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To cite this article: Chloé-Marie Kikillus & Umakrishnan Kollamparambil (2025) Sex crime rate and female labour force participation in South Africa, *Development Southern Africa*, 42:1, 53-72, DOI: [10.1080/0376835X.2024.2424889](https://doi.org/10.1080/0376835X.2024.2424889)

To link to this article: <https://doi.org/10.1080/0376835X.2024.2424889>



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Published online: 13 Nov 2024.



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Sex crime rate and female labour force participation in South Africa

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ABSTRACT

South Africa's high violent crime rates and associated fears of victimisation are known to affect residents' everyday decision-making. Rape and sex crimes (which predominantly target women), compounded by social stigma and high HIV-contraction risks, thus plays an influencing factor in a woman's life. At the same time, South Africa's gender participation gap exceeds the Sub-Saharan African average. The first of its kind in the South African context, this study uses panel data to assess the impact of district municipality sex crime rates on female labour force participation (FLFP). It improves on similar studies performed in other country contexts methodologically by highlighting the mediating effect of education in the relationship between sex crime rate and FLFP. The negative significant relationship between district sex crime rates and FLFP is found to be robust to the inclusion of a wide variety of controls and several instrumental variable specifications, with adverse impacts on education emerging as a mediating factor. The analysis points to an underrated cost of sex crimes in South Africa, especially on women. The risk-averting behaviour extends beyond victims themselves to women in the general population who, perceiving a high risk of victimisation, face restricted freedoms, worse educational and economic outcomes.

ARTICLE HISTORY

Received 15 November 2022
Accepted 28 October 2024

KEYWORDS

Sex crime rate; violent crime; labour force participation; female labour supply; risk perceptions; risk-averting behaviour

JEL CODES

J21; J16

1. Introduction

South Africa has one of the highest unemployment rates in the world at 42.6% (Stats SA, 2024). The unemployment rate for women is significantly higher at 46.1% against 39.5% for men. There is also a substantial gender participation gap – the difference between male and female labour force participation rates (henceforth MLFP and FLFP respectively) – with only 55.8% of working-age women, versus 65.9% of working-age men, participating in the labour force (Stats SA, 2024). Further, South Africa's MLFP-to-FLFP ratio remains above the Sub-Saharan African average (ILO, 2020). There is hence a need to explore the factors behind the low FLFP in South Africa.

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Alongside the high unemployment rate, South Africa (SA) also has among the world's highest crime rates. SA has recently been ranked as having the world's highest rape incidence (NationMaster, 2020; World Population Review, 2020). The recorded rape rate is 70.2 per 100 000 people for 2022/2023 (SAPS, 2023), with 90% of sex crime victims being female (SAPS, 2023). Women's fears are exacerbated by the stigma of sex crime victimisation and the high risk of HIV-contraction in SA (Abrahams & Jewkes, 2010).

In contrast to the longstanding and rich body of literature, both international and South African, dedicated to the study of the impact of economic factors, including unemployment, inequality, and labour market outcomes, on crime (Chiricos, 1987; Aaltonen et al., 2013; Bhorat et al., 2017; Prescott & Pyle, 2019), our review reveals a paucity of economic research examining the effect of regional crime victimisation risk on labour force participation.

Where the impacts of crime on unemployment and labour force participation are studied, the focus is overwhelmingly limited to the costs to victims themselves (Lloyd & Taluc, 1999; Cuesta & Alda, 2010; Sabia et al., 2013; Raghavendra et al., 2017). Where the regional prevalence of crime is considered, studies tend to examine the costs for real estate prices and tourism (Schwartz et al., 2003; Nkosi, 2010; Frischtak & Mandel, 2012; Moyo & Ziramba, 2013). The economic costs of crime victimisation risk for the region's population are largely overlooked or portrayed as secondary (Louw & Shaw, 1997). This is surprising given the finding by Møller (2005) that the fear of crime victimisation in SA impacts more on life satisfaction than victimisation itself. In addition, there is a wealth of evidence that crime perceptions and associated fears influence decision-making and everyday behavioural outcomes (Cops & Pleysier, 2011; Collins, 2016).

Given the gendered differences in crime victimisation and the corresponding fears and risk perceptions, some of the labour force participation gap may reflect risk-averting behaviour by women who avoid working outside the home to reduce exposure to crime associated with commuting and other work activities (Cops & Pleysier, 2011). There is hence a need to explore not just the direct impact of crime on FLFP, but also the pathways through which crime effects FLFP.

