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Female labour force participation and economic development

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Abstract

Purpose – The purpose of this paper is to present a theoretical model, which is aggregated across individuals to analyse the labour force participation rate, and empirical results to provide evidence of a U-shaped relationship between women's labour force participation and economic development.

Design/methodology/approach – The U-shaped relationship is investigated by employing a panel data approach of 40 countries around the world over the period 1960–2005. It is investigated whether the labour force behaviour of women in different age groups can be lumped together by considering ten different age groups.

Findings – The paper finds evidence in favour of the U-shaped relationship. For every age group and explanatory variable in the model, a particular point is found where the regime of falling participation rates changes into a regime of rising participation rates.

Research limitations/implications – To evaluate this relationship, microeconomic analysis with primary data can also provide significant insights.

Social implications – Every country can narrow the gap between the labour participation rates of men and women in the long term. Fertility decline, shifts of employment to services, part-time work, increased opportunities in education, and the capital-to-labour ratio as a measure for economic development are the key determinants.

Originality/value – In addition to the U-shaped relationship, considerable research has been carried out on demographic transition. This paper brings these two strands of literature together, by econometrically investigating the impact of demographic transition on female labour force participation given its U-shaped relation with economic development, i.e., turning points for different explanatory variables are calculated and their implications for economic growth are discussed.

Keywords Economic development, Female labour force participation, Panel fixed effect estimation, Demographic transition, Interactive modelling, Arellano–Bond estimates

Paper type Research paper

1. Introduction

This paper presents a theoretical model and empirical results related to women's labour force participation and the process of economic development. Boserup (1970), Goldin (1995), and Mammen and Paxson (2000) recognise U-shaped relationships between female labour force participation rates and per capita income around the world, as Figure 1 shows for a cross-section of 40 countries in 2005. That is, women's labour force participation rates first fall and then start to increase again during the process of economic development; the female participation rates are relatively high in low-income countries (e.g. Tanzania, Madagascar, Zambia), relatively low in middle-income countries (e.g. Egypt, Tunisia), and then relatively high in both upper middle (e.g. China, Brazil) and high (e.g. Canada, Italy, the USA) income countries. Table I provides an overview of all these countries.

Although the U-shaped relationship is widely recognised, testing this relationship remains challenging. A good example is the recent study by Gaddis and Klasen (2014) in which the evidence in favour of this relationship appears to be rather weak and to depend on the data used, the countries that are included, and whether a cross-section or panel data approach is adopted. In view of past studies that consider a quadratic functional form of

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Figure 1.
GDP per capita and
female labour force
participation, 2005

Low income	Lower middle income	Upper middle income	High income
Bangladesh	China	Argentina	Australia
India	Colombia	Brazil	Belgium
Kenya	Ecuador	Chile	Canada
Madagascar	Egypt	Malaysia	France
Nigeria	Indonesia	Mexico	Italy
Pakistan	Morocco	South Africa	Japan
Tanzania	Peru	Turkey	The Netherlands
Zambia	Philippines		New Zealand
Zimbabwe	Sri Lanka		South Korea
	Syria		Spain
	Thailand		The UK
	Tunisia		The USA

Notes: Economies are divided according to 2006 GNI per capita, calculated using the World Bank Atlas method. The groups are as follows: low income \$935 or less; lower middle income \$936–3,705; upper middle income \$3,706–11,455; and high income \$11,456 or more

Table I.
Countries by income

gross domestic product (GDP) per capita and a set of additional control variables (see Fatima and Sultana, 2009; Pampel and Tanaka, 1986; Tansel, 2002; Tsani *et al.*, 2013)[1], and the more recent studies that lack control variables and, therefore, might suffer an omitted variables bias (Luci, 2009; Tam, 2011; Gaddis and Klasen, 2014), the current study seeks to identify the main determinants of female labour force participation during the course of economic development and tests a more flexible functional form than has appeared in previous studies.

Studies that use GDP per capita often find that its coefficient is negative and significant, with a positive and significant squared term, but not all of them. One reason might be that one interaction term is not sufficient to capture the U-shaped relationship between female labour force participation and economic development; instead, it is necessary to test whether economic development affects female labour force participation in combination with other explanatory variables and perhaps even moderates the effects of those variables (Pampel and Tanaka, 1986). We, therefore, propose a regression model with interaction effects for our measure for economic development. Furthermore, we test for parameter heterogeneity

among women of different age groups. With this approach, we can model the regime shift between decreasing and increasing female participation rates, as well as identify turning points for our measure for economic development in different age groups, another main contribution of this paper.

