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A Reexamination of the Feminization U Hypothesis

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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 large literature claims that female labor force participation (FLFP) follows a U-shaped trend over the course of economic development. This feminization U hypothesis is motivated by secular patterns of structural change in combination with education and fertility dynamics. We show that empirical support for the hypothesis is rather feeble and hinges on the data used for the assessment. The PWT 7.0 revision of international GDP estimates paints a completely different picture of the relationship between aggregate GDP and FLFP than the previous PWT 6.3, with the U coming out much stronger under PWT 7.0 than under PWT 6.3. The feminization U also tends to vanish if we use dynamic instead of static panel data methods. Moreover, differences in *levels* of FLFP across the world related to historical contingencies are much more important determinants of women's employment opportunities than the muted U patterns found in some specifications. Given the large margins of error in international GDP estimates at purchasing power parities (PPP) and the sensitivity of the U-relationship we propose an alternative way to explore the effect of structural change on FLFP. We use data on sector-specific growth, which do not require PPP comparisons and allow for a direct test of the effect of structural change on women's economic activity. Our results suggest that agriculture, mining, manufacturing and services generate different dynamics for FLFP, but the effects are small in magnitude. We conclude that the feminization U hypothesis, especially its declining portion, has little relevance for most developing countries today.

KEY WORDS: Female Labor Force Participation, Economic Development, Structural Change, Purchasing Power Parties, Panel, GMM

JEL CLASSIFICATION: J16, J21, J22, O11, O15

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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 2002a, b; Blecker and Seguino 2002; Esteve-Volart 2004; Cavalcanti and Tavares 2007; Klasen 2002; Klasen and Lamanna 2009) another strand of the literature studies the impact of economic growth on the 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, York and Anker 2003; Lincove 2008; Luci 2009; Tam 2011). One of the key hypotheses in this context 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 services-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-shape 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, Canning, Fink and Finlay 2009; Aguero 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 the U-shape re-emerges under the newly released PWT 7.0. The nature of the relationship is also heavily affected by the versions of the 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 the large margins of error in international GDP estimates at purchasing power parity (PPP) exchange rates and the sensitivity of the U-relationship we suggest moving away from testing the feminization U hypothesis on the basis of PPP-adjusted GDP per capita data.

Second, we argue that the effect of economic development on women's labor force participation is more complex than it is supposed 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 socio-economic transformation, forces that are not well captured by the level of GDP, not even under a non-linear relationship, and that depend on the country-specific nature of the growth process. Hence even if we abstract from the sensitivity of the U-relationship to international price and income comparisons, testing the feminization U hypothesis at the level of aggregate GDP does not get to the heart of the matter being explored. Substantively, we hypothesize that initial conditions and historical contingencies as well as particular patterns of structural change are more important drivers of female labor force participation than the secular trends suggested by the femininization U.

Therefore we carefully examine level differences in female labor force participation rates (i.e. the fixed effects in our econometric specification) and link them to the literature on historical and structural determinants of female labor force participation rates. Moreover, we propose an alternative way to explore one of the key mechanisms supposedly underlying the feminization U hypothesis - the effect of structural change on female economic activity. Our main innovation is to directly assess the effect of disaggregated sectoral growth on female labor force participation, rather than to estimate a non-linear relationship between aggregate GDP and women's activity. By exploiting information on sector-specific growth we can allow for various non-linearities 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 from international price comparisons and PPP revisions. 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 it is more useful to study the impact of these sectoral changes directly.

Our results suggest first that there are substantial level differences in female labor force participation rates that relate to historical contingencies, policies, and factor endowments and dwarf any secular trend implied by the U hypothesis. We also find that agriculture, mining, manufacturing and services generate 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 conclude that empirical evidence for the feminization U hypothesis is weak, particularly for its declining portion motivated by secular patterns of structural change, and especially in terms of its ability to explain and predict changes in female labor force participation in the developing world today. We therefore suggest that the hypothesis should no longer be treated as a 'stylized fact' of economic development.

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 United States) 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-section 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, Ravallion, and Squire (1996) 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 re-examines the feminization U hypothesis at the aggregate level using static and dynamic panel data methods. Section 5 explores the relationship between the 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 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 auto-consumption counts as labor force participation, while producing a non-marketed *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

[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).

participation in the economy as measured by the SNA. While this view might clearly be seen as limiting the scope to only particular aspects of female 'work', currently it would be impossible to analyze broader definitions of women's 'work' due to conceptual and data availability issues (OECD 1995; Gutiérrez 2003)

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.[2] Due to low levels of female education and the incompatibility of wage work with child care as well as socio-cultural restrictions on female employment outside of the home, women are not able to benefit from the emerging opportunities in the manufacturing industry and other formal sectors; this is especially the case for married women with children so that female employment often terminates after marriage or the birth of a child. This may be re-enforced 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.).[3] 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

[2] 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 18th 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).

[3] 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.

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.