In a first of its kind in the South African context, this study follows only four existing studies in other country contexts (Chakraborty et al., 2018; Siddique, 2018; Chakraborty & Lohawala, 2019; Velásquez, 2019) to examine the impact of crime in an area on residents' labour force participation (LFP). All four studies (with three from India and the fourth from Mexico) find a significant negative impact of (perceived) crime in an area on FLFP.

This paper is therefore intended to address the paucity of literature, especially in the SA context, by exploring the impact of district level crime rates on FLFP, with the objective of contributing to understandings of the participation gap's origins and solutions. We also claim improvements on existing works with the use of more contextually appropriate estimation techniques including probit, and Lewbel's special regressor for binary-outcome models with endogenous and mismeasured regressors which has proven valuable for similar applications in the public health literature (Lewbel & Dong, 2015; Bon-temps & Nauges, 2016). Lastly, the study takes forward the findings from the above analysis by establishing the mediating effect of education through a multilevel generalised structural equation model (GSEM) suitable for the binary dependent variable as well as

accounting for the differences in the levels variables (FLFP at individual level and crime at district level).

The contribution of our paper rests on three focal points: (a) the first econometric exploration of the relationship between sex crime risk perceptions and low FLFP in the South African context, (b) identification of the mediating effect of education in the relationship between sex crime victimisation risk perceptions and FLFP, not yet accounted for by the existing empirical literature in any country context; and (c) the improved identification strategies in the context of possible endogeneity in binary-outcome estimations.

2. Literature review

The neo-classical theory, which integrates the ideas of Alfred Marshall and William Stanley Jevons, frames the supply of labour within the context of individual choice. This framework is built on the premise of a trade-off between work and leisure, governed by two key mechanisms: the income effect and the substitution effect. According to Weiss (2009), the income effect occurs when an increase in income from higher wages allows an individual to afford more leisure, reducing their need to work. In contrast, the substitution effect suggests that higher wages make leisure more expensive in terms of foregone income, incentivising individuals to work more. While this theoretical model is powerful for understanding individual labour supply decisions, particularly in terms of how individuals balance work and leisure, it fails to adequately address the gender gap in labour force participation, particularly when considering female labour force participation (FLFP).

Much of the literature on FLFP moves beyond the neo-classical framework and draws on Gary Becker's (1964) rational utility maximisation analyses, which emphasise the economic decision-making processes within families. Becker's framework, often applied to household production and time allocation, posits that families, and particularly married women, make economic choices based on utility maximisation. A critical insight of Becker's theory is that married women often opt to prioritise childcare over formal labour force participation due to the division of household labour. Pollak (2003) further refines this argument, explaining that the family unit functions as a cooperative entity where individuals allocate their time between market and non-market activities based on comparative advantages and opportunity costs. This division of labour often results in women taking on childcare and other household responsibilities while men engage in paid work especially when women have lower wages relative to men. Thus, fertility considerations, such as the number of children a family has, often significantly influence a woman's decision to enter or remain in the labour force.

In addition to fertility considerations and social norms, which influence gender roles within households, gendered discrepancies in education and investment in human capital also play a crucial role in explaining FLFP. The human capital theory, first articulated by Schultz (1961), emphasises that individuals' investments in education and skills determine their labour market outcomes. According to this theory, higher investments in education and skills, referred to as 'human capital,' increase individuals' productivity, which, in turn, raises their earning potential. However, the theory also acknowledges

that historically, women have received lower investments in human capital compared to men. This discrepancy can be attributed to societal expectations and norms that assign primary caregiving responsibilities to women, making investments in their education less of a priority.

Jaumotte (2003) notes that educational attainment is a critical determinant of whether women participate in the labour force. Women with higher levels of education are more likely to engage in paid work, as their higher levels of human capital increase their market productivity, making it more economically viable for them to work. Similarly, Yakubu (2010), Verick (2014) and Chaudhary & Verick (2014) highlight the strong correlation between women's educational attainment and labour force participation rates across different regions. In the context of South Africa, these studies emphasise that education is one of the key pathways through which gender disparities in labour force participation can be addressed.

Other economic variables such as women's wages, spousal wages, child support grants, and tax structures also exert considerable influence on women's decisions to participate in the labour market. Empirical studies, both in South Africa and globally, have confirmed the significant role of child support grants in driving FLFP (Eyal & Woolard, 2011). Jaumotte (2003) underscores that when women's wages are relatively low compared to men's, their opportunity cost of staying out of the labour force decreases, which can discourage their participation. Conversely, as women's wages increase relative to men's, the opportunity cost of remaining at home becomes higher, providing greater incentives for women to enter the labour market.