In their investigation of the U-shaped curve, Tansel (2002) and Fatima and Sultana (2009) use data from a single country. We instead gather time-series, cross-sectional data from various countries. Recent studies of Luci (2009), Tam (2011), Tsani *et al.* (2013), and Gaddis and Klasen (2014) also use time-series, cross-sectional data. With the time-series component, we investigate whether countries move along the curve as their economy develops; the cross-sectional component enables us to address every part of the U-shaped relationship. According to Tam (2011) and Gaddis and Klasen (2014), an analysis limited to cross-sectional data only, or pooled data without controlling for country fixed effects, might lead to severely biased estimates due to unobserved time-invariant heterogeneity. An analysis limited to one country or a set of developing countries might also not reflect the focal relationship accurately. As Pampel and Tanaka (1986) point out, if the effects of development are linear, examining a sample of nations at a single level of development would not bias the results; the linear effect would be the same at various levels of development. However, if the effects are not linear, a restricted sample might misspecify the relationship. Finally, an analysis limited to developed countries only (Eckstein and Lipshitz, 2011; Pena-Boquete, 2016) may not reflect the U-shaped relationship accurately, since these economies already moved beyond the turning point.

First, we propose a micro-economic framework for the labour force decision and its causal factors, which we aggregate across individuals to analyse the labour force participation rate at the national level. Although GDP per capita is a logical proxy for economic development, by departing from an economic-theoretical model this paper shows that the capital-to-labour ratio might be another one when comparing female labour force participation rates across different countries and different stages of economic development. Moreover, GDP per capita is not exogenous to female labour force participation. Luci (2009) even suggests applying Granger causality tests to investigate whether GDP per capita determines female labour force participation or vice versa. Because aggregation is permitted only if individual marginal reactions do not differ significantly, we present a framework to test this hypothesis. Next, we present and discuss the data and their empirical implementation in our model, along with the results of different (mis)specification tests and the empirical results. Finally, we summarise our findings and discuss some policy implications.

2. Theoretical framework

The labour force participation rate can be derived from a choice model between consumption and working time, subject to the usual budget constraint that (the present value of) consumption does not exceed (the present value of) income. At the micro level, the decision to participate in the labour market is a dichotomous random variable, equal to 1 if the decision is positive and 0 if it is negative. If we start with country level, instead of individual, data, the variable consists of the proportion LFP_i of women who belong to the female working age population in country i ($i = 1, \dots, N$) who decide to participate. We present a theoretical framework to identify key determinants of the individual labour force decision, before we explain the transition from the micro level to the country level.

2.1 Participation decisions at the micro level

A woman participates in the labour market if the utility level U associated with participation exceeds the utility level associated with being inactive[2]. In poor, mainly agricultural economies, the number of women who are in the labour force is relatively high, mostly as unpaid workers on family farms who combine agricultural work

with childcare. When income levels rise, often through the expansion of the manufacturing sector and the introduction of new technologies, women's labour force participation rates tend to fall. Men move into new blue-collar jobs that increase family income, exerting unearned income effects that reduce women's participation. Furthermore, there are fewer family farms on which women can work. At the same time, some women may be barred from employment by the nature of the work; women in manufacturing are mostly self-employed or unpaid family workers, such as those working in home-based craft production (Schultz, 1990).

If a woman in a poor economy has a job, she receives an hourly wage (w_f) for the number of hours being supplied (h_f). Women who work on a family farm do not receive an hourly wage rate, but their wage rate may be determined by the shadow wage rate, according to the production part of a household production model (Singh *et al.*, 1986). The probability (P_d) that a woman will lose her job depends on labour market conditions (l), such that a high value of l refers to favourable conditions. If labour market conditions are unfavourable (e.g. loss of employment in agriculture), we find a decrease in l and increase in $P_d(l)$. In addition, the woman's utility level depends on the number of children to whom she gives birth (fertility). Although having more children may increase the woman's utility level in principle, the counteracting effect is that the time available for work diminishes with greater childcare responsibilities. Therefore, working time is a function of fertility (τ), $h_f = h_f(\tau)$, where the first derivative of h_f with respect to τ is negative, $\partial h_f / \partial \tau < 0$. The relationship between economic development, in terms of income, and fertility may be negative also because the need to have children for old-age security diminishes. Lower mortality also reduces the returns on large families, representing another force towards lower fertility (Soares and Falcao, 2008). Finally, children are useful from an early age on farms in low-income economies, but they become increasingly less useful and more expensive if income levels increase, especially if they spend an increasing number of years in school (Jacobsen, 1999).

The woman's utility further depends on the income earned by her husband. Improvements in men's wages due to an expansion of the manufacturing sector, without corresponding improvements in women's wages, reduce women's labour force participation, because a jump in unearned income (i.e. income of a woman, independent of hours worked) unambiguously leads to fewer hours worked. In lower income countries, the effect may be that a woman quits working altogether. Therefore, a woman already employed remains active as long as:

$$U\{[1-P_d(l)] \times w_f \times h_f(\tau), \tau, q(w_m, w_f), w_m\} > U\{0, \tau, q(w_m, 0), w_m\}. \quad (1)$$

When economic development continues, women move back into the labour force. First, their educational attainment tends to improve, so the value of women's time in the market increases, which strengthens the incentives of women to work outside the home. Second, employment in agricultural and manufacturing sectors tends to fall, while employment in the services sector increases, in more developed countries, so more women enter the labour market. Bowen and Finegan (1969) note that the sectoral composition of employment can explain structural differences across metropolitan areas in terms of the relative abundance of jobs commonly held by women. In a study of women's labour force participation from a global perspective, Schultz (1990) also finds that the shift in the composition of production, out of agriculture and into manufacturing and services, is associated with expanded opportunities for women's employment relative to men's, particularly as wage earners. The possibility of part-time work, especially in the service sector, also is important, because this option permits women to combine work outside the household with their domestic activities within it (Jaumotte, 2003). Third, more women enter the labour market because fertility

tends to decline when the economy develops. This shift is one of the main effects of demographic transition, that is, the change from high to low rates of mortality and fertility.

