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Economic development, structural change, and women's labor force participation:

A reexamination of the feminization U hypothesis

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Abstract A sizable literature claims that female labor force participation (FLFP) follows a U-shaped trend as countries develop due to structural change, education, and fertility dynamics. We show that empirical support for this secular trend is feeble and depends on the data sources used, especially GDP estimates. The U also vanishes under dynamic panel estimations. Moreover, cross-country differences in levels of FLFP related to historical contingencies are more important than the muted U patterns found in some specifications. Given the large error margins in international GDP estimates and the sensitivity of the U relationship, we propose a more direct approach to explore the effect of structural change on FLFP using sector-specific

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growth rates. The results suggest that structural change affects FLFP consistent with a U pattern, but the effects are small. We conclude that the feminization U hypothesis as an overarching secular trend driving FLFP in the development process has little empirical support.

Keywords Female labor force participation · Economic development · Structural change · Panel · GMM

JEL Classifications J16 · J21 · O15

1 Introduction

There is a significant body of literature that examines the relationship between economic development and women's participation in the economy. While one line of research focuses on the impact of gender gaps in education and employment on growth (Seguino 2000a, b; Blecker and Seguino 2002; Esteve-Volart 2004; Cavalcanti and Tavares 2007; Klasen 2002; Klasen and Lamanna 2009), another strand of the literature studies on the impact of economic growth on labor force participation of women (Sinha 1967; Boserup 1970; Durand 1975; Pampel and Tanaka 1986; Psacharopoulos and Tzannatos 1989; Goldin 1990, 1995; Cağatay and Özler 1995; Mammen and Paxson 2000; Clark et al. 2003; Lincove 2008; Luci 2009; Tam 2011). One of the key hypotheses that has emerged is that there is a U-shaped relationship between female labor force participation and economic development, the latter typically being proxied by GDP per capita. As the economy moves from an agrarian society with close linkages between household and market production to an industrial and service-based formal economy, female labor force participation rates fall. Spurred by structural change as well as increases in education and declining fertility, female economic activity increases again in later stages of development. This hypothesis dates back to the 1960s (Sinha 1967) and has become a "stylized fact" in the development economics literature, often called the feminization U hypothesis.

Understanding the relationship between economic development and female labor force participation is important for a variety of reasons. First of all, if the feminization U hypothesis holds, it suggests that there is a trade-off between growth and gender equality in employment for the poorest countries. Understanding the nature of this trade-off is important for policy makers to interpret trends in overall labor supply and to design adequate policies. But if there is no such U relationship, the policy recommendations that flow from it might not be well tailored either. Second, the notion of a U-shaped relationship between economic development and female labor force participation has profoundly influenced the academic discipline as many scholars motivate and interpret research findings in light of the seemingly uncontroversial feminization U hypothesis (examples include Bloom et al. 2009; Agüero and Marks 2011; Jensen 2012; Rees and Riezman 2012). Reviewing the empirical foundation of the hypothesis will thus be informative for policy makers and academics alike. We are particularly interested in understanding whether the feminization U hypothesis has relevance for today's developing countries, many of whom still have a large agricultural sector and would thus be expected to move along the declining portion of the U with rising per capita income.

While there is some prior empirical literature on the topic, there are two main reasons that motivate us to have a fresh look at the feminization U hypothesis and its underlying forces. First, newly available data on female labor force participation and per capita GDP as well as advancements in panel data techniques allow us to provide an updated and improved assessment of the relationship between female labor force participation and development. We will show that empirical support for the feminization U hypothesis hinges on the data used for the assessment. Particularly the periodic updates of international purchasing power parity (PPP) estimates and Penn World Table (PWT) GDP data have a large effect, while there is little support for the feminization U based on the previous PWT 6.3 where the U shape reemerges under the newly released PWT 7.1. The nature of the relationship is also heavily affected by the versions of the International Labour Organization's (ILO) database on female labor force participation, where past and present estimates are regularly revised. Moreover, the U relationship tends to vanish if we use dynamic instead of static panel data methods. Given this dependence of the results on data revisions and methods, we conclude that the evidence for the feminization U as a secular trend of the development process is feeble and not robust. Second, we show that even in the cases where a U is empirically supported, it is so shallow that it cannot explain a substantial share of the differences in levels and trends of female labor force participation rates across the world. Instead, we find that initial conditions, factor endowments, and historical contingencies (captured by studying the fixed effects in our regression framework) are much more important determinants of female labor force participation rates across the world than the secular pattern presumed by the U.

Third, we argue that the effect of economic development on women's labor force participation is more complex than implied by much of the existing empirical literature. In fact, the feminization U hypothesis is based on the notion of economic development as a process of profound structural change and socioeconomic transformation, forces that are not well captured by the level of GDP, not even under a nonlinear relationship, and that depend on the country-specific nature of the growth process. Substantively, we hypothesize that particular patterns of structural change are important drivers of female labor force participation and thus could support one of the key mechanisms underlying the feminization U hypothesis. We therefore directly assess the effect of disaggregated sectoral growth on female labor force participation. By exploiting information on sector-specific growth, we can allow for various nonlinearities and the differential impact of growth on female labor force participation across countries at different stages of the development process without relying on cross-country GDP comparisons. The sectoral perspective advocated for in this section is also much closer to the original idea of the feminization U hypothesis, which emphasized structural change as a key driving factor of women's economic activity. As countries are undergoing different types and speeds of structural change, we think that it is more useful to study the impact of these sectoral changes directly.

We find that agriculture, mining, manufacturing, and services are associated with different dynamics for female labor force participation, but the effects are, in most cases, quantitatively small and cannot explain the large increases in women's economic activity observed in most developing countries over the past decades. We therefore conclude that there is little empirical support for the feminization U as a secular trend of the development process, although there is some evidence that patterns of structural change are affecting female participation rates in ways consistent with the hypothesis. Given the different dynamics of structural change across countries, which are often not well captured by aggregate income changes, the existence of these mechanisms can easily be reconciled with the absence of an empirically robust U using GDP as a proxy for the development process.

In analyzing the feminization U hypothesis, there are several parallels with the more famous Kuznets inverted U hypothesis on the relationship between inequality and growth (e.g., Kuznets 1955; Deininger and Squire 1998). Similar to the initial stages of discussion of the Kuznets hypothesis, the early empirics relied largely on some aggregate cross-sectional analysis and one or two historical country case studies (e.g., Kuznets 1955; Lindert and Williamson 1985; Ray 1998). The same was the case for initial tests of the feminization U hypothesis which was also based on a single historical country study (the USA) and cross-sectional data both of which supported the hypothesis (Goldin 1990, 1995). Of course, finding a U in a cross-section does not imply that it will materialize over time in a given country. Since the feminization U hypothesis is about changes over time in a country, the cross-sectional results are not an adequate test. Second, in both U hypotheses, empirical analyses are based on panel data from developing countries where data quality issues are a serious concern (Atkinson and Brandolini 2001; Klasen and Lamanna 2009). Third, there are a large range of theoretical mechanisms proposed in the literature that could trace out both U relationships, and that are often not well captured by the empirical literature seeking to test the hypotheses. Fourth, this paper demonstrates that the U-shaped relationship between aggregate GDP per capita and female labor force participation is not robust across different data sources and econometric specifications. As will be recalled from Ravallion (1995), Bruno et al. (1998), and Deininger and Squire (1998), among others, the stylized Kuznets inverted U hypothesis also found no confirmation in a panel framework using fixed effects (see also Grün and Klasen 2003). Lastly, similar to the Kuznets curve, level differences between countries are very large in relation to secular changes within countries.

This paper is organized as follows: Section 2 provides a brief theoretical discussion of the hypothesis and discusses the deficiencies of the existing empirical literature. Section 3 details the available data and documents trends in women's economic activity over the past decade. Section 4 reexamines the feminization U hypothesis at the aggregate level using static and dynamic panel data methods. Section 5 explores the relationship between structural change as measured by sectorally disaggregated growth in value added and employment and women's labor force participation. The final section concludes.

2 Theory and literature review

Given women's important role in household production in many countries, it is important to briefly remind readers of what women's participation in the labor force actually refers to. Labor force participation is linked to being engaged in (or being available to be engaged in) activities that are included in the System of National Accounts (SNA) (Benería 2003; UNDP 1995). Any employment for pay (as well as availability for employment) is included. Self-employment is included if it produces a marketed product or service or if it produces a product that is consumed within the household. Thus, producing food for autoconsumption counts as labor force participation, while producing a nonmarketed *service* (e.g., care for own children, elderly, general housework) does not count (OECD 1995). This will be important to bear in mind as women who are "out of the labor force" are often concentrating on these household production tasks that happen not to be included in the SNA (e.g., UNDP 1995; Waring 1988). Secondly, it is important to bear in mind that labor force participation includes those who are employed in SNA activities and those unemployed that are willing to work and are actively seeking employment in SNA activities.[1] Thus female participation in the labor force is about availability and participation in the economy as measured by the SNA. This, of course, may also depend greatly on the demands on women (and their preferences) regarding household production, which may depend on the number of children, available household technologies, prevailing norms and standards, and the division of labor within the home (e.g., Ramey 2009; Ramey and Francis 2009). While information on time use and household production is available for some countries (e.g., UNDP 1995; Ramey and Francis 2009), it is impossible to fully capture household production in this analysis for a range of conceptual and empirical reasons (OECD 1995; Gutiérrez 2003).[2]

The theoretical underpinning of the feminization U hypothesis linking development and female labor force participation is the following (Goldin 1990, 1995): Early in the process of economic development, when incomes are very low and much of the population earns a living from agriculture, most women participate in the labor force. Fertility rates are still high; yet most women work on family farms or in household enterprises, which allows them to combine economic activity with child-rearing. As the society becomes richer, the structure of the economy shifts towards industrial production and a formal sector-based economy emerges, which tends to lower women's participation in the labor market.[3] Due to low levels of female education and the incompatibility of wage work with child care as well as sociocultural restrictions on female employment outside of the home, women are not able to benefit from the emerging opportunities in industry and other formal sectors; this is especially the case for married women with children so that female employment often terminates

[1] See Klasen and Lamanna (2009) for a more detailed discussion of the unemployment issues (and its empirical relevance for cross-country differences in labor force participation).

[2] The literature on household production also considers availability and prices of household technologies as a potential driver of female labor force participation rates. As these technologies improve over the development process, one would presume that they increase the ability of women to participate in market work. See Ramey (2009) for a discussion in the context of the USA.

[3] At the very early stages of industrialization, young unmarried women (and children) may play a significant role in the nascent industrial sectors, as they did in Britain in the late eighteenth century. But as industrialization proceeded, women's employment in these sectors became increasingly rare, replaced by male workers who often were able to get better employment conditions and wages. For a discussion, see Marglin (1974) and Humphries (1991).

after marriage or the birth of a child. This may be reenforced by social stigma and even formal restrictions against female industrial workers or, more generally, formal employment outside of the home of married women (Boserup 1970; Goldin 1995). This may be particularly relevant in sectors where heavy manual labor is required (such as construction, mining, etc.).[4] In addition, and consistent with basic labor economic theory, the overall increase in productivity and family earnings (earned mostly by the male household head) has a negative income effect on female labor supply.

As the society develops even further, female labor force participation increases once again. The expansion of post-primary education among females and the emergence of a white-collar service sector offer new, attractive employment opportunities for women, which are not subject to stigmatization (or the stigmas and restrictions erode over time). Moreover, the decline in fertility, the increasing availability of part-time jobs, and greater access to child-care facilities enable women to combine work outside the home with raising children. At this stage of development, the substitution effect linked to much higher potential female wages dominates the income effect, and female labor force participation is positively related to per capita income (Psacharopoulos and Tzannatos 1989; Goldin 1990, 1995; Mammen and Paxson 2000).

The feminization U hypothesis has also influenced some recent theoretical work. Rees and Riezman (2012) create a model, in which an exogenous process of globalization creates gender-specific labor demand. Men and women have identical preferences for consumption and fertility, but women care more about child quality. They then show that if the emerging sector requires predominantly male labor, the economy converges to a low income, low female labor force participation, and low human capital steady state. If, on the other hand, the emerging sector creates jobs for females, the economy enters a virtuous cycle of positive, reinforcing dynamics and reaches a steady state with high per capita income, low fertility, and high female economic activity. To the extent that economic development initially creates jobs for men, and then later for women, their model could provide a micro-foundation for the feminization U hypothesis.

To summarize, the theoretical literature suggests that structural change and sectoral shifts in production and employment have important implications for the dynamics of women's labor force participation. Based on the discussions in Goldin (1990, 1995) and Boserup (1970), rising labor demand in agriculture and the service economy should be linked to increasing levels of women's economic activity, while industrial sector growth—particularly in mining, construction, and other heavy industries—should be linked to stagnating or even declining levels of female labor force participation. However, the empirical literature on the feminization U hypothesis so far (discussed further below) has refrained from directly investigating the link between sector-specific growth and women's economic activity and rather focused on the bivariate relationship between aggregate GDP per capita and female labor force participation.

[4]Of course, agriculture also includes heavy manual labor. But if men and women share agricultural tasks, this may be no barrier to female participation if men then do the heavy manual labor (e.g., land clearing, plowing with heavy implements, etc.). Outside of the home, such sharing of tasks is generally not feasible.

