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Why are Fertility and Female Participation Rates Positively Correlated across OECD countries?

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Abstract

The aim of this paper is to understand recent observations of fertility, female employment, and participation rates in O.E.C.D. countries. These observations indicate that fertility rates are positively correlated with female employment ratios and participation rates across O.E.C.D. countries during the period 1985-1996. Moreover, the time series observations show that fertility rates are procyclical in developed countries. Economic theories of fertility developed after the seminal work of Mincer (1962) and Becker (1965) are consistent with secular trends of fertility and female employment but do not account for these recent observations. In this paper we explore the role of labor market frictions in understanding the positive association between fertility and employment among O.E.C.D. countries. To this end we develop a framework of fertility and labor market participation decisions which is designed to quantitatively study the impact of labor market frictions on the timing of births, the fertility rate, and the labor market participation of females. We find that unemployment induces females to postpone and space births which, in turn, reduces the total fertility rate. In our framework, economies with a high unemployment rate are characterized by a low fertility rate, female participation, and female employment ratio. We also find that in our framework, differences in unemployment rates similar to the ones observed among O.E.C.D. countries, can generate a positive correlation between fertility and labor market participation rates. Interestingly, a temporary shock that increases job destruction can generate a decrease of the fertility rate and of the female employment ratio that mimics time series observations of Sweden during the 90's.

JEL classification numbers: J13, J24, J64.

Keywords: Total fertility rates; female employment ratios; unemployment; timing of births.

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1 Introduction

The goal of this paper is to explore the role of labor market frictions in understanding recent observations of total fertility rate, female participation rate, and employment ratio in OECD countries. The standard theory of labor market and fertility decisions, based on the seminal work of Mincer (1962) and Becker (1965), abstracts from labor market frictions. This theory implies that an increase in real wages induces women to allocate more time into the labor market and decrease non-market activities such as home production and child bearing. This theory thus implies a negative association between fertility rates and female employment ratio, which is consistent with the secular trends of fertility rates and female employment ratios among developed countries. However, during the period 1985-1996, average total fertility rates and female employment rations are *positively* associated among O.E.C.D. countries (see Figure 1). There is also time series evidence of a *positive* correlation between female employment ratio and total fertility rate along the business cycle. In this paper, we introduce unemployment and the timing of births into an otherwise standard fertility decision model and show that these features can go along way in accounting for the positive association between female employment ratio and total fertility rate in O.E.C.D. countries.

Our paper is motivated by some observations suggesting that unemployment can play a role in understanding the positive association between fertility rate and female employment ratio. For instance, in Sweden the fertility rate decreased significantly during the 90's when female and male employment fell (see Figures 10, 11 and 12 in Section 6.2). In East Germany fertility collapsed at the same time that unemployment raised during the transition to democracy (Kreyenfeld, 2000). More generally, Ahn and Mira (2002) find that in most O.E.C.D. countries the fertility rate shows a negative response to unemployment along the business cycle (i.e. fertility is procyclical). In their empirical analysis using O.E.C.D. data, Ahn and Mira (2002) find that the cross-country correlation between female participation rate and fertility rate became of positive sign by the late 80's. They point out that the reverse of the sign of the cross country correlation between participation and fertility rates occurred simultaneously with the emergence of high unemployment rates. Indeed, Spain and Italy, which have exhibited the highest unemployment rates among O.E.C.D. countries, have also the lowest fertility rates as Table 1 shows (O.E.C.D., 1999).

[**Insert Figure 1**]

We build a quantitative life cycle model of fertility and labor market decisions and show that labor market frictions can generate a positive correlation between fertility and labor market participation rates across economies. In our framework, unemployment has non trivial effects on fertility and labor market decisions. Unemployment reduces the opportunity cost of mothers' time which

	Fertility	Unemployment
U.S.	2.02	4.5%
Sweden	1.74	5.9%
Italy	1.17	12.6%
Spain	1.18	27.5%

Table 1: **Fertility and Female Unemployment Rates in 1995**

induces females to decrease their market participation and have more children. On the other hand, unemployment may affect negatively fertility because of its consequences for the timing of births. If births are frequent, working mothers have to interrupt their career because children are time costly. Career interruptions are costly in terms of the forgone wages and the skills lost during a job separation. Since labor market frictions increase the duration and thus the cost of a career interruption, they induce working mothers to space births. The spacing of births, due to a finite fertile life, lead to a decrease in the total number of births.

Our model builds on Ljungqvist and Sargent (1998) in several dimensions. We introduce a time allocation decision in the spirit of Mincer (1962) and Becker (1965). We assume that individuals allocate their time in market and non-market activities. Market activities consist in working and searching for a job and non-market activities consist in raising children and enjoying leisure. Children are intensive in mothers' time and also involves costs in terms of consumption goods.[1] While the time cost provides a channel through which unemployment may increase fertility rates, the cost in goods implies that unemployment has a negative income effect on fertility decisions. We consider a life cycle framework in order to model the timing of births. This assumption plays an important role in our results.

We calibrate the steady state of our model to match some stylized facts of the U.S. economy. We use our model to generate cross section and time series artificial data of total fertility rates and female participation rates. In a first experiment, we generate steady state observations of economies that only differ in the job finding rate. Our results show that births are delayed and total fertility rate is lower in economies where unemployment is larger. Moreover, higher unemployment induces a lower labor participation and employment. As a consequence, fertility and labor participation rates are positively correlated across steady state economies. In a second experiment, we generate

[1]There is evidence that family status conditions how women allocate their time between market and non-market activities. In fact, according to Hill (1981) women spend 25% of their time working at home when they work full-time in the market, while males spend only 12% of their time working at home. The difference between male and female time allocated in home production is higher if women work part-time. In this case, they spend 34% of their time working at home. Income and social security taxes maybe responsable of the preference of women for part-time jobs in some OECD countries. See, Employment Outlook, chap. 6, 1990.

time series data of total fertility rate and labor participation rate of an economy that is affected by a transient unemployment shock. In the spirit of Ljungqvist and Sargent (1998) we assume that an unexpected shock that lasts one period increases job separation and partially destroys skills. We find that birth rates decrease for females of all age groups which induces a decrease of the total fertility rate. At the same time, employment and participation rates decrease. This implication of the model is consistent with the time series observations for Sweden during the 90's.

Our findings are supported by recent empirical papers suggesting that labor market institutions have a significant impact on fertility rates in developed countries. Del Boca (1999) focuses on the dramatic decrease of fertility rates in Italy and its relation with rigidities of the Italian labor market. She estimates a reduced form model of participation and fertility probabilities. She finds that the availability of child care and part-time work increases both the probability of having a child and working. However, her analysis ignores the impact of unemployment on labor market participation and fertility decisions. Adserà (2001) estimates a reduced form model of fertility and age specific birth rates using a panel of 23 O.E.C.D. countries for the last 35 years. Her main findings are a strong negative impact of unemployment on fertility especially since the 80's and, contrary to Del Boca (1999), a negative impact of part-time work on fertility. Adserà (2001) also finds that unemployment has a stronger negative impact on the fertility of younger than of older women which may be evidence that births are postponed due to unemployment. A contribution of our paper is to provide a quantitative framework of labor market and fertility decisions in which to study the impact of labor market frictions on fertility rates.

Our paper is related to quantitative studies on economics of the family. Most of these papers model marriage decisions and ignore the labor participation decision of women (see, for instance, Aiyagari, Greenwood and Guner (2000), Chade and Ventura (2002), Fernández and Rogerson (2001), and Regalia and Rios-Rull (1999)). Similarly to us, Conesa (1999) and Caucutt, Guner and Knowles (2002) model the timing of births but they abstract from labor market decisions. Differently from this literature, our paper and Erosa, Fuster, and Restuccia (2002) model the interaction between labor market and fertility decisions. In particular, Erosa, Fuster, and Restuccia (2002) focus on the effect of fertility decisions on female labor market turnover and the determination of the gender wage gap in the U.S. and do not study the cross country association between female employment ratios and fertility rates.

The paper is organized as follows: The next section presents the key features of the model. Sections 3 and 4 state the decision problem of a household and the definition of stationary population growth. Section 5 presents the calibration of the steady state of the model. Section 6 reports the results of the numerical experiments and Section 7 concludes the paper.

2 The Model

Our model builds on Ljungqvist and Sargent (1998) in that individuals have finite lifetime, take fertility and labor market participation decisions. Females decide how to split their time between market activities (working and searching) and non-market activities (raising children and enjoying leisure).

Demographics

The economy is populated by overlapping generations of females that live T periods as adults and t_1 periods as children. Only adult individuals take economic decisions. We assume that females are fertile only during the first t_2 periods of adulthood. When females are fertile, they face a stochastic shock determining whether they can consider having a newborn child or not.

Preferences

Females derive utility from lifetime consumption, leisure, and the number of children, where the per-period utility function $u(c, l, N) = \alpha_1 \log c + \alpha_2 \log N + l$. They maximize the expected present value of the per-period utility

$$E\left\{\sum_{i=1}^{T} \beta^{i-1} u(c_i, l_i, N_i)\right\},$$

where β is the intertemporal discount factor and i denotes an individual's age.

Endowments

When females become adults, they draw an initial endowment of human capital, H_1, and an age-profile of consumption goods, $\omega \equiv (\omega_1, \omega_2, ...\omega_T)$ from an exogenous distribution $\Psi(H_1, \omega)$. The endowment of goods ω represents households income other than female earnings. Human capital will evolve stochastically depending on the labor market experience of females as we shall later describe. Females are also endowed with one unit of time in each period of their lives which can be allocated to market and non-market activities. Market activities consist in working and searching for a job. Non-market activities consist in enjoying leisure and raising children.

Market activities: Working and Searching

Consumption goods are produced with a linear technology on labor input. We assume that females can only work either $\overline{h}$ or 0 hours. Labor productivity depends on human capital and an index of market luck w. As a result, total ouput of consumption goods is given by $Y = wH\overline{h}$.

Individuals differ in their labor productivity because of different labor market experience and luck. Experience affects labor productivity because human capital is accumulated on the job and depreciates when females do not work (this is consistent with the evidence reported by Mincer and Ofek (1982) among others). In order to reproduce a reasonable age-wage profile, we assume that the human capital growth rate, ε_i , and depreciation rate, δ_i, depend on individuals' age. Modeling the effect of experience on earnings is necessary to capture the cost of fertility-induced career interruptions. However, the effect of experience on wages is not sufficient to account for the heterogeneity in wages that we observe in the data. Since wages are a crucial determinant of fertility and labor market decisions, we want the model to reproduce the heterogeneity of wages observed in real data. To this end, we introduce a stochastic component of labor productivity which we interpret as market luck and is given by $w = e^{u_t}$, where u_t follows a first order Markov process $u_t = \rho u_{t-1} + \varepsilon_{u,t}$, $\varepsilon_{u,t} \backsim N(0, \sigma_\varepsilon^2)$.

We assume that individuals search in order to obtain a production technology. Search is costly in terms of time. In particular, search requires a fix amount of time z. When females search, they obtain a production technology with probability π. In this case, we say that females have a job offer. An exogenous fraction of production technologies (jobs) λ are terminated each period.

Costs of raising children

Mothers face an extra cost of participating in market activities relative to non-mothers. We assume that there are two types of children, time intensive children and non-time intensive children. The first type of children require one unit of child care services per hour that their mothers allocate to market activities, while the second type does not require child care services. We assume that all children are born as time-intensive types and become non-time intensive with a fix probability. Non-time intensive children remain so until the end of their childhood. The expected length of the time intensive period is calibrated to last 6 years. Modeling two childhood stages is intended to capture, in a computational simple way, the idea that young children are more time costly than older children.[2] For notational convenience, we will denote children at the time intensive stage as "children younger than 6".

We also assume that all children require a fixed amount of mother time that cannot be substituted by child care services. In this way, the opportunity cost of rasing children increases with mothers' labor productivity. The time cost of raising time intensive children is equal to τ_1 and is assumed to be higher than the cost of raising non time intensive children τ_2. Raising children is also costly in terms of goods since each child requires $\varkappa$ units of consumption goods per period. Given that individuals cannot borrow or save, the fixed cost in consumption goods imposes a limit on the number of children of mothers with low labor productivity (i.e. low opportunity cost of raising children).

3 The Decision Problem of Females

It is useful to assume the following timing for decisions: First, females decide whether to participate in market or non-market activities. Second, if the female enjoys a fertility opportunity, she decides

[2] The stochastic duration of the time intensive stage is quite convenient for computational reasons. Under this specification, only the total number of children and the number of children in the time intensive stage are state variables in the females' decision problem. If we were to assume that the time intensive stage last from age-1 to age-6, the age distribution of children would be part of the state of a female.

whether to have a child or not. At the end of the period, she faces labor market and fertility shocks.

First stage: Choosing whether to participate or not in market activities

Females without a job offer decide whether to search or not while those with a job offer decide whether to work or reject the offer. We start describing the first type of decision.