A woman who finds a job obtains the benefits of being active ($w_f h_f$) but faces the disadvantage of having less time available for childcare. In addition, a woman seeking a job incurs search costs (s), which are relatively higher than those for a woman who already has a job and might be looking for another one. The probability of finding a job depends on labour market conditions (l): if these conditions are favourable (or unfavourable) (e.g. relatively many jobs in the services sector or few jobs in the agricultural sector (or vice versa)), the probability $P_f(l)$ increases (decreases). This yields a similar expression as in Equation (1), but then $1 - P_d(l)$ replaced by $P_f(l)$.

From this theoretical framework, it follows that the participation decision positively relates to the female wage rate (w_f) and favourable labour market conditions (l) but negatively to the male wage rate (w_m), fertility (τ), and search costs (s). Importantly, by including (un)favourable labour market conditions, we not only control for supply but also for demand factors, an issue especially stressed by Pena-Boquete (2016). Note that these conditions also cover unemployment for which we have no (reliable) data, at least not for developing countries (see Footnote 3). Although other variables might also affect the labour force participation rate (e.g. Costa, 2000; Eckstein and Lipshitz, 2011; Jacobsen, 1999; Jaumotte, 2003; Lim, 2001; Pena-Boquete, 2016), our analysis focusses on key variables related to the process of economic development, following from our theoretical framework. Since this study focusses on developing countries, we prefer to use the number of jobs in agriculture as the indicator of (un)favourable labour market conditions, the complement of the number of jobs in services. Studies that do not control for these key variables might suffer an omitted variables bias (Luci, 2009; Tam, 2011). Gaddis and Klasen (2014) neither control for these variables when testing the U-shaped relationship (see their Tables II and IV), which might explain why they do not find clear evidence in favour of this relationship. In the second part of their paper, they therefore start looking for the key mechanisms supposedly underlying the U-shaped relationship. They identify the substantial decline in agricultural value added and the capital vs employment intensity of growth and mention fertility decline and female education as potential factors requiring further research. It is these variables the female labour force participation rate will be taken to depend on when implementing the theoretical model in Section 3.

2.2 Participation rate at the country level

Transitioning from the micro to the meso level is the focus of Elhorst and Zeilstra's (2007) work. Let $F(w)$ be the cumulative distribution function, denoting the proportion of women who add positive hours of work to the labour market, because the market wage rate exceeds their reservation wage. Then the labour force participation rate LFP , given observable explanatory variables X and a set of fixed but unknown parameters β , is the cumulative distribution of w , evaluated at $w = w^*$:

$$LFP(w, X, \beta) = F(w|X, \beta). \quad (2)$$

If different age groups have different observable explanatory variables w_g and X_g for $g = 1, \dots, G$, total labour force participation rates depend on the sum of the group-specific cumulative density functions $F_g(w_g|X_g, \beta_g)$, weighted by the share of each age group in the total female working age population (a_g). In mathematical terms:

$$LFP_{\text{total}} = \sum_{g=1}^G a_g F_g(w_g|X_g, \beta_g). \quad (3)$$

From this equation, it follows that there are two ways to deal with heterogeneous groups. The first is to consider a limited number of regression equations for broad population

groups and correct for the composition effect of groups with different observable explanatory variables X (Fatima and Sultana, 2009; Jaumotte, 2003; Pampel and Tanaka, 1986; Pena-Boquete, 2016; Tansel, 2002). Luci (2009) and Tam (2011) consider the entire female working age population (15–64 years), whereas Gaddis and Klasen (2014) also report separate results for women aged 25–44 and 45–59 years. The second, more prevalent method includes as many population groups as necessary to obtain within-group homogeneity, then estimates a separate regression equation for each age group (Bloom *et al.*, 2009; Eckstein and Lipshitz, 2011; Elhorst, 2008). Bloom *et al.* (2009) exclude women aged 45 years and older, with the untested argument that fertility beyond this age is very low. Yet older women still may need to care for children who have not left home or cannot re-enter the labour market, even if they want to do so. Elhorst (2008) tests for whether the marginal reactions of two age groups are the same. Considering two participation rate equations for two age groups, say A and B , we have:

$$LFP_A = X_A\beta_A + \varepsilon_A, \text{ and } LFP_B = X_B\beta_B + \varepsilon_B, \quad (4)$$

where the wage rate w is assumed to be part of X , and ε_A and ε_B are independently and identically normally distributed error terms with zero mean and variance σ_A^2 and σ_B^2 , respectively. Starting from $X_A = X_B$, it is possible to test the hypothesis $H_0: \beta_A = \beta_B$ against the alternative hypothesis $H_1: \beta_A \neq \beta_B$ using the test statistic:

$$(\hat{\beta}_A - \hat{\beta}_B)'(V_A + V_B)^{-1}(\hat{\beta}_A - \hat{\beta}_B), \quad (5)$$

where V_A and V_B represent the covariance matrices of both groups, respectively. Under the null hypothesis, this test statistic has a χ^2 distribution with degrees of freedom equal to the number of explanatory variables in both X_A and X_B .