Apart from the literature on the feminization U hypothesis, there is a related literature that tries to explain the substantial level differences in female labor force participation between countries. In particular, many authors have shown (often using data from World Value Surveys) that gender attitudes and role perceptions are highly correlated to gender-specific employment outcomes (Fortin 2005; Fernández and Fogli 2009; Fernández 2007). However, that only leads to the deeper question of what factors cause such entrenched cultural differences in gender norms. A number of authors have put forth explanations emphasizing historical contingencies, factor endowments, as well as the role of policies.

First, one school of thought attributes time-invariant differences in gender attitudes to historical differences in land-cultivation patterns. Boserup (1970) suggests that societies that traditionally practiced plow agriculture have lower levels of female participation in the economic and political spheres even today. The main argument is that plow cultivation required manual strength, which favored men over women and thus led to persistent gender biases, which linger on to the present (Alesina et al. 2011, 2013). Second, other scholars have emphasized the role of religion, often citing the influential work of Weber (1905) on the link between Protestantism and capitalism. Feldmann (2007) argues that female labor force participation is significantly higher in countries shaped by Protestantism compared to those dominated by other religious convictions. Guiso et al. (2003) investigate the link between religious beliefs and economic attitudes based on data from the World Value Surveys. They find that all religious denominations (in comparison to atheist beliefs) are associated with more conservative attitudes towards women's work, but the effects are strongest for adherents of Islam. Similarly, using micro-level data for ten OECD countries, Jaeger (2010) finds that the labor supply response of women with children to changes in family benefits depends on the strengths of their religious ties. However, there is controversy whether low levels of female labor force participation in Middle Eastern and North African countries are primarily related to deep-seated cultural values and religious beliefs (Norris 2010) or to the region's economic dependence on oil exports, which influence family earnings and women's bargaining position and crowd out female-intensive tradable sectors (Ross 2008). Third, shocks matter. In particular, the experience of war-time labor shortages is said to have permanently increased women's employment opportunities in warring nations, including the USA, Britain, France, etc. (Goldin 1991; Fernández et al. 2004). Fourth, ideology clearly can make a lasting difference. This is particularly visible in the very high female labor force participation rates of the former Socialist bloc. Here, labor shortages, combined with an ideological focus to promote gender equality in all spheres of life, led to substantially higher female labor force participation rates than elsewhere; even 20 years after transition began, this is having a lasting impact on women's labor force participation rates (Kornai 1992; Klasen 1994).

Apart from historically contingent factors, policies can have a direct impact as well. This has been mostly studied in the context of industrialized countries where taxation policies (e.g., individual versus joint taxation of couples) as well as childcare policies have been found to have a substantial impact on female labor force participation rates (Gustafsson 1992; Gustafsson et al. 1996; Jaeger 2010). In addition, policies to promote universal education and export-oriented growth in light manufacturing are also held to have played a significant role in promoting female labor force participation in the high-growth East and Southeast Asian economies (e.g., World Bank 2011; Seguino 2000a; Klasen and Lamanna 2009).

Turning to empirical studies, most of the earlier assessments of the feminization U hypothesis were based on simple cross-sectional correlations between the female labor force participation rate and GDP per capita; the results typically confirmed the U-shaped relationship (e.g., Psacharopoulos and Tzannatos 1989; Clark et al. 2003). Among the most well-known and meticulous analyses in this category is the work by Goldin (1990, 1995), who combines cross-sectional regression analyses based on data from 1980 with a historical case study of the USA. Her results also support the notion of a U-shaped relationship between female labor force participation and economic development. Another study that tests the feminization U hypothesis in a cross-sectional context is the work by Cağatay and Özler (1995). Even though the authors have data for two points in time (1985, 1990), they do not exploit the panel feature of their data but pool observations for both years and regress women's share of the labor force on log GDP per capita, its square, and other independent variables. The results reject the notion of a U-shaped relationship, as the parameter estimate for log GDP per capita turns out to be positive, and the estimate for log GDP squared negative.[5] However, the authors mistakenly claim that their findings were in support of the feminization U hypothesis.

Thus, similar to early tests of the Kuznets hypothesis, these early articles use cross-sectional data to test a hypothesis for a time-series relationship within a country, thereby implicitly assuming that the only reason for the cross-sectional differences in female labor force participation derives from their different stages of development (rather than different initial conditions). The failure to find a Kuznets curve by using trends within countries (or panel fixed effects models) shows the pitfalls of this assumption (see Bruno et al. 1998; Deininger and Squire 1998).

Mammen and Paxson (2000) use data for 90 countries from 1970 to 1985 (in 5-year intervals) to trace out the relationship between economic development and female labor force participation. First, they reassess the cross-sectional relationship by means of a nonparametric regression of women's labor force participation on the log of GDP per capita. The results confirm a U-shaped pattern for each of the four time periods presented. Next, they run a parametric regression of female labor force participation on log GDP and its square, with and without a set of country-specific fixed effects. The fixed effect model generates a considerably more muted U-shape than the ordinary least square (OLS) model, though it still appears to confirm the feminization U hypothesis. However, the paper only uses a relatively short period of data (15 years) and does not use dynamic panel methods, which can address some of the problems inherent to the static model. Moreover, the database for the panel analysis (the third version of the United Nations' WISTAT database, with labor force estimates until 1985) is by now clearly outdated.

[5] These results point to an inverted U, rather than a U-shaped relationship. Since both parameters are significant, the feminization U hypothesis could be rejected at a conventional significance level.

More recently, studies by Luci (2009) and Tam (2011) analyzed the relationship between female labor force participation and development using both static and dynamic panel methods. They argue that the feminization U hypothesis also has support within countries over time; some of the identified turning points appear, however, to be peculiarly low. Similarly problematic is that both authors seem to use labor force participation rates from the fourth or even earlier versions of the Estimates and Projections of the Economically Active Population (EAPEP) database of the ILO, but do not take into account the more recent revisions of the data (see discussion below). In addition, Tam (2011) uses the 5.5 revision of Penn World Tables from 1993, which is by now clearly outdated. Another shortcoming is that the authors do not discuss the potential endogeneity of GDP, even though the dynamic estimators would allow addressing this issue. In general, the current empirical literature testing the feminization U hypothesis suffers from a lack of sensitivity analyses.

The present paper sets out to remedy these deficiencies and to present a more robust and updated assessment of the relationship between female labor force participation and economic development. The first objective is to test whether the feminization U hypothesis holds for newly available data on female labor force participation and per capita GDP at international purchasing power parties. We use static and dynamic panel methods, which base identification exclusively on over-time variation and which allow (in the case of dynamic GMM methods) considering the endogeneity of GDP. And unlike previous studies, we address the sensitivity of our results to differences in data and methods upfront. The second objective is to study the time-invariant fixed effects and link them to the literature on long-term determinants of female labor force participation rates. The third aim is to move beyond the stylized regression analyses at the level of aggregate GDP and to investigate the effects of sectoral shifts in production and employment on women's economic activity by using disaggregated national accounts data from the United Nations Statistics Division and newly available data on employment by sector from the Groningen Growth and Development Centre (GGDC). The next section discusses the data sources we use and presents descriptive trends in female labor force participation over the last three decades.

3 Data and trends in female labor force participation

Whether the feminization U hypothesis correctly describes changes in female labor force participation over the course of economic development is essentially an empirical question. However, measuring women's economic activity is fraught with difficulties, especially in developing and emerging economies, and there are significant uncertainties regarding the international comparability of such data (Anker and Anker 1989; Psacharopoulos and Tzannatos 1989; ILO 2009b; Bardhan and Klasen 1998, 1999; Klasen and Lamanna 2009). We start with a description of the data utilized in this paper.

Our data on female labor force participation are drawn from the ILO's EAPEP database. The EAPEP contains male and female labor force participation rates based on country reports and ILO staff estimates. The ILO conducts periodic revisions of the EAPEP data, and we test the feminization U hypothesis using the most recent sixth revision (ILO 2011a) and the previous fifth revision (ILO 2009a). Both the fifth and sixth revisions include 191 countries, but while the fifth revision extends over the period of 1980–2008, the sixth revision covers 1990–2010 (though it also contains estimates for the 1980s for some countries). To compare the results to the earlier empirical literature, we also perform robustness checks on the fourth EAPEP revision, which covers the period of 1950 to 1990 (in 10-year intervals) and comprises 178 countries (ILO 1996).[6] According to the ILO documentation, estimates from each revision are incomparable to earlier versions because of improved data availability and differences in the estimation procedures used to fill data gaps. We view in particular the fourth revision with great caution, as the quality of labor force estimates for the developing world going as far back as the 1950s, a time at which most African countries were still under colonial rule, seems highly uncertain.

To gauge the level of correspondence between the revisions, Table 1 compares female labor force participation estimates of women aged 25 to 59 years for the fourth and fifth revision (which overlap in 1980 and 1990) and for the fifth and sixth revision (which overlap 1990 to 2008). The upper panel shows that unweighted averages across all countries are remarkably similar between the fourth and fifth revisions. However, there are substantial differences at the level of regions, especially for developing countries. The fifth revision shows in both years considerable higher female activity rates for Latin America and the Caribbean (+4.4 percentage points in 1990), and much lower rates for East Asia and the Pacific (−5.5 percentage points in 1990), the Middle East and North Africa (−4.8 percentage points in 1990), and South Asia (−11.8 percentage points in 1990) than the fourth revision. Differences are somewhat smaller for changes in female labor force participation between 1980 and 1990, but still significant. For example, the fifth revision shows an average increase in female labor force participation in Latin America by 3.7 percentage points, compared to 7.6 percentage points under the fourth revision. At the level of individual countries, the discrepancies are even more striking.[7]

The bottom panel compares the fifth and the sixth EAPEP revision, which are the key data sources used in the present study. Moving from the fifth to the sixth revision, female labor force participation estimates were revised downwards in Europe and Central Asia (−3.8 percentage points in 2008) and the Middle East and North Africa (−7 percentage points in 2008), but upwards in high-income non-OECD countries (+3.1 percentage points in 2008) as well as in Latin America and the Caribbean (+2 percentage points in 2008). There are virtually no adjustments in regional averages for Sub-Saharan Africa, South Asia, and OECD countries. Although over-time changes between 1990 and 2008 derived from the fifth and sixth revisions are very similar at the regional level, there are again significant differences for individual

[6] Both EAPEP datasets also contain labor force projections. For the fourth revision, these extend from 1995 to 2010, and for the fifth revision, from 2009 to 2020. However, the analyses in this paper are based on the labor force estimates only, disregarding the projections.

[7] In the case of Nepal, the fourth revision reports a minor decline in female labor force participation between 1980 and 1990 (from 59 to 58 %), while the fifth revision shows an increase by around ten percentage points, albeit from a much lower level (from 45 to 55 %).

Table 1 Female labor force participation rates (FLFPR): comparisons of the fourth, fifth and sixth revisions of the ILO's EAPEP database

Comparison of the 4th and 5th revisions	Average FLFPR in 1980			Average FLFPR in 1990			Average change in FLFPR 1980–1990		
	5th rev.	4th rev.	Δ	5th rev.	4th rev.	Δ	5th rev.	4th rev.	Δ
High-income: OECD members	0.586	0.567	0.019	0.662	0.664	−0.002	0.076	0.097	−0.021
High-income: non-OECD members	0.437	0.433	0.004	0.520	0.531	−0.011	0.083	0.099	−0.015
East Asia and Pacific	0.651	0.692	−0.041	0.664	0.720	−0.055	0.013	0.028	−0.014
Europe and Central Asia	0.730	0.755	−0.024	0.738	0.736	0.002	0.008	−0.018	0.026
Latin America and the Caribbean	0.455	0.372	0.083	0.492	0.449	0.044	0.037	0.076	−0.039
Middle East and North Africa	0.189	0.249	−0.060	0.218	0.266	−0.048	0.029	0.017	0.012
South Asia	0.409	0.539	−0.130	0.426	0.544	−0.118	0.016	0.005	0.012
Sub-Saharan Africa	0.678	0.697	−0.019	0.681	0.694	−0.012	0.004	−0.003	0.006
All	0.559	0.564	−0.005	0.593	0.605	−0.012	0.034	0.040	−0.006
Comparison of the 5th and 6th revisions	**Average FLFPR in 1990**			**Average FLFPR in 2008**			**Average change in FLFPR 1990–2008**		
	6th rev.	5th rev.	Δ	6th rev.	5th rev.	Δ	6th rev.	5th rev.	Δ
High-income: OECD members	0.665	0.667	−0.002	0.758	0.758	0.000	0.093	0.091	0.002
High-income: non-OECD members	0.499	0.468	0.031	0.619	0.588	0.031	0.120	0.120	0.001
East Asia and Pacific	0.660	0.657	0.003	0.683	0.681	0.002	0.022	0.023	−0.001
Europe and Central Asia	0.710	0.736	−0.026	0.686	0.724	−0.038	−0.023	−0.012	−0.011
Latin America and the Caribbean	0.507	0.496	0.010	0.631	0.612	0.020	0.124	0.115	0.009
Middle East and North Africa	0.188	0.248	−0.060	0.261	0.331	−0.070	0.073	0.083	−0.010
South Asia	0.434	0.426	0.008	0.517	0.516	0.001	0.083	0.090	−0.007
Sub-Saharan Africa	0.670	0.677	−0.008	0.732	0.734	−0.002	0.062	0.057	0.005
All	0.588	0.592	−0.004	0.659	0.662	−0.004	0.071	0.070	0.001

Labor force participation rates of women aged 25–59 years from EAPEP fourth revision (ILO 1996), fifth revision (ILO 2009a), and sixth revision (ILO 2011a). Unweighted country averages. Only countries available in both revisions. World Bank country classification as of November 2011 countries. In sum, we feel that the recent revisions of the EAPEP are sufficiently different in terms of levels and trends from the data used in earlier studies to merit a reinvestigation and robustness analyses of the feminization U hypothesis for that reason alone.