The state of a female without a job offer is the tuple $(f, N, N_6, H, \omega, i, u)$ where f indicates if the female is fertile, N and N_6 represent the total number of children and the number of children younger than 6 respectively, H denotes human capital, ω is the endowment of goods, i is the age of the household, and u denotes the realization of the shock on labor productivity. Individuals decide to search if the indirect utility associated with searching (V_s) is larger than the indirect utility associated with no-searching (V_{ns}). Thus, the indirect utility associated with not having a job-offer is

$$W_{no}(f, N, N_6, H, \omega, i, u) \equiv \max\{V_s(f, N, N_6, H, \omega, i, u), V_{ns}(f, N, N_6, H, \omega, i, u)\}. \tag{1}$$

The state of a female with a job offer is also the tuple $(f, N, N_6, H, \omega, i, u)$. A job offer is accepted if the indirect utility associated with being employed (V_e) is larger than the indirect utility associated with not having a job-offer W_{no}. Thus, the indirect utility associated with having a job offer is

$$W_o(f, N, N_6, H, \omega, i, u) \equiv \max\{V_e(f, N, N_6, H, \omega, i, u), W_{no}(f, N, N_6, H, \omega, i, u)\}. \tag{2}$$

The following diagram describes the decision problem of females depending on whether or not they participate in market activities:

V_e *Utility if she accepts*

job offer $\nearrow$

(W_o) $\searrow$

W_{no} *Utility if she rejects* $\qquad$ V_s *Utility if she searches*

$\nearrow$

no job offer $\searrow$

(W_{no}) $\qquad$ V_{ns} *Utility if she does not search*

Second stage: Fertility and consumption decisions

Females participating in market and non-market activities, choose their consumption of goods and leisure. Moreover, a fertility decision takes place if they enjoy a fertility opportunity. When making these decisions, females face a budget constraint and a time constraint and take into account the law of motions of their skills and number of children. In what follows we explain the decision problems of females that work, search, and do not search, respectively.

The decision problem of an employed female is

$$V_e(f, N_6, N, H, \omega, i, u) = \underset{\{c,l,n\}}{Max} \{ u(c, l, N+n) + \beta E_{f'\phi u'/u} [\lambda W_{no}(f', N_6', N', H', \omega, i{+}1, u') + (1{-}\lambda) W_o(f', N_6', N', H', \omega, i{+}1, u')] \}$$

$$subject\ to:$$

$$n \in \{0,1\}\, if \quad f = fertile;\ otherwise\ n = 0 \tag{3}$$

$$N' = N + n;\ N_6' = N_6 + n - \phi \tag{4}$$

$$H' = H(1 + \varepsilon_i) \tag{5}$$

$$c + \varkappa(N+n) + p_{ch}\, \overline{h}\, (N_6 + n) = \omega_i + e^u H \overline{h} \tag{6}$$

$$l + \tau_1(N_6 + n) + \tau_2(N - N_6) = 1 - \overline{h}, \tag{7}$$

where the expectations of next period indirect utility are taken over the distributions of fertility opportunities,f, number of children that become older than 6, ϕ, and the productivity shock, u'. Notice also that females loose their job offer next period with probability λ. The first of the constraints implies that females can choose whether or not to have an additional child when they have a fertility opportunity. The next two equations are the law of motion of the total number of children N and the number of children younger than 6, N_6'. The number of children younger than 6 increases with the newborn n, and decreases with the number of children that become old, ϕ. The third equation is the law of motion of the female's skills which increase at the rate ε_i when she works. The last two equations are the budget constraint and the time constraint. The budget constraint restricts the sum of consumption, expenditure in raising children, and child-care services to be lower than the sum of goods endowment and earnings, where we assume that the cost of a unit of child care services is equal to p_{ch} units of consumption goods. The time constraint restricts the sum of leisure and the time allocated to raising children to be equal to the endowment of time net of the time allocated to working.

The decision problem of a female who searches for a job is

$$V_s(f, N_6, N, H, \omega, i, u) = \underset{\{c,l,n\}}{Max} \{ u(c, l, N+n) + \beta E_{f'\phi u'/u} [\pi_u W_o(f', N_6', N', H', \omega, i+1, u') + (1 - \pi_u) W_{no}(f', N_6', N', H', \omega, i+1, u')] \}$$

$$subject\ to: (3),\ (4)\ and$$

$$H' = H(1 - \delta_i) \tag{8}$$

$$c + \varkappa(N+n) + p_{ch}\, z(N_6 + n) = \omega_i \tag{9}$$

$$l + \tau_1(N_6 + n) + \tau_2(N - N_6) = 1 - z. \tag{10}$$

where the expectation of next period indirect utility is taken over the distributions of fertility opportunities,f, number of children that become older than 6, ϕ, the productivity shock u', and the distribution of offers π_u. The restriction (8) indicates that skills depreciate when females do not work. The budget constraint (9) and the time restriction (10) differ from (6) and (7) in the time allocated to market activities which is z when individuals search.

Finally, the decision problem of a female that does not search is

$$\begin{aligned} V_{ns}(f, N_6, N, H, \omega, i, u) = & \underset{\{c,l,n\}}{Max} \{u(c, l, N+n) + \beta E_{f'\phi u'/u} W_{no}(f', N_6', N', H', \omega, i+1, u')\} \\ subject\ to: & (3),\ (4),\ (8)\ and \\ & c + \varkappa(N+n) = \omega_i \qquad (11) \\ & l + \tau_1(N_6+n) + \tau_2(N-N_6) = 1. \qquad (12) \end{aligned}$$

Since the female does not search, she will not receive a job offer for the next period. Therefore, the expectation of future indirect utility does not depend on the distribution of job offers. Females draw a realization of the productivity shock u' which affects the future wage that the female would obtain if she decided to participate in the labor market.[3] Notice that females do not consume child care services because they do not allocate time to market activities. Moreover, they have more time to raising children and to enjoying leisure than females who work or search as restriction (12) shows.

The decision problem of non-fertile females is simpler than the problem just described because they do not take fertility decisions ($n = 0$ for ages between t_2 and T).

4 Stationary Population Growth

In this economy, the rate of growth of population is endogenously determined by the fertility decisions of females. Since one of the targets of our calibration is a constant population growth rate, it is convenient to define stationary population growth in our model. When population growth is stationary, the relative sizes of cohorts are constant over time. We define the relative size of age-i-cohort as the ratio of its size to the size of the age-(t_1+1)-cohort (adult of age 1). When population grows at a constant rate η, the relative size of age-i-cohort is constant and equal to $(1+\eta)^{t_1+1-i}$ for all $i = \{1, 2, ..., t_1 + T\}$.

The relative size of the new born generation is given by the sum of children born from fertile cohorts ($t_1 + 1$ to $t_1 + t_2$). Since the relative size of the new born generation is equal to $(1+\eta)^{t_1}$,

[3] This assumption generates heterogeneity among women of similar observable characteristics. Heterogeneity is important in our model because all decisions are discrete.

the stationary population growth rate must satisfy the following equation

$$(1+\eta)^{t_1} = \sum_s n(s,1)X_1(s) + (1+\eta)^{-1}\sum_s n(s,2)X_2(s) + ... \\ +(1+\eta)^{1-t_2}\sum_s n(s,t_2)X_{t_2}(s);$$

where $n(s,i)$ is the optimal policy of fertility, (s,i) denotes the state of the household $(f, N, N_6, H, \omega, u,$ and $i)$ and X_i denotes the distribution of states s across adult households of age i. In other words, the right hand side of the above equation is the weighted sum of births across fertile households with different states. The weights used in the sum are the relative sizes of generations times the measure of individuals of a given age i with state s.[4]

5 Calibration of the Benchmark Economy

In this section we choose functional forms and parameters values such that the steady state of this economy is consistent with observations of the U.S. economy in 1995 that are relevant for the purpose of our research question. In calibrating the model economy, the value of some parameters can be chosen with no need to solve the model. The value of these parameters are shown in Table 2. The calibration of the other parameters involves solving the model economy and their values are shown in Table 3.

Time and Demographic Parameters

Since age is a state variable of the individuals decision problem, choosing the length of the model period affects the computational cost of our economy. For this reason, we choose a model period to be one year. Females become adults at age 21, receive fertility opportunities during the first 20 years of adulthood and die when they are 80 years old. The time preference parameter is selected to match an annual interest rate of 4%.

Stochastic Process of Productivity

We estimate the stochastic process of labor productivity using data on female earnings from the Panel Study on Income Dynamics (PSID). We construct a panel data from the surveys of 1972 to 1993 which is restricted to households where a spouse of the head is present. Our panel selects households where both the head and spouse are between 25 to 64 years old and work at least 775 hours per year.[5] We estimate the following equation:

$$\log w_{ij} = \theta X_{ij} + \alpha_i + u_{ij} \tag{13}$$

[4] Given the initial distribution $X_1(s)$ of states across adult households of age 1, the measures $X_i(s)$, for $i = 2, ...T$, are endogenously determined by individuals decisions and the demographic and labor market shocks.

[5] Males are on average 2 years older than females.

where w_{ij} are real annual earnings of female i at time j, $\alpha_i \backsim N(0, \sigma_\alpha^2)$ represents a time invariant unobserved individual heterogeneity and $u_{ij} = \rho u_{ij-1} + \varepsilon$ where $\varepsilon \backsim N(0, \sigma_\varepsilon^2)$. The variables considered in X_{ij} are education, race, work experience (full time or part time), experience squared, hours worked, age, age squared, marital status, number of children, dummy for the presence of children younger than 6 years old, and annual dummy variables. The estimated parameters of the AR(1) process for u are $\widehat{\rho} = 0.58$ and $\widehat{\sigma}_\varepsilon = 0.29$. In the benchmark calibration we approximate the AR(1) process for u by a five-state Markov chain following Tauchen (1986). The grid for u, the transition probability matrix, and the invariant distribution of the shocks are, respectively,

$$u(i) = \begin{bmatrix} \text{-1.08} \\ \text{-0.54} \\ 0. \\ 0.54 \\ 1.08 \end{bmatrix}; P = \begin{bmatrix} 0.2623 & 0.6226 & 0.1139 & 0.0012 & 0.0 \\ 0.045 & 0.511 & 0.4199 & 0.0239 & 0.0002 \\ 0.003 & 0.1763 & 0.6414 & 0.1763 & 0.003 \\ 0.0001 & 0.0239 & 0.4199 & 0.511 & 0.0451 \\ 0.0 & 0.0012 & 0.1139 & 0.6226 & 0.2623 \end{bmatrix}; \mu = \begin{bmatrix} 0.0156 \\ 0.2208 \\ 0.5272 \\ 0.2208 \\ 0.0156 \end{bmatrix}.$$

Endowments

We calibrate the joint distribution of initial human capital and endowments of goods $\Psi(H_1, \omega)$ to match some characteristics of the profile of earnings of couples in our PSID sample. In particular, we want to mimic the correlation between husband and wife earnings and the shape of the average profile of male earnings. In order to quantify the correlation between husband and wife earnings we estimate the following equation

$$\log w_{ij}^H = \gamma Z_{ij} + \xi_i;\ \xi_i \backsim N(0, \sigma_\xi^2)$$

where w_{ij}^H are real annual earnings of husband in household i in period j, and the variables included in Z_{ij} are the logarithm of earnings potential of his wife and a year dummy. Earnings potential of wives is defined as the predicted earnings $X_{ij}\widehat{\theta}$ where $\widehat{\theta}$ denotes the estimated coefficients in females earnings equation (13) and (annual) hours worked are equal to two thousand (full time workers). The estimated correlation is $\widehat{\gamma}_1 = 0.55$ and standard deviation is $\widehat{\sigma}_\xi$ =0.57. We use the estimated correlation $\widehat{\gamma}_1$ and $\widehat{\sigma}_\xi$ to obtain the initial endowment as a function of the initial skills of a female, that is,

$$\log \omega_0 = \widehat{\gamma}_1 \log H_0 + \xi$$

where we discretize the distribution of ξ to the four states $\{0.417, 0.7856, 1.2633, 2.3801\}$. Thus, for each level of initial human capital, H_0, there are four possible endowment levels in the initial period. The unconditional distribution of initial human capital of females is assumed to be lognormal with zero mean and a standard deviation denoted by σ_{H_0}. The calibration of σ_{H_0} is explained in the subsection about parameters calibrated by solving the model. Finally, the endowments of subsequent periods are chosen to mimic the slope of the age-profile of average earnings of males in our PSID sample.

Cost of children

Hofferth and Wissoker (1991) report that the child to staff ratio in child care services of 6.67. Assuming that workers in the child care service have the average initial human capital level ($H = 1$) and an average market luck ($u = 0$), the cost of one unit of child care services can be approximated by 1/6.67.

We also assume that each child younger than 6 needs a fraction τ_1 of mother's time and that each kid between 6 and 20 years old needs a fraction τ_2 of mother's time. The time that mothers spend raising children is chosen to match the difference in hours worked by mothers versus non-mothers. The data on working hours by females are taken from McGrattan and Rogerson (1998). We obtain an average time spent with child younger than 6 years old of $\tau_1 = 0.074$, and an average time spent with a child older than 6 years of $\tau_2 = 0.032$.

