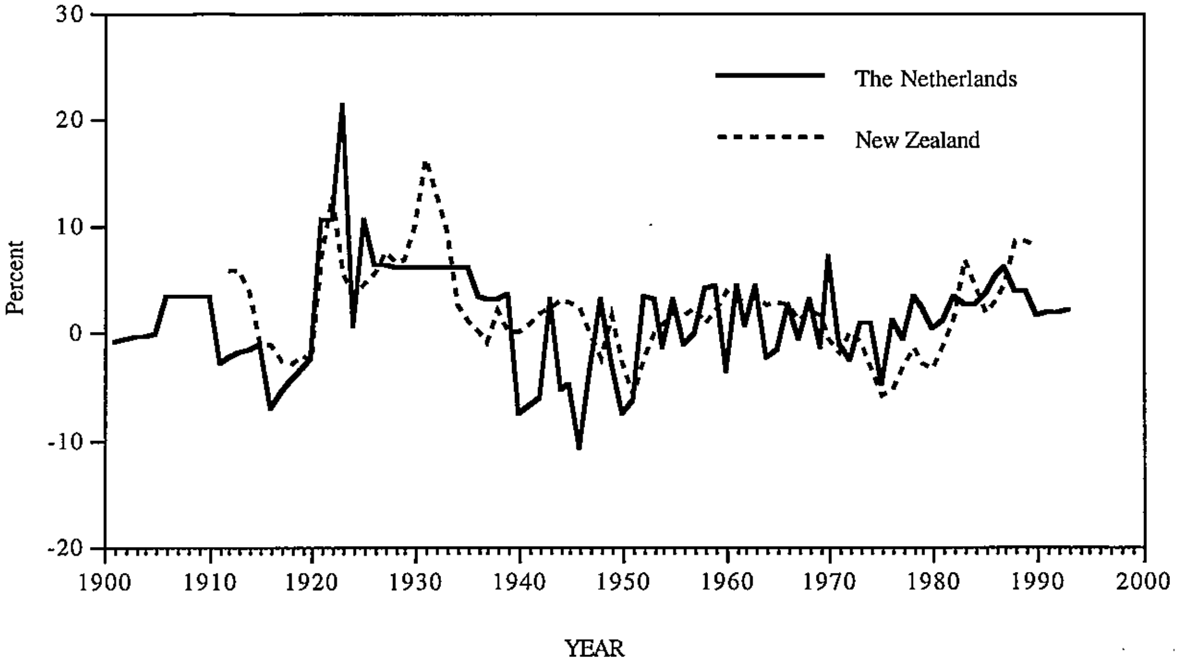


Table 1 Unit Root Tests

Procedure: Phillips-Perron, 10% Significance level*					
	H.1	*H.2*	*H.3*	*H.4*	
Critical Values:	- 18.30	5.34	4.03	3.78	
Variables					*Conclusion*
LOGNTFR	-4.33	1.07	2.25	2.48	I(1)
DLOGNTFR	-92.89	39.80	26.54	40.15	I(0)
LOGZTFR	-2.01	0.55	0.64	0.70	I(1)
DLOGZTFR	-53.41	19.09	12.73	19.23	I(0)
NSURVPB	-19.89	7.45	6.20	7.97	I(0)
DNSURVPB	-95.34	142.95	95.34	120.81	I(0)
ZSURVPB	-7.36	42.67	56.26	55.40	I(0) with trend
DZSURVPB	-76.25	32.81	21.91	22.63	I(0)
NNUPTRT	-19.44	5.23	3.51	4.58	
DNNUPTRT	-58.85	56.99	38.00	56.41	I(0)
ZNUPTRT	-16.76	4.48	3.00	4.59	
DZNUPTRT	-31.47	19.54	13.04	20.19	I(0)
NRYPW	-3.32	3.14	4.71	3.88	
DNRYPW	-63.84	22.03	14.69	20.84	I(0)
ZRYPW	-7.25	2.12	3.32	3.00	I(1)
DZRYPW	-76.92	37.05	24.71	37.49	I(0)
NCHLDSS	-3.56	1.20	2.85	4.10	
DNCHLDSS	-29.38	13.38	8.92	13.24	I(0)
	-18.95	5.86	3.93	5.96	
DZCHLDSS	-25.51	18.75	12.50	19.21	I(0)
NAGEDSS	-1.60	0.94	2.32	3.55	I(1)
DNAGEDSS	-33.55	13.50	9.00	12.85	I(0)
ZAGEDSS	-5.22	1.47	2.21	1.91	I(1)
DZAGEDSS	-27.83	10.26	6.84	10.52	I(0)
NRI	-46.33	15.05	10.04	15.22	I(0)
DNRI	-116.54	149.98	99.99	152.14	I(0)
ZRI	-17.83	4.53	3.02	4.58	
DZRI	-45.66	27.04	18.03	27.36	I(0)

*The data consist of annual observations from 1901 to 1993 for The Netherlands and 1912 to 1990 for New Zealand, except for the social security variables. The Phillips-Perron tests for the latter variables used observations from 1950 onwards.