Figure 1 shows broad regional trends of female labor force participation and the share of agricultural value added between 1980 and 2010. The graphs confirm the widely recognized trend of increasing economic activity amongst women over the past decades (see Killingsworth and Heckman 1986; Blundell and MaCurdy 1999 for advanced economies; Klasen and Pieters 2012; Gaddis and Pieters 2012 for some developing countries). In terms of regional variation, the data show that the increases in female labor force participation were particularly strong in high-income countries (OECD and non-OECD) as well as in many Latin-American countries. In Sub-Saharan Africa, rates of female labor force participation (linked to large agricultural sectors) are traditionally high, but have still seen a modest increase since the 1980s. Many countries in Europe and Central Asia were able to achieve high rates of female labor force participation in the 1980s, when women's economic participation was encouraged by the communist regimes, but experienced a decline in the early 1990s, followed by a modest recovery in the late 1990s (see Klasen 1994).[8] Female labor force participation in Eastern Asia remained relatively stagnant between 1980 and 2010, though China and Indonesia saw moderate increases. Most countries in Southern Asia and the Middle East and North Africa region experienced rising women's labor force participation, albeit, in many cases, from low initial levels. The fact that all regions except Europe and Central Asia experienced increases in female economic activity between 1980 and 2010, regardless of their initial levels of development and industrialization, already casts some doubts on the notion of a U-shaped relationship between the labor force participation of women and economic development.

The trends in the share of value added in agriculture, also shown in Fig. 1, give evidence on the link between the decline of agriculture and female participation, an important argument supporting the declining portion of the U hypothesis. The share has declined everywhere (at different speeds from different levels), but there is no clear link between changes in the share and the female participation rate. In particular, there is no evidence that in places where the agricultural share has fallen furthest from high levels (e.g., South or East Asia), female participation rates have fallen as a result (as the feminization U hypothesis would imply). This will be examined in more detail below.

As it is common in the literature on testing the feminization U hypothesis, we use GDP per capita at PPP exchange rates as a proxy indicator for economic development. We test the feminization U hypothesis using data from the PWT (Heston et al. 2009, 2012). The most recent available PWT 7.1 version incorporates the PPP conversions of the 2005 round of the International Comparison Program (ICP), while the

[8]That recovery is more pronounced under the fifth than under the sixth revision of the EAPEP. It seems likely that labor force estimates for the 2000s under the sixth revision are influenced by the financial crisis (through interpolations by the ILO, the 2008 recession could be reflected in earlier participation rates).

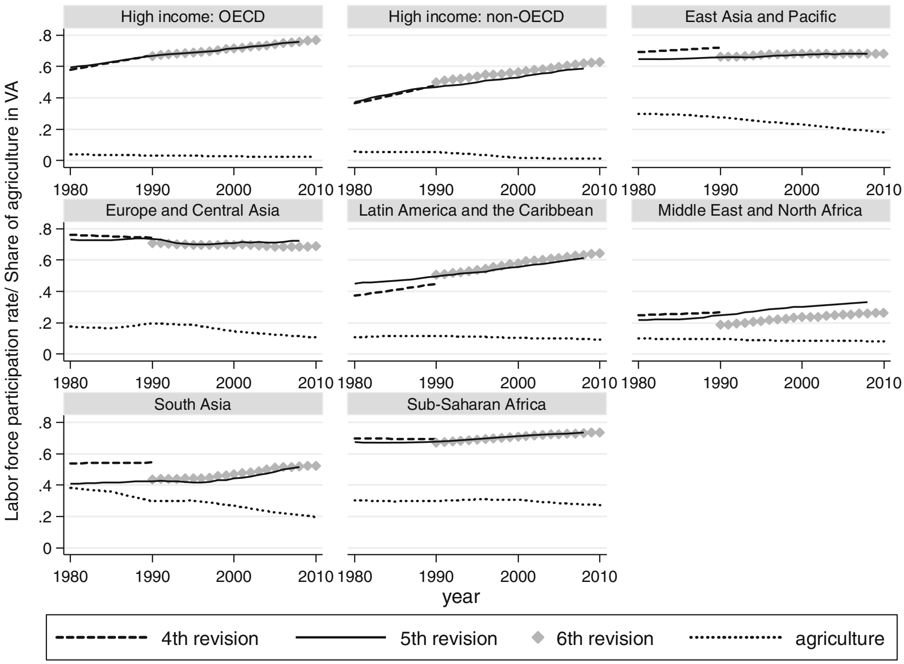

Fig. 1 Regional trends in female labor force participation and agricultural value added, 1980–2010. Labor force participation rates of women aged 25–59 years from ILO EAPEP fourth revision (ILO 1996), fifth revision (ILO 2009a), and sixth revision (ILO 2011a). Data on agricultural value added from UNSTATS (2011). Unweighted country averages, not affected by compositional changes (based on a balanced panel). World Bank country classifications as of November 2011

PWT 6.3 was still based on the 1996 ICP benchmark round. As it is well known, the 2005 ICP round resulted in higher price levels for many developing countries, which in turn led to a strong downward revision in their real GDP—of some 40 % for a country like China (World Bank 2008a, b; Ravallion 2010, 2012). While the 2005 ICP round has clearly improved the coverage and quality of international price data relative to the more deficient previous rounds, there has been a concern that much of the upward revision of price levels in developing countries could be related to methodological changes, and the reliability of the new estimates is highly controversial (Maddison and Wu 2008; Deaton 2010; Deaton and Heston 2010; Ravallion 2010, 2012).[9] This is particularly problematic as the PWT data that use the 2005 ICP are actually based

[9] As noted by Deaton (2010), there is an inherent tension in international price comparisons between surveying goods that are representative for consumption patterns in each country and specifying goods that are strictly comparable between countries. In contrast to previous ICP rounds, the 2005 round erred on the side of inter-country comparability by surveying precisely specified goods, at the expense of a potential lack of intra-country representativity.

on linking estimates from several recent PPP rounds, each with their own problems, generating substantial uncertainty about the accuracy of the trends they report (PWT 2012).[10]

What is important for this paper is that there is plenty of evidence that revisions in international PPP deflators can have strong implications for international income comparisons (Chen et al. 1994; Ackland et al. 2012; Ravallion et al. 2009; Deaton 2010) and cross-country correlations (see Johnson et al. 2013; Ciccone and Jarociński 2010 on the sensitivity of growth empirics to PWT revisions). This is why we assess the sensitivity of the feminization U hypothesis to changes in PPP deflators, using two recent versions of PWT data (PWT 6.3 and PWT 7.1).

4 A U-shaped relationship between GDP and female labor force participation?

In this section, we re-examine whether the hypothesis of a U-shaped relationship between female labor force participation and aggregate GDP per capita holds up to the scrutiny of updated data and improved methods. Our independent variable is the female labor force participation rate estimated from the fourth, fifth, and sixth revisions of the EAPEP database. Estimates from the sixth revision differ from those of earlier versions in that the data set is now accompanied by metadata for each data point that describe, amongst other things, the imputation approach used to fill data gaps. The ILO (2011b) conducts three broad imputation methods—linear interpolation (of log-transformed labor force participation rates), imputation based on panel regressions, and judgmental adjustments (in cases where the panel model is deemed unreliable). The regression-based imputation is problematic for our analysis, because the ILO uses the assumption of a U-shaped relationship between GDP per capita and labor force participation to impute missing data points (in other words, the imputation regression includes GDP and GDP squared as regressors).[11] This is why we run all our regressions also on a reduced sample of the sixth revision data, which exclude observations imputed based on the regression approach and judgmental adjustments.

We distinguish between three cohorts—women aged 25 to 44 years, 45 to 59 years, and the combined age group 25 to 59 years. Analyses by Goldin (1995) and Mammen and Paxson (2000) rely largely on the older cohort of women, who are past the child-bearing age and whose labor supply decision should not be directly influenced by fertility choices. However, some of the more recent studies in this field consider women aged 15 years and above (Luci 2009) or 15 to 64 years (Tam 2011).

[10]The alternative procedure, used by the World Bank, to base the entire assessment of economic performance on the latest PPP round, is also problematic as PPPs that are valid in 2005 are unlikely to have been valid 20 years earlier when products, demands, and prices differed considerably. This can also lead to substantial uncertainty about GDP trends.

[11]Interestingly, the ILO also notes that there is *no* significant U-shape relationship between GDP and labor force participation for men and women aged between 20 and 55 years (ILO 2011b). This is motivated by a series of graphs, which, however, only show cross-sectional patterns (despite the fact that the estimated regressions seem to be based on over-time variation only).

As discussed above, our explanatory variable is GDP per capita at PPP exchange rates (chain index) from the PWT 6.3 and 7.1 (Heston et al. 2009, 2012). Because we are not interested in short-term cyclical effects and want to follow in the tradition of the feminization U literature, we use 5-year intervals.

Traditionally, the literature analyzing the feminization U hypothesis estimates a regression of the following form:

$$FLFPR_{it} = \alpha + \beta \, ln \, y_{it} + \gamma \, (ln \, y_{it})^2 + \mu_{it} \qquad (1)$$

where i denotes a country, and t denotes time. FLFPR is the female labor force participation rate, and y is a measure of PPP-deflated GDP per capita. If the feminization U hypothesis holds, we would expect to obtain $\widehat{\beta} < 0$ and $\widehat{\gamma} > 0$.

Early attempts to investigate the feminization U hypothesis relied largely on OLS estimations on the pooled sample (e.g., Cagatay and Ozler 1995), whereby parameter identification is based on cross-sectional variation. This means essentially that data on female labor force participation from countries at different income levels are used to infer the relationship within a single country over time. However, it is well known that the pooled OLS estimator can be seriously biased in the presence of time-invariant unobserved heterogeneity, as was famously the case in the empirical assessments of the Kuznets hypothesis (Deininger and Squire 1998). A more appropriate estimation technique is to use a fixed effects estimator, which allows for country-specific intercepts and bases identification exclusively on over-time variation (here the equation also contains time-specific fixed effects, δ_t to capture common time trends):

$$FLFPR_{it} = \alpha_i + \beta \, ln \, y_{it} + \gamma \, (\ln \, y_{it})^2 + \delta_t + \mu_{it} \qquad (2)$$

The fixed effects estimator also allows us to recover these time-invariant factors affecting female labor force participation rates that may be linked to the literature discussed above.[12]

More sophisticated approaches acknowledge the persistence of labor force participation over time and estimate a dynamic (autoregressive) model of the following form:

$$FLFPR_{it} = \alpha_i + \phi FLFPR_{it-1} + \beta \, ln \, y_{it} + \gamma \, (\ln \, y_{it})^2 + \delta_t + \mu_{it} \qquad (3)$$

In Eq. 3, the first lag of the dependent variable is included as an additional regressor to account for the dynamics of the process (where current realizations of the dependent variable are influenced by past values). However, estimating Eq. 3 by OLS or fixed effects would lead to a dynamic panel bias, because of the correlation between the lagged dependent variable and the error term. In addition, there are endogeneity issues that ought to be addressed. A common strategy to deal with these issues is to use a difference or system GMM estimator (Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998). Both estimators are designed

[12] We do not include further control variables as we are, in the spirit of this literature, interested in the reduced form of relationship between development and female participation and because some of the most likely candidates for control variables (education, fertility) are also potential transmission channels of the U.

for situations where the number of time periods is small relative to the number of observation units, and can accommodate autocorrelation, fixed effects, and endogenous regressors (Roodman 2009). But whereas difference GMM (Arrelano–Bond) estimates a first-differenced model with lagged levels as instruments, system GMM (Blundell–Bond) estimates the first-differenced and second-level equation (where instruments are in first differences) simultaneously, exploiting additional moment conditions. However, the system GMM estimator requires an additional assumption, which is that the instruments are uncorrelated with the individual effects (Bond 2002; Windmeijer 2005). This implies in turn that in the initial period, the economy on average is in the steady state, so that subsequent growth is uncorrelated with the individual effects. In our case, we feel that this assumption is hard to maintain given that we do not have a fully specified model and deal with a country sample undergoing rapid economic development. This is why we prefer to use difference GMM for the analysis in this paper.

One of the advantages of the GMM estimator is that it allows treating the two GDP variables as endogenous—this is achieved by using second order and higher lags as instruments. In implementing the estimations, we use an algorithm that allows us to deal systematically with the various possible lag structures. We start with second-order lags, which is the standard choice of instruments for endogenous regressors. We then test for first-order and second-order autocorrelation and perform the Hansen test of overidentifying restrictions. We accept the estimation if we detect first-order autocorrelation ($p < 0.05$), but not second-order autocorrelation ($p > 0.1$), and if we cannot reject the null of joint validity of instruments under the Hansen test ($p > 0.1$). We also check that the coefficient of the lagged dependent variable is not larger than 0.95 to avoid the possibility of a random walk. If all conditions are met, the regression is considered as valid; otherwise, we estimate a new model using higher-order lags and repeat the diagnostic tests described above. In cases where we are not able to obtain a valid estimation even using fifth-order lags, the respective column (in Table 4) is left blank.

