Working Paper No. 2012/66

Women's Labour Supply and Household Insurance in Africa

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July 2012

Abstract

This paper investigates whether cyclical variation in women's labour supply in Africa contributes to smoothing household consumption. We find little support for this hypothesis. Using comparable individual data on about 0.5 million women in 30 Sub-Saharan African countries merged with country level panel data on GDP during 1987-2006, we find that the within-country relationship of women's employment and income is, on average, positive. This finding is robust to controls for country-specific trends and potentially correlated shocks. Examination of business cycle variation in the distribution of women's employment across sectors suggests that recessions are associated with increases in unemployment and self-employment relative to paid employment. The results have potentially important implications for understanding coping mechanisms, labour markets, fertility timing, and investments in children.

Keywords: insurance, women's labour supply, added worker effect, business cycles, Africa

JEL classification: J22, J13

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Acknowledgements

This paper has benefited from presentation at the CSAE Oxford conference (March 2009), the IZA/World Bank Employment and Development conference (Bonn, May 2009), the Gender and Development Department of the World Bank (Washington, DC, June 2009), the European Society of Population Economics conference (June 2009), the Regulating for Decent Work conference at the ILO (Geneva, July 2009) and CMPO (Bristol, July 2009). We are grateful to Alex Barr for excellent assistance with setting up the data and to David Newhouse, Frank Windmeijer, and Jon Temple for helpful comments.

Tables and Figures appear at the end of the paper.

1   Introduction

A vast literature discusses risk and informal insurance in poor countries in general and in Africa in particular (Dercon 2004). Incomes are low and uncertain, and most households have limited access to credit (Morduch 1995) or to formal insurance mechanisms such as unemployment benefits (van Ours and Vodopivec 2006). As a result, even if income shocks are transitory, they often have severe and irreversible consequences. They may throw families into poverty traps, for example, through the codependence of wage income and adult health (e.g. Dasgupta 1997; Eriksson et al. 2005; Ray 1998), raise the death toll amongst newborns (Baird et al. 2007; Bhalotra 2010), or leave the survivors amongst exposed children scarred with the prospect of greater later-life morbidity and lower educational attainment (van den Berg et al. 2006; Ferreira and Schady 2009).

Previous work shows how households attempt to cope with idiosyncratic shocks through asset decumulation or reliance upon informal insurance networks (Morduch 1995; Skoufias 2003). However many households have no assets to sell and risk pooling arrangements are challenged by aggregate shocks that impose covariant risks on members (e.g. Townsend 1995). Households may then need to fall back on the one asset they have, which is their labour. Understanding the dynamics of employment is therefore key to understanding the dynamics of poverty. We focus upon women's labour supply, investigating its response in economic downturns and upturns. Even if women desire to increase their work participation in downturns, they may be limited by a decline in labour demand. We therefore investigate transitions between unemployment and types of employment, illustrating the buffering role of self-employment.

Women's labour supply in richer countries is pro-cyclical, rising in upturns when the offered wage is more likely to exceed the opportunity cost of women's time; for example, see Joshi (1981) for the UK, Killingsworth and Heckman (1987) for the USA, and Darby et al. (2001) for other OECD countries. There are no stylized facts regarding the cyclicality of women's work in poorer countries. There is some evidence from historical data that women's employment rose during periods of economic crises and industrial restructuring in nineteenth century England (Anderson 1974; Scott and Tilly 1978) and New England (Hareven 1982, 1990; Lamphere 1987). Scott and Tilly (1978: 144) argue that 'the reallocation of women's labour between productive and reproductive work was part of a widespread economic adaptation of households that emerged to maintain household living standards under restructured economic conditions'. There is some compelling evidence that the economic crisis in 1997/8 in Indonesia threw women into employment, even as male employment rates fell, and that the added female workers were primarily in the informal sector (Thomas et al. 2003, also see Section 5 below). However, in terms of the proportional decline in average hourly wages, the Indonesian crisis was as severe as the Great Depression of the 1930s in the USA or the collapse of Soviet Union in the early 1990s (Fallon and Lucas 2002). It is unclear how well these findings would generalize to the case of smaller shocks or to the African setting, characterized by different labour market structure and household institutions.

We use a micro-dataset of unprecedented scope in this literature that contains comparable information on 0.4 million ever-married women (and a further 0.05 million

never-married women), from Sub-Saharan Africa, of age 20-49 interviewed in 75 survey rounds conducted in 30 countries across 20 years, 1987-2006. The micro-data are merged by country and year of interview with cross-country panel data on income (GDP) and other relevant macroeconomic variables. The macro-panel is exploited to create country-year specific indicators of the state of the business cycle. In line with a wider literature (e.g. Ruhm 2000), we use the words 'recession' and 'cycle' to refer to deviations of GDP from a country-specific trend. The micro-data are exploited to investigate heterogeneity in the response parameters predicted by theory, for example, with respect to wealth and the stage of the lifecycle (Gruber and Cullen 1996; Attanasio et al. 2005). We report a range of specifications designed to balance the trade-off between robustness and efficiency that has been emphasized in the recent literature on growth econometrics (Durlauf et al. 2005) and to explore robustness of the estimates to controls for trended unobservables and country-year varying shocks.