Shocks

We assume that the probability of receiving an offer is one because unemployment duration is lower than one year in the U.S. economy. Since a separation from a job implies a one year unemployment spell, we assume a conservative job separation rate of only 5%.[6]

We assume that the probability that a young child becomes older than 6 is 0.83 which implies that, in average, it takes 6 periods to become older than 6. Given the probability distribution of the types of children, we are able to characterize the binomial distribution of the number of children younger than 6 and the number of children older than 6.

Parameters Calibrated by Solving the Model

We have to calibrate ten parameters: the preference parameters for consumption α_1 and number of children α_2, the fertility opportunities at ages 25, 30 and 35, the variance of initial skills σ_{H_0}, the depreciation δ and growth rates of human capital ε, the cost of searching z, and the expenditure per child $\varkappa$. The values of these parameters are chosen so that the steady state of the model reproduces the following ten targets: an activity rate of women between ages 20 and 54, the total fertility rate, the birth rates at ages 25-29, 30-34 and 35-39, the Gini coefficient of earnings, the mean wages at age 45, the Gini of earnings at age 45, the unemployment rate and the expenditure on children to GDP ratio. Consequently our calibration procedure consists in solving a system of ten equations in ten unknowns.[7]

Description of data targets

[6] For instance, Clark (1990) reports a 15% transition rate from employment to non employment in the U.S. economy in 1974.

[7] In order to simplify the calibration procedure, we assume that skills remain constant after age 45, that is, $\delta_2 = \epsilon_2 = 0$. We checked that the evolution of wages after age 45 does not affect fertility decisions.

Table 2: **Parameters Calibrated without Solving the Model**

Parameter value	**Parameter meaning**	**Source**
	Demographics	
$T = 60$	Years duration of adulthood.	
$t_1 = 20$	Years duration of childhood.	
$t_2 = 20$	Fertile years.	
	Endowments	
$(\omega_1, \omega_2, ..., \omega_T)$	Husband's earnings	PSID
$\Psi(H_1, \omega)$	Initial distribution H and ω.	PSID
	Market activities	
$h = 0.40$	Full-time working time.	
$\pi_u = 1.00$	Probability of a job offer.	average unemployment duration
$P_0 = \pi_u$	Proportion of 21's old that have jobs.	
$\pi = 0.05$	Probability being laid-off.	
u	AR(1) process of the shock on wages	PSID
	Non market activities	
$\tau_1 = 0.074$	Time raising children younger 6	matches mother's working hours
$\tau_2 = 0.032$	Time raising children older than 6.	"
$p_{ch} = 1/6.67$	Price of child care	Hofferth &Wissoker (1991)
	Preferences	
$\beta = 0.96$	Discount rate.	

A short comment about the choice of some functional forms and data targets is worth making. We would like the model to be consistent with realistic birth-age profiles. For this reason, we assume that fertility opportunities depend on females' age. In order to restrict the number of parameters, we assume that fertility opportunities depend on three age categories: 25-29, 30-34 and 35-39 years old. The targets chosen for these parameters are the birth rates of women belonging to age groups 25-29, 30-34 and 35-39 in 1995 which are obtained from the Bureau of Census (1997).

The activity rate of women between ages 20-54 was 76%, the unemployment rate of women between ages 20-54 was 4.5%, and the fertility rate was 2.02 in the U.S. in 1995 according to O.E.C.D. data (O.E.C.D., 1999).

We choose a value for the cost in goods per child, $\varkappa$, such that the ratio of children's expenditures over GDP is 0.15 which is the number reported by Haveman and Wolfe (1995) for the U.S. economy.

The initial skills of females are assumed to follow a log-normal distribution. We choose the standard deviation of the logarithm of skills, σ_{H_0}, in order to reproduce the Gini coefficient of earnings of women that we observe in our PSID sample.

Given the initial distribution of wages, the depreciation rate and the growth rate of human capital, the working history of women, and the stochastic process of the shock that affects wages determine the distribution of earnings at any age. For this reason, information of the mean and

Table 3: **Parameters Calibrated by Solving the Model**

Parameters		**Calibration Targets**
$\alpha_1 = 1.73$	Utility of consumption	Activity rate of women ages 20-54
$\alpha_2 = 0.96$	Utility of children	Total fertility rate
$p_1 = 0.55$	Fertility opportunity Age 25.	Birth rate 25-29.
$p_2 = 0.27$	Fertility opportunity Age 30.	Birth rate 30-34.
$p_3 = 0.30$	Fertility opportunity Age 35.	Birth rate 35-39.
$\sigma_{H_0} = .43$	Variance initial skills	Gini earnings of women
$\delta_1 = 0.24$	Depreciation rate younger than 45	Women's mean wage age 45 / age 21
$\varepsilon_1 = 0.055$	Growth rate of skills younger than 45	Gini earnings of age 45 women
$z = 0.39$	Searching time.	Unemployment rate of women ages 20-54.
$\varkappa = 0.41$	Child's consumption.	Expenditure on children/GDP

Table 4: **Benchmark Economy versus. U.S. in 1995**

	U.S. 95 Data	Benchmark Economy
Activity rate ages 20-54	76%	74.6%
Unemployment rate ages 20-54	4.5%	4.57%
Fertility rate	2.02	2.03
Expen. ch./GDP	15.0%	21.0%
Birth rate 25-29	99	99
Birth rate 30-34	84	94
Birth rate 35-39	37	38
Gini of earnings	0.35	0.35
Mean wage age 45 / age 21	2.2	2.31
Gini wages age 45	0.35	0.30

Gini coefficient of earnings at age 45 can be used to pin down the values for the depreciation and growth rates of human capital.

5.1 The Benchmark Economy

Table 4 presents the observations of the U.S. economy that we try to match in the calibration exercise and the data produced by our benchmark economy. Our model matches almost perfectly the targets for activity rate, unemployment rate, total fertility rate, gini coefficients of earnings, and the mean wage at age 45.

The benchmark economy matches reasonably well the timing of births of the U.S. economy in 1995 (Bureau of Census, 1997) as Figure 2 shows. Figure 2 compares the ratio of births of a given age group to the total number of births in the benchmark economy with the equivalent statistic of the U.S. economy in 1995. We can see that the benchmark economy overestimates the birth rate of the youngest group and underestimates the birth rate of the oldest group. This may be due to the assumption that females take fertility decisions only between ages 21-40 in our benchmark economy while birth rates are positive for women younger than 21 and older than 40 in actual data.

[Insert Figure 2]

The distributions of wages and endowments in our benchmark economy was constructed to mimic the distributions of wages of wives and their husbands of the PSID data. This is crucial for the purpose of our paper because fertility and labor decisions are very much affected by individuals' wages and endowments. In particular, the impact of unemployment on fertility decisions is more important for individuals with low endowment because they are the ones that participate in the labor market. For this reason, it is very important to reproduce the distribution of husbands' wages across wives. For those who participate in the labor market, unemployment decreases their future expected wages because skills depreciate when individuals do not work and increase only when individuals work. Consequently, individuals can afford fewer children when unemployment is higher. Since the impact of unemployment on fertility decisions depends on the effect of labor market history on wages, the calibration of the stochastic component of wages is key because it determines the component of wages independent of the labor market history of a female.

6 Numerical Experiments

In this section we perform two numerical experiments in order to investigate the consistency of our model with the cross-section and time series evidence on employment ratios and fertility rates. In the first experiment, we ask the following question: Can differences in unemployment rates generate a positive correlation between fertility and participation rates and between fertility rates and employment ratios? We find fertility and participation rates decrease with the unemployment rate. We also find that this decrease of the fertility rate is partially driven by the postponement of births due to the high unemployment rate.

In the second experiment, we quantify the effects of a temporary shock that increases the unemployment rate and increases the depreciation rate of skills in an economy on the fertility and participation rates. The goal of this experiment is to check if our model can generate time series observations of participation and fertility rates consistent with the time series evidence of Sweden during the 90's. We find that a temporary shock to unemployment has an important negative impact on fertility and participation rates and that these effects are quite persistent over time.

6.1 The Spanish Experiment

The goal of this experiment is to show that participation rates and fertility rates and employment ratios and fertility rates are positively correlated across economies that only differ with respect to the probability of finding a job. We think that this experiment provides some insights about the situation of countries like Spain and Italy with high female unemployment rates and low fertility rates.

In order to generate female unemployment rates higher than the US level, we reduce the probability of finding a job relative to the benchmark level. Figures 3 and 4 plot the data generated by the model for economies with a job finding rate between 1 and 0.1. As the job finding rate decreases, both employment and participation rates decrease and since the former falls more than the latter, the unemployment rate increases. The increase of unemployment induces a decrease of fertility and, thus, both participation and employment rates are positively correlated with fertility rates across economies (see Figures 3 and 4).

[**Insert Figure 3**]
[**Insert Figure 4**]

Table 5: **The Spanish Experiment**

	Model		Data 1995	
	Benchmark	**High unemploy.**	**U.S.**	**Spain**
%Unemployment	4.6	23	4.5	27.5
Fertility rate	2.03	1.71	2.02	1.18
Participation rate	.75	.30	.76	.54

Table 5 compares two model economies characterized by unemployment rates which are similar to the levels of women unemployment rates observed in the U.S. and Spain in 1995, respectively.[8] This table shows that the differential between the 1995 unemployment rates of women in Spain and the U.S. can explain almost 40 percent of the fertility gap observed between these countries.

[**Insert Figure 5**]

The impact of unemployment on fertility is not trivial. On the one hand, unemployment induces a positive effect on fertility. Since our model captures the fact that children are costly in mother's time, an increase of unemployment increases the disposable time of women and, thus, induces a positive effect on fertility. Indeed, Figure 5 shows that the employment ratio of females decreases as the number of children increases in the benchmark economy. This indicates that the time constraint on fertility is binding in our model economy. On the other hand, unemployment induces two negative effects on fertility. First, unemployment decreases the income of households (present and future) which has a negative effect on fertility. Second, an increase of the unemployment rate

[8] The data source is OECD (1999). The participation and unemployment rates correspond to women between 25-54 years old.

induces a postponement and spacing of births. In particular, the lower the job finding rate is, the longer it takes to accumulate skills on the job and the later individuals have children. Moreover, the higher the unemployment is, the more costly is a career interruption which can be avoided by spacing births. Since females' fertile lifetime is finite, both postponement and spacing of births induce a lower fertility rate.

In order to illustrate the effect of unemployment on the timing of births, we compare the timing of births of model economies with high and low unemployment (that is, the model economies displayed in Table 5). Figure 6 shows that unemployment affects the timing of births. In fact, the percentage of births that occur between ages 20 and 24 is significantly higher in the economy with low unemployment while the percentage of births that occur after age 30 is significantly higher in the economy with high unemployment. The impact of unemployment on the timing of births in our model is consistent with the evidence of differential timing of births between the U.S. and Spain. Figure 7 compares the timing of births in these countries in 1995 which shows that in Spain, births occur much later than in the US.[9]

[Insert Figure 6]
[Insert Figure 7]

Figure 7 also shows that in Spain the timing of births has changed significantly from 1976 to 1995. In 1976 most births occurred at ages 20-24 and 25-29 while in 1995 most births occur at ages 25-29 and 30-34. Some authors point out that the increase in schooling attainment of females could explain the recent demographic changes in Spain (see, for instance, Bover and Arellano (1994) and Conesa (1999)). However, in Spain births occur later in lifetime while education attainment levels are lower than in the U.S.. These facts indicate that the increase of education attainment cannot be the only reason why births have been postponed in Spain. Our results indicate that the differential in unemployment levels between the U.S. and Spain can partially explain the differential in total fertility rate and timing of births between Spain and the U.S..

The Effects of a Reduction of the Endowment of Goods

In the previous experiment we assumed that changes in the probability of finding a job only affect female earnings but not other household income (goods endowment ω). In principle, one would expect that an increase in unemployment would likely be associated with a reduction of non-female income (because of a reduction of males' employment). This negative wealth effect can have important consequences on females' fertility and labor market decisions. To investigate this effect, we assume that the females' endowments of goods decrease as the job finding rate decreases. In particular, we assume that each percentage point decrease in the job finding rate is associated with a 0.1 percentage point reduction in the support of the distribution of the endowment of goods

[9] The source of the data on birth rates per age groups in 1995 in Spain is the *Instituto Nacional de Estadistica*. The U.S. data on births rates per age group in 1995 comes from the U.S. Bureau of Census (1997).

(interpreted as a 0.1 percentage point increase in male unemployment rate relative to the U.S. level in 1995).

We perform an experiment that consists in computing steady states for ten economies that differ in two dimensions: the probability of finding a job and the distribution of females' goods-endowment. In order to describe the economies considered more precisely, let us represent the benchmark economy by the pair $(1, \varpi)$, where 1 is the probability of finding a job and ϖ is the support of the distribution of the endowment of goods in the benchmark economy. Then, we consider economies characterized by the pair $(1 - 0.1j, (1 - 0.01j)\varpi)$, for $j = 0, ..., 9$.