Table 2 Estimation of equation (17)

Note: t-ratios are in parentheses				
Dependent Variable	The Netherlands: LOGNTFR		New Zealand: LOGZTFR	
Explanatory Variables				
OLS; using growth rates of child rearing cost indicators				
TREND	-0.01553	(-15.09)	0.00079	(0.29)
G SURVPB	-1.0240	(-1.64)	8.2725	(0.91)
NUPTRT	0.03685	(3.66)	-0.00812	(-0.51)
G RYPW	0.56277	(2.36)	-0.1013	(-0.39)
G CHLDSS	0.00077	(10.05)	0.00038	(8.02)
G AGEDSS	-0.00006	(-10.64)	-0.00007	(-5.62)
RI	0.00023	(0.10)	-0.00197	(-0.53)
CONSTANT	1.2663		1.1263	
OBS	*92*		*78*	
R^2	*0.95*		*0.74*	
DW	*0.96*		*0.38*	
PP Z TEST CR.VAL. = -43.5	*-41.6*		*-16.58*	
PP T TEST CR.VAL. = -4.70	*-5.19*		*-3.05*	
OLS; using levels of child rearing cost indicators				
TREND	-0.01453	(-6.61)	-0.02281	(-2.95)
SURVPB	-0.11487	(-0.18)	6.2589	(1.99)
NUPTRT	0.03897	(3.74)	0.00453	(0.32)
RYPW	-0.000008	(-1.55)	0.00003	(4.18)
CHLDSS	0.00078	(9.86)	0.00030	(6.29)
AGEDSS	-0.00005	(-5.16)	-0.00004	(-2.82)
RI	0.00409	(2.06)	0.00905	(2.34)
CONSTANT	1.4052		-4.6451	
OBS	*93*		*79*	
R^2	*0.95*		*0.78*	
DW	*0.97*		*0.50*	
PP Z TEST CR.VAL. = -43.5	*-42.16*		*-21.56*	
PP T TEST CR.VAL. = -4.70	*-5.27*		*-3.52*	

Table 3 Simple Error Correction Models

Note: t-ratios are in parentheses

Dependent Variable	The Netherlands: DLOGNTFR		New Zealand: DLOGZTFR	
Explanatory Variables				
OLS; using levels of child rearing cost indicators				
D SURVPB	0.31648	(0.89)	1.0320	(0.35)
D SURVPB$_{-1}$	-0.04842	(-0.13)	0.5280	(0.18)
D NUPTRT	0.01221	(2.09)	0.011113	(1.41)
D NUPTRT$_{-1}$	0.02285	(3.90)	0.02566	(3.22)
D RYPW	-0.0000006	(-0.12)	-0.0000004	(-0.82)
D RYPW$_{-1}$	-0.000002	(-0.36)	0.000002	(0.37)
D CHLDSS	0.000271	(5.00)	0.00005	(0.96)
D CHLDSS$_{-1}$	-0.000038	(0.69)	0.000008	(0.22)
D AGEDSS	-0.00001	(-1.51)	-0.000008	(-0.61)
D AGEDSS$_{-1}$	-0.00001	(-1.63)	-0.000007	(-0.59)
D RI	-0.00025	(-0.25)	0.00047	(0.21)
D RI$_{-1}$	0.00067	(0.73)	0.00174	(0.92)
EC$_{-1}$	-0.13227	(-2.06)	0.024458	(0.44)
CONSTANT	-0.01093	(-2.53)	-0.00555	(-0.69)
OBS	91		77	
R^2	0.58		0.31	
DW	1.60		1.63	

Table 4 The Cross-Section Heteroscedastic Time-Wise Autoregressive Model

Note: t-ratios are in parentheses		
Dependent Variable	The Netherlands & New Zealand DLOGTFR	
Explanatory Variables		
Kmenta (1986) pp. 622-625 model		
TREND	-0.006158	(-3.11)
SURVPB	1.5053	(2.72)
NUPTRT	0.016584	(2.73)
RYPW	0.000003	(1.15)
CHLDSS	0.0001	(2.96)
AGEDSS	-0.00003	(-5.48)
RI	0.000361	(0.35)
CONSTANT	-0.28275	(-0.57)
OBS	*158*	
BUSE R^2	*0.43*	
DW	*1.01*	
RHO NL *RHO NZ*	*0.82088* *0.79191*	

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