In the continent as a whole, we find no evidence that women are able to insure household earnings. Economic fluctuations are mirrored in significant fluctuations in women's work. Although there is variation across countries in Africa, the average tendency is for African women to fall out of paid employment in recessions, to the more vulnerable position of being self-employed or unemployed. This contrasts with Asia and Latin America (Bhalotra and Umaña-Aponte 2010). Amongst possible explanations of this difference are the following. African families being are likely to pool incomes (Udry 1996), opportunities for paid employment are more limited, and aggregate income variation is more closely tied to rainfall variation with the implication that income shocks strike the sector where women most naturally seek employment.

Previous cross-sectional research shows that women's labour supply tends to be U-shaped in economic development (Schultz 1988; Goldin 1995; Mammen and Paxson 2000). The upturn at higher levels of development is thought to be driven by gains in women's education and the emergence, through structural change, of jobs 'suitable' to women. The upturn at low levels of development arises because families often need the income from women's work, and their participation is facilitated by the prevalence of family farms and enterprises. This paper presents a dynamic and more disaggregate picture of life at the low end.

Studies of poverty dynamics have paid limited attention to the role of macroeconomic fluctuations (Baulch and Hoddinott 2000; Ravallion 2001). Similarly, studies of the effects of macroeconomic crises on poverty in poorer countries have paid limited attention to the mediating influence of labour market dynamics (Conceição et al. 2009; Fallon and Lucas 2002; Skoufias 2003). This is topical given the ongoing world recession, thought to be the worst since the Great Depression. Growth in developing countries was 1.2 per cent in 2009, compared with 5.6 per cent in 2008 (World Bank 2010).[1] In fact, developing countries have been routinely ravaged by crises stimulated by natural disasters, wars, debt, commodity price shocks, financial collapse, and the spread of HIV/AIDS. This paper is therefore more broadly relevant to growing interest in the effects of income volatility in poor countries (Koren and Tenreyro 2007) and especially its effects on human capital investment at critical periods of childhood

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[1] Uncertainty concerning the likely impact on women's labour market status is evident in the media, not only for developing countries but also in, for example, the UK and the USA.

(Almond 2006; Cunha and Heckman 2007; Ferreira and Schady 2009; van den Berg et al. 2009), in the transmission of which women's labour supply is an understudied mechanism (Agénor and Agénor 2009; Basu and Basu 1991; Bhalotra 2010; Rose 2000).

2 Background

The motivating hypothesis is rooted in a literature on the added worker effect (AWE) that originated around the Great Depression (see Humphrey 1940; Woytinsky 1940). This casts married women as secondary workers who temporarily increase labour supply when their husbands suffer unemployment. The underlying theory is developed in Ashenfelter (1980), Heckman and MaCurdy (1980), Lundberg (1985), Ehrenberg and Smith (2003), and Borjas (2005). In the simple static model, women raise labour supply following a transitory dip in family income if their leisure is a normal good and this effect is enhanced if the increased non-market time of the husband lowers the opportunity cost of market work for the wife through substitution in home production. Given evidence that cross-substitution effects are typically small, the AWE relies upon wealth effects. In a lifecycle setting, as long as the income loss from unemployment is small relative to the husband's lifetime earnings, AWE effects are expected to be small and concentrated amongst families that face liquidity constraints or fixed consumption commitments (Mincer 1962; Lundberg 1985). Unemployment insurance in richer countries will tend to crowd out any need for wives to provide insurance (Gruber and Cullen 1996). Consistent with these predictions, studies set in the USA and UK find small if any added worker effects (Stephens 2002). In aggregate data, the discouraged worker effect tends to dominate and women's work is pro-cyclical (see references in the previous section).

As indicated earlier, there is typically no unemployment insurance in developing countries and a vast fraction of households face subsistence constraints that they are not equipped to borrow to smooth over. In this setting, we may expect to see dominant wealth effects and, in the aggregate, counter-cyclical labour supply, see, for example, Barzel and McDonald (1973) and Stern (1984), who show the importance of asset levels and subsistence constraints in determining the shape of the labour supply curve. The tendency for women in poorer countries to act as secondary workers is likely to be strengthened by traditional family structures and low levels of education and skill amongst women. Moreover, the informal sector that characterizes developing countries facilitates transitory work spells as entry and exit barriers and search costs are low (Basu et al. 2000). The literature on household insurance mechanisms in developing countries has considered child labour as an insurance mechanism (Jacoby and Skoufias 1997; Skoufias 2003) but it contains relatively limited investigation of the role of changes in women's labour supply.

3 Data and descriptive statistics

3.1 Data

The micro-data are assimilated from 75 demographic and health surveys (DHS) conducted using a similar questionnaire in 30 African countries between 1986 and 2006.

There are no similar cross-country micro-data on employment and the DHS data have not been used for this purpose before. The potential sample contains 590495 observations on women's work, education, and demographics.[2] Countries and survey years in the sample are in Table 1. The six countries that have only one survey round do not contribute to the main results, which are estimated on mean-deviations.

The surveys interview all women of reproductive age, typically 15-49 years. To allow for continued education until age 20, we drop women younger than 20 at the time of the survey. There are no data on hours of work or wages. Information on years of education is used to construct dummy variables indicating whether the individual is uneducated (none), has some education but less than secondary (some), or has completed secondary or higher education (high). A household wealth index is constructed using data on ownership of assets for each country and this is used to create indicators for the quartile of the wealth distribution that the household falls into (see the Data Appendix). The micro-data are merged by country and year of interview with country panel data on GDP per capita in constant prices. Definitions and sources of these variables are in the Data Appendix.