[Insert Figure 8]

Figure 8 compares the artificial data on employment ratios and fertility rates generated by this experiment with the O.E.C.D. cross country data in 1995. We can see that the model mimics quite well the data. In our model economy, the reduction of the endowment induces a decrease of fertility and an increase of both the employment ratio and participation rate of females. The decrease of the fertility rate is partially driven by the postponement of births that the reduction of the endowment of goods induces. Figure 9 compares the births rates by age groups of two model economies that differ in the endowment of goods. In one of the economies the endowment of goods is at the benchmark level while in the other economy the endowment of goods is 93% of the benchmark level. Both economies display high female unemployment since the probability of finding a job is 0.3. The figure shows that the percentage of total births by the age groups 21-25 and 31-35 decrease while the percentage of total births by the age groups 26-30 and 36-40 increase as a consequence of the reduction of the endowment of goods. Thus, the reduction of the endowment of goods induces a further delay of births.

[Insert Figure 9]

The results of these experiments suggest that permanent differences in unemployment rates across economies could generate a positive correlation between fertility rates and employment ratios of females across countries. The next experiment investigates some time series implications of our quantitative theory.

6.2 The Swedish Experiment

In this section we perform an experiment that is motivated by the large reduction in the fertility rate and in the female employment ratio experimented by Sweden during the period 1990-1997. In fact, the fertility rate decreased by 28% while the female employment ratio fell 18% during this period (see Figures 10 and 11).[10] Moreover, between 1990 and 1993 male employment experienced

[10] The data source is the OECD Health and Labor Statistics (1999). The employment ratio is computed for females of age between 15-54 years old.

a 14 percent decrease (see Figure 12). It is interesting to compare the time series behavior of the employment ratio and fertility rate across Sweden and the U.S. during the period 1970-1996 (see Figures 10 and 11). Up to 1990 the time trends of these statistics follow similar patterns. Interestingly, in contrast to Sweden, in 1990 the US only experienced a small reduction in the female employment ratio. Suggestively, while the U.S. fertility rate remain roughly constant, the fertility rate in Sweden dropped from 2.1 to 1.5 during the period 1990-1996.[11]

In this experiment we investigate if a temporary aggregate supply shock can induce the qualitative behavior of employment ratios and fertility rates observed in Sweden during the 90's. During the period 1990-1997 the unemployment rate experienced a 5-fold increase. Moreover, there was an increase in the income inequality among females.[12] In order to capture these two observations, we follow Ljungqvist and Sargent (1998) in assuming that the economy experiences a once and for all shock that induces a 10-th fold increase of the lay-off rate in a single period and that the shock reduces in 50% the skills of individuals upon a job separation. The following period, the lay-off rate and the depreciation rate of skills are set as in the benchmark economy. All other parameter values are kept constant. Notice that since we are modeling a one time unexpected shock the optimal decisions of individuals are the same as in the benchmark economy. The transient shock, however, does affect the distribution of states across individuals, the relative sizes of future cohorts, and all aggregate statistics in the model economy.[13]

[Insert Figure 10]
[Insert Figure 11]
[Insert Figure 12]

[11] The increase of the fertility rate in Sweden and in the U.S. from 1985 to 1990 could be the result of the postponement of births ocurred in previous years (see Conesa (1999)). The postponement of births induces a 'temporary' decrease of the total fertility rate during the years when the birth rates of young generations have decreased while the birth rates of older generations have not increased yet. Indeed, demographers use an alternative measure of fertility that is not affected by changes in the timing of births as an indicator of the long run trend of fertility, see Bongaarts and Feeney (1998).

[12] Hoem (1999) reports an increase of the proportion of low income females during the 90's in Sweden.

[13] At any period $\tau+1$, the size of the new born generation is given by the sum of birth rates across fertile cohorts and states of households. In particular, given the sizes of fertile cohorts i (for $t_1 < i \leq t_1+t_2$) in period τ, $\mu(i,\tau)$, the size of cohort 1 in period $\tau+1$ is given by the following equation:

$$\begin{aligned}\mu(1,\tau+1) &= \mu(t_1+1,\tau)\sum_s n(s,1,\tau)X_1(s,\tau)+... \\ &+\mu(t_1+t_2,\tau)\sum_s n(s,t_2,\tau)X_{t_2}(s,\tau);\end{aligned}$$

where $n(s,i,\tau)$ is the optimal policy of fertility at period τ, (s,i) denotes the state of the household $(f, N, N_6, H, \omega, u$, and $i)$ and $X_i(s,\tau)$ denotes the distribution of states s across adult households of age i at period τ. The sizes of other cohorts are consistent with the sizes of cohorts in the previous period, that is, $\mu(i,\tau)=\mu(i-1,\tau-1)$ for all $i \neq 1$. Notice that when the transient economic shock affects the economy, the sizes of the cohorts are the stationary ones, that is, $\mu(i,1)=(1+\eta)^{t_1+1-i}$ for all $i \in \{1,...,t_1+T\}$. We define the *relative* sizes of cohort-i as the ratio of its size to the size of the age-$(t_1+1)-$cohort (adult of age 1).

The transient shock reduces employment and increases wage inequality as Figures 13 and 14 show. The employment ratio decreases a 44 percent in one period but recovers quite rapidly. Still the employment ratio is below the steady state value for a long time. The response of fertility rate to the transient economic shock is shown in Figure 15. The total fertility rate decreases by 10 percent and reaches its steady state level after 17 years. The shock induces a decrease of birth rates for all age groups and this decrease is particularly more important for females between ages 25-30 whose birth rate decreases by 14%.

[**Insert Figure 13**]
[**Insert Figure 14**]
[**Insert Figure 15**]

The Effects of a Reduction of the Endowment of Goods

Since in Sweden male employment experienced a 14 percent decrease between 1990-1993, we shall also perform an experiment in which the females' endowment of goods is reduced by the transitory aggregate shock. In this experiment, we explore the effects of a transient economic shock that induces a 50 percent reduction of the endowment of goods. In order to model the persistence of the economic shock on males' employment, we assume that the reduction of the endowment lasts for three periods. This assumption implies that the decision policies are affected by the economic shock. Figure 16 shows that fertility rate experiences a much more pronounced reduction in this case relative to the case where the shock does not affect the endowment of goods. When the lay-off rate returns to the normal level, the fertility rate recovers and it reaches a value higher than the steady state level. Females decide to allocate more time to raising children because the labor income is low relatively to the endowment. This experiment shows that the reduction of females' employment coupled with a reduction of males' employment can generate important negative effects in the fertility rate of an economy as evidenced in Sweden during the 90's.

[**Insert Figure 16**]

7 Conclusions

This paper builds a framework of employment and fertility decisions in order to understand recent observations of fertility and employment in O.E.C.D. countries. The paper has shown that labor market frictions can play an important role for understanding why fertility rates and female employment ratios are positively correlated across O.E.C.D. countries and the procycality of fertility rates. We show that unemployment induces an important postponement of births, which is consistent with the evidence of high unemployment countries such as Spain.

We conclude that labor market institutions are key for understanding the behavior of fertility rates in countries where women participate in the labor market. We conjecture that the effect of an unemployment shock on fertility rates can be large in economies with parental leave policies of the type instituted in Sweden. In Sweden, parental leave benefits are proportional to mothers' wages. The proportionality of the benefits induces workers to postpone births until they reach the desired level of benefits. An increase of unemployment or depreciation of skills increases the time necessary to reach such level of benefits and, thus, enhances the incentive to postpone births. We plan to study these issues in future work.

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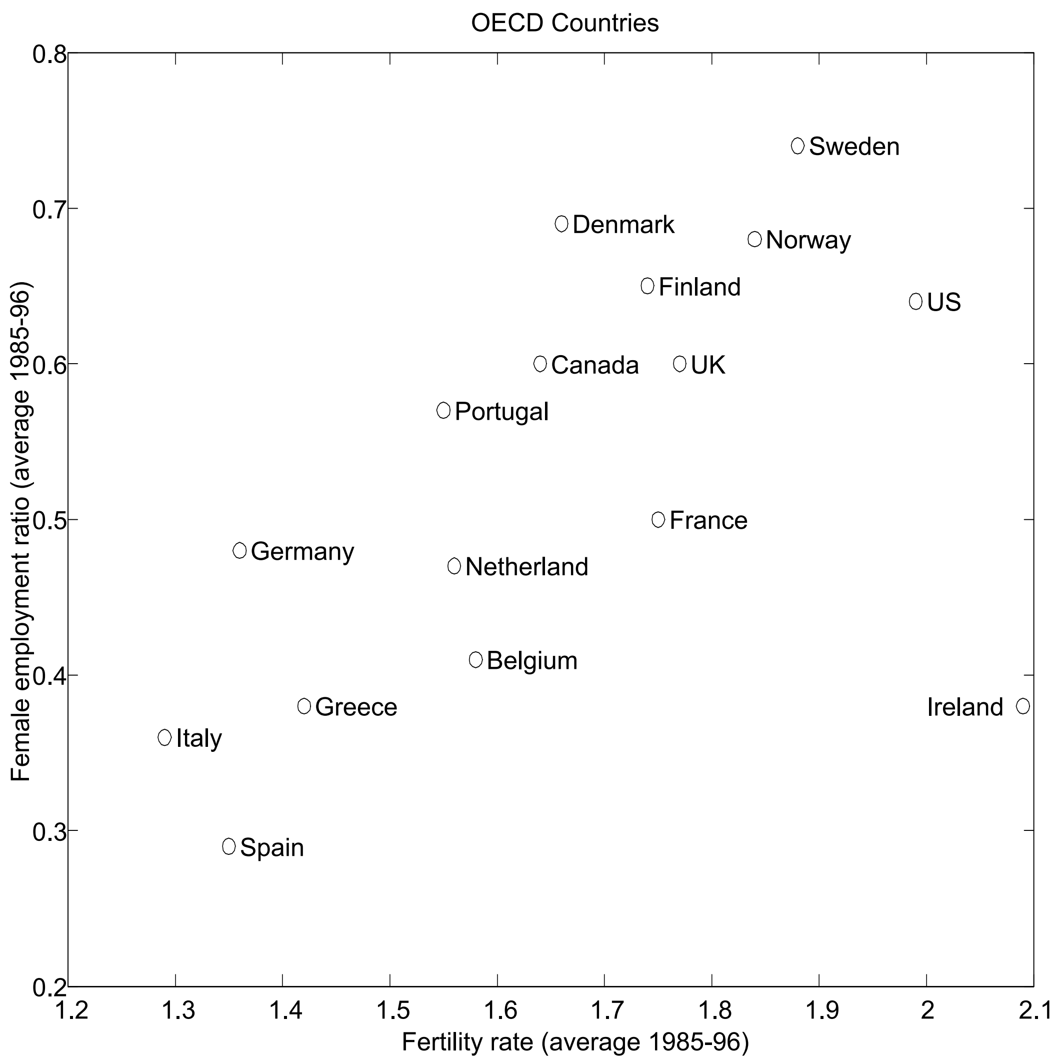

Figure 1: Fertility rates and employment ratios in OECD countries. Source: O.E.C.D. (1999)

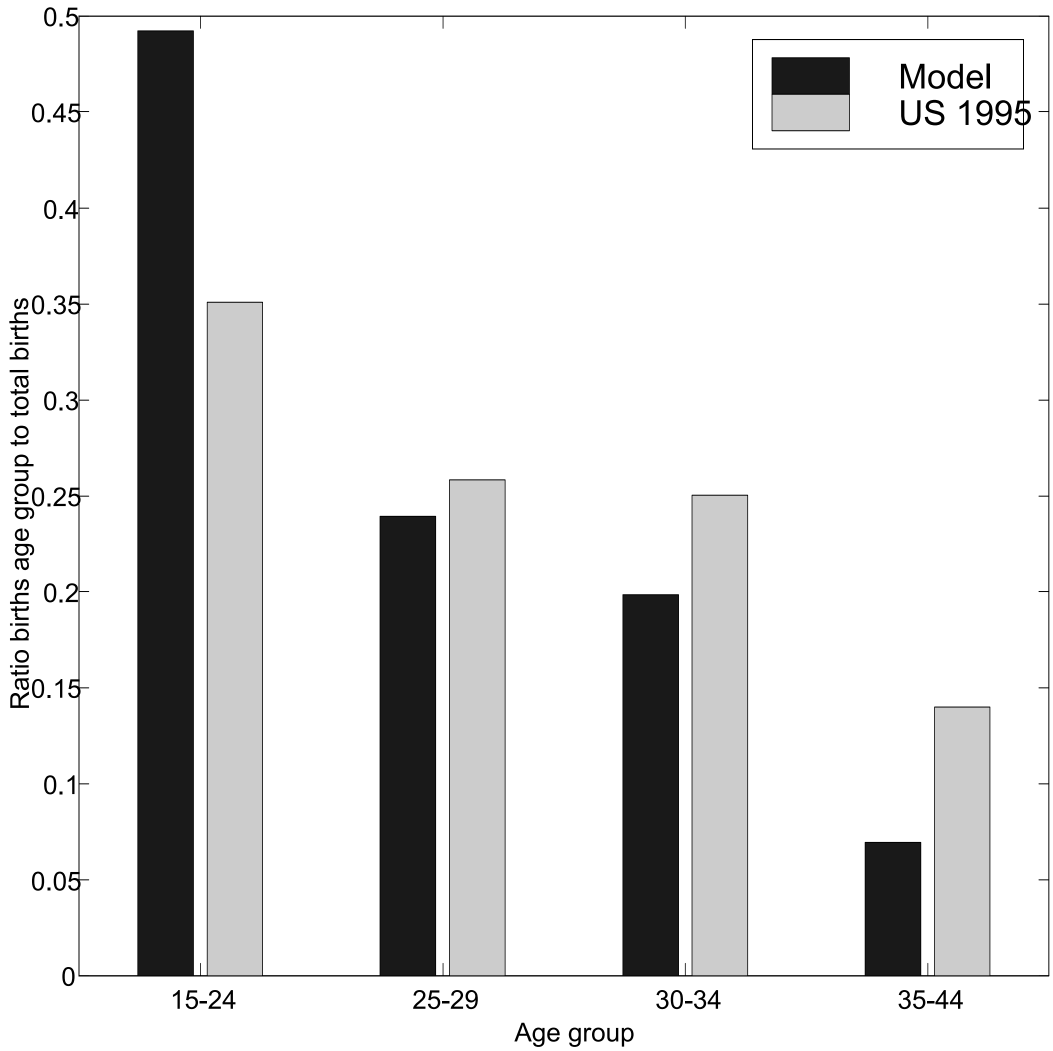

Figure 2: Ratios of births per age group to total births in the U.S. in 1995 and in the benchmark economy.