3. Empirical analysis: implementation

The data we use for the empirical analysis refer to 40 countries and 45 years (1960–2005)[3]. We selected observations in five-year intervals (1960, 1965, ..., 2000). Because the data set is not complete, we obtained 326 observations. The countries belong to different income classes (see Table I), so the sample should cover every part of the U-shaped relationship between the female labour force participation rate and economic development. The dependent variable is female labour force participation rates in 10 five-year age groups (15–19, 20–24, ..., 60–64). In addition, we report the aggregated results (15–64 years) as a kind of benchmark.

The theoretical framework set out in Section 2 invites the use of regression analysis to evaluate the impact of the female wage rate (w_f), the male wage rate (w_m), labour market conditions (l), fertility (τ), and search costs (s). However, we do not have comparable international data on male and female wage levels. To address this problem, Bloom *et al.* (2009) assume a simple Cobb–Douglas function, where output Y depends on capital K and aggregate labour L , and men and women get paid according to their marginal products. In mathematical terms, it is defined as:

$$Y = K^\alpha [L_m h_m + L_f h_f]^{1-\alpha}, \quad (6)$$

where effective labour L is the sum of the male and female forces, L_m and L_f , weighted by their education levels, h_m and h_f , and $0 < \alpha < 1$. Thus:

$$w_f = (1-\alpha) \left(\frac{K}{L}\right)^\alpha h_f \text{ and } w_m = (1-\alpha) \left(\frac{K}{L}\right)^\alpha h_m. \quad (7)$$

Because female wages rise with the capital-to-labour ratio (Hal Mason and Sakong, 1971; Arai, 2003, p. 598) and with female education (Pena-Boquete, 2016, p. 470), the latter two variables can be used as alternatives to (fe)male wages. However, such an alternative approach creates two complications. First, the capital-to-labour ratio can only be treated as an exogenous explanatory variable if the denominator of this ratio is approached by the total male and female population of working age (15–64 years) (Bloom *et al.*, 2009). Otherwise, it will be endogenous since the size of the labour force depends on the number of women who decide to participate. This problem is similar to the one associated with using GDP per capita to explain female labour force participation. Second, the correlation between the educational levels of men and women is high (0.94). To avoid multicollinearity issues, we only consider the educational level of women, proxied for by the average years of schooling of the female population aged 15 and over, and taken from Barro and Lee (2000). Except for wages, educational levels also cover search costs (and partly unemployment). In his literature overview of regional unemployment differentials, Elhorst (2003) finds that better educated women, compared with less educated ones, likely conduct more efficient searches, are less prone to layoffs, and exhibit more stable patterns of employment. Similarly, Pena-Boquete (2016, p. 470) argues that this variable is likely to capture the high potential wages associated with high human capital.

For the labour market conditions of a country, we measure the percentage share of employed people in agriculture (the complement of employment in services). Fertility refers to the total number of children a woman will have by the end of her fertile period, based on prevailing age-specific fertility rates. Data on total fertility rates came from the World Bank's (2007) Development Indicators. The relationship between fertility and female labour force participation likely is negative. However, studies of the behavioural responses to changes in fertility are complicated by issues of endogeneity, because increasing female labour force participation may dampen fertility rates. Such endogeneity requires instrumental variable methods, such as two-stage least squares, to obtain consistent parameter estimates. Conversely, according to our theoretical model set out in Section 2, changes in the employment in agriculture and educational attainment of the female population precede changes in female labour force participation, as a result of which these variables may be treated as exogenous.

The summary statistics across the different income groups appear in Table II, which demonstrate that the female participation rate of every age group shows a U-shaped relationship when moving from low- to high-income economies. The participation rates of women aged 15–19 years up to 50–54 years are the lowest for lower middle-income economies, whereas the participation rates for women aged 55–59 and 60–64 are lowest for upper middle-income economies. The average years of schooling and the capital-to-labour ratio increase if incomes rise, whereas total fertility rate and employment in agriculture fall.