3.2   Descriptive statistics

This section profiles women's employment in Africa (see Table 2). On average, 64.4 per cent of women work compared with about 98.6 per cent of men, so there is clearly less room for manoeuvre amongst men. As many as 50 per cent of all African women are self-employed, while just 11.6 per cent are in paid employment. Agricultural employment at 39 per cent dominates non-agricultural employment at 32 per cent. The employment rate of unmarried women is about 7 points higher than that of married women and about 3.4 points lower if there is at least one child under the age of five in the household. Employment rates are increasing in age, possibly reflecting the fact that younger women are more likely to have young children at home. Employment is increasing in women's education and, in contrast to the case in Asia and Latin America, is also increasing in their partner's education and largely invariant with respect to household wealth. The pooled and the between-country relationships between women's work and GDP in Africa are negative, yet a slightly larger percentage of women are employed in booms (65 per cent) as opposed to recessions (61 per cent). Overall, these correlations do not lend much support to the hypothesis that women are more likely to work in poorer circumstances, as indicated by partner's education, wealth, or recession.

4   Model specification and results

Studies of the added worker effect have tended to model women's work participation as a function of the labour market status of their husbands (Lundberg 1985; Stephens 2002) but this encounters endogeneity and selection problems (Gruber and Cullen 1996). We avoid these by modelling women's employment as a function of the business

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[2] See www.measuredhs.com where the data, documentation, and reports are available by country. We have harmonized the data across countries and survey years. For example, we have adjusted the dates in the Ethiopia and Nepal surveys for the fact that they follow the Julian and the Nepali calendar (Vikram Samwat), respectively. Details are in the Data Appendix.

cycle. Our approach has the following further advantages. First, it accommodates changes in earnings across multiple earners, which is pertinent given the extended family structures in poorer countries. A father-in-law or a brother-in-law may well be the main earner and if, say, recessions induce young men to enter the labour market early or elderly men to delay retirement then in the antecedent model their labour supplies would appear as omitted variables. Second, we capture the impact on women's work not only of unemployment amongst household members but also of under-employment and wage decline. This is relevant in poorer countries where unemployment is unaffordable and wages tend to carry most of the impact of economic crises (e.g. Thomas et al. 2003). Using US data, Maloney (1987) shows that it is only once employment constraints on the desired labour supply of both husband and wife are allowed, that an added worker effect emerges.

It is important to note that we only seek to answer the question that the reduced form permits which is what the direction of cyclicality of women's employment is; we do not attempt to tie this in directly with the (endogenous) employment status of husbands. So we are not attempting to estimate added worker effects but rather to characterize the impact of aggregate income variation on women's employment which will involve both supply and demand factors.

The dependent variable in the analysis is an indicator for whether the woman reports working in the week of the survey.[3] Since employment in developing countries exhibits considerable seasonal variability the pattern of which may differ across space and time, we control in all specifications for the quarter of interview of the individual woman. We also adjust annual GDP data by the month of interview of the woman so that, for every woman, GDP refers to GDP in the 12 months preceding her month of interview.

The data are micro-data nested within a short country panel. The baseline model incorporates country-fixed effects and trends and consistently allows heterogeneity in the income effect by education (Section 4.1). So as to evaluate the labour supply behaviour of women who have relatively limited alternative sources of insurance, we exploit availability of individual data to model interactions of aggregate income with proxies for the wealth and the consumption commitments of women (Section 4.2). We then investigate cyclical employment transitions across sectors (Section 4.3). The results are subject to a range of robustness checks (Section 4.4). The findings are woven into the discussion of methods that follows.

4.1   Baseline specification

Individual employment is regressed upon country-specific log income (Y_{ct}), controlling for individual characteristics, country-fixed effects and country-specific trends:

$$L_{ict} = \alpha + \beta Y_{ct} + X_{ict}\gamma + Z_{ct}\theta + \eta_c + \delta_{1c}t + \varepsilon_{ict}, \qquad (1)$$

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[3] Current employment is likely to be reported by women with little error. In contrast, labour force participation and unemployment are notoriously difficult concepts in developing countries where unemployment insurance is scarce and job search is largely informal. The exact definition of our dependent variable is in the Data Appendix.

L_{ict} is an indicator for whether woman i from country c reports employment when interviewed in year t. Country dummies comprehensively capture persistent institutional and cultural determinants of women's work, so that time-invariant omitted variables will not bias the estimates even if they are correlated with the explanatory variables. The country panel is unbalanced and contains irregular time intervals between observations once it is matched into the micro-data because the number of surveys and the spacing between surveys varies across countries. The within-groups estimator is (unlike the first difference estimator) robust to this; it simply translates each observation into deviations from the country mean. The distance between observations (typically quinquennial) diminishes serial correlation in the errors. Country trends control for trended unobservables and including trends in GDP. Therefore, our variable of interest Y_{ct} is capturing the effect of deviations of GDP from its trend (i.e. the cycle).

Controls, X, for individual heterogeneity include dummy variables for the woman's age cohort (20-24, 25-35, 36+), her education (none, some, high), her current marital status, her partner's education if she is currently married, whether she is household head, the season of her interview, her rural/urban location, the wealth quartile of her household and the number of children in the household under the age of five. Z includes the share of women of working age in the population and the inverse of the urbanization rate. These are not displayed in Equation (1) but we also include interactions of income with the index woman's education.