We start with the results for the static models (OLS and fixed effects) based on the four datasets of female labor force participation (EAPEP fourth revision, fifth revision, and sixth revision—full and reduced sample) and the two sets of GDP data (PWT 6.3 and PWT 7.1) as shown in Table 2. We also estimate separate regressions for all countries, OECD and non-OECD countries, where the term OECD refers to high-income OECD countries based on the World Bank's country classification (version November 2011). We report for each regression the coefficients for log GDP (LOGGDP) and log GDP squared (LOGGDP2), as well as the implied turning point (TURNPOINT).[13] The table also shows for each sample the number of countries (N_COUNTRY) and the total number of observations (N_OBS).

We commence our discussion with the regressions on the left side of Table 2, which are based on PWT 6.3. For the sample of all countries (OECD and

[13] Standard errors for all turning points based on the approach outlined in Kuha and Temple (2003) are shown in the ESM (Table A.1). They are quite narrow and allow tests of significant differences in those turning points.

Table 2 Economic development and female labor force participation: static estimates

Penn World Tables 6.3

PWT revision		Penn World Tables 6.3											
EAPEP revision		4th rev. (1950-1990)			5th rev. (1980-2005)			6th rev. (1980/90 ⁺-2005 ⁺⁺)			6th rev. - red. sample (1980/90 ⁺-2005 ⁺⁺)		
Cohort (years)		25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59
All countries													
OLS	LOGGDP	-0.84***	-0.77***	-0.83***	-0.36**	-0.43**	-0.39**	-0.39**	-0.48**	-0.42**	-0.49*	-0.66**	-0.54**
	LOGGDP2	0.05***	0.04***	0.04***	0.02**	0.02**	0.02**	0.02**	0.03**	0.02**	0.03*	0.04**	0.03**
	TURNPOINT	*10,810*	*18,061*	*12,342*	*6,659*	*17,345*	*9,064*	*5,428*	*12,884*	*7,300*	*4,494*	*9,034*	*5,881*
FE	LOGGDP	-0.61***	-0.48***	-0.55***	-0.14	-0.19**	-0.14	-0.23**	-0.31***	-0.23***	-0.39*	-0.58***	-0.40*
	LOGGDP2	0.04***	0.03***	0.03***	0.01	0.01**	0.01	0.01**	0.02***	0.01***	0.02*	0.03***	0.02*
	TURNPOINT	*2,365*	*3,216*	*2,553*	*1,790*	*1,863*	*1,805*	*5,062*	*4,775*	*5,225*	*7,397*	*9,212*	*7,743*
N_COUNTRY		155	155	155	177	177	177	177	177	177	145	145	145
N_OBS		607	607	607	993	993	993	776	782	775	515	520	509
OECD countries													
OLS	LOGGDP	-1.15	-0.91	-1.08	-0.60	-0.87	-0.69	-0.28	-0.50	-0.34	-0.32	-0.53	-0.38
	LOGGDP2	0.07*	0.05	0.07*	0.03	0.05	0.04	0.02	0.03	0.02	0.02	0.03	0.02
	TURNPOINT	*3,135*	*3,807*	*3,376*	*9,459*	*9,629*	*9,219*	*5,332*	*6,061*	*4,996*	*5,095*	*6,591*	*5,094*
FE	LOGGDP	-0.41	0.12	-0.23	-1.39***	-1.51***	-1.47***	-1.64***	-1.41***	-1.55***	-1.60***	-1.42***	-1.53***
	LOGGDP2	0.02	-0.01	0.01	0.08***	0.08***	0.08***	0.09***	0.08***	0.09***	0.09***	0.08***	0.09***
	TURNPOINT	*77,469*	*(a)*	*(b)*	*5,493*	*9,046*	*6,556*	*6,637*	*10,445*	*7,568*	*6,813*	*10,932*	*7,835*
N_COUNTRY		31	31	31	31	31	31	31	31	31	31	31	31
N_OBS		131	131	131	178	178	178	158	158	158	153	153	153
Non-OECD countries													
OLS	LOGGDP	-0.62***	-0.57***	-0.62***	-0.15	-0.14	-0.17	-0.22	-0.19	-0.24	-0.34	-0.36	-0.37
	LOGGDP2	0.03***	0.03***	0.03***	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02
	TURNPOINT	*30,782*	*90,954*	*36,848*	*(b)*	*(b)*	*(b)*	*20,949*	*(b)*	*41,142*	*8,409*	*55,027*	*12,530*
FE	LOGGDP	-0.17	-0.15	-0.15	-0.02	-0.06	-0.01	-0.14*	-0.20**	-0.13*	-0.31	-0.43*	-0.26
	LOGGDP2	0.01	0.01*	0.01	0.00	0.00	0.00	0.01	0.01**	0.01	0.02	0.02*	0.01
	TURNPOINT	*1,021*	*3,204*	*1,318*	*1,382*	*1,322*	*430*	*9,801*	*6,164*	*10,892*	*10,761*	*10,103*	*11,122*
N_COUNTRY		124	124	124	146	146	146	146	146	146	114	114	114
N_OBS		476	476	476	815	815	815	618	624	617	362	367	356

Penn World Tables 7.1

PWT revision		Penn World Tables 7.1											
EAPEP revision		4th rev. (1950-1990)			5th rev. (1980-2005)			6th rev. (1980/90 ⁺-2010)			6th rev. - red. sample (1980/90 ⁺-2010)		
Cohort (years)		25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59
All countries													
OLS	LOGGDP	-1.08***	-0.99***	-1.06***	-0.57***	-0.67***	-0.61***	-0.55***	-0.65***	-0.58***	-0.58***	-0.75***	-0.62***
	LOGGDP2	0.06***	0.05***	0.06***	0.03***	0.04***	0.04***	0.03***	0.04***	0.03***	0.04***	0.04***	0.04***
	TURNPOINT	*5,945*	*8,299*	*6,555*	*4,839*	*8,118*	*5,796*	*4,665*	*7,785*	*5,608*	*3,921*	*6,256*	*4,689*
FE	LOGGDP	-0.75***	-0.53***	-0.67***	-0.26***	-0.29***	-0.26***	-0.29***	-0.40***	-0.31***	-0.56***	-0.67***	-0.56***
	LOGGDP2	0.05***	0.03***	0.04***	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***	0.03***	0.04***	0.03***
	TURNPOINT	*1,846*	*2,704*	*2,004*	*1,480*	*1,660*	*1,535*	*4,922*	*4,099*	*4,868*	*6,317*	*7,101*	*6,461*
N_COUNTRY		155	155	155	177	177	177	177	177	177	147	147	147
N_OBS		597	597	597	987	987	987	954	960	953	574	578	567
OECD countries													
OLS	LOGGDP	-1.14*	-1.01*	-1.11*	-0.84	-1.58	-1.11	-0.38	-0.82	-0.51	-0.37	-0.78	-0.49
	LOGGDP2	0.07**	0.06*	0.07**	0.05	0.08	0.06	0.02	0.05	0.03	0.02	0.04	0.03
	TURNPOINT	*3,492*	*4,605*	*3,872*	*11,173*	*12,632*	*11,668*	*5,952*	*7,588*	*6,247*	*4,904*	*7,406*	*5,548*
FE	LOGGDP	-0.59	-0.09	-0.42	-1.43***	-1.60***	-1.51***	-1.69***	-1.62***	-1.62***	-1.63***	-1.56***	-1.56***
	LOGGDP2	0.03	0.00	0.02	0.08***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***	0.08***	0.09***
	TURNPOINT	*27,268*	*(b)*	*69,384*	*5,675*	*9,007*	*6,698*	*8,652*	*11,925*	*9,562*	*8,581*	*12,621*	*9,654*
N_COUNTRY		31	31	31	31	31	31	31	31	31	31	31	31
N_OBS		131	131	131	178	178	178	189	189	189	184	184	184
Non-OECD countries													
OLS	LOGGDP	-0.89***	-0.73***	-0.86***	-0.43***	-0.43***	-0.45***	-0.45***	-0.44***	-0.46***	-0.51**	-0.52***	-0.52***
	LOGGDP2	0.05***	0.04***	0.05***	0.02***	0.02**	0.02***	0.03***	0.02***	0.03***	0.03**	0.03**	0.03**
	TURNPOINT	8,228	19,439	9,756	8,390	30,729	11,005	6,772	22,257	8,941	5,126	13,339	6,551
FE	LOGGDP	-0.40***	-0.17*	-0.34***	-0.16	-0.16	-0.13	-0.27***	-0.31***	-0.25***	-0.54***	-0.56***	-0.46***
	LOGGDP2	0.03***	0.01**	0.02***	0.01	0.01*	0.01	0.02***	0.02***	0.01***	0.03***	0.03***	0.03***
	TURNPOINT	1,170	2,725	1,312	1,512	1,572	1,515	5,820	4,103	5,809	6,774	5,588	6,212
N_COUNTRY		124	124	124	146	146	146	146	146	146	116	116	116
N_OBS		466	466	466	809	809	809	765	771	764	390	394	383

Clustered standard errors (country-level). (a) denotes no convex function. (b) denotes turning point> 100,000. Turning points in USD 2005 PPP (PWT 6.3 or PWT 7.1). Intercept (OLS, FE) and time dummies (FE only) not reported

$***p < 0.01$; $**p < 0.05$; $*p < 0.1$

⁺6th revision data cover the period 1990–2010 (balanced panel), but some countries have data on the 1980s

⁺⁺PWT 6.3 runs until 2008

non-OECD), we see that the U relationship comes out clearly from the fourth revision of the EAPEP, but not from the fifth revision data, where the U tends to vanish moving from OLS to fixed effects regressions. The U reemerges under the sixth revision (both using OLS and fixed effects)—though part of this can be explained by the ILO's imputation approach. If we exclude imputed observations, the U is only marginally significant for the combined cohort and the younger cohort under the fixed effects estimation. Generally, the U is much more shallow in the fixed effects approach than in the OLS, similar to findings from Mammen and Paxson (2000). There is also a strong variability in turning points—which are in the range of 1,800 USD PPP for the fifth regression (fixed effects estimations), but much higher for the sixth revision (between 4,700 and 9,200 USD PPP); the turning points are nearly always lower in the fixed effects specification and are often quite low with few observations to the left of the turning points.

While there is some evidence for a U-shaped relationship between GDP per capita and female labor force participation if we use the combination of PWT 6.3 and the sixth revision of the EAPEP, it is interesting to note that under the fifth and sixth revisions, the convex function is entirely driven by high-income OECD countries, where the U always comes out highly significant from the fixed effects estimations. Further investigation reveals that this is driven by the former transition countries (Estonia, Hungary, Poland, Slovak Republic, and Slovenia) and the two Asian countries (Japan and Korea) in the OECD sample. If we exclude those countries, the coefficients on log GDP and log GDP squared turn insignificant. This particularly suggests that the declining female labor force participation rates in transition countries after 1990, which came in a situation of rapidly rising overall unemployment and an end of the policies to promote female employment, are important drivers of the U finding in the data (Klasen 1994). This is, of course, a one-time historical event, quite unrelated to the secular patterns that are alleged to drive the U. The turning points in the fixed effects regressions, when they exist, are rather low with often very few observations on the declining portion of the U.

In contrast, there is no evidence for a U relationship amongst non-OECD countries, where the coefficients for log GDP and log GDP squared from the fixed effects regressions are always insignificant, except for one specification (sixth revision, women aged 45–59 years, which is heavily affected by the imputations). Hence, based on GDP data from PWT 6.3, there is hardly any evidence for a U-shaped relationship between GDP per capita and female labor force participation amongst the large group of developing countries in our sample. Thus, it is safe to conclude that this combination of data (PWT 6.3 and EAPEP fifth or sixth revision) does not provide support for the U and its mechanisms.

This changes fundamentally if we move to the right side of the table, which uses data from PWT 7.1. Now, the fixed effects regressions for non-OECD countries reveal a clear U-shaped relationship if we use the fourth or sixth revision (full or reduced) of the EAPEP data (bottom panel). However, the U remains insignificant if we rely on female labor force participation data from the fifth revision of the EAPEP. Since under PWT 7.1 the U is still significant amongst OECD countries, there is now also a much stronger U relationship if we pool OECD and non-OECD countries (upper panel). To sum up, using PWT 7.1 GDP data, we see evidence in support of the feminization U hypothesis in the context of developing countries—but only if we use the fourth or sixth (rather than the fifth) revision of the EAPEP data.