Apart from the literature on the feminization U hypothesis, there is a related literature that tries to explain the substantial differences in female labor force participation between countries. At one level 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. 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 plough agriculture have lower levels of female participation in the economic and political spheres even today. The main argument is that plough cultivation required manual strength, which favored men over women and thus led to persistent gender-biases, which linger on to the present (Alesina, Giuliano and Nunn 2011a, b). Other scholars have emphasized the role of religion, often citing Max Weber's (1905) influential work on the link between Protestantism and capitalism. Feldman (2007) argues that female labor force participation is significantly higher in countries shaped by Protestantism compared to those dominated by other religious convictions. Guiso, Sapienza and Zingales (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 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 US, Britain, France, etc. (Goldin 1991; Fernández, Fogli and Olivetti 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; even 20 years after transition began, this is likely to have a lasting impact on women's employment opportunities (Kornai 1992; Klasen 1993).

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, Wetzels, Vlasblom and Dex 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 rates in the high growth East and South-East 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, York and Anker 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 United States. 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.[4] 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 using country trends (or panel fixed effects models) shows the pitfalls of this assumption (see Bruno, Ravallion, and Squire 1996; Deininger and Squire 1998).

Mammen and Paxson (2000) use data for 90 countries from 1970 to 1985 (in five-year intervals) to trace out the relationship between economic development and female labor force participation. First, they re-assess the cross-sectional relationship by means of a non-parametric 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 OLS model, though it still appears to confirm the feminization U

[4] 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.

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 data base for the panel analysis (the 3rd version of the United Nations' WISTAT database, with labor force estimates until 1985) is by now clearly outdated.

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 4th revision of the International Labour Organizations' (ILO) EAPEP database (ILO 1996), but do not take into account the more recent and more reliable 5th revision of data (ILO 2009a). 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) addressing the endogeneity of GDP. 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 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 Center (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 Estimates and Projections of the Economically Active Population (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 6th revision (ILO 2011a) and the previous 5th revision (ILO 2009a). Both the 5th and 6th revisions include 191 countries, but while the 5th revision extends over the period 1980-2008 the 6th 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 4th EAPEP revision, which covers the period 1950 to 1990 (in ten-year intervals) and comprises 178 countries (ILO 1996).[5] 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 4th 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 A1 compares female labor force participation estimates of women aged 25 to 59 years for the 4th and 5th revision (which overlap in 1980 and 1990) and for the 5th and 6th revision (which overlap 1990 to 2008). The upper panel shows that unweighted averages across all countries are remarkably similar between the 4th and 5th revisions. However, there are substantial differences at the level of regions, especially for developing countries. The 5th 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 4th revision. Differences are somewhat smaller for changes in female labor force participation between 1980 and 1990, but still significant. For example, the 5th 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 4th revision. At the level of individual countries the discrepancies are even more striking.[6]

The bottom panel compares the 5th and the 6th EAPEP revision, which are the key data sources used in the present study. Moving from the 5th to the 6th 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 5th and 6th revisions are very similar at the regional level, there are again significant differences for individual 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 A1 shows broad regional trends of female labor force participation between 1980 and 2010 (based on the 5th and 6th revision of the EAPEP data). The graphs confirm the widely recognized trend of increasing economic activity amongst women over the past decades (see

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[5] Both EAPAP datasets also contain labor force projections. For the 4th revision these extend from 1995 to 2010; and for the 5th revision from 2009 to 2020. However, the analyses in this paper are based on the labor force estimates only, disregarding the projections.

[6] In the case of Nepal, the 4th revision reports a minor decline in female labor force participation between 1980 and 1990 (from 59 to 58 percent), while the 5th revision shows an increase by around ten percentage points, albeit from a much lower level (from 45 to 55 percent).

Killingsworth and Heckman 1987; 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 1993).[7] 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 about the notion of a U-shaped relationship between the labor force participation of women and economic development.

As it is common in the literature 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 Penn World Tables (PWT) (Heston, Summers and Aten 2009, 2011). The most recent available PWT 7.0 version (released June 3, 2011) incorporates the PPP conversions of the 2005 round of the International Comparison Program (ICP), while the previous 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 developing countries, which in turn led to a strong downward revision in their real GDP –of some 40 percent for a country like China (World Bank 2008a, b; Ravallion 2010a, b). While the 2005 ICP round has clearly improved the coverage and quality of international price data, there has been the concern that much of the upward revision of price levels in developing countries could be related to methodological changes.[8]

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, Datt and Ravallion 1994; Ackland, Dowrick and Freyens 2004; Ravallion, Chen and Sangraula 2009; Deaton 2010) and cross-country correlations (see Johnson et al. 2009; Ciccone and Jarocinski 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 the two most recent versions of PWT data (PWT 6.3 and PWT 7.0).

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[7] That recovery is more pronounced under the 5th than under the 6th revision of the EAPEP. It seems likely that labor force estimates for the 2000s under the 6th revision are influenced by the financial crisis (through interpolations by the ILO, the 2008 recession could be reflected in earlier participation rates).

[8] 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, and there has been significant controversy regarding the reliability of the new estimates (Maddison and Wu 2008; Deaton 2010; Deaton and Heston 2010; Ravallion 2010a, b).