We estimate linear probability models (LPM) and adjust the standard errors for heteroskedasticity. The LPM is expected to behave well as the mean of the dependent variable is close to 0.5. We nevertheless checked that there were few (1.2 per cent) predictions outside the 0-1 range, and that the marginal effect from a probit (0.067) is almost identical to the LPM coefficient. A number of alternative specifications are investigated below. The estimation sample pools data from the 23 African countries with at least two survey rounds. It contains 352,893 women (n), 23 countries (N), and between two and four survey rounds (T).

Results are in Table 3. We find that women's employment is significantly pro-cyclical (0.07). A recession involving a 10 per cent drop in GDP is associated with a 0.70 per cent point decrease in women's employment. A one standard deviation change in GDP in this sample is 3.84 per cent, and our estimates predict that this would result in a 0.27 per cent point change in women's employment. This effect is increasing in the level of women's education. Coefficients on covariates other than income are in Appendix Table°1.

4.1.1 Country-specific equations

As the model is linear, the pooled coefficient in Equation (1) provides the average treatment effect. To investigate heterogeneity in the income coefficient across countries, we estimate the following country-specific equation for the six countries for which T ≥ 4

$$L_{it} = \breve{\alpha} + \breve{\beta}Y_t + X_{it}\,\breve{\gamma} + Z_t\,\breve{\theta} + \breve{\delta}_1 t + \breve{\varepsilon}_{it}, \tag{2}$$

To benchmark the country-specific results, we present panel estimates of Equation (1) using the (smaller) sample of countries for which T ≥ 4 (n=0.110m, N=6), see panel B,

Table 3. The income coefficients are negative in this sub-sample, with an average coefficient of -0.47. The country-specific results are in Table 4. The income coefficient is significantly negative in Kenya and Senegal, insignificant in Mali and Uganda, and significantly positive in Ghana and Zimbabwe. This large heterogeneity within Africa implies that the sign of the pooled coefficient for Africa will be sensitive to the country composition of the sample (as we have seen) and to the strength of controls for regional heterogeneity (as we shall see in Section 4.4). [4]

4.2 Gradients of the relationship

This section investigates the sensitivity of the income coefficient to indicators of alternative sources of insurance (W). The baseline equation is augmented to include interactions of income with marital status, partner's education, household wealth, land ownership, rural location, and the presence of at least one child under the age of five.

$$L_{ict} = \hat{\alpha} + \hat{\beta}Y_{ct} + \varphi(Y_{ct} \times W_{ict}) + \omega W_{ict} + X_{ict}\hat{\gamma} + Z_{ct}\hat{\theta} + \hat{\eta}_c + \hat{\delta}_{1c}t + \hat{\varepsilon}_{ict}, \quad (3)$$

The striking finding is that the employment of women who own agricultural land is immune to the business cycle. The pro-cyclicality identified is restricted to women in landless households. In line with this, the point estimate is larger for urban than for rural households. It is also larger for women without young children and for women in the top quartile of the household wealth distribution but these differences fall short of being statistically significant. Marital status and partner's education exert no impact on the cyclicality of women's employment (Tables 5-8).

4.3 Employment transitions

The discouraged worker effect tends to overwhelm the added worker effect in aggregate data (Cain 1966). If the unemployment of men is rising or their wages are falling on account of a general downturn then the shadow wage of their wives will be falling as well, making it less likely that women seek and are able to find employment. We expect that this argument is less relevant in developing countries to the extent that binding subsistence constraints override marginal substitution effects and there is an expansive informal sector to which entry and exit barriers are low. To illuminate this, we estimate three individual probit models by employment status or sector. For the first case, the dependent variable indicates whether the woman is self-employed (.50), not employed (.38), or paid employee (.12). Definitions of these categories of work are in the Data Appendix. The sample and the specification of the independent variables are as for the baseline Equation (1). On average, recessions are associated with a large increase in self-employment, a smaller increase in non-employment, and a decline in paid employment. We also cut the data by agriculture (.29), non-agriculture (.39), and unemployment (0.32). We see that recessions are associated with increases in non-agricultural employment relative to agricultural employment and non-employment.

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[4] The countries in Africa which show positive $\ln(GDP)$ coefficients (even if it is not significant) tend to have low GDP (Table 4) and a high rate of female employment (60 per cent-80 per cent). This is consistent with our argument that African women are relatively likely to be primary workers (Section 5.1).

Overall, it appears that recessions induce women to shift towards non-agricultural self-employment (Table 8).

4.4 Specification checks

4.4.1 Sub-region and region-fixed effects

A recognized problem in the growth literature is that any reduction in bias gained by discarding between-country variation tends to exacerbate measurement error and typically comes at the expense of lower efficiency. For these reasons, Barro (1997), Pritchett (2000), Temple (1999), and Wacziarg (2002) all argue that country-fixed effects in cross-country models need to be used with caution; see Durlauf et al. (2005). These concerns suggest that we may be under-estimating the GDP coefficient. Moreover, GDP in developing countries is often measured with error. For example, the Penn World Tables, from which GDP data are routinely drawn for research, reckons that data for all 43 Sub-Saharan African countries have margins of error of 30-40 per cent. Johnson et al. (2009) show that successive versions of the Penn World Tables produce radically different rankings of African countries by rates of growth between the same years.[5] Also, an increase in the noise to signal ratio generated by taking differences or deviations from means is greater the more persistent the variable, and income (GDP) is a highly persistent variable (Griliches and Hausman 1986).