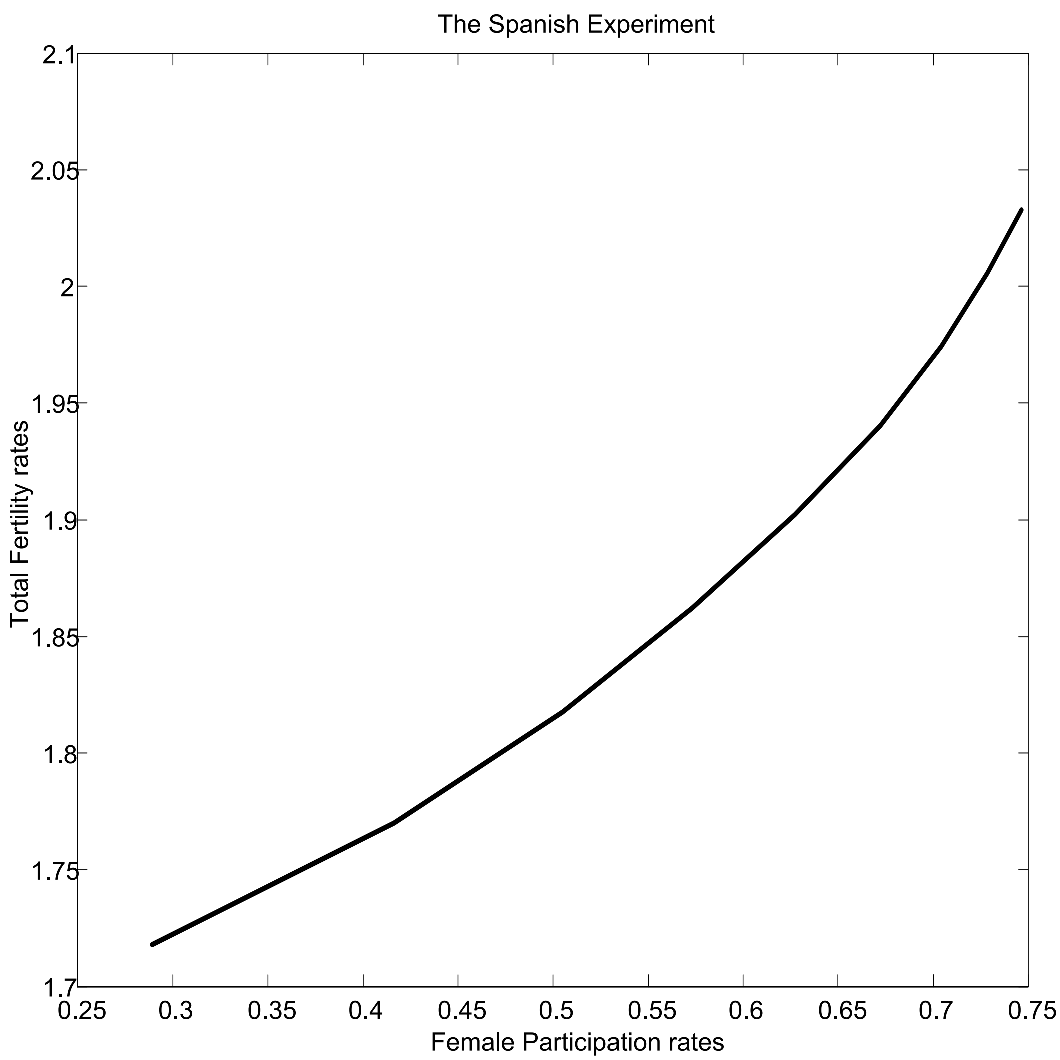

Figure 3: Fertility and participation rates for different steady states.

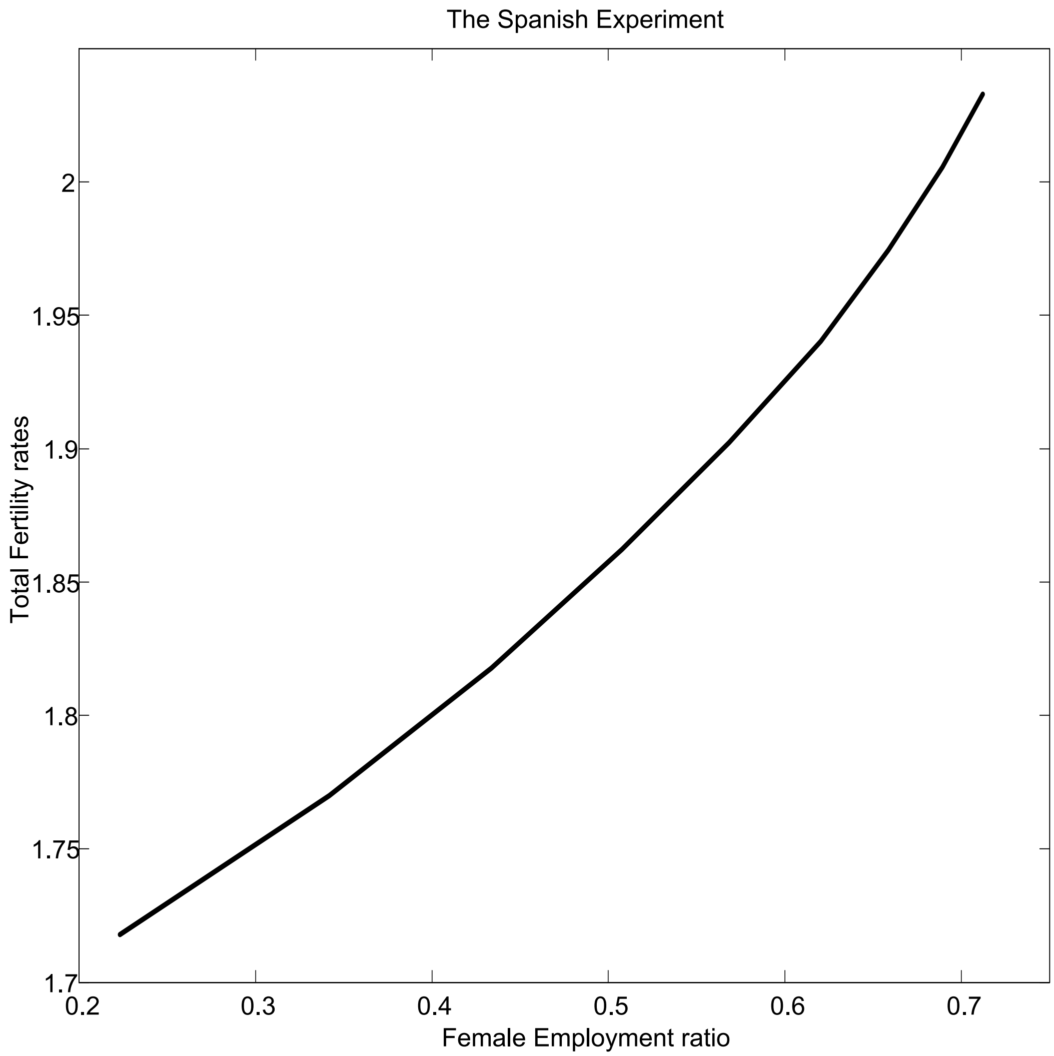

Figure 4: Fertility rates and employment ratios for different steady states.

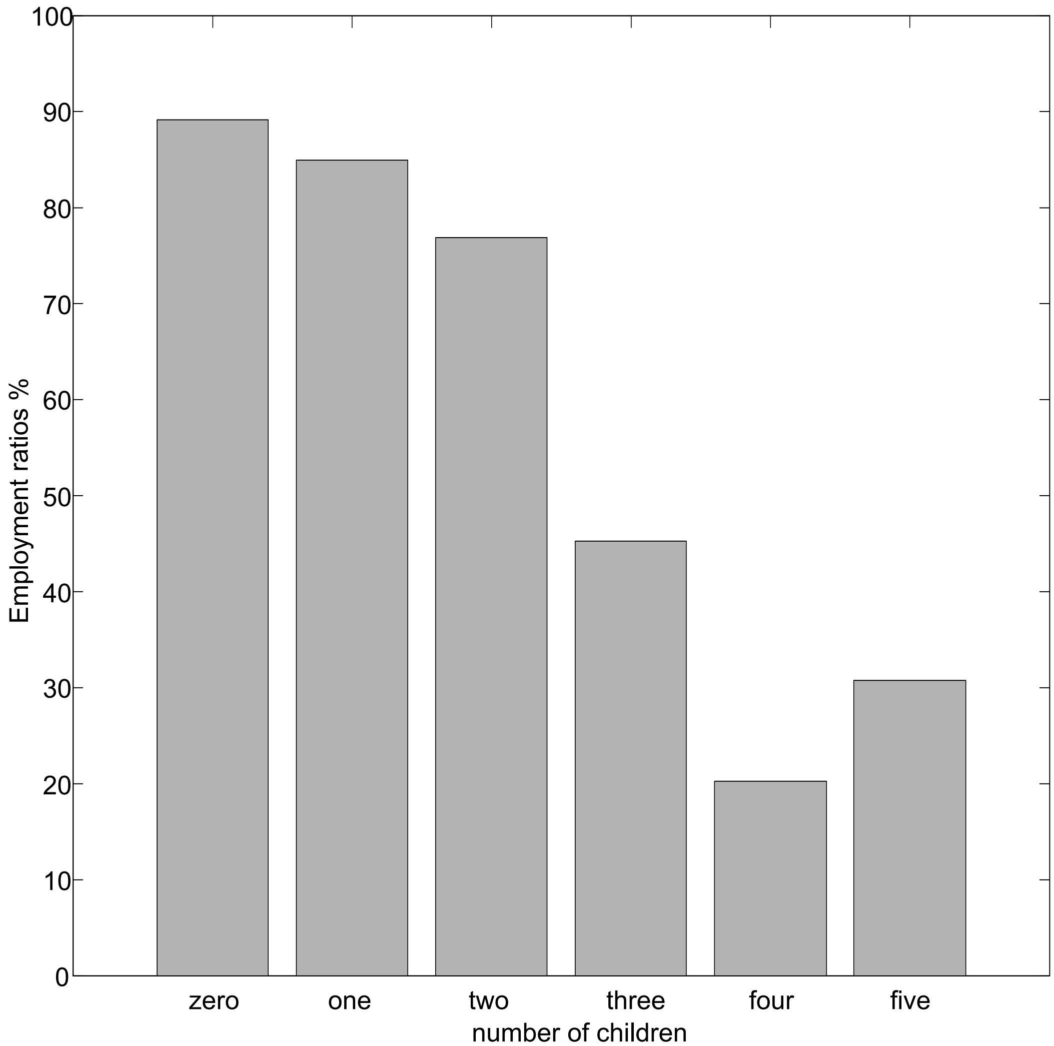

Figure 5: Employment ratios per number of children in the benchmark economy.