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 4th, 5th and 6th revisions of the EAPEP database. Estimates from the 6th 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).[9] This is why we run all our regressions also on a reduced sample of the 6th revision data, which excludes 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). As discussed above, our explanatory variable is GDP per capita at PPP exchange rates (chain index) from the PWT 6.3 and 7.0 (Heston, Summers and Aten 2009, 2011). 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.[10]

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 $\hat{\beta} < 0$ and $\hat{\gamma} > 0$.

Early attempts to investigate the feminization U hypothesis relied largely on ordinary least square (OLS) estimations on the pooled sample (e.g. Cağatay and Özler 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

[9] 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 2011). 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).

[10] When estimating regression using the 6th revision of the EAPEP data (which run to 2010) and PWT 7.0 (which run to 2009) we use a 4-year interval at the end of the period.

estimator can be seriously biased in the presence 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.

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

$$FLFPR_{it} = \alpha_i + \varphi \, FLFPR_{it-1} + \beta \, ln \, y_{it} + \gamma \, ln \, y_{it}^2 + \delta_t + \mu_{it} \qquad [3]$$

In equation (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 equation (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 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 2006). However, while 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 5th order lags the respective column (in table 3) is left blank.

Table 1: 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 7.0

PWT revision			Penn World Tables 7.0											
EAPEP revision			4th rev. (1950-1990)			5th rev. (1980-2005)			6th rev. (1980/90^{+}-2009^{+++})			6th rev. - red. sample (1980/90^{+}-2009^{+++})		
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	-1.05***	-0.96***	-1.03***	-0.53***	-0.62***	-0.56***	-0.52***	-0.61***	-0.55***	-0.61***	-0.75***	-0.64***
		LOGGDP2	0.06***	0.05***	0.06***	0.03***	0.03***	0.03***	0.03***	0.03***	0.03***	0.04***	0.04***	0.04***
		TURNPOINT	*6,058*	*8,627*	*6,715*	*4,887*	*8,603*	*5,942*	*4,619*	*8,055*	*5,624*	*4,014*	*6,381*	*4,785*
	FE	LOGGDP	-0.77***	-0.54***	-0.68***	-0.21**	-0.23**	-0.21**	-0.26***	-0.32***	-0.27***	-0.56***	-0.65***	-0.55***
		LOGGDP2	0.05***	0.03***	0.04***	0.01**	0.02***	0.01**	0.02***	0.02***	0.02***	0.03***	0.04***	0.03***
		TURNPOINT	*1,801*	*2,505*	*1,931*	*1,395*	*1,465*	*1,421*	*4,582*	*3,771*	*4,502*	*6,572*	*7,009*	*6,532*
	N_COUNTRY		155	155	155	177	177	177	177	177	177	149	149	149
	N_OBS		597	597	597	984	984	984	951	957	950	592	596	585
OECD countries														
	OLS	LOGGDP	-1.19*	-0.99	-1.14*	-0.76	-1.37	-0.97	-0.37	-0.61	-0.42	-0.37	-0.63	-0.43
		LOGGDP2	0.07**	0.06*	0.07*	0.04	0.07	0.05	0.02	0.03	0.02	0.02	0.04	0.03
		TURNPOINT	*3,428*	*4,269*	*3,723*	*10,728*	*11,978*	*11,071*	*5,613*	*5,707*	*4,994*	*4,856*	*6,018*	*4,720*
	FE	LOGGDP	-0.44	-0.01	-0.30	-1.40***	-1.51***	-1.47***	-1.66***	-1.45***	-1.54***	-1.59***	-1.44***	-1.49***
		LOGGDP2	0.02	-0.00	0.01	0.08***	0.08***	0.08***	0.09***	0.08***	0.08***	0.09***	0.08***	0.08***
		TURNPOINT	*48,299*	*(a)*	*(b)*	*5,620*	*9,135*	*6,646*	*8,577*	*12,437*	*9,548*	*8,534*	*12,834*	*9,614*
	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	-0.82***	-0.67***	-0.79***	-0.37***	-0.36***	-0.39***	-0.41***	-0.39***	-0.42***	-0.54***	-0.51***	-0.53***
		LOGGDP2	0.04***	0.03***	0.04***	0.02***	0.02**	0.02***	0.02***	0.02***	0.02***	0.03***	0.03**	0.03***
		TURNPOINT	*9,341*	*25,803*	*11,334*	*10,192*	*58,129*	*14,245*	*7,164*	*30,538*	*9,871*	*5,018*	*13,430*	*6,439*
	FE	LOGGDP	-0.44***	-0.19*	-0.37***	-0.12	-0.12	-0.10	-0.23***	-0.24***	-0.21***	-0.57***	-0.54***	-0.47***
		LOGGDP2	0.03***	0.01**	0.03***	0.01	0.01	0.01	0.01***	0.01***	0.01***	0.03***	0.03***	0.03***
		TURNPOINT	*1,265*	*2,418*	*1,382*	*1,455*	*1,327*	*1,408*	*5,549*	*3,893*	*5,509*	*7,124*	*5,749*	*6,456*
	N_COUNTRY		124	124	124	146	146	146	146	146	146	118	118	118
	N_OBS		466	466	466	806	806	806	762	768	761	408	412	401

Notes: *** p<0.01, ** p<0.05, * p<0.1. 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 7.0). Intercept (OLS, FE) and time dummies (FE only) not reported. $^{+}$6th revision data cover the period 1990-2010 (balanced panel), but some countries have data on the 1980s. $^{++}$ PWT 6.3 runs until 2008. $^{+++}$ PWT 7.0 runs until 2009 - we use a 4-year interval at the end of the period.