For these reasons we re-estimated Equation (1) replacing country-fixed effects (c) with sub-region-fixed effects (r), using the four sub-regions Africa (West, Central, East, and South) indicated in Table 1.[6] As the time series within-country is now much longer, these equations include a quadratic sub-region trends and year-fixed effects.[7]

$$L_{icrt} = \ddot{\alpha} + \ddot{\beta} Y_{crt} + X_{icrt}\ddot{\gamma} + Z_{crt}\ddot{\theta} + \ddot{\eta}_r + \ddot{\lambda}_t + \ddot{\delta}_{1r}t + \ddot{\delta}_{2r}t^2 + \ddot{\varepsilon}_{icrt}, \quad (4)$$

Amongst omitted variables that may bias the estimated relationship between women's employment and income are labour market or family institutions, for example, the extent of state-provided unemployment insurance or conventions regarding income pooling. There is no reason to believe that the country is the natural level at which these institutions vary, for example, family norms may vary across ethnic groups that cut across countries. Regions represent a stable division of people with a fairly distinct history and culture. In contrast, the borders of countries within these regions are, in

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[5] If the measurement error is fixed at the country level then the country-fixed effects model is at an advantage. However, this may be too restrictive a characterization of measurement error.

[6] This sort of strategy is not uncommon. For example, Besley and Kudamatsu (2006) use region (continent) rather than country-fixed effects in their baseline model and Acemoglu et al. (2001), amongst others, include no controls for unobserved heterogeneity in their baseline specification, exploring region-fixed effects in a variant. In the micro-panel literature, there are thousands of individual firms or households that, unlike countries, have no particular identity of interest and the accepted strategy is to purge firm effects. In the growth literature, on the other hand, including country-fixed effects often absorbs a lot of the variation of interest, especially when the variation is limited whether because the variable is naturally sluggish or because T is small. The latter is the case in our baseline model.

[7] The income coefficient is stronger if instead we use region- year-fixed effects.

many cases, arbitrary, with ethnicity, language, and culture crossing country borders. A vast literature questions the construction of nation states under colonial rulers.[8]

The finding of pro-cyclicality is robust to this variation (Table 9). We are now able to incorporate countries with only one survey round (panel B) and this larger sample shows a similar pattern.

4.4.2   Other specification checks

As explained earlier, we use GDP adjusted for the month of interview of the index woman. Since this is of potential relevance to other studies that use information gathered at a point in time on a variable that exhibits seasonal variation, we investigate how much difference this makes. We find that the coefficient on unadjusted GDP is almost four times as large. If families do not anticipate aggregate income variation or there are job search lags, women's employment may respond with a lag. Including lagged GDP in the model together with its current value, we find that the action is in the first lag and that the long run effect (the sum of the coefficients on current and lagged income) is the same as in the baseline model (column 4). If we retain only lagged income in the model (not shown), its coefficient and standard error are almost identical to those on current income. We therefore proceed with the baseline model.[9] We next included a quadratic in Y, so as to allow larger income shocks to have different impacts. We find that pro-cyclicality in women's employment is weaker for larger shocks, possibly because women are more likely to be compelled into distress work at such times.

5   Discussion

The pro-cyclical behaviour of women's labour supply in Africa contradicts the insurance hypothesis whereby women enter the labour market in recessions (and leave in booms) so as to smooth household consumption. However, the benchmark model for analysis of married women's labour supply assumes income pooling (e.g. Lundberg 1985). Empirical evidence has called this into question and a number of the violations documented are in Africa (Schultz 1999; Udry 1996; Jones 1986). To the extent that African women do not rely financially upon men, they will tend to behave as primary workers. As we have shown, pro-cyclical employment signifies the loss of paid jobs in recessions, only some of which is compensated by a rise in self-employment. Aggregate income shocks in Africa, more than in Asia and Latin America, are often driven by

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[8] This literature cuts across history, political science, and anthropology. Amongst them the following studies more than make the point. All of the chapters in Cohen (1995) are relevant but see, for example, Aderanti Adepoju's contribution to Section 6. Baud and van Schendel (1997) and Parker (2006) provide an accessible overview. The Centre for International Borders Research at www.qub.ac.uk/cibr/ provides links to a wealth of material for each sub-region, for example, www.qub.ac.uk/cibr/BordersBiblioAfrica.htm. Howard French (undated) provides useful detail for Africa. Multiple authors document sub-region specific cases in a book series, *Arbitrary Borders: Political Boundaries in World History Set, 17-Volumes* published by Chelsea House.

[9] Recall that the DHS sample contains irregular intervals between years. However, we have annual GDP data and so we use the genuine first lag. A simple regression of income (GDP) on its first lag yields a coefficient of 1 and has an R2 of 0.996.

unexpectedly adverse rain conditions and the main sector in which women work is agriculture. So a possible explanation of our findings is that African women are disadvantaged by the fact that the sector that experiences the negative shock is the sector in which they naturally seek employment. The alternative of informal paid employment appears to be more restricted in Africa than in the other two regions. For each region, we ran a regression of ln(GDP) on rainfall shocks, country and year dummies, country-specific trends, and demographic controls. The coefficient on rain shocks was -0.048 in Africa, 0.007 in Asia, and 0.021 in Latin America, significant at the 1 per cent level in each case.