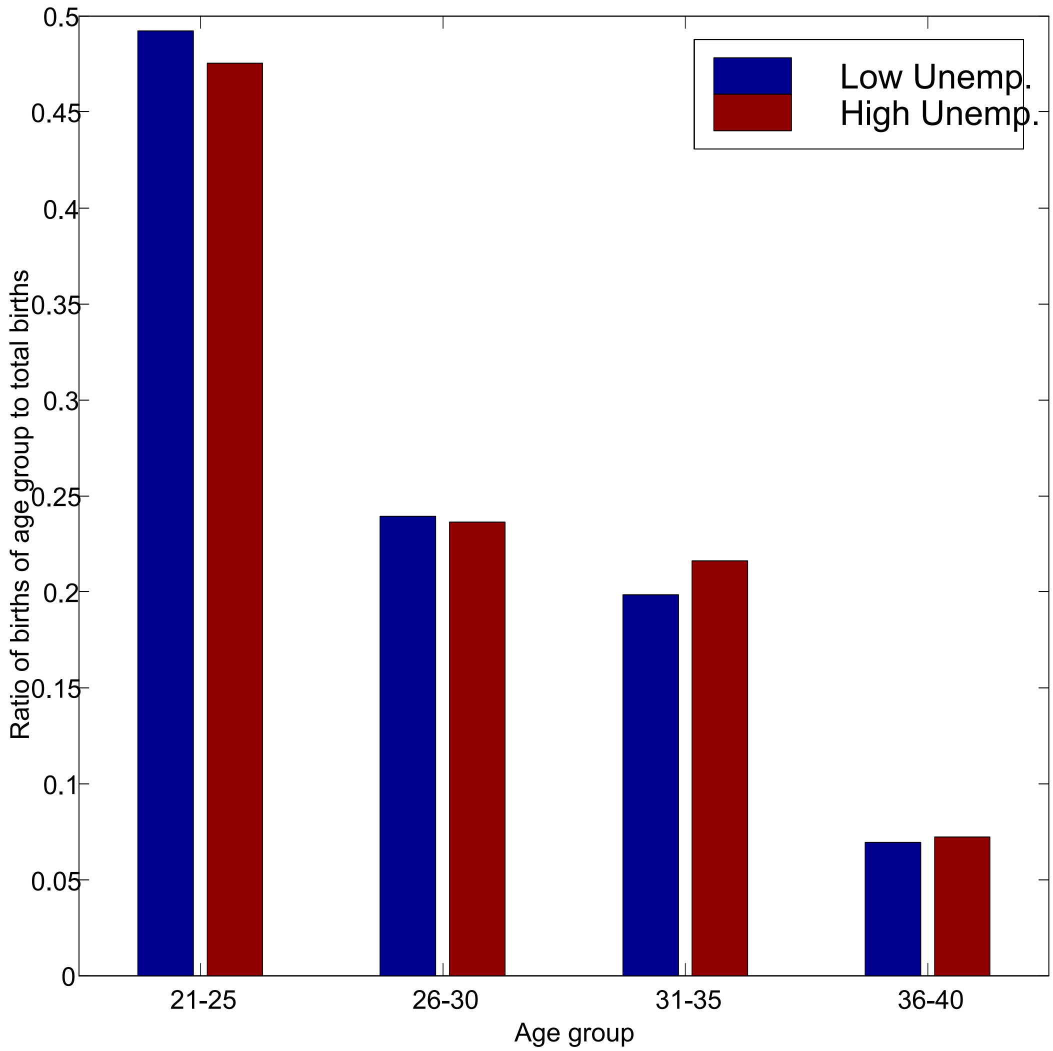

Figure 6: Ratios of births per age groups to total births in model economies with high and low unemployment.

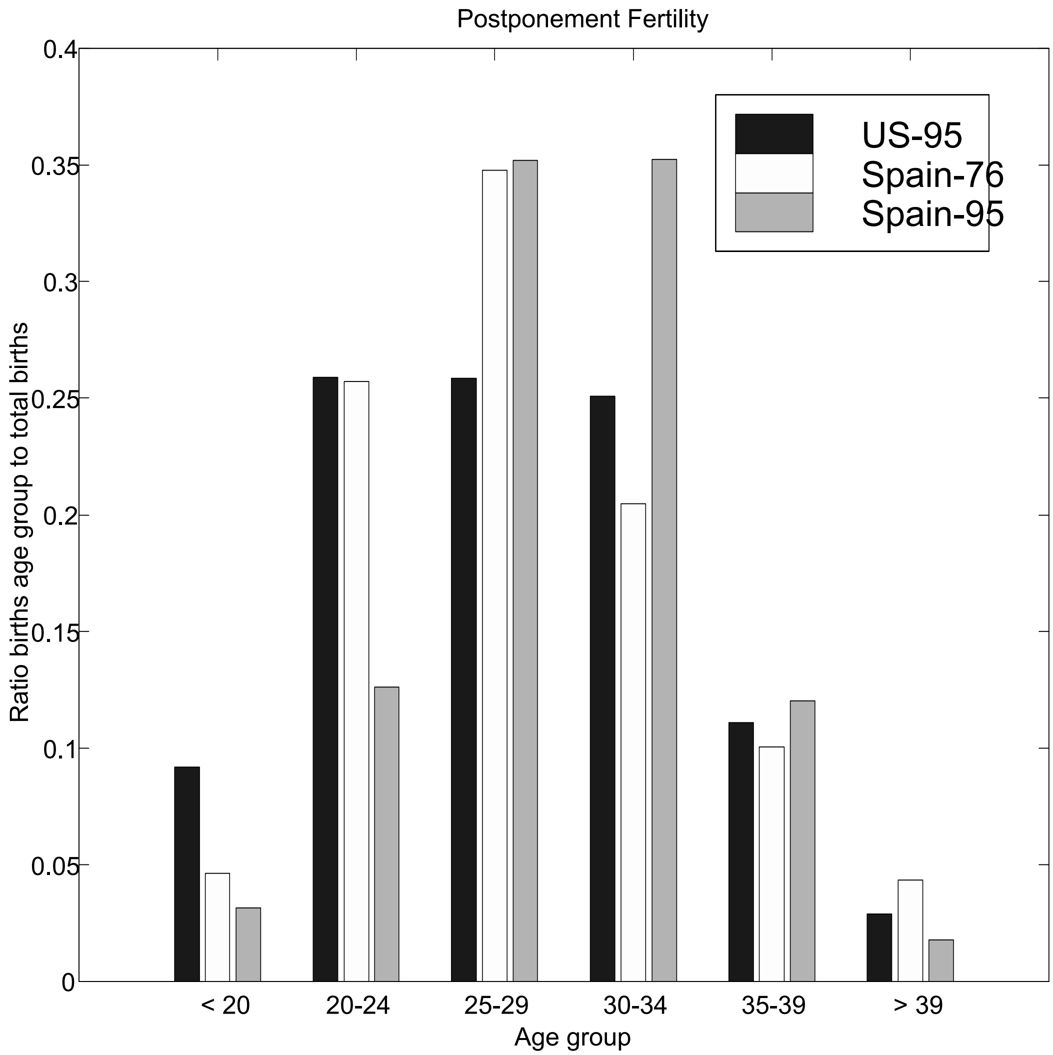

Figure 7: Ratios of births per age group to total births in the U.S. and Spain.

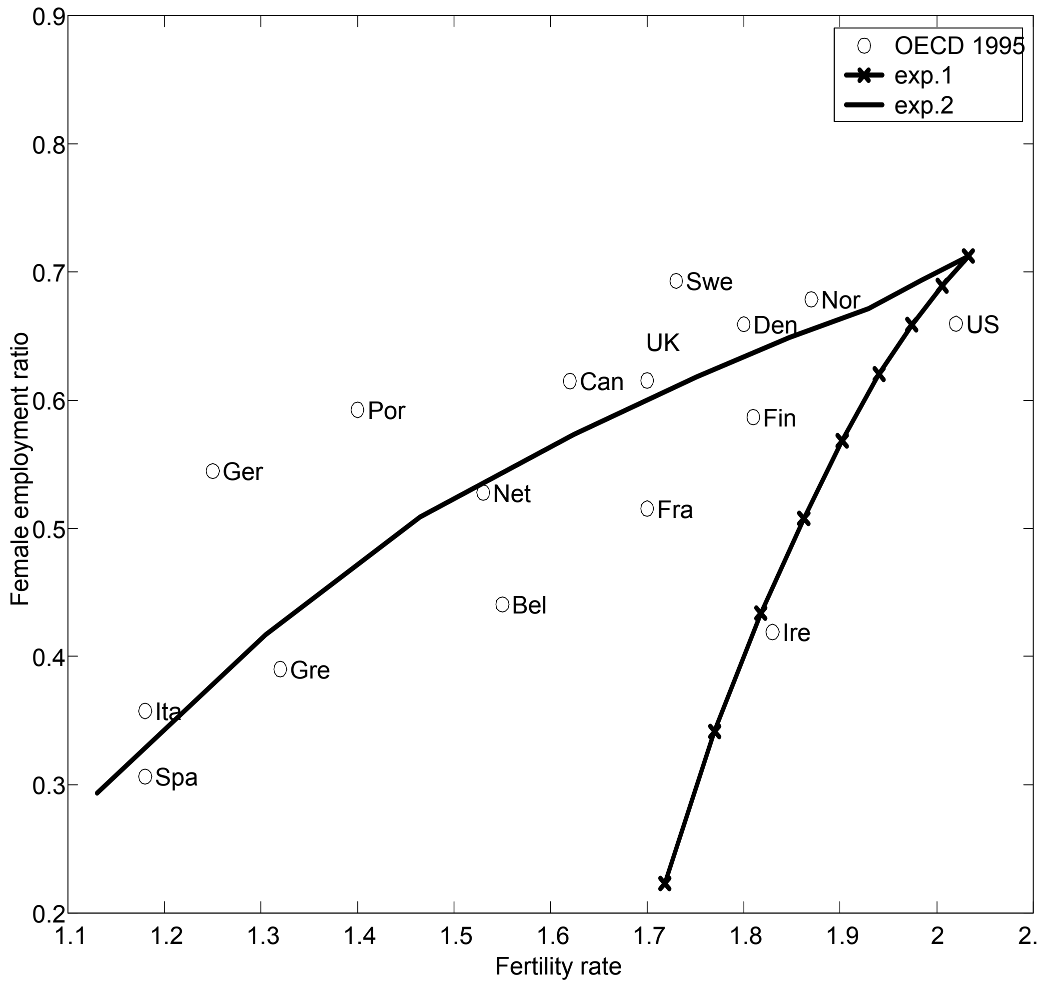

Figure 8: Fertility rates and employment ratios in O.E.C.D. countries in 1995 and in model economies. Experiment 1: No reduction of endowments. Experiment 2: Reduction of the endowments.

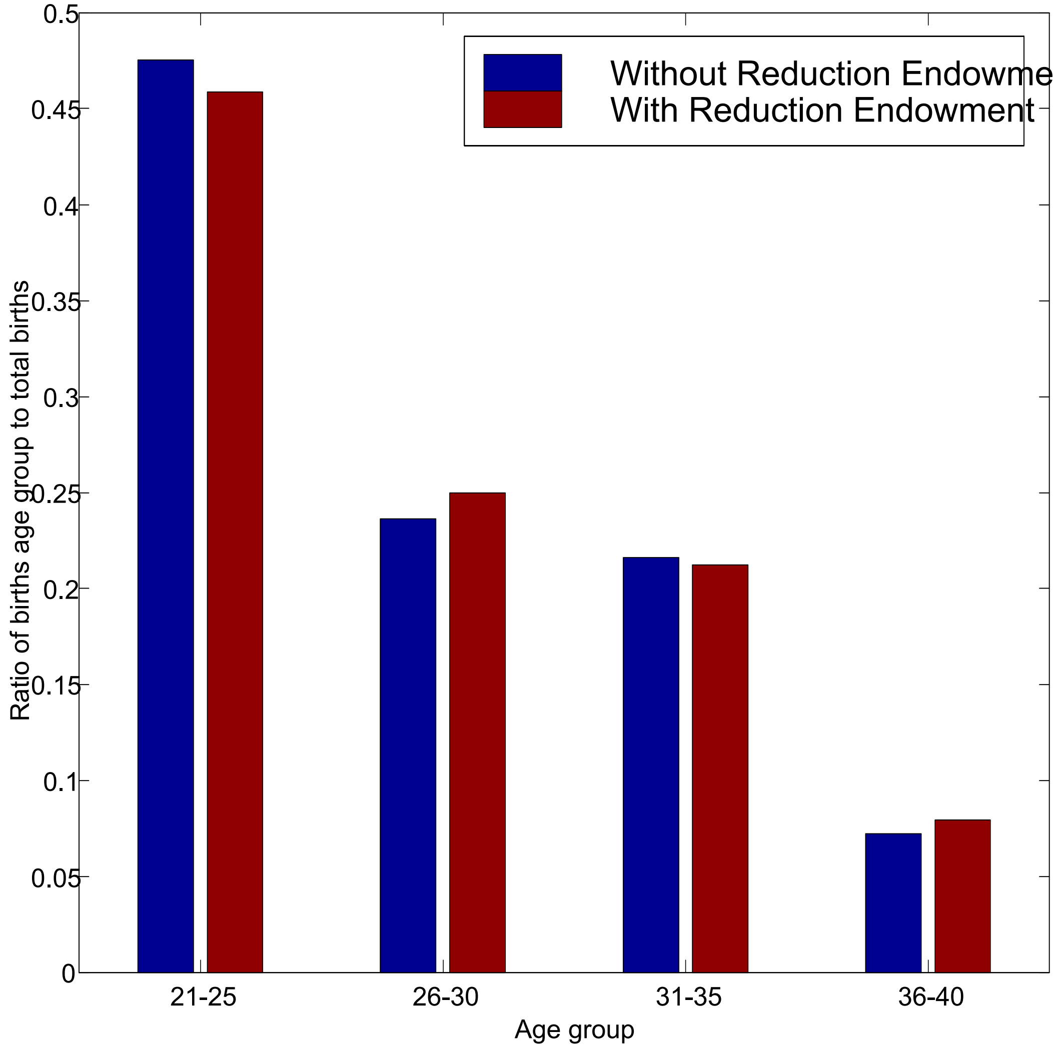

Figure 9: Effect of a reduction of the endowment of goods on birth rates of different age groups.