We start with the results for the static models (OLS and fixed effects) based on the four datasets of female labor force participation (EAPEP 4th revision, 5th revision, and 6th revision – full and reduced sample) and the two sets of GDP data (PWT 6.3 and PWT 7.0) as shown in table 1. We also estimate separate regression 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 and log GDP squared, as well as the implied turning point. The table also shows for each sample the number of countries, and the total number of observations.

We commence our discussion with the regressions on the left side of table 1, which are based on PWT 6.3. For the sample of all countries (OECD and non-OECD) we see that the U-relationship comes out clearly from the 4th revision of the EAPEP, but not from the 5th revision data, where the U vanishes if we move from OLS to fixed effects regressions. The U re-emerges under the 6th 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 younger cohort as well as for the combined cohort and the younger cohort under the fixed effects estimation. There is also a strong variability in turning points – which are in the range of 1,800 USD PPP for the 5th regression (fixed effects estimations), but much higher for the 6th revision (between 4,700 and 9,200 USD PPP).

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 6th revision of the EAPEP, it is interesting to note that under the 5th and 6th 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, 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 1993). This is, of course, a one-time historical event, quite unrelated to the secular patterns that are alleged to drive the U.

It is important to note that (under PWT 6.3) 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 (6th 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 5th or 6th revision) does not provide any 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 7.0. Now the fixed effects regressions for non-OECD countries reveal a clear U-shape relationship if we use the 4th or 6th 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 5th revision of the EAPEP. Since under PWT 7.0 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 7.0 GDP data we see evidence in support of the feminization U hypothesis in the context of developing countries – but only if we use the 4th or 6th (rather than the 5th) revision of the EAPEP data.

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 its level of GDP or over-time changes. Figure 1 shows the estimated fixed effects using the regression based on PWT 7.0 and the 5th 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.[11] Table 2 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 Boserup's (1970) claim of the relative importance of female labor in agriculture in countries not traditionally using ploughs, creating path dependencies as discussed in Alesina, Giuliano and Nunn (2011a, b). 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 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 rates (Kornai 1992). Conversely, female labor force participation is below average in South Asia (with the exception of Bangladesh and Nepal), again consistent with Boserup's (1970) claim of lower female labor force participation in the South Asian plough 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 region, 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 6th revision of the EAPEP (from 74 percent in 2008 under the 5th revision, to only 36 percent). 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; Feldman 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).

[11] 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 fixed effects using other combinations of data sources are available on request.

Figure 1: Country-Specific Fixed Effects by Country Group, 1980-2005

Notes: Fixed effects regression based on EAPEP 5th revision and PWT 7.0 (1980-2005) – women 25 to 59 years (see table 1). World Bank country classifications as of November 2011.

Table 2: Summary of Country-Specific Fixed Effects by Country Group, 1980-2005

Country group	Mean FE	Countries with FE<0	Countries with FE>0	Bottom three (FE<0)	Top three (FE>0)
High income: OECD	0.01	13	18	Luxembourg, Spain, Ireland	Iceland, Sweden, Estonia
High income: non-OECD	-0.17	15	3	Saudi Arabia, Malta, Oman	Croatia, Bahamas, Bahamas
East Asia & Pacific	0.10	6	10	Solomon Islands, Fiji, Malaysia	Vietnam, Cambodia, Laos
Europe & Central Asia	0.12	3	18	Turkey, Macedonia, Tajikistan	Lithuania, Belarus, Kazakhstan
Latin America & Caribbean	-0.07	19	7	Colombia, Costa Rica, Mexico	Uruguay, Bolivia, Jamaica
Middle East & North Africa	-0.31	11	1	Iraq, Libya, Lebanon	Djibouti
South Asia	-0.12	6	2	Pakistan, Afghanistan, Maldives	Nepal, Bangladesh
Sub-Saharan Africa	0.13	10	35	Niger, Sudan, Mauritius	Tanzania, Rwanda, Burundi

Notes: Fixed effects regression based on EAPEP 5th revision and PWT 7.0 (1980-2005) – women 25 to 59 years (see table 1). World Bank country classifications as of November 2011.

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 1 would affect female labor force participation rates, compared to the absolute value of the fixed effects in a regression. Using the age group 25-44, the 6th revision and PWT 7.0, where the U is sizable and significant, moving from the turning point, situated at a per capita income level of about 4,500 USD PPP (the level of Armenia) to 34,200 USD PPP (the level of the United Kingdom) 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.