6   Conclusions

Although the between-country relationship of women's employment and aggregate income is negative in Africa, the within-subregion and the within-country relationships are, on average, positive. So, in general, African women increase their labour supply when GDP is above trend and withdraw it when it is below trend. The identified effect is largely driven by recessions inducing women to move from paid employment to self-employment, predominantly in non-agriculture. Women who own land are immune to the business cycle. While the average characterization is useful, country-specific estimates for selected countries indicate considerable heterogeneity in income responses within the continent.

Future work might conduct more experimental studies of specific cases and analyse more carefully the role of institutions. A fine extension of the analysis would be to model fertility timing jointly with the timing of women's employment. Further research is also needed on the impact of exogenous changes in the employment of mothers on current or later life outcomes of young children.

Appendix Table 1: Covariates in the baseline model

No. adult members in HH	0.002*
	[0.000]
HH wealth - quartile 2	0.012*
	[0.002]
HH wealth - quartile 3	0.008*
	[0.002]
HH wealth - quartile 4	0.002
	[0.002]
% women working age	196.452*
	[13.276]
Rural (% of total) pop	-9.821*
	[0.717]
Interview was in second quarter	0.006*
	[0.002]
Interview was in third quarter	-0.005
	[0.003]
Interview was in fourth quarter	0.019*
	[0.003]
Constant	6.319*
	[0.744]
Observations	352,893
R-squared	0.15

Notes: Robust standard errors in brackets. *significant at 5%. Results are from the baseline model (Equation (1) in text). See Notes to Table 3.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Data Appendix

This section presents further information on the sources and definitions of the variables used in the analysis. The Demographic and Health Surveys are available at www.measuredhs.com where information on survey design and sampling strategy is available.

The Julian and Nepali calendars: The year of interview was adjusted for two countries. The Julian calendar is 7 years and 8 months behind the Gregorian calendar. The cutoff date for asking health questions is normally in Meskerem which roughly corresponds to September (see Chapter 8 of the 2000 and 2005 DHS reports for Ethiopia). The Nepali calendar is 56 years and 9 months ahead the Gregorian calendar. The cutoff date for asking health questions is normally in Baisakh which corresponds to April (see Chapter 8 of the 2001 and 2006 DHS reports for Nepal).

Employment: Source: DHS. Women are asked the following question: 'As you know, some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work on the family farm or in the family business. Are you currently [/in the last 7 days] doing any of these things or any other work? (y/n)'. Our employment variable is the response to this question. In addition, women who work were classified into two categories, paid employee and self-employed using three DHS variables. Every woman was asked (i) whether she worked for a family member, for someone else or was self-employed (v719) and (ii) whether she received cash for this work (v720)[10], or (iii) whether she received cash for her work, or was paid in kind, or in cash and kind, or not paid (v741).[11] As a check on the DHS data, we obtained employment rates as country level means and compared these with the labour force participation rates for the 15+ population recorded in the World Development Indicators of the World Bank (http://publications.worldbank.org/WDI/) (see our companion paper, Bhalotra and Umaña Aponte 2010). The labour force participation rate is defined as the proportion of the population (ages 15+) that is economically active, i.e. who supply labour for the production of goods and services.

GDP: Per capita GDP in constant 2000 USD from the World Development Indicators (WDI) of the World Bank (http://publications.worldbank.org/WDI/). We adjust GDP for month of interview. For example, if a woman is interviewed in December 1992, then she is matched to GDP for the calendar year Jan-Dec 1992. If she is interviewed January 1993 then she is matched to GDP constructed as 1/12(GDP in 1993) +11/12(GDP in 1992), and so on.

Education: Source: DHS. We identified cutoff points for the number of years of education needed to complete primary and secondary school by (sub-) regions, and created the variables accordingly. People complete secondary school when they have 12 years of education in Sub-Saharan Africa. For women who do not have a partner at the time of the survey (i.e who are not 'currently married') the indicators for partner's

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[10] Available from 1990–99.

[11] Available from 2000–06. Payment in kind or in kind and cash is considered paid work.

education are set to zero and an indicator for current marital status is included in the model.

Wealth index: Source: DHS. The index is calculated as the first principal component using DHS information on the household's ownership of radio, fridge, bike, motorbike, car and television set, the type of toilet (flush, pit, none), and whether the household has electricity, for each country. Agricultural land was not included in the index as only women who reported working in agriculture were asked about land ownership.

Rural population as per cent of total population: Source: World Bank, World Development Indicators.

Rainfall: Rainfall data are obtained from the Food and Agriculture Organization of the United Nations (FAO) (http://geonetwork3.fao.org/climpag/agroclimdb en.php). We constructed rainfall shocks as deviations from the mean of country rainfall across 1985-2005 excluding the year of interview.