To test for the U-shaped relationship between women's labour force participation in different age groups during the process of economic development, we postulate a mixed linear functional form in respectively the fertility rate, employment in agriculture, and women's educational levels and a quadratic functional form of these variables with the capital-to-labour ratio. Since this ratio reflects the capital (or employment) intensity of growth and according to Gaddis and Klasen (2014, Section 5) is one of the key mechanisms behind female labour force participation, we use this ratio to measure economic development. More arguments in favour of this variable and the postulated mixed functional form, which better reflects the transition of economies from low- to middle- and high-income levels, have been provided in the introduction of this paper:

$$LFP_{it} = \beta_1 \tau_{it} + \beta_2 \tau_{it} \left(\frac{K}{L} \right)_{it} + \beta_3 \left(\frac{K}{L} \right)_{it} + \beta_4 \left(\frac{K}{L} \right)_{it}^2 + \beta_5 A_{it} + \beta_6 A_{it} \left(\frac{K}{L} \right)_{it} + \beta_7 h_{fit} + \beta_8 h_{fit} \left(\frac{K}{L} \right)_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (8)$$

Table II.
Mean values
of countries by
income group

Variable name	Low income	Lower middle income	Upper middle income	High income
Female participation age 15–19	50.31	31.14	34.89	39.81
Female participation age 20–24	60.55	44.82	49.46	62.85
Female participation age 24–29	65.02	46.06	49.35	58.56
Female participation age 30–34	69.55	46.35	47.85	55.13
Female participation age 35–39	71.01	46.18	49.05	57.38
Female participation age 40–44	70.38	46.53	47.97	58.33
Female participation age 45–49	70.18	44.19	45.81	55.99
Female participation age 50–54	68.71	39.34	41.46	48.98
Female participation age 55–59	64.85	33.31	31.72	37.60
Female participation age 60–64	56.37	23.26	21.63	22.21
Total fertility rate	6.03	4.47	3.93	2.14
Average years of schooling (females, age > 15)	2.15	3.99	4.65	8.13
Capital stock per worker (000)	4.95	15.20	29.18	90.30
Employment in agriculture (%)	73.56	47.55	30.49	11.04
Lagged birth rate/1,000	42.63	36.44	29.67	20.06
Infant mortality rate/1,000	102.45	66.61	55.62	14.19
Under 5 mortality rate/1,000	167.15	96.84	73.36	16.75

Note: Based on sample of 326 observations

where LFP_{it} denotes the female participation rate of a particular age group of country i at time t ; τ is the fertility rate; K/L is the capital-to-labour ratio; A is the share of employment in agriculture; h_f is the educational level of women; ε_{it} are independently and identically normally distributed error terms for all i and t with zero mean and variance σ^2 ; μ_i denotes a country fixed effect; and λ_t indicates a time-period fixed effect. Country fixed effects control for all country-specific time-invariant variables, such as cultural and social norms, whose omission could bias the estimates in a typical cross-sectional study; similarly, time period fixed effects control for all time-specific, country-invariant variables whose omission could bias the estimates in a typical time-series study. On testing these fixed effects, they were found to be jointly significant.

The marginal effects of the variables in Equation (8) are obtained by differentiation as shown in the following:

$$\frac{\partial LFP}{\partial \tau} = \beta_1 + \beta_2 \frac{K}{L}, \quad \frac{\partial LFP}{\partial A} = \beta_5 + \beta_6 \frac{K}{L}, \quad \frac{\partial LFP}{\partial h_f} = \beta_7 + \beta_8 \frac{K}{L},$$

and:

$$\frac{\partial LFP}{\partial \frac{K}{L}} = \beta_3 + \beta_2 \tau + 2\beta_4 \frac{K}{L} + \beta_6 A + \beta_8 h_f, \quad (9)$$

which implies that turning points at which the impact of the capital-to-labour ratio changes sign are $K/L = -\beta_1/\beta_2$ for the fertility rate (τ), $K/L = -\beta_5/\beta_6$ for the share of employment in agriculture (A), and $K/L = -\beta_7/\beta_8$ for the educational level of women (h_f), respectively. The marginal effect of the capital-to-labour ratio appears to depend on τ , A , and h_f . We could calculate its turning point at the sample means of these three variables, but this calculation ignores that these variables in their turn also depend on the capital-to-labour ratio and thus may take different values along a country's economic development path. To account for this,

we substitute the first derivatives of these variables into that of the capital-to-labour ratio, to get (after rearranging terms):

$$\frac{\partial L}{\partial K} = \beta_3 + \beta_1\beta_2 + \beta_5\beta_6 + \beta_7\beta_8 + (2\beta_4 + \beta_2^2 + \beta_6^2 + \beta_8^2)\frac{K}{L}, \tag{10}$$

as a result of which the turning point of the capital-to-labour ratio on its own marginal impact is determined by:

$$-\frac{\beta_3 + \beta_1\beta_2 + \beta_5\beta_6 + \beta_7\beta_8}{2\beta_4 + \beta_2^2 + \beta_6^2 + \beta_8^2}. \tag{11}$$

4. Empirical analysis: specification tests

Because female labour force participation may have a negative feedback effect on fertility rates, we treated the fertility rate and the product term between the fertility rate and the capital-to-labour ratio as two separate endogenous explanatory variables. We tested several potential instrumental variables, and eventually selected the birth rate lagged five years in time, measuring the number of childbirths per 1,000 of the population, the infant mortality rate (up to 1 year of age), and the mortality rate under five years. Data on the birth rate were extracted from the World Population Prospects (United Nations, 2006), and data on infant mortality rates came from the World Development Indicators (World Bank, 2007). Summary statistics of these variables are presented in the bottom rows of Table II.