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 3 shows the coefficients for log GPD and log GPD squared alongside with the coefficient of the lagged dependent variable. We also report estimated turning points, sample sizes and important regression diagnostics.[12] 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 significant in three out of 15 specifications. 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 somewhat 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.

[12] When estimating the dynamic model with data from the 4th revision we always encountered 2nd order autocorrelation, which renders the moment conditions of the GMM estimator invalid. This is why this section presents the dynamic estimates only for the 5th and 6th revision data.

Table 3: Economic Development and Female Labor Force Participation – Dynamic Estimates

PWT revision	**Penn World Tables 6.3**									**Penn World Tables 7.0**								
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^{+}-2009^{+++})			6th rev. - red. sample (1980/90^{+}-2009^{+++})		
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	-0.18	-0.01	-0.02	no valid specification	-0.12	0.04	-0.50**	-0.12
LOGGDP2	0.00	0.02**	0.00	0.01		0.00	-0.00		0.01		0.01	0.01	-0.00		0.01	-0.00	0.03**	0.01
TURNPOINT	*(a)*	*1,544*	*(a)*	*98,071*		*4,469*	*(a)*		*16,470*		*596*	*3*	*(a)*		*60,398*	*(a)*	*8,917*	*39,566*
FLFPR (first lag)	0.81***	0.70***	0.70***	0.70***		0.72***	0.78***		0.62***		0.65***	0.72***	0.74***		0.62***	0.81***	0.44***	0.67***
Arellano-Bond test for AR(2) - p-value	0.91	0.63	0.56	0.57		0.50	0.56		0.49		0.51	0.55	0.46		0.48	0.63	0.40	0.72
Hansen-test for overid. restr. - p-value	0.12	0.17	0.16	0.61		0.47	0.26		0.32		0.29	0.52	0.92		0.88	0.35	0.10	0.30
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;2	4;4
N_COUNTRY	175	175	175	175		175	102		101		176	176	177		177	108	107	107
N_OBS	664	664	664	437		436	253		248		660	660	614		613	325	330	319
OECD countries																		
LOGGDP	-0.78	no valid specification	-0.11	0.07	no valid specification	0.29	0.05	no valid specification	0.11	-0.84	0.22	-0.02	0.18	no valid specification	0.30	0.16	no valid specification	0.28
LOGGDP2	0.04		0.01	-0.00		-0.01	-0.00		-0.00	0.05	-0.01	0.00	-0.01		-0.02	-0.01		-0.01
TURNPOINT	*8,304*		*1,246*	*(a)*		*(a)*	*(a)*		*(a)*	*8,168*	*(a)*	*54*	*(a)*		*(a)*	*(a)*		*(a)*
FLFPR (first lag)	0.64***		0.72***	0.68***		0.89***	0.75***		0.79***		0.93***	0.73***	0.63***		0.67***	0.68***		0.77***
Arellano-Bond test for AR(2) - p-value	0.61		0.50	0.37		0.25	0.37		0.24	0.58	0.75	0.54	0.54		0.12	0.31		0.13
Hansen-test for overid. restr. - p-value	0.36		0.67	0.74		0.42	0.74		0.68	0.42	0.45	0.70	0.83		0.98	0.90		0.35
Lag structure (FLFPR; GDP VAR)	4;3		4;4	4;2		3;4	4;2		3;2	4;3	4;3	4;4	4;2		3;2	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	-0.18	-0.10	-0.06	-0.23***	-0.12	-0.29	-0.39	-0.36
LOGGDP2	0.02**	0.02*	0.02**	0.01		0.01	0.01		0.01		0.01*	0.01*	0.00	0.01***	0.01	0.01	0.02	0.02
TURNPOINT	*1,019*	*826*	*1,181*	*20,098*		*11,631*	*(b)*		*31,073*		*455*	*225*	*(b)*	*8,397*	*77,984*	*18,491*	*8,305*	*23,356*
FLFPR (first lag)	0.70***	0.59***	0.67***	0.74***		0.63***	0.77***		0.58***		0.74***	0.72***	0.75***	0.50***	0.61***	0.75***	0.41***	0.61***
Arellano-Bond test for AR(2) - p-value	0.97	0.45	0.95	0.69		0.65	0.74		0.66		0.70	0.87	0.50	0.52	0.70	0.79	0.32	0.80
Hansen-test for overid. restr. - p-value	0.20	0.16	0.15	0.78		0.57	0.66		0.37		0.23	0.13	0.96	0.11	0.91	0.18	0.25	0.39
Lag structure (FLFPR; LOGGDP)	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;4
N_COUNTRY	144	144	144	144		144	71		70		145	145	146	146	146	77	76	76
N_OBS	544	544	544	341		340	162		157		540	540	487	493	486	203	208	197

Notes: *** p<0.01, ** p<0.05, * p<0.1. 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 7.0). Time dummies (FE only) not reported. Difference GMM estimation. Lag structure denotes the lags used to instrument (lagged) female labor force participation and the two LOGGDP variables. $^{+}$6th revision data cover the period 1990-2010 (balanced panel), but some countries have data on the 1980s. $^{++}$ PWT 6.3 runs until 2008. $^{+++}$ PWT 7.0 runs until 2009 - we use a 4-year interval at the end of the period.