At the macroeconomic level, Goldin's U-shaped FLFP theory presents FLFP as a function of development with decreasing share of females through the industrialisation phase and subsequent increase upon the increase in share of services (Goldin, 1994; Elborgh-Woytek et al., 2013; Chaudhary & Verick, 2014; Verick, 2014). Some evidence from SA finds a corresponding U-shaped relationship between FLFP and the share of non-agricultural employment in a given municipality (Roncolato, 2016). However, cross-sectional results from 2007 might not explain FLFP's trajectory in SA in recent times (Roncolato, 2016). In fact, SA appears to be moving backwards along Goldin's U: manufacturing's employment share has declined since the 2008 global financial crisis and agriculture's share of women's employment has grown faster than all other sectors' in recent years, increasing annually by 9.9% in 2019 and 5.9% in 2019 (SARB, 2017; Stats SA, 2019b, 2020). The applicability of Goldin's proposed mechanism to the SA context is also unclear: blue-collar stigma is challenged by former female dominance in textile manufacturing, and household reliance on male income is limited by the prevalence of female-headed households which tend to push women into the labour force (Casale, 2003; Klasen & Pieters, 2012; Roncolato, 2016). Recent panel evidence suggests that country-specific contextual factors dwarf U-shaped effects, as with the paradox of rising education and stagnant, or even declining FLFP in India (Klasen & Pieters, 2013; Gaddis & Klasen, 2014). This suggests the importance of looking beyond stylised facts in explaining SA's low FLFP, especially outside of agriculture. Where contextual factors are considered, crime has been overlooked by studies attempting to explain low FLFP until very recently.

To our knowledge, there are only four econometric analyses examining the impact of crime through perceived victimisation risk as a spatial consideration, rather than through victimisation itself, on labour force participation (Chakraborty et al., 2018; Siddique, 2018; Chakraborty & Lohawala, 2019; Velásquez, 2019). All find a significant negative

impact of (perceived) crime in an area on FLFP in particular in high crime developing country contexts, with three from India and the fourth from Mexico, suggesting that similar outcomes might exist in SA.

Velásquez (2019) is unique in finding a negative impact of homicide rates in an area on the LFP of self-employed women living there through the mechanism of disruptive crime-prompted migration. Closer to our study, however, are those by Chakraborty et al. (2018), Siddique (2018), and Chakraborty & Lohawala (2019), the only three studies modelling the impact of sex crime measures, among other crime measures, on individuals' LFP. These all use individual-level survey data combined with higher-level crime data in binary-outcome estimations, but crime variables and mechanisms differ slightly.

Siddique (2018) makes use of panel data to find a negative significant relationship between lagged media-reported sexual assaults in a district from the Global Database of Events, Language, and Tone (GDELT) and labour force participation outside the home for district residents. This study, however, does not address endogeneity explicitly. Notably, Chakraborty et al. (2018) find that social stigma increases the deterrent effect of sex crimes on FLFP, which aligns with studies suggesting that social capital mediates women's fear of crime and its deterrent effects on other outcomes (Ferguson & Mindel, 2007; Garcia-Reid, 2007; Kruger et al., 2007). Chakraborty & Lohawala (2019) represent an improvement. Using panel data, they too find a negative significant relationship between sex crime rates – reports to the police – at the district level and LFP outside the home for women residing there. Heeding endogeneity concerns from working women's higher victimisation and crime-reporting probabilities, they use state alcohol law changes as a shock to crime against women, and robust results seem to validate the causal mechanism proposed: reduced FLFP outside the home reflects, in part, a risk-averting response to the perceived sex crime victimisation risk. The study however lacks external validity given the limited geographical scale used to validate the causal mechanism.

This study contributes to the literature not only by investigating the relationship between sex crime rates and FLFP in a different social context from these four existing studies, but also by introducing key mediating factors like education, which compound the relationship of interest, into the analysis.

3. Methodology

3.1. Data & variables

Data and methodology are largely determined by availability since no single source includes all necessary variables. We construct a panel matching individual-level data from the National Income Dynamics Study (NIDS) produced by the Southern African Labour and Development Research Unit (SALDRU, 2018a, 2018b) with crime data from SAPS (2018) and population data from Stats SA's Census and Community Survey for each of South Africa's 52-district municipalities (henceforth 'districts') including 9 metropolitan municipalities (Stats SA, 2017). The hierarchical / clustered structure is accounted for in estimation using district level clustered standard errors (McNeish, 2023).