The results of the first-stage regressions in Table III show that the capital-to-labour ratio, employment in agriculture, and education have negative effects on the fertility rate; the lagged birth rate and the two mortality rates have positive effects. Many of these results align with previous studies (e.g. d’Addio and d’Ercole, 2005; Becker *et al.*, 2010). Both the fertility rate and the product term between the fertility rate and the capital-to-labour ratio reveal relatively high R^2 values, indicating that the instruments together with the exogenous regressors have predictive power with respect to fertility rates. This point also is illustrated by the F -tests of the first-stage regressions.

We also tested whether the instruments were relevant. Instruments are irrelevant if their correlation with the endogenous regressors is weak. The results (27.81, χ^2 statistic with K_1 degrees of freedom (df), where K_1 is the number of potential endogenous regressors,

Instrumental variables	Dependent variable:	
	Dependent variable: fertility	fertility $\times$ capital-to-labour ratio
Lagged birth rate	0.076*** (0.01)	2.569*** (0.369)
Capital-labour ratio	-0.012 (0.008)	1.836*** (0.398)
Capital-labour ratio $\times$ capital-labour ratio	0.001 (0.008)	-0.0002 (0.001)
Agriculture	-0.003 (0.005)	-1.028*** (0.021)
Agriculture $\times$ Capital-labour ratio	-0.0001 (0.0001)	0.062*** (0.006)
Education	-0.380*** (0.058)	-2.23 (2.01)
Education $\times$ Capital-labour ratio	0.002*** (0.0005)	-0.067*** (0.033)
Infant mortality rate	0.003 (0.007)	1.557*** (0.253)
Mortality rate below five years of age	0.005 (0.005)	-0.883*** (0.161)
R^2	0.91	0.79
First-stage F -test	28.26	27.36

Table III.
First-stage
regression results

Notes: All regressions are based on the sample of 326 observations and include country and time-period fixed effects. Coefficient of squared capital-to-labour ratio is multiplied by 1,000. Robust standard errors are shown in parentheses. *, **, ***Significant at 10, 5 and 1 per cent levels, respectively

p -value < 0.01) indicated that this hypothesis for our instrument set must be rejected. Next, we carried out Davidson and MacKinnon's (1993) test for whether instrumental variable techniques are required in a regression equation with fixed effects. The results (11.5, F -statistic with K_1 and $K_2 - K$ df, where K_2 is the number of observations and K the number of regressors, p -value 0.01) demonstrated that the null prediction of exogeneity must be rejected, and thus that the fertility rate and the product term between the fertility rate and the capital-to-labour ratio may not be treated as exogenous explanatory variables. Finally, we carried out the Sargan–Hansen test of overidentifying restrictions. The results (0.72, χ^2 statistic with $K_3 - K$ df, where K_3 is the total number of instruments, p -value 0.39) showed that the null hypothesis that the instruments are valid and the model correctly specified cannot be rejected.

Table IV contains the estimation results of the nonlinear regression model from Equation (8) for the different age groups. The share of employment in agriculture is measured in percentages, so its coefficient represents the shift in participation rates, measured on the interval 0–100 per cent, when this variable rises by one percentage point. The coefficient of the fertility rate shows the shift in the participation rate when this variable increases by one child; that of education refers to the change with one additional year of schooling; and the capital-to-labour ratio indicates the change when the ratio increases by US\$1,000. The R^2 values range from 0.07 for women aged 60–64 years to 0.57 for those between the ages of 25 and 29 years.

We first tested whether it was necessary to adopt a quadratic functional form for the capital-to-labour ratio. The nonlinearity test whether the coefficients of the interaction effects can be set to zero, reported in the bottom line of Table IV, indicate that the linear functional form should be strongly rejected for all age groups. In every regression equation, three out of four interaction variables are significant. This finding indicates that a single interaction term, the standard approach in previous studies, is generally not sufficient to capture the U-shaped relationship between female labour force participation and economic development.

Finally, we tested the equality of the coefficients of the eight explanatory variables in Table IV for all crosswise combinations of population groups (including total female working age population), for a total of 55 pairs, using Equation (5). The results indicated that the null hypothesis must be rejected in 46 cases. Only female labour force behaviour in the successive age groups from 24–29 to 40–44 years was similar. That is, identical marginal reactions by different population groups are an exception rather than a rule. It follows from this finding that age-targeted policies to enhance female labour force participation rates likely would be more successful than a “one-size-fits-all” policy.