When interpreting the results, three points are worth noting. First, the country samples differ somewhat in the different estimations due to data availability in the different ILO revisions. In a robustness check, we confined the analysis to a common set of countries (those already captured under the fourth revision), and this did not change the results in a substantial way (see Table A.2 in the ESM). Secondly, the ILO revisions cover different and only partially overlapping time periods. But since the main differences appear when moving from the fifth to the sixth revision of the ILO data which cover mostly the same time period, the change in time period is not central to the changes in our results. Also, the move from PWT 6.3 to 7.1 makes a big difference though covering largely the same time period. Third, the results of the fourth revision using PWT 6.3 are closest to the results by Mammen and Paxson (2000) and indeed reproduce their findings for the overall sample. Here, one should also note, however, that the U does not appear in the fixed effects specification in non-OECD countries, and that the fourth revision is arguably the least reliable data.[14]

Besides the signs and significance levels of the GDP variables, the fixed effects regressions also provide useful information on country-specific differences in female labor force participation, which cannot be explained by the level of GDP or over-time changes. Figure 2 shows the estimated fixed effects using the regression based on PWT 7.1 and the fifth revision of the EAPEP data (women aged 25–59 years). Using different combinations of data sources only had a very minor effect on the estimated fixed effects.[15] Table 3 also shows the countries with the largest positive and negative fixed effects. The graph reveals striking regional patterns in female labor force participation, which in contrast to the descriptive statistics in Section 3, are now conditioned on the level of GDP. The great majority of Sub-Saharan African countries have large, positive fixed effects—confirming the notion that the region, with the exception of some of the Sahel states (Sudan, Niger), has above average rates of female labor force participation. This is consistent with the claim of Boserup (1970) of the relative importance of female labor in agriculture in countries not traditionally using plows, creating path dependencies as discussed by Alesina et al. (2011, 2013). The East Asia and Pacific region also has high female activity rates, though there are negative effects for Malaysia and some of the small island states. Here, the

[14]The fourth revision data include years that are not included in the fifth revision (1950–1970). The ILO cut them out as they were deemed unreliable, but one might argue that they come from a time where the patterns of the U were more visible. We test using the overall sample whether these earlier years drive the results (by progressively cutting out the earlier observations) and find that this does not qualitatively change the results. Moreover, we think we have enough variation in economic conditions and stages of development when using the fifth revision and beyond so that a U-shaped process should be identifiable in the data. We also experimented on using IV regressions to purge our regression of possible (classical) measurement error of the GDP variables which could bias our coefficients towards zero. Specifically, we used PWT 6.3 to predict PWT 7.1 GDP. This did not change the results materially.

[15]The fixed effects regressions were estimated using Stata's xtreg, fe command, which constrains the system so that the reported intercept is the average value of fixed effects. The full list of estimated fixed effects based on the fifth revision of the EAPEP and PWT 7.1 is included in the ESM (Table A.3). The fixed effects using other combinations of data sources are available on request.

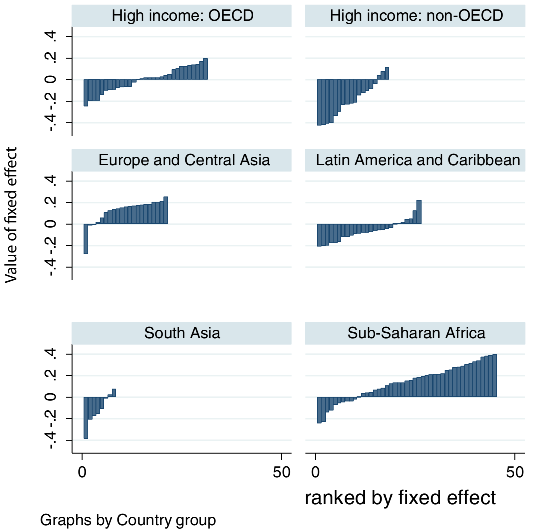

Fig. 2 Country-specific fixed effects by country group, 1980–2005. Fixed effects regression based on EAPEP fifth revision and PWT 7.1 (1980–2005)—women 25 to 59 years (see Table 2). World Bank country classifications as of November 2011

Table 3 Summary of country-specific fixed effects by country group, 1980–2005

Country group	Mean FE	Countries with		Bottom three (FE < 0)	Top three (FE > 0)
		FE < 0	FE > 0		
High-income: OECD	0.00	13	18	Luxembourg, Ireland, Spain	Iceland, Sweden, Estonia
High-income: non-OECD	−0.19	15	3	Saudi Arabia, UAE, Malta	Croatia, Bahamas, Barbados
East Asia and Pacific	0.10	6	10	Solomon Islands, Fiji, Malaysia	Cambodia, Vietnam, Laos
Europe and Central Asia	0.12	3	18	Turkey, Macedonia, Tajikistan	Bulgaria, Belarus, Kazakhstan
Latin America and Caribbean	−0.06	19	7	Colombia, Costa Rica, Mexico	Uruguay, Bolivia, Jamaica
Middle East and North Africa	−0.30	11	1	Libya, Iraq, Lebanon	Djibouti
South Asia	−0.12	6	2	Pakistan, Afghanistan, Maldives	Nepal, Bangladesh
Sub-Saharan Africa	0.13	11	34	Niger, Sudan, Mauritius	Tanzania, Rwanda, Burundi

Fixed effects regression based on EAPEP fifth revision and PWT 7.1 (1980–2005)—women 25 to 59 years (see Table 2). World Bank country classifications as of November 2011. See ESM for full list (Table A.3) policies to promote female education and employment, associated with the export-oriented growth strategies, are likely to have played a role (e.g., Klasen and Lamanna 2009; Seguino 2000b; Klasen 2006). In Europe and Central Asia, consisting largely of transition countries, there are also nearly universally positive fixed effects, likely a legacy of socialism which promoted female labor force participation (Kornai 1992). Conversely, female labor force participation is below average in South Asia (with the exception of Bangladesh and Nepal), again consistent with the claim of Boserup (1970) of lower female labor force participation in the South Asian plow cultures.

In much of Latin America (apart from a few countries such as Uruguay, Bolivia, and Jamaica), there are negative fixed effects and the largest negative fixed effects are found in the Middle East and North Africa regions, where the only country that has a positive estimated fixed effect, Djibouti, has seen a large downward revision of its female labor force participation rate under the sixth revision of the EAPEP (from 74 % in 2008 under the fifth revision to only 36 %). There are also large negative fixed effects amongst some high-income non-OECD countries, which are particularly driven by the oil-rich countries in the Gulf (Saudi Arabia, Oman, United Arab Emirates). The graph also confirms the well-known pattern of female labor force participation amongst high-income OECD countries, with large negative fixed effects in southern European countries (Italy, Spain), but also in Ireland and Luxembourg, and positive effects in much of northern Europe. The fixed effects in these regions are consistent with the claim that different types of religions and religiosity with their associated values play a large role in explaining these patterns, with Latin America, the Middle East, and southern Europe being dominated by religions (Islam and Catholicism) that have historically placed and/or continue to place limits on female labor force participation, while the Protestant northern European countries place few limits (e.g., Norris 2010; Feldmann 2007). The particularly sizable negative fixed effects in the Middle East can, of course, also be related to the reliance on primary exports in the region as suggested by Ross (2008).

These fixed effects are rather large and, in fact, dominate the changes implied by tracing out the U in the fixed effects regressions. To illustrate this, consider how a move from the turning point of the U to the 90th percentile in the data in Table 2 would affect female labor force participation rates, compared to the absolute value of the fixed effects in a regression. Using the age group of 25–44, the sixth revision and PWT 7.1, where the U is sizable and significant, moving from the turning point, situated at a per capita income level of just below 5,000 USD PPP (the level of Albania) to 34,000 USD PPP (the level of the UK) would raise female labor force participation rates by about 6 percentage points; the average absolute value of the fixed effect in that specification is about 15 percentage points. Thus turning from a lower middle-income country to a high-income country will only have a rather moderate impact on female labor force participation rates, compared to the large historically contingent differences between countries. In most specifications, the changes implied by the U are even smaller, esp. for its declining portion. Thus, we not only have doubts about the statistical significance of the U, but its economic significance is modest even in the cases where it is statistically significant.

The strong inertia of historically contingent women's economic activity is also one of the key motivations for now turning to the dynamic model, which allows current rates of female labor force participation being influenced by past values. This also has the advantage that we can treat log GDP and log GDP squared as endogenous, using lagged values as instruments. As discussed earlier, we use difference GMM to estimate the dynamic model. Table 4 shows the coefficients for log GPD and log GPD squared alongside with the coefficient of the lagged dependent variable. We also report on estimated turning points, sample sizes, and important regression diagnostics.[16] One immediately notices the perseverance of women's activity rates over time, as the coefficient of the first lag of the female labor force participation rate is always sizable and highly significant.

Overall, there is no clear evidence for the feminization U hypothesis from the dynamic estimations—the coefficients of log GDP and log GDP squared are often insignificant, and sometimes the estimated functional form is concave, rather than convex. Moreover, the estimated turning points exhibit a great deal of variety, which is hardly reconcilable with the notion of a common trend in female labor force participation over the course of economic development. Interestingly, whatever evidence there is to support the U relationship now rather comes from the sample of non-OECD countries, where the GDP variables tend to have the expected sign and are, at least, marginally significant in six out of 15 specifications (but contrary to the static fixed effects model, only under the fifth revision of the EAPEP). However, comparisons are hampered by the fact that there are several samples on which no regression model satisfied the diagnostic tests specified earlier. Further robustness checks also revealed that the estimates are sensitive to the specific choice of lag structure. While we interpret the dynamic regressions as providing little evidence for the feminization U hypothesis, we are mindful that the GMM estimates are sensitive to the choice of instruments.

On the whole, the static and dynamic estimates in this section demonstrate that the U relationship is not robust across alternative data sources and estimation methods—especially if the focus lies on non-OECD countries. The static fixed effects regressions using PWT 6.3 provide little support for a U-shaped relationship between per capita GDP and female labor force participation, apart from a small group of high-income OECD countries. Conversely, the feminization U comes out much stronger under the newly released PWT 7.1, but even this U is rather muted, compared to the sizable fixed effects. For both sets of PWT data, the U-relationship tends to vanish if we use dynamic instead of static panel data methods.

As a further robustness check, we also use an alternative test for a U-shaped relationship recently proposed by Lind and Mehlum (2010). This tests if the slope of the curve is negative at the start and positive at the end of the data range. However, this does not affect our conclusions; the U-shape remains highly sensitive to changes in data and specification. In light of such fragile results, we argue that an assessment of the feminization U hypothesis relying on international PPP income comparisons

[16]When estimating the dynamic model with data from the fourth revision, we always encountered second-order autocorrelation, which renders the moment conditions of the GMM estimator invalid. This is why this section presents the dynamic estimates only for the fifth and sixth revision data.

Table 4 Economic development and female labor force participation: dynamic estimates

PWT revision	Penn World Tables 6.3									Penn World Tables 7.1								
EAPEP revision	5th rev. (1980-2005)			6th rev. (1980/90 +-2005 ++)			6th rev. - red. sample (1980/90 +-2005 ++)			5th rev. (1980-2005)			6th rev. (1980/90 +-2010)			6th rev. - red. sample (1980/90 +-2010)		
Cohort (years)	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59
All countries																		
LOGGDP	0.05	-0.25**	0.04	-0.15	no valid specification	-0.04	0.04	no valid specification	-0.21	no valid specification	-0.25	-0.03	0.01	no valid specification	-0.12	0.04	no valid specification	-0.19
LOGGDP2	0.00	0.02**	0.00	0.01		0.00	-0.00		0.01		0.02*	0.01	-0.00		0.01	-0.00		0.01
TURNPOINT	*(a)*	*1,544*	*(a)*	*98,071*		*4,469*	*(a)*		*16,470*		*1,125*	*10*	*(a)*		*(b)*	*(a)*		*34,526*
FLFPR (first lag)	0.81***	0.70***	0.70***	0.70***		0.72***	0.78***		0.62***		0.60***	0.69***	0.78***		0.64***	0.77***		0.64***
Arellano-Bond test for AR(2) - p-value	0.91	0.63	0.56	0.57		0.50	0.56		0.49		0.58	0.64	0.49		0.63	0.63		0.70
Hansen-test for overid. restr. - p-value	0.12	0.17	0.16	0.61		0.47	0.26		0.32		0.21	0.32	0.94		0.87	0.46		0.62
Lag structure (FLFPR; GDP VAR)	3;4	4;2	4;4	4;3		3;4	4;4		3;3		4;4	4,4	4;4		4;4	4;4		4;4
N_COUNTRY	175	175	175	175		175	102		101		177	177	177		177	108		107
N_OBS	664	664	664	437		436	253		248		663	663	616		615	310		304
OECD countries																		
LOGGDP	-0.78	no valid specification	-0.11	0.07	no valid specification	0.29	0.05	no valid specification	0.11	0.14	0.18	0.01	-0.72	no valid specification	-0.32	0.22	no valid specification	0.12
LOGGDP2	0.04		0.01	-0.00		-0.01	-0.00		-0.00	-0.01	-0.01	0.00	0.04		0.02	-0.01		-0.00
TURNPOINT	*8,304*		*1,246*	*(a)*		*(a)*	*(a)*		*(a)*	*(a)*	*(a)*	*(a)*	*7,393*		*1,900*	*(a)*		*(a)*
FLFPR (first lag)	0.64***		0.72***	0.68***		0.89***	0.75***		0.79***	0.66***	0.95***	0.72***	0.76***		0.83***	0.70***		0.82***
Arellano-Bond test for AR(2) - p-value	0.61		0.50	0.37		0.25	0.37		0.24	0.62	0.88	0.52	0.44		0.20	0.22		0.18
Hansen-test for overid. restr. - p-value	0.36		0.67	0.74		0.42	0.74		0.68	0.56	0.54	0.72	0.22		0.53	0.86		0.48
Lag structure (FLFPR; GDP VAR)	4;3		4;4	4;2		3;4	4;2		3;2	4;4	4;3	4;4	3;4		3;4	4;2		3;4
N_COUNTRY	31		31	31		31	31		31	31	31	31	31		31	31		31
N_OBS	120		120	96		96	91		91	120	120	120	127		127	122		122
Non-OECD countries																		
LOGGDP	-0.25**	-0.23	-0.23**	-0.25	no valid specification	-0.23	-0.16	no valid specification	-0.20	no valid specification	-0.31**	-0.20**	-0.04	-0.29***	-0.13	-0.42	-0.54*	-0.38
LOGGDP2	0.02**	0.02*	0.02**	0.01		0.01	0.01		0.01		0.02**	0.02***	0.00	0.02***	0.01	0.02	0.03*	0.02
TURNPOINT	*1,019*	*826*	*1,181*	*20,098*		*11,631*	*(b)*		*31,073*		*1,184*	*713*	*83,658*	*8,376*	*(b)*	*26,888*	*5,816*	*44,097*
FLFPR (first lag)	0.70***	0.59***	0.67***	0.74***		0.63***	0.77***		0.58***		0.66***	0.67***	0.82***	0.51***	0.63***	0.69***	0.32**	0.62***
Arellano-Bond test for AR(2) - p-value	0.97	0.45	0.95	0.69		0.65	0.74		0.66		0.91	0.75	0.62	0.51	0.86	0.89	0.67	0.84
Hansen-test for overid. restr. - p-value	0.20	0.16	0.15	0.78		0.57	0.66		0.37		0.17	0.13	0.96	0.13	0.82	0.20	0.11	0.26
Lag structure (FLFPR; GDP VAR)	4;2	4;3	4;2	3;3		3;3	4;3		3;3		4;3	4;2	4;4	3;2	4;4	4;4	2;3	4;3
N_COUNTRY	144	144	144	144		144	71		70		146	146	146	146	146	77	77	76
N_OBS	544	544	544	341		340	162		157		543	543	489	495	488	188	193	182