The NIDS data has information on district municipality of residence of the individual. The study uses wave 3 (2012) and wave 5 (2017) of NIDS and merges it with SAPS data

(available at the municipal level annually) for the preceding year. Since SAPS data provides the recorded cases (not crime rate), the study uses the population of the municipality to derive the crime ratio at the municipal level. The municipal level population size for the two time points is derived from Census (2011) and community survey (2016). This is used to calculate the crime rate at the municipal level for each individual based on their municipality of residence. We use district crime rates since this is the most precise scale at which crime data can be matched with individuals' households of residence based on NIDS. This is also considered appropriate given the mobility of individuals surveyed and criminals within a district. For each district, annual crime rates for a given category of crime are calculated as the number of incidents reported to police, from SAPS data, divided by the district population obtained from Census and Community Survey data. Of primary interest are sex crimes, the impact of which is expected to be negative for women's LFP based on the gender profile of victims and the literature (Chakraborty et al., 2018; Siddique, 2018; Chakraborty & Lohawala, 2019; Stats SA, 2019a).

The panel is restricted to two annual periods of the national census and community survey data, 2011 and 2016. The SAPS district crime data for 2011 and 2016 are matched to NIDS Wave 3 (W3) for 2012 and Wave 5 (W5) for 2016 which provide a sample of 13 659 women of working age, defined here as those aged 15–65 years, after balancing using nearest neighbour propensity score matching. The one-year lag between district crime rates and individuals' LFP outcomes is considered valid and useful assuming individuals' crime perceptions for an area depend on crime over the past few years.

A binary LFP outcome variable is created, assigning 1 to persons either employed or actively seeking employment and 0 otherwise, including those who are discouraged or not economically active. Ideally, commute distance and sector could be accounted for: working from, or close to, home, as is prevalent in agriculture, could insulate persons from, or reflect their response to, a high perceived crime risk outside the home. This is of particular interest given SA women's trends towards employment in agriculture. Unfortunately, the data to create a more sophisticated outcome taking this into account for a substantial sample is lacking. The study however observes the effect indirectly by distinguishing the respondents between urban, farm, and traditional areas of residence.

NIDS provides a rich variety of variables at the individual and household-levels. We identify key controls based on theory, the South African context, and the literature. For all genders, we expect the probability of LFP to increase with age and decrease with age squared: individuals reach working age, complete their education, and enter the labour market out of need or are drawn by returns to working which may increase with work experience, before exiting to rear children, owing to poor health, or retirement (Kozel & Alderman, 1990; Dinkelman & Pirouz, 2002; Guest & Parr, 2013). The LFP impacts of various crime rates may also differ by age group based on real and perceived vulnerability: for instance, individuals aged 16–34 are most frequently assaulted in South Africa (Stats SA, 2019a: 47), while Chakraborty et al. (2018) find that crimes against women deter women aged 21–40 from the labour force while not affecting older women.

The probability of LFP is also expected to increase for all individuals with increased years of education as a result of the higher associated returns (Kozel & Alderman, 1990; Dinkelman & Pirouz, 2002; Hosney, 2016). We also include marital status. Per

the literature, women who are married or live with their partners are less likely to participate in the labour force as they may depend on their partner's income, while, conversely, married men are more likely to participate (Dinkelman & Pirouz, 2002; Casale, 2003; Hosney, 2016). Similarly, we expect FLFP to decrease with the number of young children in the household owing to traditional roles in childcare: FLFP is particularly impeded by children below primary-school age who require more supervision at home, especially where daycare is unaffordable (Kozel & Alderman, 1990; Casale, 2003; Hosney, 2016).

At the household level, we include both labour market and non-labour market income to account for socioeconomic status. Some ambiguity exists, however the probability of LFP generally decreases with non-labour income for both genders (Kozel & Alderman, 1990) while FLFP is often higher in lower-income households overall as women are pushed to work by necessity (Casale, 2003; Klasen & Pieters, 2012). Heterogeneity is therefore expected: Chakraborty et al. (2018) and Siddique (2018) find a lower deterrent impact of crimes against women for lower income households, although we posit that high-income individuals may also experience higher deterrence owing to their ability to insulate themselves from crime residentially, in commuting methods, and otherwise.