5. Empirical analysis: results

The share of employment in agriculture appears to have a positive effect on the female participation rate in every group (significant for five age groups); the interaction effect between the share of employment in agriculture and the capital-to-labour ratio reveals a negative effect (significant for all age groups). The positive sign of the agricultural variable might be explained by the women's ability to combine farm work with family responsibilities in low-income and developing economies. We explain the negative sign of the interaction term with two rationales. First, a rising capital-to-labour ratio represents a structural shift, from employment in agriculture to industry and services. Consequently, the agricultural sector employs fewer women, but they cannot immediately move to other sectors, due to their lack of skills and knowledge. Second, when an economy develops, the mechanisation of farm activities increases labour productivity, so fewer people are needed in the agricultural sector. In this respect, Boserup (1970, 1990) and Gladdis and Klasen (2014) argue that industrialisation marginalises women by hindering their participation in wage work. Our results corroborate the hypothesis that agricultural employment has a

Notes: All regressions are based on the sample of 326 observations and include country and time-period fixed effects. Coefficient of squared capital-to-labour ratio is multiplied by 1,000. Robust standard errors are shown in parentheses. *, **, ***Significant at 10, 5 and 1 per cent levels, respectively

positive effect in lower-income countries and a negative effect in higher-income countries. The point at which the marginal effect, which is the first-order derivative for the total female working age population with respect to agriculture, changes its sign amounts to \$9,210. This point reflects the real-world situation: in countries of Africa and South Asia, the capital-to-labour ratio is lower than the level at which the marginal effect of the share of employment in agriculture changes sign. In these two regions of the world, we also find the highest rate of women employed in the agricultural sector, namely, 69 and 61 per cent in 2007, respectively. Schultz (1990) finds that changes in the sectoral composition of the labour force trace the U-shaped relationship between female labour force participation rate and economic development. Our results are consistent with this finding.

Education has a negative, significant effect on the female participation rate of every age group, and the interaction effect between education and the capital-to-labour ratio exerts a positive, significant effect on every age group. These coefficient estimates show that education does not have a positive effect on women's labour force participation in lower-income countries but does in higher-income countries. The point at which the marginal product for the total female working age population changes sign amounts to \$53,215. In other words, education has a positive effect only for countries located in Europe, North America, and Oceania. Similar results emerged from Smith and Ward's (1985) study of the USA in 1900 and Kottis' (1990) investigation of Greece during 1971–1981. The impact of education depends on a country's stage of development. Most women in low-income countries are unpaid workers on family farms; more schooling does not help to improve their position in this labour market.

Fertility appears to have a substantial and significant negative effect on the participation rate of women in every age group; the interaction effect between fertility and the capital-to-labour ratio instead appears to have a positive effect. Therefore, fertility has a negative effect on the female labour force participation rate in low-income economies and a positive effect in high-income economies. Even though, this positive effect is only significant for women aged between 15 and 19 or 20 and 24 years, it is explained by the fact that in the longer term relatively more women keep participating if they reach the older age cohorts. The point at which the marginal product of fertility for the total female working age population changes sign amounts to \$69,410. In countries located in Africa, South Asia, the Middle East, North Africa, and South America, fertility negatively affects participation; in countries located in Europe, North America, and Oceania, fertility positively affects participation.

On the basis of our regression results, we also computed a demographic transition effect, that is, the increase in female labour force participation due to a change from high to low rates of fertility when the economy develops. As Table II shows, the fertility rate declines from 6.03 births per woman in low-income economies to 2.14 in high-income economies. Taking into account the positive but different effects of fertility decline for every age group, which diminishes with higher capital-to-labour ratio, in Figure 2 we graph the extent to which the female labour force participation rate rises for these age groups. The impact of the fertility decline for the prime age groups is stronger than that for teenagers and elderly women. If we weight these impacts by the share of each age group in the total female population, the total effect becomes 22 per cent. If this calculation would be based on the estimation results of the total female labour force participation rate, we obtain just 19 per cent, indicating that the aggregation of different female age groups into one single group underestimates this effect. Bloom *et al.* (2009) indicate 11 per cent, but they also warn that this percentage may underestimate the total effect, because they only consider the labour supply of women younger than 45 years (and according to our estimation result, older age groups explain approximately 5 per cent of the total increase). Furthermore, they estimate a linear instead of a quadratic functional form[4], such that they cannot account for regime switch effects.

The turning point of the capital-to-labour ratio on its own marginal product is calculated using Equation (11); it has a negative effect on the female labour force

Figure 2.
Percentage increase of
fertility decline for
female labour force
participation in
different age groups

Note: Fertility decline was from 6.03 to 2.14 births per woman

participation rate in countries with ratios below \$86,445 and a positive effect above it. This finding is consistent with the hypothesis that improvements in men’s wages, due to an expansion of the manufacturing sector in developing countries, without corresponding improvements in women’s wages, exert (unearned) income effects that reduce women’s participation. Only when the value of women’s time considerably increases do women move back into the labour force. Figure 3 illustrates the turning points for different age groups. An inverse U-shaped relationship is apparent, such that the turning points for women in the prime age groups are higher than those for younger and older age groups. Therefore, teenagers and elderly women are the first to benefit from higher capital-to-labour ratios when an economy develops. The second group to benefit are women in the younger and older age groups, 20–24, 25–29, 45–49, 50–54, followed finally by women in the age groups 30–34, 35–39, and 40–44. It should be stressed that

Figure 3.
Regime shift turning
points of the capital
stock per worker for
different age groups