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Table 1: African countries by region and sub-region, observations, rounds and years of interview

Country / region	Acronym	Total obs.	Per cent obs.	No. of surveys	ln(GDP)[*]	Years of interview
Sub-Saharan Africa						
West Africa						
Benin	BJ	29,504	1.7	3	12.60	1996, 2001, 2006
Burkina Faso	BF	25,276	1.4	3	12.23	1992/93, 1998/99, 2003
Côte d'Ivoire	CI	11,139	0.6	2	13.34	1994, 1998/99
Ghana	GH	19,584	1.1	4	12.36	1988, 1993, 1998, 2003
Guinea	GN	14,707	0.8	2	12.80	1999, 2005
Mali	ML	40,336	2.3	4	12.36	1987, 1995/96, 2001, 2006
Niger	NI	23,303	1.3	3	12.08	1992, 1998, 2006
Nigeria	NG	26,211	1.5	3	12.82	1990, 1999, 2003
Senegal	SN	33,920	1.9	4	13.02	1986, 1992/93, 1997, 2005
Togo	TG	11,929	0.7	2	12.43	1988, 1998
Central Africa						
CAR	CF	5,884	0.3	1	12.42	1994/95
Cameroon	CM	20,028	1.1	3	13.42	1991, 1998, 2004
Chad	TD	13,539	0.8	2	12.15	1996/97, 2004
Congo	CG	7,051	0.4	1	13.89	2005
Gabon	GA	6,183	0.3	1	15.32	2000
East Africa						
Burundi	BU	3,970	0.2	1	11.72	1987
Comoros	KM	3,050	0.2	1	12.88	1996

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Country						
Ethiopia	ET	29,437	1.7	2	11.68	2000, 2005
Kenya	KE	30,766	1.7	4	12.95	1989, 1993, 1998, 2003
Madagascar	MD	21,269	1.2	3	12.39	1992, 1997, 2003/2004
Malawi	MW	29,767	1.7	3	11.84	1992, 2000, 2004
Mozambique	MZ	21,197	1.2	2	12.28	1997, 2003
Rwanda	RW	28,293	1.6	3	12.38	1992, 2000, 2005
Tanzania	TZ	27,687	1.6	3	12.51	1992, 1996, 2004
Uganda	UG	27,577	1.6	4	12.24	1988, 1995, 2000/01, 2006
Zambia	ZM	22,739	1.3	3	12.75	1992, 1996, 2001/02
Zimbabwe	ZW	25,143	1.4	4	13.28	1988, 1994, 1999, 2005/2006
Southern Africa						
Lesotho	LS	7,095	0.4	1	12.95	2004
Namibia	NM	12,176	0.7	2	14.40	1992, 2000
South Africa	ZA	11,735	0.7	1	14.95	1998
Sub-total	30	590,495	33.2	75	12.79	

Note: [*]average ln(GDP), 1986-2006.

Source: Demographic and Health Surveys, DHS (raw data). Authors' calculations.

Table 2: Employment status and individual characteristics of African women in the sample

	All women	Employment status	
		Not working	Working
Occupation			
Not working	29.1		
Agriculture	39.2		
Non-agriculture	31.8		
Type of work			
Not working	38.3		
Self-employed	50.1		
Paid employee	11.6		
Total	100	35.6	64.4
Age			
20-24	20.5	44.0	56.0
25-35	46.0	35.6	64.5
36 +	33.6	30.6	69.4
Education			
None	52.2	36.4	63.6
Some	44.2	35.3	64.7
Complete	3.6	28.3	71.7
Partners' education			
None	43.4	37.0	63.0
Some	48.0	34.8	65.2
Complete	8.6	33.5	66.5
Wealth quartiles			
1	38.2	36.9	63.1
2	21.4	33.7	66.3
3	20.9	35.0	65.0
4	19.5	35.9	64.1
Area			
Urban	26.4	37.7	62.3
Rural	73.6	34.9	65.1
Marital status			
Not married	11.0	29.7	70.3
Married	89.0	36.3	63.7
Children under 5 in HH			
No	22.7	33.0	67.0
Yes	77.3	36.4	63.6
log(GDP p.c.) quintile			
1	51.0	35.7	64.3

2	24.8	24.6	75.4
3	19.4	46.0	54.0
4	1.1	29.3	70.7
5	3.8	55.2	44.8
Asymmetry			
Booms (dlgdp>0)	78.2	34.6	65.4
Recessions (dlgdp>0)	21.8	39.2	60.8

Notes: Sample of women 20-49 years old at interview. Marital status is recorded at the time of survey. 'Some' education is greater than zero but less than secondary. Dlgdp is the change in logs.

Source: Demographic and Health Surveys, DHS (raw data). Authors' calculations.

Table 3: Income effects on women's employment by education, country-fixed effects

	N	Country-fixed effects			
		Total effect	Women's level of education		
			none	some	higher
		(1)	(2)	(3)	(4)
A. The thirty countries with two or more surveys					
Lgdp	352893	0.070*	0.064*	0.075*	0.099*
se (robust)		[0.023]	[0.023]	[0.023]	[0.024]
Per cent each category (mean)		100	54.0	42.9	3.1
B. The six countries with 4 or more surveys: restricted sample					
Lgdp	110422	-0.466*	-0.500*	-0.445*	-0.245*
se (robust)		[0.035]	[0.036]	[0.035]	[0.041]
Per cent each category (mean)		100	48.7	47.9	3.4