In the South African context in particular, households' receipt of child grants or pension is often key to subsistence and the LFP decisions, of all members, especially women (Dinkelman & Pirouz, 2002; Eyal & Woolard, 2011). We include the number of pensioners and a child grant indicator over and above non-labour income to separate these effects from higher SES households' interest and rent earnings.

We also distinguish between urban, farm, and traditional areas of residence. The relative impact of crime on FLFP deterrence for urban versus non-urban strata is ambiguous. We may expect higher marginal FLFP deterrence owing to perceived crime victimisation risks associated with work outside the home for non-urban strata if reversion to subsistence farming is more feasible. However, since our FLFP outcome includes agricultural work, we may observe lower deterrence for non-urban residents who substitute into this sector given that rural commutes are less risky according to SA crime perceptions (Stats SA, 2015) and are likely to be shorter.

Finally, provincial fixed effects are included in all cases to control for province-level factors that are omitted or unobservable and potentially confounding, like local labour market conditions.

3.2. Estimation

Given the binary nature of the outcome variable, probit regressions are estimated using the maximum likelihood method with STATA16:

$$FLFP_{iht} = (\beta_0 + \beta_1 SexCrime_{dt} + \beta_2 X_{it} + \beta_3 X_{ht} + P + \varepsilon_{iht} \geq 0) \quad (1)$$

where in year t , $FLFP$ represents the latent decision of female individual i living in household h in district d to work or seek work (outside the home), $SexCrime_{dt}$ is the sex crime rate in the individual's district of residence, X_{it} is a vector of individual-specific controls, X_{ht} is a vector of household-specific controls, P is a vector of provincial fixed effects

introduced through dummy variables, and ε_{ihdt} is the error term. The standard errors are clustered at the district level in order to account for the hierarchical data structure.

In studies of factors affecting individuals' LFP, controls are often correlated in substantial and complex ways, leading to multicollinearity and difficulty estimating impacts with precision. We therefore progressively phase in controls, noting any changes in variables' signs and significances towards the full specification. As we work with survey self-report and crime data, we acknowledge the presence of measurement error. Survey data's validity depends on respondents' accuracy and honesty, while under-reporting of crime incidents to the police in South Africa is an established problem. For instance, the percentage of crime victims surveyed by Stats SA (2019a) who reported incidents to the police ranges from 35% for street robbery to 50% for assault. Notably, Stats SA (2019a) finds that an estimated 88% of sex crime victims reported incidents to police, but a small sample and the stigma of sexual assault cast doubt on this figure's representativity. It needs to be noted that the study is based on the assumption that any under-reporting of sexual crime is random and is devoid of systemic pattern that could bias the estimates. This can be pointed out as a study limitation.

Several sources of endogeneity threaten our ability to isolate the deterrent impact of crime victimisation risk on LFP. Most concerningly, negative crime-LFP relationships may reflect reverse causality through unemployment's strong contribution to property crimes and moderate contribution to sexual and other violent crimes (Chiricos, 1987). This is much less likely given our female sample: criminal profiles in South Africa and elsewhere indicate that contact crimes, especially sex crimes, are overwhelmingly perpetrated by males (Hindelang, 1979; Heidensohn, 1989; Kanazawa & Still, 2000; SAPS, 2020). Further, unemployment's impact on crime is generally found to be the strongest for young males (Lee & Holoviak, 2006; Grönqvist, 2011; Aaltonen et al., 2013; Caruso, 2015). However, Caruso (2015) also finds a causally ambiguous positive relationship between several nations' female unemployment rates and rape in particular, which could reflect the deterrent effect of rape on LFP but could also suggest that women of low socioeconomic status (SES) are more vulnerable to crime. They may lack the monetary means to insulate themselves by living in favourable low-crime areas or using safe commuting methods and may be reliant on abusive partners' incomes. A cycle would result from low LFP to high crime victimisation risks to low LFP and so on. Accounting for SES is therefore crucial to our success in testing the causal mechanism and direction of deterrence specified.

Additionally, a positive relationship between crime and LFP might arise if working persons are more likely to be victimised during commutes and other work-related activities and/or more willing and able to report crimes (Siddique, 2018; Chakraborty & Lohawala, 2019). This could wholly or partially counteract the negative crime-FLFP relationship.