Robust standard errors. (a) denotes no convex function. (b) denotes turning point >100,000. All turning points in USD 2005 PPP (PWT 6.3 or PWT 7.1). Time dummies not reported. Difference GMM estimation. Lag structure denotes the lags used to instrument (lagged) female labor force participation and the two LOGGDP variables

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

+Sixth revision data cover the period 1990–2010 (balanced panel), but some countries have data on the 1980s

++PWT 6.3 runs until 2008

is not robust, partly related to the large changes and margins of error associated with the different versions of the data. Moreover, the findings from this section suggest that the relationship between economic development and female labor force participation is more complex than is suggested by the rather simple model considered so far. One of the complexities relates to the large differences in patterns of structural transformation between regions and countries, a subject to which we now turn.

5 Structural change and female labor force participation

We now consider one of the key mechanisms supposedly underlying the feminization U hypothesis—structural change as reflected in sectoral growth in value added and employment. Our key innovation is to directly assess the effect of disaggregated sectoral growth on female labor force participation, rather than to estimate a nonlinear relationship between aggregate GDP and women's activity. By exploiting information on sector-specific growth, we can allow for various nonlinearities and the differential impact of growth on female labor force participation across countries at different stages of the development process without relying on cross-country GDP comparisons. This renders the assessment independent of international price comparisons and PPP revisions, which hampered the analyses in the preceding chapter. The sectoral perspective advocated for in this section is also much closer to the original idea of the feminization U hypothesis, which emphasized structural change as a key driving factor of women's economic activity. We argue that the pattern and process of structural change experienced by the developing world today is too diverse (even for countries with similar GDP levels) to trace out a common trend in female labor force participation (see also McMillan and Rodrik (2011) on patterns of structural change across countries). Therefore, it is preferable to directly analyze the relationship between structural change (as captured by disaggregated sectoral growth) and women's economic activity.

In the ESM (Figs. A.1 and A.2), we document the pattern of structural change by region, showing particularly the substantial decline in agricultural value added and employment in Africa and Asia. As a simplified starting point, we split our sample into two groups based on the initial level as well as the trend in agricultural value added (as a share of total value added).[17] Related to the theory underlying the feminization U, we would expect that countries with a large agricultural share, or a strong decline in this share, should face falling female participation as they grow. We then estimate a fixed effects model similar to Eq. 2, but excluding the quadratic term in log GDP (Table 5). In a few specifications, we see indeed that female labor force participation declines with GDP growth in countries with a high initial share of agriculture in total GDP (respectively with a strong decline in the share), but in most cases, the

[17]The sample is split in such a way that one quarter of countries are expected to transition through the declining portion of the U and thus experience a fall in female labor force participation with rising per capita income, while the remaining three quarters are assumed to experience an increase in female labor force participation with rising per capita income. This corresponds approximately to the J-shaped patterns found in Section 4, with fewer observations to the left of the turning point.

Table 5 Two-sector model (based on the share of agriculture in value added)

		PWT revision	Penn World Tables 6.3									Penn World Tables 7.1								
		EAPEP revision	5th rev. (1980-2005)			6th rev. (1980/90 ⁺-2005 ⁺⁺)			6th rev. - red. sample (1980/90 ⁺-2005 ⁺⁺)			5th rev. (1980-2005)			6th rev. (1980/90 ⁺-2010)			6th rev. - red. sample (1980/90 ⁺-2010)		
		Cohort (years)	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59	25-44	45-59	25-59
Version A: Sample split based on the share of agricultural value added in 1980																				
Countries with an expected decline in FLFP																				
	FE	LOGGDP	-0.015	-0.010	-0.013	-0.010*	-0.012*	-0.011**	0.015	-0.047	-0.001	-0.016	-0.012	-0.014	-0.016**	-0.016**	-0.017***	0.025	0.019	0.023
		N_COUNTRY	38	38	38	38	38	38	24	24	24	38	38	38	38	38	38	25	25	25
		N_OBS	228	228	228	162	162	162	55	55	55	228	228	228	200	200	200	57	57	57
Countries with an expected increase in FLFP																				
	FE	LOGGDP	0.029	0.037**	0.028	0.017	0.003	0.010	0.023	-0.008	0.013	0.051**	0.045**	0.046**	0.014	-0.001	0.007	0.026	-0.015	0.012
		N_COUNTRY	112	112	112	112	112	112	100	100	100	112	112	112	112	112	112	100	100	100
		N_OBS	672	672	672	525	531	524	405	410	399	662	662	662	634	640	633	448	452	441
Version B: Sample split based on the *change* in the share of agricultural VA 1980-2005																				
Countries with an expected decline in FLFP																				
	FE	LOGGDP	-0.002	-0.000	-0.001	0.007	0.010	0.006	0.150	0.099	0.128	-0.000	-0.000	0.000	-0.002	0.000	-0.003	0.058	0.039	0.052
		N_COUNTRY	37	37	37	37	37	37	25	25	25	37	37	37	37	37	37	25	25	25
		N_OBS	222	222	222	160	161	160	77	79	77	222	222	222	197	198	197	83	85	83
Countries with an expected increase in FLFP																				
	FE	LOGGDP	0.047***	0.054***	0.046***	0.025	0.014	0.019	0.040	0.013	0.032	0.071***	0.068***	0.068***	0.029*	0.019	0.024	0.060**	0.024	0.048
		N_COUNTRY	113	113	113	113	113	113	99	99	99	113	113	113	113	113	113	100	100	100
		N_OBS	678	678	678	527	532	526	383	386	377	668	668	668	637	642	636	422	424	415

Clustered standard errors (Country level). In Version A, the total country sample is split based on the share of agricultural value added in 1980; the 25 % of countries with the highest initial share of agricultural value added (at least 28 % of total VA) are expected to see a decline in FLFP, while the remaining 75 % of countries are expected to see an increase in FLFP. In Version B, the total country sample is split based on the change in the share of agricultural value added 1980–2005; the 25 % of countries with the largest fall in the share of agricultural value added (by at least 7.6 percentage points) are expected to see a decline in FLFP, while the remaining 75 % of countries are expected to see an increase in FLFP. Based on the following model: $FLFPR_{it} = \alpha_i + \beta \ln y_{it} + \delta_t + \mu_{it}$

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

⁺Sixth revision data cover the period 1990–2010 (balanced panel), but some countries have data on the 1980s

⁺⁺PWT 6.3 runs until 2008

relationship turns out to be insignificant. Nonetheless, this provides some suggestive evidence that structural change might affect female participation in ways consistent with the U hypothesis. We now turn to explore this in more detail.

We start with a simple accounting identity that shows how changes in the female employment rate are related to sector-specific growth in value added (see Ravallion and Datt 1996; Loayza and Raddatz 2010; Christiaensen et al. 2011 for a similar approach in relating changes in poverty to sectoral value-added growth). Our objective is not to provide a structural model or to establish causality but to present a very simple conceptual framework that aids interpretation of the empirical analyses later on. The focus lies on direct effects of economic growth on female labor force participation stemming from employment generation and labor demand in the different sectors.[18]

Let e be the overall employment rate in a country, that is, the ratio of the employed population (E) to the total population (P). Likewise, the female employment rate (e_f) is defined as the ratio of employed females (E_f) to the total female population (P_f). For simplicity, we assume that men and women have the same population share ($P_f = P_m = 1/2P$) so that we obtain

$$ef = \frac{E_f}{P_f} = 2\frac{E_f}{P} = 2\frac{E_f}{E}\frac{E}{P} = 2\,r_f e \tag{4}$$

where r_f is the female intensity of employment (female employment per total employment).

The proportionate change in female employment is given by the GDP elasticity of female employment (ε_{efy}, defined as the proportionate change in the female employment rate divided by the proportionate change in GDP per capita) multiplied by the proportionate change in per capita GDP (y):

$$\frac{de_f}{e_f} = \left(\frac{de_f}{e_f}\frac{y}{dy}\right)\frac{dy}{y} = \varepsilon_{efy}\frac{dy}{y} \tag{5}$$

Applying a logarithmic approximation, we obtain for small changes:

$$dln\, e_f = \varepsilon_{efy}\, dln\, y \tag{6}$$

Substituting (4) into the equation for the GDP elasticity of female employment (first term of Eq. 5) shows that the latter can be expressed as the sum of the GDP elasticity of total employment (ε_{ey}, the proportionate change in the total employment rate divided by the proportionate change in GDP) and the GDP elasticity of the female employment intensity (ε_{rfy}, the proportionate change in the female employment share divided by the proportionate change in GDP):

$$\varepsilon_{efy} = \frac{\frac{de_f}{dy}}{\frac{e_f}{y}} = \frac{\frac{d(2r_f e)}{dy}}{\frac{(2r_f e)}{y}} = \frac{\frac{dr_f}{dy}e + r_f\frac{de}{dy}}{\frac{r_f e}{y}} = \frac{\frac{dr_f}{dy}}{\frac{r_f}{y}} + \frac{\frac{de}{dy}}{\frac{e}{y}} = \varepsilon_{rfy} + \varepsilon_{ey} \tag{7}$$

[18] Of course there are also indirect effects, such as growth in overall family incomes due to structural transformation and associated income effects. Those are not directly captured by the above framework.

Substituting Eq. 7 into Eq. 6 and considering that overall GDP growth can be approximated by the sum of share-weighted growth rates of the different economic sectors ($j = 1, \ldots, J$) finally delivers:

$$dln\, e_f = \sum_{j=1}^{J} \left(\varepsilon_{rfy\ j} + \varepsilon_{ey\ j}\right) s_j dln\, y_j \tag{8}$$

According to Eq. 8, one can decompose growth in the female employment rate into the following proximate determinants at the sectoral level: the growth rate of sector j ($dlny_j$), the elasticity of total employment to growth in sector j ($\varepsilon_{eyj} s_j$), and the elasticity of the total female employment intensity to growth in sector j ($\varepsilon_{rfyj} s_j$). For simplicity, we will denote ε_{rfyj} and ε_{eyj} as size-adjusted GDP elasticities, which show the responsiveness of the total female employment intensity, respectively, of the total employment rate, to growth originating in sector j, controlling for the sector's size. However, it is important to bear in mind that the proportionate change in the female employment rate also depends on the sector's share in total value added (s_j).

This simple decomposition helps to explain why not all growth creates employment opportunities for women, even if we control for the share of the sector in total GDP. In fact there is ample reason to believe that the two (size-adjusted) elasticities above will exhibit significant variation between the sectors. ε_{ey} depends on the sector-specific labor intensity of production. Capital-intensive growth, for example, in the mining sector, may not generate many jobs for men and women alike. Likewise, employment levels in low productivity sectors with surplus labor (such as subsistence agriculture) may only be weakly linked to value added. ε_{rfy} depends on changes in sectoral employment segregation, whether women tend to become more engaged in certain sectors during the growth process, and whether the sectors that grow have above or below average female employment intensities. It has well been observed that women are often clustered in specific sectors, due to occupational preferences, educational gender gaps, discrimination, social stigma, or opportunity cost considerations (see World Bank 2011). Farm work, for example, is often considered an attractive sector for women because it is compatible with child-rearing and home work responsibilities, despite the sector's low productivity and earnings. Goldin (1990, 1995) argues that female employment in blue-collar occupations is constrained by stigmatization and social norms, whereas white-collar service jobs are deemed much more acceptable for women; this may explain why women are disproportionately employed in the service sector. However, it is important to note that Eq. 7 shows clearly that the initial share of female employment in the economy is not important for the percentage change in the female employment rate.[19] What matters is whether the economy's female employment intensity changes with increases in sectoral value added—that is whether the economy feminizes or defeminizes, irrespectively, of it's initial level of feminization (across all sectors).

[19]This is because we look at relative (in percent) changes, rather than absolute (percentage point) changes. Please note that the initial female employment intensity of the growing sector does matter for the percentage change in the female labor force participation rate. Growth of sectors where the female employment intensity is high will have a larger impact on the growth of aggregate female employment rate. However, we do not have data on sector-specific female employment intensities and cannot isolate this element empirically.