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 7.0, 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 is not robust, 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 non-linear relationship between aggregate GDP and women's activity. By exploiting information on sector-specific growth we can allow for various non-linearities 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 from 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 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.

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; Christiaensen, Demery and Kuhl 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.[13]

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 ($P_f = P_m = ½ P$) so that we obtain:

$$e_f = \frac{E_f}{P_f} = 2\,\frac{E_f}{P} = 2\,\frac{E_f}{E}\frac{E}{P} = 2\,r_f e \qquad [4]$$

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) multiplied by the proportionate change in per capita GDP (y):

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

Applying a logarithmic approximation we obtain for small changes:

$$dln\, e_f = \varepsilon_{efy}\, dln\, y \qquad [6]$$

Substituting [4] into the equation for the GDP elasticity of female employment (first term of equation [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):

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

Substituting [7] into [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,…,J) finally delivers:

$$dln\, e_f = \sum_{j=1}^{J}(\varepsilon_{rfy\,j} + \varepsilon_{ey\,j})s_j dln\, y_j \qquad [8]$$

According to [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 ($dln\, y_j$), the GDP elasticity of total employment of sector j ($\varepsilon_{ey\,j}\, s_j$) and the GDP elasticity of the female employment intensity in that sector ($\varepsilon_{rfy\,j}\, s_j$). For simplicity, we will denote $\varepsilon_{rfy\,j}$ and $\varepsilon_{ey\,j}$ as size-adjusted GDP elasticities, which show the responsiveness of the 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).

[13] 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.

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_{eyj} 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. 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 equation [7] shows clearly that the initial share of female employment in a sector is not important for the percentage change in the female employment rate.[14] What matters is whether the female employment intensity changes with increases in sectoral value added – that is whether the sector feminizes, or de-feminizes – irrespectively of the sector's initial level of feminization.

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.

- 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: 114) we expect a positive ε_{rfy}. This 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.

- 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.

[14] This is because we look at relative (percent) changes, rather than absolute (percentage point) changes.

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).

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

Share-weighted implies that 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 (π^F_0) and allows for time-specific fixed effects (δ_t^F) to capture common changes in female labor force participation across periods. We do not allow for country-specific fixed effects because equation [9] is already expressed in first differences. The π^F_j's are the sectoral effects to be estimated; equation [6] shows that they can be interpreted as the sum of the size-adjusted GDP elasticities of total employment and the female employment intensity.

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

$$\Delta lnTLFPR_{it} = \pi_0^T + \sum_{j=1}^{7} \pi_j^T \cdot s_{ijt-1} \cdot \Delta lny_{ijt} + \delta_t^T + \varepsilon_i \quad [10]$$

This allows us to distinguish the two elasticities identified above – in particular the sectoral parameters π^T_j can now be interpreted as the size-adjusted GDP elasticity of employment in sector j. The size-adjusted GDP elasticity of the female employment intensity is then $\pi^F_j - \pi^T_j$.

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 re-allocation 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.[15] 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):

$$\Delta lnFLFPR_{it} = \pi_0^{F*} + \sum_{j=1}^{7} \pi_j^{F*} \cdot s_{ijt-1}^{*} \cdot \Delta lne_{ijt} + \delta_t^{F*} + \varepsilon_i \quad [11]$$

The s^*_{ijt-1} are then the sector's share in total employment in the initial period. π^{F*}_j 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 sector feminizes or de-

[15] 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 EAPAP database.

feminizes as employment expands. In principle it would be enough to compare the estimated coefficients against unity to gauge feminization or de-feminization. However, since our dependent and explanatory variables come from different data source any measurement error will bias the estimated coefficients towards zero. However, we can still obtain useful information from comparing the $\pi^{F*}{}_j$ across sectors.

An important caveat of our approach is that we 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 spill-overs 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.

To estimate equations [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 A2.[16] Second, we use the 10-Sector Database of the Groningen Growth and Development Center (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 gives us a sample of 39 countries in total.[17] As documented in Timmer and de Vries (2007) the GGDC employment time series are of much higher quality than those provided by the World Bank's (2008c) World Development Indicators (WDI), 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 5th 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 6th 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 4 reports the results for the *value added* regressions (equations [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 weekly 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 sector. Table 5 reports results for equation [11]. We see that *employment* growth in agriculture is highly correlated to increases in female labor force participation in the sub-sample of countries for which we have data on sectoral employment trends.[18] The effect is much larger for the older women, who

[16] The classification is based on the ISIC 3.1 industry classification system, but some of the one-digit sectors are combined in the dataset.

[17] 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.

[18] It is somewhat surprising that all coefficients in table 4 are below unity. This would suggest that female labor force participation increases less than proportionately with employment growth in any sector (an

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.