Notes: Robust standard errors (s.e.) in brackets. *significant at 5 per cent. The dependent variable is a dummy for women's employment (mean=0.49). The estimator is OLS. The model includes country-fixed effects and trends, the woman's age cohort, her level of education, her current marital status, whether she is household head, her partner's level of education, number of children under five in household, rural/urban location, number of adult members in household, wealth quartile of her household, the share of women of working age in the population, the inverse of the urbanization rate and seasonal controls; see equation (1) in text. ln(GDP) is interacted with the level of education of the index woman.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 4: Income effects on women's employment by country for six countries

| | Sub-Saharan Africa | | | | | |
	Ghana	Kenya	Mali	Senegal	Uganda	Zimbabwe
log(gdp)	10.609	-7.871	0.140	-11.692	0.573	0.449
	[1.598]*	[0.296]*	[0.205]	[2.344]*	[0.335]	[0.086]*
elasticity	13.230	-15.687	0.236	-24.425	0.856	0.914
mean(working)	0.802	0.502	0.592	0.479	0.669	0.492
ln(GDP)	12.35	12.96	12.37	13.01	12.26	13.26
Observations	12393	19685	29843	15306	18390	14805
R-squared	0.13	0.22	0.06	0.06	0.33	0.07

Notes: Robust standard errors (s.e.) in brackets. * significant at 5%. See notes to Table 3. These are estimates from country-specific time series, Equation (2), for the 6 countries with T≥4.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 5: Income effects by marital status and partners' education

| | N | Marital status | | | Partner level of education | | | |
		Total effect	Not married	Currently Married	Total effect	none	some	higher
Sub-Saharan Africa								
lgdp	352893	0.072*	0.061*	0.073*	0.067*	0.055*	0.078*	0.074*
se (robust)		[0.023]	[0.023]	[0.023]	[0.023]	[0.023]	[0.023]	[0.023]
% each category (mean)		*100*	*10.7*	*89.4*	*100*	*44.8*	*47.4*	*7.9*

Notes: Robust standard errors (s.e.) in brackets. *significant at 5%. See notes to Table 3. The specification estimated corresponds to Equation (3). ln(GDP) is interacted with either the marital status of the index woman or her partner's level of education.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 6: Income effects by household wealth quartiles and agricultural land ownership

	N	**Household wealth quartiles**					N	**Owns agricultural land**		
		Total effect	first	second	third	fourth		Total effect	No	Yes
Sub-Saharan Africa										
lgdp	352,893	0.075*	0.063*	0.065*	0.072*	0.110*	#####	0.066*	0.094*	0.027
se (robust)		[0.023]	[0.023]	[0.023]	[0.023]	[0.023]		[0.022]	[0.022]	[0.022]
% each category (mean)		*100*	*38.4*	*21.3*	*21.0*	*19.4*		*100*	*56.4*	*43.6*

Notes: Robust standard errors (s.e.) in brackets. *significant at 5%. See notes to Table 3. The specification estimated corresponds to Equation (3). ln(GDP) is interacted with either the wealth quartile of household or the family's land ownership.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 7: Income effects by location and fertility

	N	Zone			Children under 5 in household		
		Total effect	**urban**	**rural**	**Total effect**	**No**	**Yes**
Sub-Saharan Africa							
lgdp	352893	0.072*	0.098*	0.063*	0.070*	0.088*	0.065*
se (robust)		[0.023]	[0.023]	[0.023]	[0.023]	[0.023]	[0.023]
% each category (mean)		*100*	*25.1*	*74.9*	*100*	*22.0*	*78.0*

Notes: *significant at 5%.

Robust standard errors (s.e.) in brackets. *significant at 5%. See notes to Table 3. The specification estimated corresponds to Equation (3). ln(GDP) is interacted with either rural/urban location or whether there are children under five in household.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 8: Employment transitions, Probit estimations of individual employment status and sector

	N	Marginal effects		
Employment status		*Paid employee*	*Self- employed*	*Not working*
log(GDP)	306,175	0.253*	-0.339*	-0.090*
		[0.013]	[0.027]	[0.025]
mean		38.3	50.1	11.6
Sector		*Agriculture*	*Non-agriculture*	*Not working*
log(GDP)	320,403	0.166*	-0.112*	0.190*
		[0.028]	[0.027]	[0.024]
mean		29.1	39.2	31.8

Notes: Robust standard errors in brackets. *significant at 5%. See notes to Table 3. The specification estimated corresponds to equation (1) in text.

Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 9: Income effects on women's employment by women's education and region. (Sub-region fixed effects)

		Sub-Region fixed effects			
		Total	Women's level of education		
	N	effect	none	some	higher
		(1)	(2)	(3)	(4)
(A) 23 Countries (T ≥2)					
lgdp	352,893	0.152*	0.186*	0.109*	0.146*
s.e.		[0.003]	[0.004]	[0.004]	[0.008]
% each category (mean)		100	54.0	42.9	3.1
(B) All 30 countries (T ≥1)					
lgdp	378,145	0.068*	0.111*	0.016*	0.078*
s.e.		[0.003]	[0.003]	[0.003]	[0.005]
% each category (mean)		100	52.2	44.2	3.6

Notes: Robust standard errors (s.e.) in brackets. *significant at 5%. See notes to Table 3. The specification estimated corresponds to Equation (4) in text.
Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.

Table 10: Specification checks

	Unadjusted GDP (1)	Lagged GDP (2)	Quadratic GDP (3)
log(GDP)		-0.115	3.854*
		[0.062]	[0.513]
log(real GDP pc)	0.215*		
	[0.022]		
log(GDP)t-1		0.179*	
		[0.056]	
[log(GDP)]2			-0.149*
			[0.020]

Notes: Robust standard errors in brackets. *significant at 5%. Column 2 shows the baseline model (Equation (1) in text). Columns 3, 4, and 5 are run using the specification in column 2.
Source: Data from DHS on 30 African countries1986–2006. Estimates are authors' calculations.