In light of this discussion, we formulate the following hypothesis:

- Agriculture: ε_{ey} is small or even negative because of surplus labor in the agricultural sector in poor countries, and because of the increasing mechanization of agriculture in advanced economies. We expect ε_{rfy} to be negative, because young women have increasingly benefitted from expanding education opportunities and are less likely than their mothers to enter the agricultural sector, though this could be counteracted by the fact that the agricultural sector often will still have an above average initial level of female participation.
- Mining: ε_{ey} is small because production is capital-intensive. ε_{rfy} is close to zero, or even negative.
- Manufacturing: ε_{ey} is potentially large. Despite the widespread perception that women worldwide "shun the factory" (Boserup 1970, p. 114), we expect a positive ε_{rfy}. This is because it has been observed that women (esp. young, unmarried women) are increasingly engaged in export-oriented garment and other light manufacturing industries and that women often play a crucial role as subcontracted own-account or piece-rate industrial laborers working at home or in small workshops (Ghosh 2002; World Bank 2011; Seguino 2000a).
- Construction: ε_{ey} is potentially large because of the sector's high labor intensity. Our expectation is that ε_{rfy} is close to zero or negative.
- Services: We anticipate ε_{ey} to be comparatively large because services are labor intensive. We also expect a positive ε_{rfy} because the sector is attractive for young women entering the labor market, and because services most likely have an above average initial level of female participation.

As in the previous section, we use female economic activity as a proxy for female employment (see Klasen and Lamanna (2009) for a similar approach). In order to test empirically if and how the sectoral structure of growth matters for female economic activity and employment, we regress the proportionate change in the female labor force participation rate on the share-weighted growth in per capita value added in seven sectors of the economy (expressed in log first differences).

$$\Delta lnFLFPR_{it} = \pi_0^F + \sum_{j=1}^{7} \pi_j^F \cdot s_{ijt-1} \cdot \Delta lny_{ijt} + \delta_t^F + \varepsilon_i \tag{9}$$

Share-weighted growth implies that growth in each sector is weighted by the sector's share in total value added in the initial period. The regression equation also contains a common intercept $\left(\pi_0^F\right)$ and allows for time-specific fixed effects $\left(\delta_t^F\right)$ to capture common changes in female labor force participation across periods. We do not allow for country-specific fixed effects because Eq. 9 is already expressed in first differences. The $\pi_j^{F\prime}$s are the sectoral effects to be estimated; Eq. 8 shows that they can be interpreted as the sum of the size-adjusted GDP elasticities of total employment and the total female employment intensity.

Despite the fact that our ultimate interest lies in female employment, we also estimate the Eq. 9 with the overall (male and female) labor force participation rate on the left-hand side:

$$\Delta lnTLFPR_{it} = \pi_0^T + \sum\nolimits_{j=1}^{7} \pi_j^T \cdot s_{ijt-1} \cdot \Delta lny_{ijt} + \delta_t^T + \varepsilon_i \tag{10}$$

This allows us to distinguish the two elasticities identified above—in particular, the sectoral parameters π_j^T can now be interpreted as the size-adjusted elasticity of total employment to growth in sector *j*. The size-adjusted elasticity of the total female employment intensity to growth in sector *j* is then $\pi_j^F - \pi_j^T$.

So far, we considered sector-specific value added as an indicator of structural change, which is closely related to the analysis of the previous section and the existing empirical literature on the relationship between aggregate GDP and women's labor force participation. However, we may also interpret structural change as a process of labor reallocation and thus investigate the relationship between female labor force participation and sectoral *employment* growth directly. This allows us to get a sense of the responsiveness of female labor force participation to employment expansions in sectors where employment changes are only weakly correlated with variations in value added.[20] Another reason for focusing on the sectoral allocation of the labor force is that national accounts data in developing countries are often of poor quality, especially when it comes to capturing output from agriculture and informal enterprises, sectors which provide a livelihood for many women worldwide. Therefore, we also estimate the following equation, where we regress the change in the female labor force participation rate on the share-weighted growth in per capita employment (again, expressed in log first differences):

$$\Delta lnFLFPR_{it} = \pi_0^{F*} + \sum\nolimits_{j=1}^{7} \pi_j^{F*} \cdot s_{ijt-1}^{*} \cdot \Delta lne_{ijt} + \delta_t^{F*} + \varepsilon_i \tag{11}$$

The s_{ijt-1}^{*} is then the sector's share in total employment in the initial period. π_j^{F*} can be interpreted as the responsiveness of the female labor force participation rate to employment growth originating in sector *j*, controlling for its size, which depends on whether the economy feminizes or defeminizes as employment expands. In principle, it would be enough to compare the estimated coefficients against unity to gauge feminization or defeminization. However, since our dependent and explanatory variables come from different data source, any (classical) measurement error will bias the estimated coefficients towards zero. However, we can still obtain useful information from comparing the π_j^{F*} across sectors.

An important caveat of our approach is that it might be seen to imply a causal relationship from structural change to female labor force participation. In reality, sectoral growth and women's economic activity are equilibrium outcomes that depend on a range of exogenous and endogenous factors and complex interactions, including potential spillovers between sectors. For the purpose of the present paper, our objective is limited to understanding whether there are consistent patterns between sectoral growth and female economic activity, which would support the notion of the feminization U hypothesis that structural change is one of the key drivers of trends in female labor force participation.

[20] If there were cross-country data on male and female employment by disaggregated sector, we could also directly decompose the change in female employment into various sectoral contributions. However, here we use a regression approach to relate data on the sectoral allocation of total employment, which are not disaggregated by sex, to female labor force participation estimates from the EAPEP database.

To estimate Eqs. 9 to 11, we use two main data sources. First, we draw on the National Accounts Main Database of the United Nations Statistics Division (UNSTATS) for annual national accounts data (1970–2010) for more than 200 countries (UNSTATS 2011). Value added is disaggregated into seven broad sectors as shown in Table 6.[21] Second, we use the 10-Sector Database of the Groningen Growth and Development Centre (GGDC), which contains annual employment data (from 1950 onwards) by sector for 28 countries in Latin America, Asia, and the OECD (GGDC 2011). We complement this database with additional data for nine African countries, China, and Turkey provided by McMillan and Rodrik (2011), which give us a sample of 39 countries in total.[22] As documented in Timmer and de Vries (2007), the GGDC employment time series are of much higher quality than those provided by the World Development Indicators of the World Bank (2006), as the latter suffer from frequent gaps and various inconsistencies. For our analysis, we combine some sectors of the GGDC database to match the seven sectors of the national accounts data. Our analysis draws on the fifth revision of the ILO's EAPEP (1980–2005) which is the longest time series and which is not affected by the turbulences during the recent financial crisis, though we briefly turn to the sixth revision at the end of this section. As before, we use 5-year intervals and distinguish between three cohorts, because the effect of structural change on women's labor force participation is likely to differ according to age.

Table 7 reports the results for the *value-added* regressions (Eqs. 9 and 10). Growth in agricultural value added is neither significantly correlated to total labor force participation nor to female labor force participation. This confirms our expectation that agricultural value added and employment are only weakly correlated (ε_{ey} is close to zero). Another potential explanation is that national accounts data on agricultural production in low-income countries are notoriously weak. ε_{rfy} is negative but very small, indicating no significant feminization or defeminization in the economy. Table 8 reports results for Eq. 11. We see that *employment* growth in agriculture is highly correlated to increases in female labor force participation in the subsample of countries for which we have data on sectoral employment trends.[23] The effect is much larger for the older women, who seem to have a stronger attachment to the farming sector. Since agricultural employment tends to decline in most countries, this means that this decline is associated with a decline in female employment as well, consistent with the structural change arguments leading to the feminization U.

[21] The classification is based on the ISIC 3.1 industry classification, but some of the one-digit sectors are combined in the dataset. Of course, one may argue that seven sectors are still too broad to uncover specific subsector dynamics (e.g., differential trends in female labor force participation in different types of agriculture, or manufacturing subsectors). While we are mindful of these limitations, the data do not allow estimating separate effects for different subsectors in agriculture or manufacturing.

[22] However, we have to drop West Germany and Taiwan during the analysis stage because these two countries do not have a corresponding entry in the ILO database.

[23] It is somewhat surprising that all coefficients in Table 8 are below unity. This would suggest that female labor force participation increases less than proportionately with employment growth in any sector (an across-the-board defeminization). We suspect that this weak correlation is driven by the fact that we use employment data from two different sources, which both suffer from measurement error. Another reason might be changes in female unemployment (which is included in the labor force participation rate).

Table 6 Overview of sector classifications

Category	ISIC Rev. 3.1 categories	UNSTATS national accounts main database	GGDC 10-Sector database
Agriculture	A—Agriculture, hunting, and forestry B—Fishing	Agriculture, hunting, forestry, fishing (ISIC rev. 3.1: A–B)	Agriculture (ISIC rev. 2: 1)
Industry	C—Mining and quarrying	Mining, manufacturing, utilities (ISIC rev. 3.1 C-E), and manufacturing (ISIC rev. 3.1: D)	Mining (ISIC rev. 2: 2)
	D—Manufacturing		Manufacturing (ISIC rev. 2: 3)
	E—Electricity, gas, and water supply		Public utilities (ISIC rev. 2: 4)
	F—Construction	Construction (ISIC F)	Construction (ISIC rev. 2: 5)
Services	G—Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods H—Hotels and restaurants	Wholesale, retail trade, restaurants, and hotels (ISIC rev. 3.1: G–H)	Wholesale, and retail trade (incl. hotels and restaurants) (ISIC rev. 2: 6)
	I—Transport, storage and communications	Transport, storage, and communication (ISIC rev. 3.1: I)	Transport, storage, and communication (ISIC rev. 2: 7)
	J—Financial intermediation K—Real estate, renting, and business activities	Other activities (ISIC rev. 3.1: J-P)	Finance, insurance, and real estate (ISIC rev. 2: 8)
	L—Public administration and defense; compulsory social security		Community, social and personal services (ISIC rev. 2: 9), and government services (ISIC rev. 2: 10) [combined in some countries]
	M—Education N—Health and social work O—Other community, social, and personal service activities P—Activities of private households as employers and undifferentiated production activities of private households		

Extraterritorial organizations and bodies (ISIC category Q) is disregarded in the above table. *ISIC* International Standard Industrial Classification of All Economic Activities. Based on UNSTATS (2011) and Timmer and de Vries (2007)

Table 7 Sectoral value-added growth and labor force participation (ILO EAPEP fifth revision)

	Cohort 25–44 years				Cohort 45–59 years				Cohort 25–59 years			
	Coefficients		Elasticities		Coefficients		Elasticities		Coefficients		Elasticities	
	Total LFP	Female LFP	ε_{ey}	ε_{rfy}	Total LFP	Female LFP	ε_{ey}	ε_{rfy}	Total LFP	Female LFP	ε_{ey}	ε_{rfy}
Growth in value added (per capita, share-weighted)												
Agriculture (ISIC 3.1: A–B)	−0.003	−0.008	−0.003	−0.005	−0.010	−0.022	−0.010	−0.011	−0.006	−0.011	−0.006	−0.005
Mining and utilities (ISIC 3.1: C+E)	−0.015	−0.143**	−0.015	−0.128	−0.025*	−0.142**	−0.025	−0.117	−0.020	−0.155**	−0.020	−0.135
Manufacturing (ISIC 3.1: D)	0.071**	0.169**	0.071	0.099	0.015	0.044	0.015	0.029	0.048*	0.130*	0.048	0.082
Construction (ISIC 3.1: F)	0.058	−0.002	0.058	−0.060	0.059	−0.001	0.059	−0.061	0.063	0.001	0.063	−0.062
Trade, hotels, and restaurants (ISIC 3.1: G–H)	−0.045	0.011	−0.045	0.057	0.015	0.111*	0.015	0.096	−0.031	0.029	−0.031	0.060
Transport, storage, and communication (ISIC 3.1: I)	0.080	0.162	0.080	0.082	0.166***	0.365**	0.166	0.198	0.111*	0.228	0.111	0.117
Other services (ISIC 3.1: J–P)	0.065**	0.097*	0.065	0.032	0.012	0.049	0.012	0.037	0.049**	0.081	0.049	0.032
Number of observations	803	803			803	803			803	803		
Number of countries	173	173			173	173			173	173		
R^2	0.067	0.087			0.053	0.060			0.070	0.083		

Dependent variable is the change in total/female labor force participation (5-year intervals, 1980–2005). εey is the sectoral GDP elasticity of total employment. εrfy is the sectoral GDP elasticity of the total female employment intensity. Time dummies and intercept included but not reported. Cluster robust standard errors

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table 8 Sectoral employment growth and female labor force participation (ILO EAPEP fifth revision)

	Cohort 25–44	Cohort 45–59	Cohort 25–59
Growth in employment (per capita, share-weighted)			
Agriculture (ISIC 3.1: A–B)	0.221**	0.605***	0.310***
Mining and utilities (ISIC 3.1: C+E)	−0.009	0.515	0.138
Manufacturing (ISIC 3.1: D)	−0.013	0.150	0.047
Construction (ISIC 3.1: F)	−0.233	−0.230	−0.237
Trade, hotels, and restaurants (ISIC 3.1: G–H)	0.478**	0.691*	0.507**
Transport, storage and communication (ISIC 3.1: I)	−0.877	0.282	−0.643
Other services (ISIC 3.1: J–P)	0.539***	0.515*	0.499**
Number of observations	163	163	163
Number of countries	37	37	37
R^2	0.147	0.127	0.154