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 socio-economic 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 sub-sectors, 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 5), which reflects that among the 37 countries for which we have data on sectoral employment there are only few major resource-exploiting economies (see table A3).

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 sector. 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 equations [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 39 countries for which we have sector-specific employment data (table 5).

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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 4: Sectoral Value Added Growth and Labor Force Participation (ILO EAPEP 5th revision)

	Cohort 25-44 years				Cohort 45-59 years				Cohort 25-59 years			
	Coefficients		*Elasticities*		Coefficients		Elasticities		Coefficients		Elasticities	
	Total LFP	Female	ε_{ey}	ε_{rfy}	Total LFP	Female	ε_{ey}	ε_{rfy}	Total LFP	Female	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		
R2	0.067	0.087			0.053	0.060			0.070	0.083		

Notes: *** p<0.01, ** p<0.05, * p<0.1. Dependent variable is the change in total / female labor force participation (5-year intervals, 1980 - 2005). ε_{ey} is the sectoral GDP elasticity of total employment. ε_{rfy} is the sectoral GDP elasticity of the female employment intensity. Time dummies and intercept included but not reported. Cluster-robust standard errors.

Table 5: Sectoral Employment Growth and Female Labor Force Participation (ILO EAPEP 5th 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
R2	0.147	0.127	0.154

Notes: *** 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.

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 sub-sectors (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 service industry. The regressions in table 5 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_{ey} and ε_{rfy}, the sectors' initial share in total value added (s_j) and actual changes in value added per capita ($\Delta \ln y_j$) 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 [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 1980 to 2005 (which excludes the former transition countries in Europe and Central Asia).

Table 6 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 1980 to 2005 across the countries included in the simulation exercise, of which just under 10 percent (that is one percentage point) can be explained by structural change.[19] Across all regions, 107 countries have a predicted increase in female activity based on their sectoral growth patterns, while 37 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, Republic of Congo), where the simulated

[19] It should be noted that the model in [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.

Table 6: Simulated Changes in Female Labor Force Participation, 1980-2005 (ILO EAPEP 5th revision)

All countries with data for 1980-2005				
		Simulated Δ in FLFP	Number of countries with simulated	
Country group:	Actual Δ in FLFP 1980-2005	based on structural change	ΔFLFP<0 due to sectoral change	ΔFLFP>0P due to sectoral change
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				
		Simulated Δ in FLFP	Number of countries with simulated	
Country group:	Actual Δ in FLFP 1980-2005	based on structural change	ΔFLFP<0 due to sectoral change	ΔFLFP>0P due to sectoral change
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

Notes: Based on the model in table 4 (women aged 25-59 years).

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 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 sub-group 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 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 African countries during the 1980s), which were not evened out by sub-sequent growth in other sectors.[20]

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 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 4th revision of the EAPEP, which covered the period 1950 to 1996 and for which data quality is a very serious concern. Moreover, as discussed in section 3, 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 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, Gaddis and Wacker (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 this will be a useful area for further research.

[20] We perform the following robustness checks. First, instead of 5-year intervals we use 4-year and 3-year periods, but then most of the estimated coefficients lose significance. We also re-estimate the models in [9] to [11] on data from the 6th revision of the EAPEP but again obtain much weaker correlations. Our key explanation for this finding is that the 6th 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.

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 agricultural, mining, manufacturing and services generate 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 evidence of a systematic U-shaped relationship between GDP per capita and female labor force participation from the analyses considered in this study. Moreover, while structural change is clearly correlated with female labor force participation, and some of the effects are broadly in line with the theoretical mechanisms underlying the feminization U hypothesis, sectoral trends 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 developing countries today, apart from perhaps a small group of natural resource dependent economies. The claim that countries initially experience declining and later rising female labor force participation over the course of economic development should not be considered a 'stylized fact'. 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, Canning, Fink and Finlay 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 of international labor market developments will crucially depend on the ability to collect high quality employment statistics that are not frequently subject to large revisions.

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 Bank (2011) World Development Report, the costs of failing to promote female employment opportunities are rising, suggesting that further policy action is warranted.