Note: Points calculated using Equation (11) based on the parameter estimates in Table IV for every age group

these results are closer to reality than those that can be derived from the study of Tam (2011, Table I) based on the log GDP variable. Although he does not report these turning points, they can be found by dividing the coefficient of this variable by the coefficient of its square reported in his study (see our explanation below Equation (9)). This gives 16.43 for his OLS estimation results, 13.89 for WG, 12.68 for GMM-IV, and 15.58 for GMM-SYS. Note that all these turning points are beyond the turning point of approximately 8.5 graphed in both his and our Figure 1, indicating again that controlling for other explanatory variables is important. By investigating the relationship between the capital-to-labour ratio and GDP per capita, we found that our capital-to-labour ratio of \$86,445 corresponds to a GDP per capita level of approximately \$13,650. The natural log of this value amounts to 9.5, which is much closer to the turning point graphed in Figure 1.

6. Conclusion

To test whether women's participation in the labour force first declines and then rises with economic development, we have presented an economic-theoretical model of female labour force participation indicating that the capital-to-labour ratio is a better proxy for economic development than GDP per capita. We also have presented empirical evidence in favour of a more flexible functional form than those that appear in previous studies. Because female labour force participation may have a negative feedback effect on the fertility rate, one of the main explanatory variables, we also tested for the exogeneity of the fertility rate. However, we must reject this hypothesis, so we used instrumental variables to obtain consistent parameter estimates.

We also investigate the extent to which the labour force behaviours of women in different age groups can be lumped together. Many studies ignore population distribution effects, relying instead on a representative agent paradigm. For representative agent models to describe aggregate behaviour accurately, all individual marginal reactions to changes in aggregate variables must be identical. We find strong empirical evidence contrary to this condition for women across different age groups. Instead, for each age group, the model reveals a particular point at which the regime of falling participation rates shifts into a regime of rising participation rates. For the total female working age population the turning point of the capital-to-labour ratio amounts to \$86,445. For females up to 30 and over 45, this turning point appeared to be lower, indicating that they are the first to benefit from higher capital-to-labour ratios when an economy develops, and for females in the prime age groups to be higher. These findings corroborate the hypothesis that the relationship between female labour force participation rates and economic development is U-shaped.

Because women's labour force status relative to that of men is an important benchmark of their status in society, women's integration into the economy is a desirable policy goal for both equity and efficiency considerations. The existence of a U-shaped relationship between female labour force participation rates and economic development shows that it is possible to narrow the vast gap in the labour supply measured by participation by men and women. When an economy develops and the capital-to-labour ratio passes certain turning points, four key changes arise helping to reduce the gap. In order of turning points: the industry mix shifts to employment in services, which can often be done part-time, permitting women to combine work outside the household with their domestic activities. Women gain more education, as a result of which the value of their time in the market increases, which strengthens the incentives for women to work away from home. According to Eckstein and Lipshitz (2011), education makes the most important contribution of all determinants, while according to the OECD (2017), it is also one of the primary attention fields to avoid ageing inequality, not only in terms of participation, but also of poverty, health, and life expectancy. On the other hand, more schooling is no guarantee for achieving higher participation rates. The economy should also be sufficiently developed to absorb these people (OECD, 1994). Fertility rates decline, which can free women from some childcare duties. The demographic

transition effect, the increase in female labour participation rates if fertility would decline from values typically observed in low-income countries to those in high-income countries, amounts to 22 per cent. This process can be speed up by stimulating a greater share of family responsibilities, among which the promotion of childcare systems for both pre-school-age and school-age children, as well as parental leave, especially if it evenly develops with the shift in the industry mix. Female wage rates increase, so the probability decreases that the unearned income effect (i.e. income of a woman independent of hours worked, such as the income of her husband) will lead women to quit working altogether.

Concurrently, we note that because the relationship between female labour force participation rates and economic development is U-shaped, low-income countries seemingly must first go through a dip, and then struggle persistently to eliminate the margin. This path may be the optimal choice from a welfare-maximising point of view, but we share Costa's (2000) view that it can be frustratingly slow. Information diffusion can change preferences for employment, but people require time to gather information, creating a delay in the decision-making process, and spatial evolution hence takes time to manifest itself (Fogli and Veldkamp, 2011). Consequently, progress may have to wait for the entry of new cohorts of men and women with different expectations regarding work and family into the labour market. Low- and middle-income countries can learn from policies adopted by high-income countries during this transition, while international organisations can assist them to transform these policies to their respective context.

Notes

1. Pampel and Tanaka (1986) consider energy use per capita as a proxy for economic development.
2. Although unemployed people may be said to participate in the labour market, being unemployed in developing countries is often comparable to being inactive.
3. The data from 1960–1980 and 1980–2005 came from different data sets (ILO 1997, 2007). To ensure continuity and consistency in the data, we applied the approach taken by Bloom *et al.* (2009): we linked the two data sets by multiplying the 1960–1980 data by a proportionality factor to match the 1980 figures from the 1980–2000 data set.
4. However, they account for the increase in capital, in line with the rise in labour supply.

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