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$. Reports coefficients. Dependent variable is the change in female labor force participation (5-year intervals, 1980–2005). Time dummies not reported. Cluster-robust standard errors

Countries included Argentina, Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Denmark, Ethiopia, France, Ghana, Hong Kong, India, Indonesia, Italy, Japan, Kenya, Republic of Korea, Malawi, Malaysia, Mauritius, Mexico, Netherlands, Nigeria, Peru, Philippines, Senegal, Singapore, South Africa, Spain, Sweden, Thailand, Turkey, UK, USA, Venezuela, Zambia

Value-added growth in mining and utilities is negatively related to overall labor force participation, but the effect is small and mostly insignificant. We explain the lack of responsiveness in overall levels of economic activity to mining and utility growth with the high-capital intensity of mining operations and the fact that changes in value added are often driven by short-term price fluctuations. Moreover, there is a large and significantly negative correlation between value added growth in the mining sector and female labor force participation, which merits a discussion. One explanation would be that women are disengaging from the mining sector, but this does not seem likely given that the sector probably employed few women to begin with. What seems more plausible is that income from natural resource extraction is correlated with deeper socioeconomic changes. This would confirm the observation made by Ross (2008) and Assaad (2005) that oil production in the Middle East reduces the number of women in the labor force through its effects on family bargaining power and export structure. There are at least three potential transmission channels: First, earnings accruing to male household members from employment in the oil and mining sector may reinforce patriarchal family models, especially in conservative societies. Second, higher household incomes associated with a booming mining sector could lead to a decline in female labor supply via the income effect. Third, an expansion in extractive industries is often associated with a contraction in female-labor-intensive export sectors due to Dutch Disease effects. To the extent that we cannot fully control for differential growth in the various industrial subsectors, the regressions might attribute the resulting decline in female economic activity to mining and utility growth. We do not find a correlation between employment growth in the mining sector and female labor force participation (Table 8), which partly reflects that among the 37 countries for which, we have data on sectoral employment, there are only few major resource-exploiting economies (see Table 8 footnote).

There is a positive relationship between growth in manufacturing value added and female labor force participation, which is significant for the younger cohort (25–44 years) and the combined cohort (25–59 years). ε_{ey} and ε_{rfy} are both positive, suggesting that manufacturing growth does create employment, and that an expansion in manufacturing is associated with an increasing feminization of the economy as a whole. It is indeed often noted that labor-intensive manufacturing industries, such as textiles, garments, footwear, and electronics employ young, unmarried women (Mammen and Paxson 2000), many of whom are barely even captured by our younger cohort of 25–44 year olds. Women may also work as home-based industrial workers in the informal economy, supplying middlemen and larger factories (Ghosh 2002). However, in our data set, the positive association between growth in manufacturing value added and female labor force participation is partly driven by the coinciding experience of contraction in manufacturing and declining female labor force participation in some of the former communist countries in the early 1990s. If we estimate Eqs. 9 and 10 using median regression, which are less sensitive to these outliers, the association turns insignificant. Moreover, there is no significant relationship between employment growth in manufacturing and female labor force participation for the 37 countries for which we have sector-specific employment data (Table 8).

Value-added growth in transport, storage, communication, and in other services is positively related to total labor force participation, and the coefficients are significant for two out of three cohorts. In all three service subsectors (including trade, hotels and restaurants, where value-added growth is negatively related to total labor force participation), ε_{rfy} is positive, indicating an increasing feminization of the economy. The regressions in Table 8 also show positive effects on female labor force participation from employment growth in trade, hotels, and restaurants and from employment growth in other services.

While the preceding discussion gives an indication of how responsive female employment reacts to growth in different sectors, it does not provide immediate information on the direction and magnitude of changes in women's economic activity due to structural change amongst different groups of countries. This is because apart from the two elasticities ε_{eyj} and ε_{rfyj}, the sectors' initial share in total value added (s_j) and actual changes in value added per capita (Δlny_j) over time also need to be considered. To quantify the overall effect of structural change on female labor force participation, we use the model estimated in Eq. 9 to simulate changes in participation of women aged 25 to 59 years based on actual changes in sectoral value added. For simplicity, we focus on the 143 economies for which we have data on value added by sector for the full period of 1980 to 2005 (which excludes the former transition countries in Europe and Central Asia).

Table 9 Simulated changes in female labor force participation, 1980–2005 (ILO EAPEP 5th revision)

Country group	Actual Δ in FLFP 1980–2005	Simulated Δ in FLFP based on with structural change	Number of countries simulated	
			Δ FLFP < 0 due to sectoral change	Δ FLFP > 0 due to sectoral change
All countries with data for 1980–2005				
High-income: OECD members	0.168	0.025	1	26
High-income: non-OECD members	0.196	0.017	2	14
East Asia and Pacific	0.036	0.015	2	11
Europe and Central Asia	−0.049	0.012	0	4
Latin America and the Caribbean	0.138	0.007	6	20
Middle East and North Africa	0.114	0.004	3	7
South Asia	0.079	0.013	1	6
Sub-Saharan Africa	0.052	−0.002	21	19
All	0.107	0.010	36	107
Only countries with an increase in (total) per capita value added for 1980–2005				
High-income: OECD members	0.168	0.025	1	26
High-income: non-OECD members	0.174	0.018	2	9
East Asia and Pacific	0.036	0.015	2	11
Europe and Central Asia	−0.049	0.012	0	4
Latin America and the Caribbean	0.152	0.010	2	18
Middle East and North Africa	0.099	0.008	2	5
South Asia	0.099	0.019	0	6
Sub-Saharan Africa	0.059	0.001	8	13
All	0.113	0.014	17	92

Based on the model in Table 7 (women aged 25–59 years)

Table 9 shows observed changes in female labor force participation between 1980 and 2005, as well as simulated changes based on sectoral growth in value added (unweighted country averages). The upper panel shows that women's economic activity rates increased by about 11 percentage points over the period of 1980 to 2005 across the countries included in the simulation exercise, of which just under 10 % (that is 1 percentage point) can be explained by structural change.[24] Across all regions, 107 countries have a predicted increase in female activity based on their sectoral growth patterns, while 36 have a simulated decline. At the regional level, the simulations predict the strongest increases in female labor force participation for high-income OECD countries (+2.5 percentage points) mainly due to growth in the service sectors. Most other regions have a simulated increase in activity rates in the magnitude of 0.5 to 2 percentage points. At the country-level, the largest simulated increases in female activity rates (in order of 5 to 7 percentage points) are for some of the fast-growing high-and middle-income East Asian countries, particularly Korea, Singapore, and Thailand, driven by manufacturing and service-sector growth.

The only region where the majority of countries have a simulated decline in female labor force participation is Sub-Saharan Africa. It is also the region with the greatest spread in simulation outcomes, with simulated increases in Lesotho (+3.9 percentage points), Gabon (+3.8 percentage points), and Mauritius (+3.1 percentage points), and sizeable declines in Liberia (−7.2 percentage points), Equatorial Guinea (−6.5 percentage points, though the country technically falls into the high-income non-OECD group), Angola (−5 percentage points), and the Republic of Congo (−4.6 percentage points). Those countries in Sub-Saharan Africa with a simulated decline in female activity can be grouped into two categories. The first consists of natural resource-rich countries (Angola, Equatorial Guinea, Botswana, and Republic of Congo), where the simulated change is dominated by the negative coefficient of growth in mining on female labor force participation. The second consists of countries where the UNSTATS national accounts data show a significant *contraction* in per capita value added and hence in many cases negative sectoral changes for the period of 1980–2005 (e.g., Democratic Republic of Congo, Liberia).

Since the feminization U hypothesis is essentially about growing economies, the bottom panel shows simulated changes for a subgroup of countries with positive changes in per capita value added (across all sectors) between 1980 and 2005. Now the proportion of countries with a simulated decline in female labor force participation is even smaller (17 out of 109 countries), and this negative effect is typically driven by growth in the mining sector. In some other cases, the negative simulated change over the period of 1980 to 2005 reflects strong temporary contractions in value added in sectors with a positive correlation to female labor force participation (such as significant declines in value added from manufacturing in some Sub-Saharan

[24]It should be noted that the model in Eq. 9 includes an intercept and time dummies, which capture much of the country-invariant increase in female labor force participation between 1980 and 2005. When we simulate the effect of structural change on female economic activity, we disregard those effects by basing the simulations only on sectoral growth rates.

African countries during the 1980s), which were not evened out by subsequent growth in other sectors.[25]

In a nutshell, the findings in this section suggest that structural change matters for female labor force participation, but there is little evidence that sectoral growth alone is the key driver of women's economic activity. Moreover, structural changes tend to work in the direction of increasing female labor force participation, except for countries where growth is dominated by natural resource extraction. Contrary to the notion of the feminization U hypothesis, we find no evidence that manufacturing growth is negatively related to female labor force participation.

Before turning to the conclusion, we address some potential criticisms to the analyses in this section. First, one may argue that our data on sectoral growth and female labor force participation are a noisy measure of structural change and that this, under the assumption of classical measurement error, will bias coefficients towards zero. However, we believe that the data that were previously used to test the feminization U hypothesis are at least as problematic. In fact, most of the analyses so far were based on labor force estimates from the fourth revision of the EAPEP, which covered the period of 1950 to 1995 and for which data quality is such a serious concern that the ILO no longer reports estimates prior to 1980. Moreover, the existing literature has tested the feminization U hypothesis on the basis of international GDP data at PPP exchange rates, which suffer from significant uncertainty (as discussed in Section 3) and are a poor proxy for structural transformation.

Another possible caveat is that the effect of structural change on female labor force participation depends on the degree of openness of the economy, for example, due to skill-biased technological change. In a related paper, Cooray et al. (2012) explore the relationship between FDI and trade flows and women's economic activity. Their findings suggest that increased globalization has a negative effect on the labor force participation of young women, albeit with differences across regions and sectors, and similar to our analysis here, the effects are small in magnitude. In the same way, one may argue that occupational change, rather than sectoral change, matters for women's economic activity. Though we would still expect to see a stronger correlation between trends in female labor force participation and sectoral changes in value added and employment, we think that this will be a useful area for further research.

All things considered, the empirical evidence suggests that structural change alone is only weakly linked to trends in female labor force participation. While we do see that agriculture, mining, manufacturing, and service sector expansions are associated

[25] We perform the following robustness checks. First, instead of 5-year intervals, we use 4- and 3-year periods, but then most of the estimated coefficients lose significance. We also reestimate the models in Eq. 9 to 11 on data from the sixth revision of the EAPEP but again obtain much weaker correlations. Our key explanation for this finding is that the sixth revision cover a shorter time span (mostly 1990 to 2010) and that the changes in value added and employment observed during the 2008 financial crisis (and which, due to interpolations, even affect labor force participation estimates before the onset of the crisis) are different from the long-run process of structural change. Yet another potential explanation is that the effect of structural change on female labor force participation is getting even weaker over time.

with different dynamics for women's economic activity, the effects are quantitatively small and cannot explain much of the observed over-time changes in female labor force participation.

6 Conclusion

We argue that there is no convincing empirical evidence of a systematic U-shaped relationship between GDP per capita and female labor force participation from the analyses considered in this study. While we find some evidence that structural change is correlated with female labor force participation in ways that are broadly consistent with the theoretical mechanisms underlying the feminization U hypothesis, sectoral changes in value added between 1980 and 2005 cannot explain much of the observed variation in women's economic activity. While it remains possible that today's advanced economies transitioned through the U over the course of their economic development, the U shape seems to have little relevance for most developing countries today. Instead, it appears that historically contingent initial conditions are more important drivers of female labor force participation than secular development trends, including those associated with structural change.

We would like to emphasize that our main critique vis-à-vis the feminization U hypothesis refers to the declining portion of the U, whose main rationale is structural change from agriculture towards industrial activities. We have not further addressed some of the other mechanisms that motivate much of the rising portion of the U—fertility decline and female education. In fact, there is some macro- and micro-support that fertility reductions are linked to increasing female labor force participation (Bloom et al. 2009; Angrist and Evans 1998), though there is conflicting evidence whether this also holds for developing countries (Cruces and Galiani 2007; Priebe 2010).

The analysis of the relationship between female labor force participation and economic development also highlights the need for greater harmonization and quality control in international employment statistics. As we have seen, the alterations of the EAPEP database lead to significant changes in participation rates at the level of individual countries and regions, which are large enough to affect even broad cross-country correlations. Further advances in our understanding on international labor market developments will crucially depend on the ability to collect high-quality employment statistics that are not frequently subject to large revisions. Similarly, it would be of great benefit if international labor market data allowed a degree of disaggregation, particularly by employment status. This would lead to a better understanding on the nature of jobs that men and women perform and to identify those in vulnerable employment. Many women in developing countries are self-employed (often in the informal sector) or contribute to family own-owned enterprises, and this is often associated with inadequate and volatile earnings. An analysis that takes into account job quality would most likely reveal greater inequality between men and women in the economic sphere than an analysis that focuses on labor force participation alone.

In terms of policy, our results suggest that there are no iron laws governing female labor force participation. Instead, initial conditions, norms and values, country-specific sectoral changes, domestic labor market policies, and trends, as well as policies to directly promote female employment opportunities (and associated female education) are likely to be more important drivers of female employment than some secular trends. As argued by the recent World Development Report of the World Bank (2011), the costs of failing to promote female employment opportunities are rising, suggesting that further policy action is warranted.

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