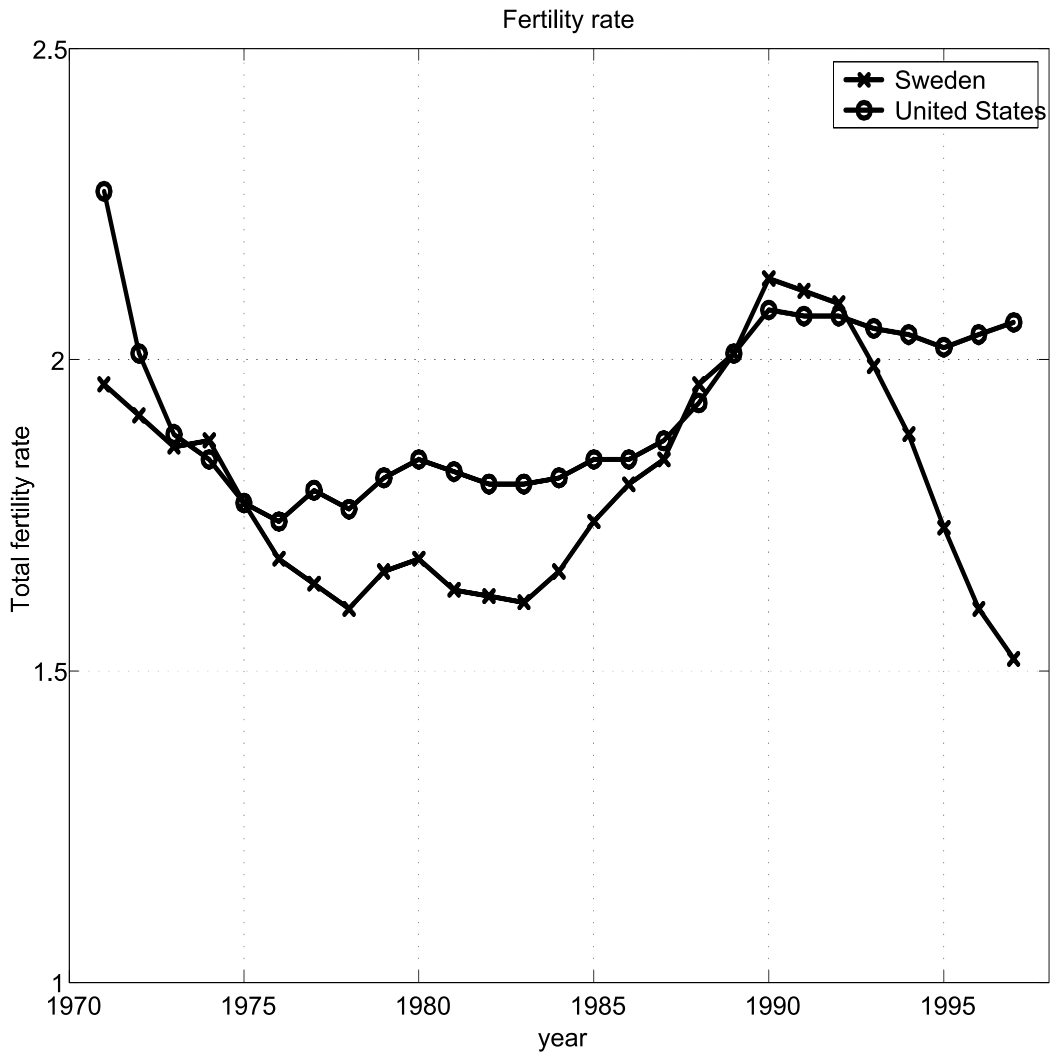

Figure 10: Total fertility rates in the U.S. and Sweden.

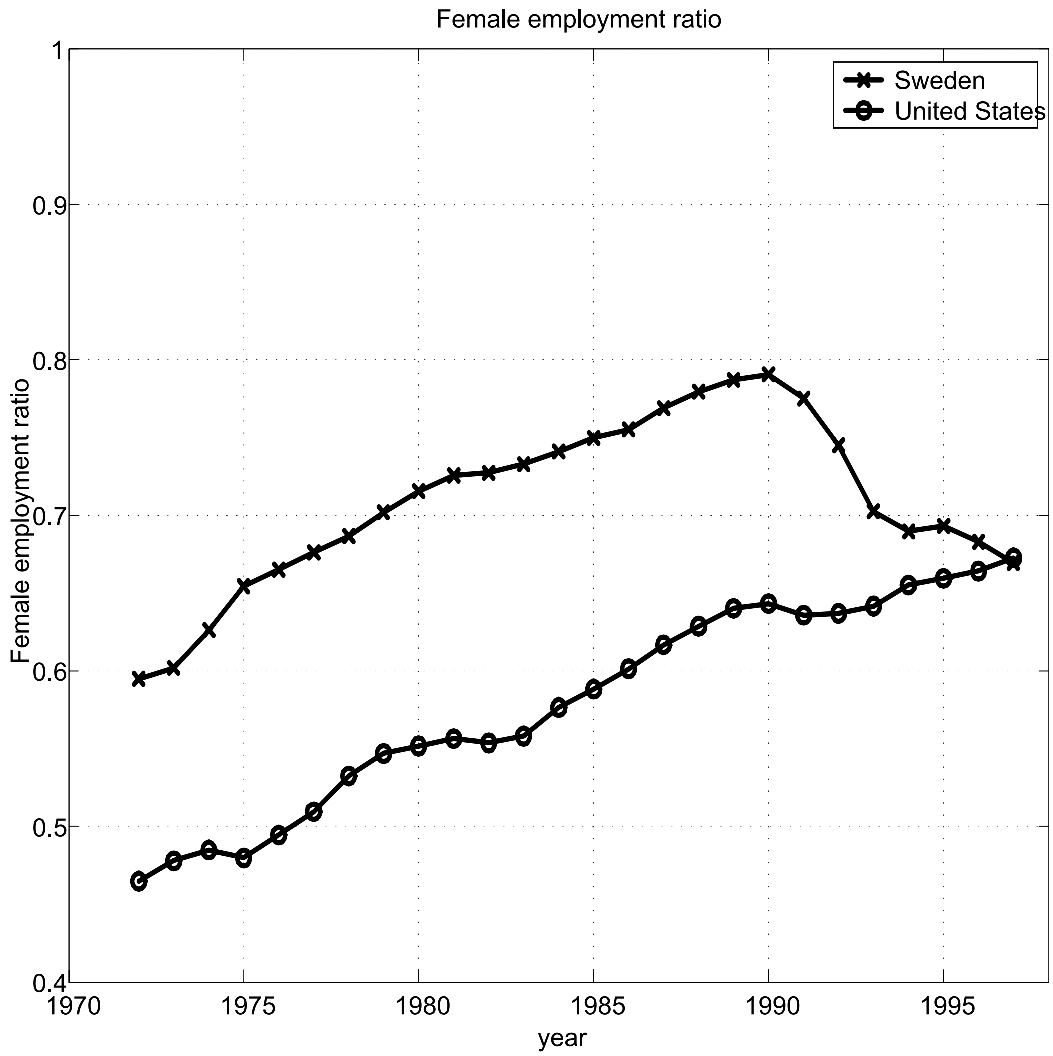

Figure 11: Female employment ratios in the U.S. and Sweden.

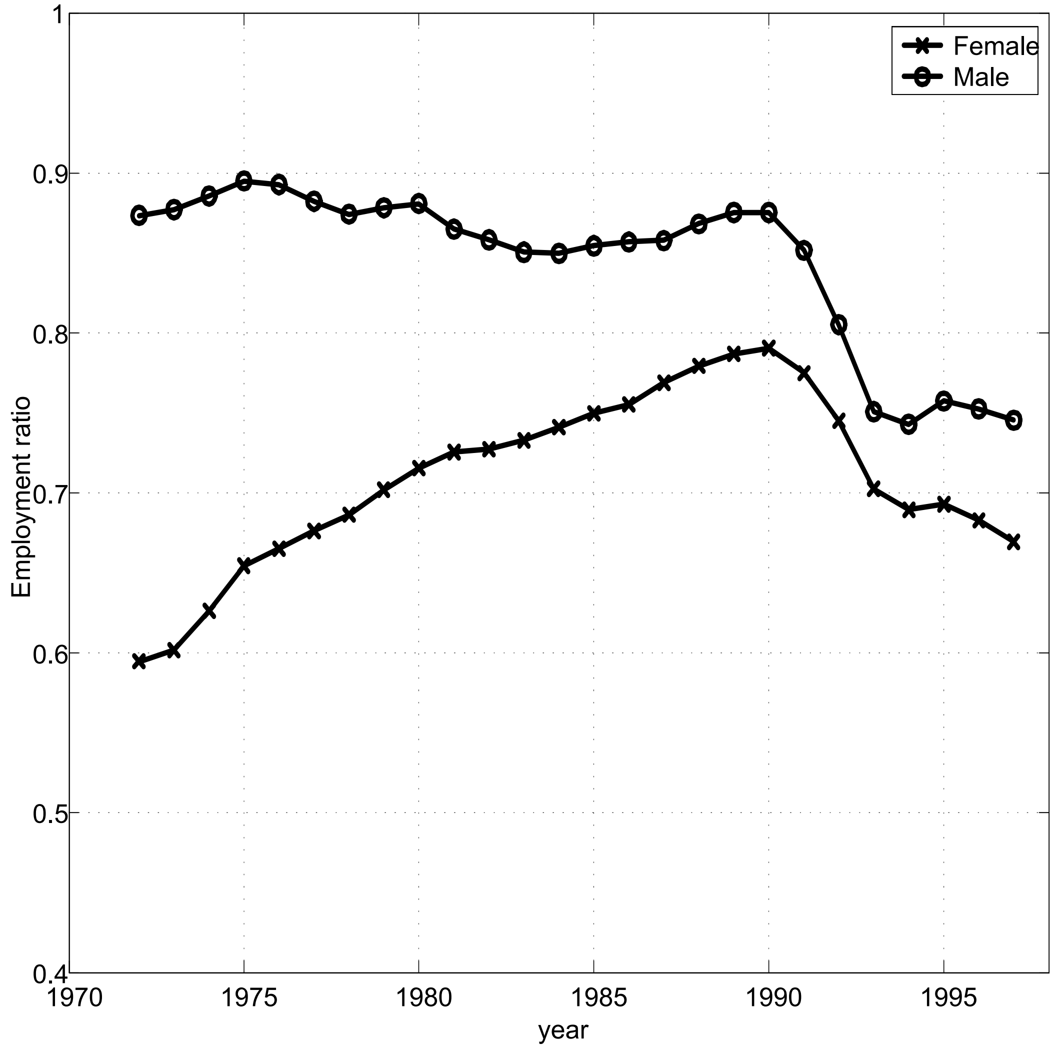

Figure 12: Male and female employment ratios in Sweden.