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Appendix

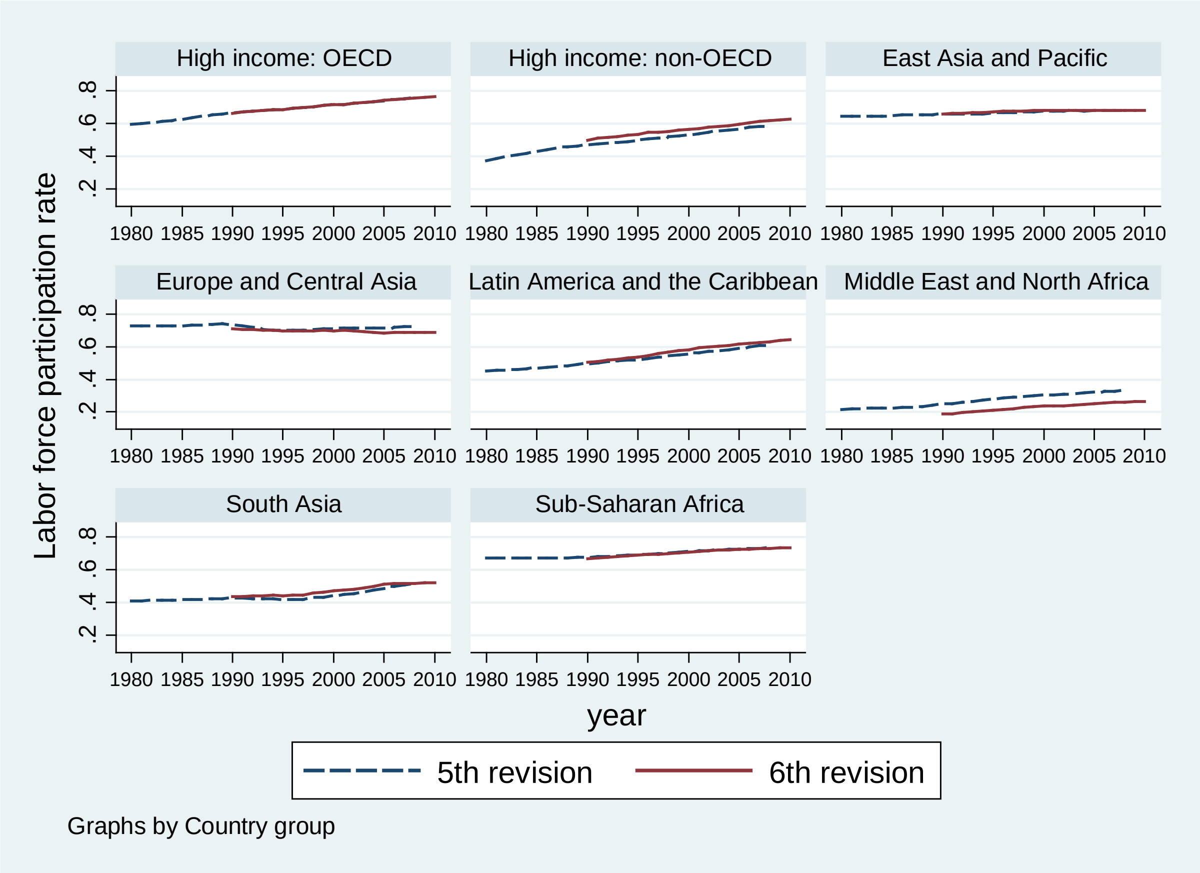
Table A1: Female Labor Force Participation Rates (FLFPR): Comparisons of the 4th, 5th and 6th Revisions of the ILO's EAPEP Database

Comparison of the 4th and 5th revision:	Average FLFPR in 1980			Average FLFPR in 1990			Average change in FLFPR 1980-90		
	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 revision:	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

Notes: Labor force participation rates of women aged 25-59 years from EAPEP 4th revision (ILO 1996), 5th revision (ILO 2009a) and 6th revision (ILO 2011a). Unweighted country averages. Only countries available in both revisions. World Bank country classification as of November 2011.

Figure A1: Regional Trends in Female Labor Force Participation 1980-2010



Notes: Labor force participation rates of women aged 25-59 years from ILO EAPEP 5th revision (ILO 2009a) and 6th revision (ILO 2011a). Unweighted country averages; not affected by compositional changes (based on a balanced panel). World Bank country classifications as of November 2011.

Table A2: Overview Sector Classifications

Category	ISIC Rev. 3.1 Categories	UNSTATS National Accounts Main Database	GGDC 10-Sector Database
Agriculture	A - Agriculture, hunting and forestry	Agriculture, hunting, forestry, fishing (ISIC rev. 3.1: A-B)	Agriculture (ISIC rev. 2: 1)
	B - Fishing		
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	Wholesale, retail trade, restaurants and hotels (ISIC rev. 3.1: G-H)	Wholesale, and retail trade (incl. hotels and restaurants) (ISIC rev. 2: 6)
	H - Hotels and restaurants		
	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	Other Activities (ISIC rev. 3.1: J-P)	Finance, insurance, and real estate (ISIC rev. 2: 8)
	K - Real estate, renting and business activities		
	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		

Notes: Extraterritorial organizations and bodies (ISIC category Q) is disregarded in the above table. ISIC stands for International Standard Industrial Classification of All Economic Activities. Based on UNSTATS (2011) and Timmer and deVries (2007).

Table A3: Countries with Data on Employment by Sector

Argentina; Bolivia; Brazil; Chile; China; Colombia; Costa Rica; Denmark; Ethiopia; France; Ghana; Hong Kong, China; India; Indonesia; Italy; Japan; Kenya; Korea, Rep.; Malawi; Malaysia; Mauritius; Mexico; Netherlands; Nigeria; Peru; Philippines; Senegal; Singapore; South Africa; Spain; Sweden; Thailand; Turkey; United Kingdom; United States; Venezuela, RB; Zambia

Notes: Based on GGDC (2011) and McMillan and Rodrik (2011).