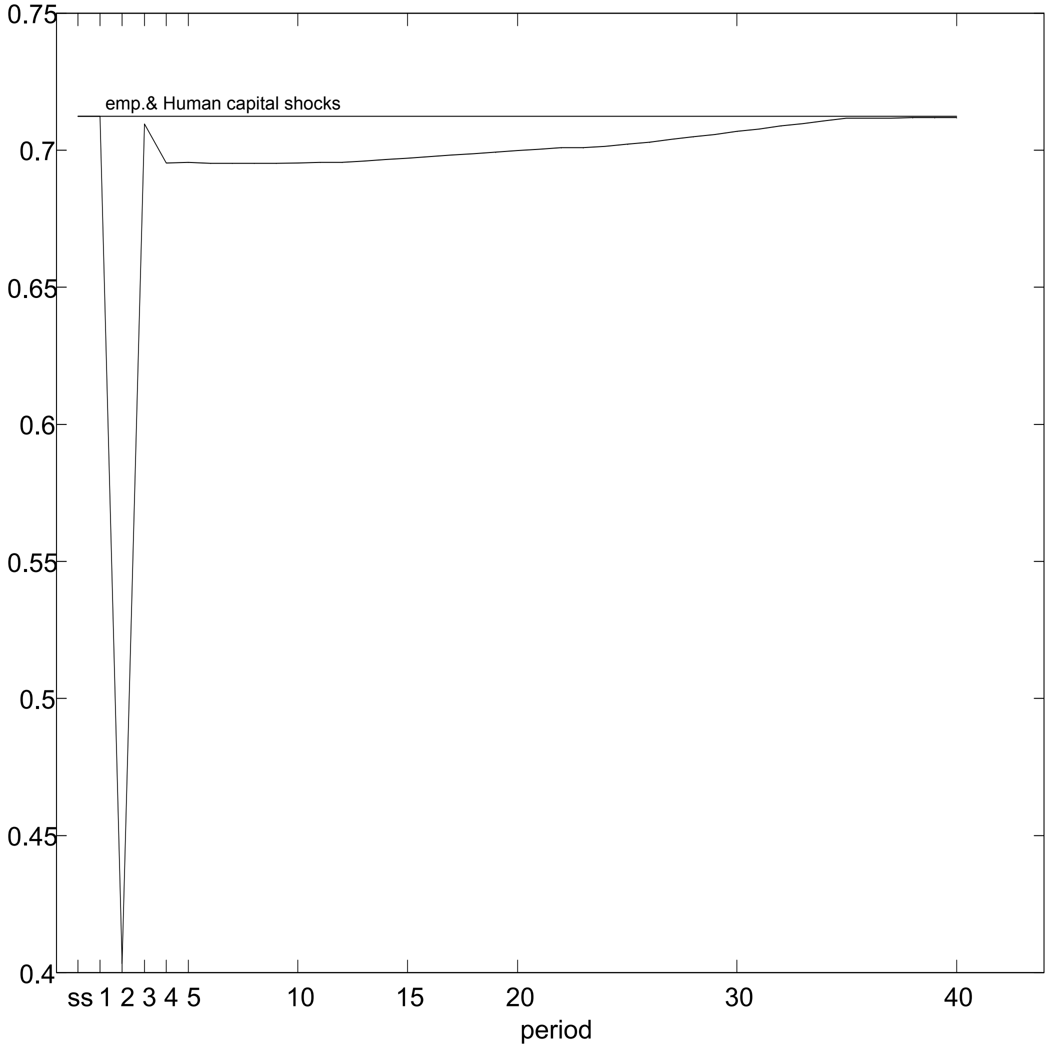

Figure 13: Employment ratio during transition.

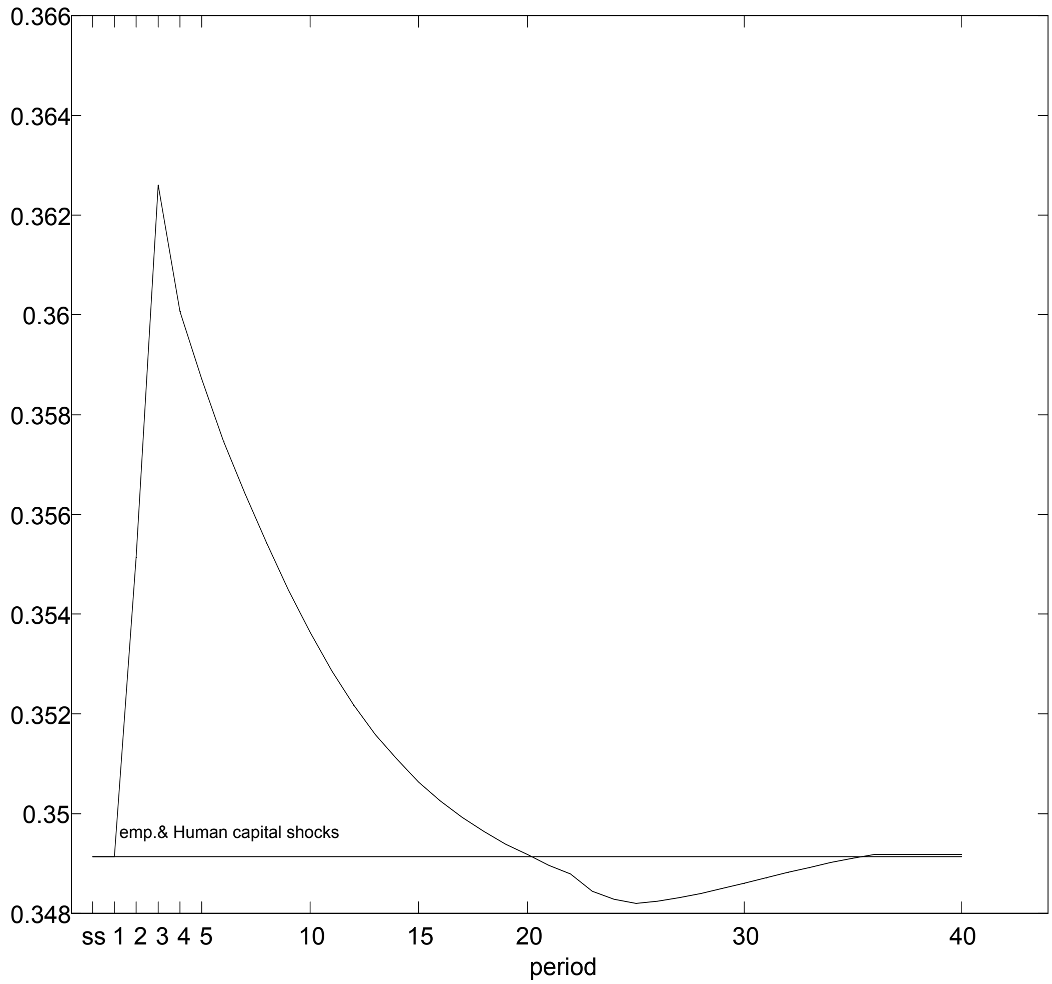

Figure 14: Gini coefficient wages during transition.

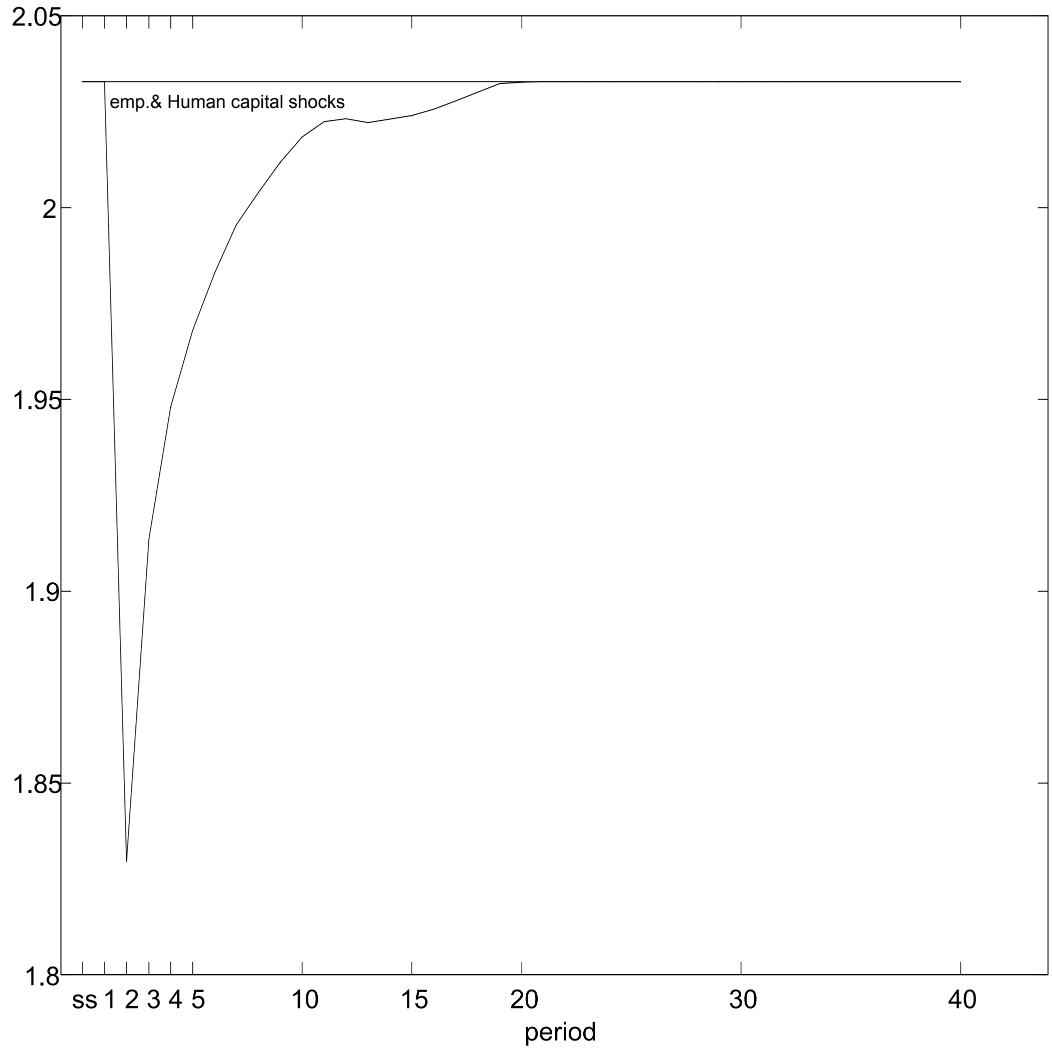

Figure 15: Fertility rate during transition.

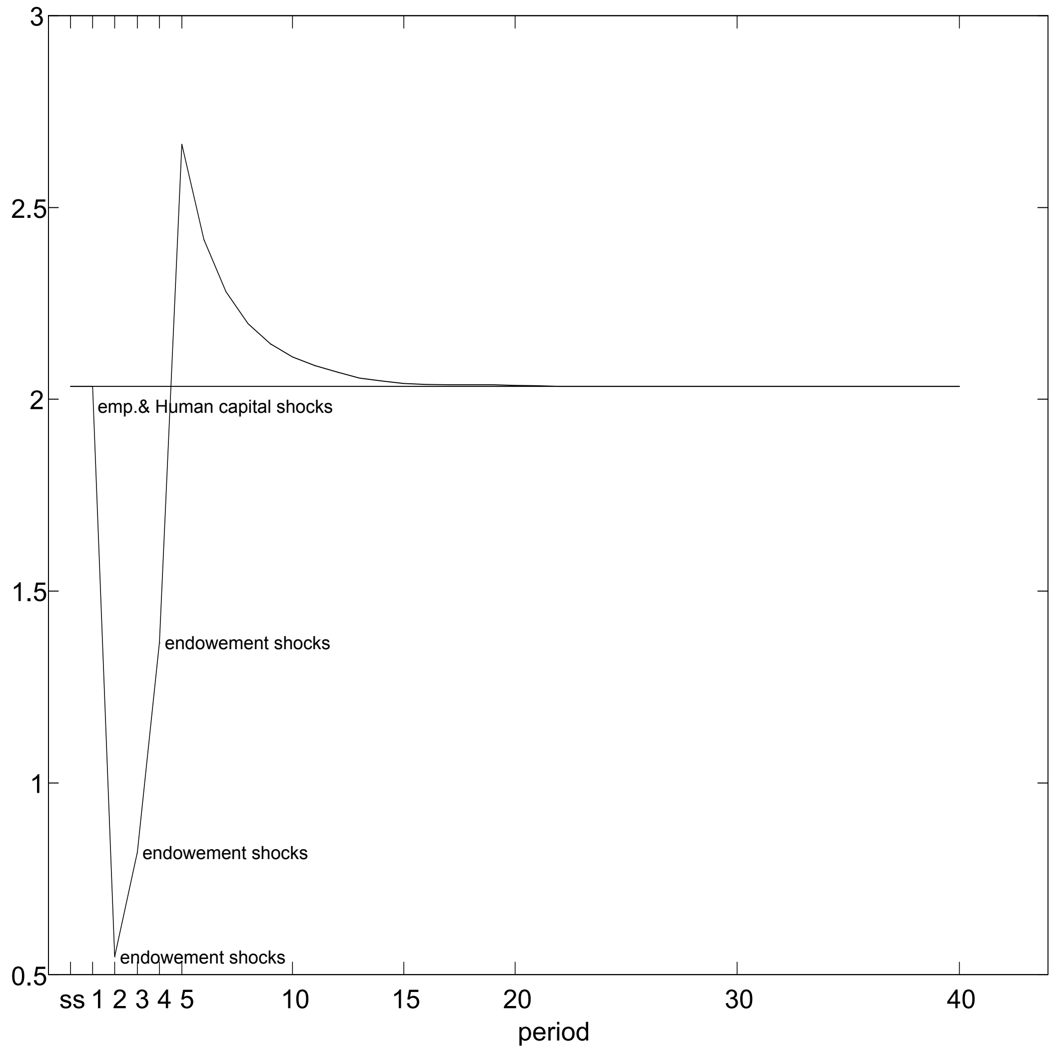

Figure 16: Fertility rate during transition when the shock affects the endowment of goods.