Given these sources of endogeneity and measurement error, we recognise that causal inference necessitates the validation of results using an instrumental variable (IV) approach over and above extensive controls. Ideal instruments for crime in this context are scarce given its socioeconomic determinants. Community Survey data provides the youth male (aged 15–34) share of each district's population, a valid instrument for crime rates insofar as it coincides with criminal profiles without affecting FLFP directly. Where appropriate, we compare results from the simple two-stage least squares (2SLS) approach (control function estimator) used in this context by

Chakraborty & Lohawala (2019) with Lewbel's more complex but more contextually reliable special regressor method for binary-outcome models with endogenous and mis-measured regressors (Lewbel & Dong, 2015). Clustered standard errors are used for both 2SLS and Lewbel regression estimations considering the hierarchical data structure.

Recognising that multicollinearity between two key variables in the model, sex crime rate and educational attainment, may reflect a mediating relationship, a structural equations approach is used to reveal the paths of impact. A structural equation model (SEM) allows a multi-equation estimation approach with multiple dependent variables (in this case, FLFP and educational attainment, both of which are potentially impacted by regional sex crime rate). The SEM allows for the estimation of the direct effect of sex crime rate on FLFP as well as the indirect effect of the sex crime rate on FLFP through its impact on educational attainment. Given the bivariate nature of FLFP, we adopt a multilevel Generalised SEM (GSEM) estimation which can account for non-normal distributions of variables. The multilevel model accounts for the district level variable (crime rate) included in the estimation when the outcome variable (FLFP) is at the individual level. Various models are tried, and the model with the lowest AIC is the model chosen for presentation.

4. Empirical analysis and discussion

4.1. Descriptive statistics

Between 2012 and 2017, there is a fall in the reported average sex crime rate. Also, we find that the average proportion of women in our sample participating in the labour force has increased (Table 1). In 2017, around 56% of women participated in the labour force, up from around 49% in 2012. On average, women in the sample are in their thirties. As expected in panel data, the average age has increased between the two periods. Black Africans account for 83.3% of the sample, which is in keeping with the demographics of the country. Although the average of the education variable has increased, it is still relatively low at 9.3 years. Changes are visible over the time periods in relation to income, marital status, etc. Relatively low levels of education and a relatively high proportion of women who are married and living with very young children (below primary-school age), as well as a relatively high share of women living in traditional areas as opposed to urban areas, are all likely to contribute to relatively low rates of FLFP.

4.2. Probit regression results

The results from probit regression estimations are presented in Table 2. We find a negative and significant relationship between the district sex crime rate and labour force participation that is robust to the inclusion of a wide variety of controls. For women, the persistent negative relationship between sex crimes in particular and FLFP is consistent with the literature (Chakraborty et al., 2018; Siddique, 2018; Chakraborty & Lohawala, 2019). Interestingly, the relationship is robust to the inclusion of all controls except the years of education variable. This could suggest that the risk of sex crime victimisation discourages women from participating in the labour force both directly and indirectly through discouraging them from education and lowering their expected returns from

Table 1. Individual and household characteristics / demographics.

	2012		2017	
	Mean	St.Dev	Mean	St.Dev
Sex crime rate (per 100 000 population)	130.43	38.23	100.94	32.59
Female Labour force participation	.493	.499	.556	.497
Age in years	34.227	13.29	39.033	13.295
Black African	.833	.373	.832	.373
Ever worked	.051	.221	.089	.285
Years of education	8.871	3.693	9.341	3.754
Married	.237	.425	.278	.448
Divorced / separated	.023	.151	.032	.176
Widowed	.058	.233	.103	.304
Never married	.604	.489	.524	.499
Household monthly labour market income	5322.4	7912.9	7196.4	9651.4
Household monthly non-labour-market income	1912.034	2790.3	3175.9	3885.9
Number of working age adults in household	3.427	1.949	3.187	1.834
Number of pensioners in household	.178	.427	.165	.413
Number of very young children in household	.924	1.1	.851	1.038
Receipt of a child support grant	.478	.496	.522	.5
Urban resident	.49	.5	.523	.5
Farm resident	.061	.239	.059	.235
Traditional area resident	.449	.497	.419	.493

Source: Authors' calculations.

working. This is consistent with international and local evidence on worsened educational outcomes for women deterred by crime in their areas, including interviews by Bhana (2012) where South African girls living in townships describe the prevalence of sexual violence in and around their schools, including predation by male teachers and peers, and express substantial associated fears.

As discussed, endogeneity is possible, albeit theoretically less likely to account for the observed sex-crime-LFP relationship in our female sample than in a male sample. We therefore undertake instrumental variable two-stage least squares (IV-2SLS) pooled probit regressions (control function estimator) and Lewbel's special regressor estimation with pooled data next. Given complex potential endogeneity between sex crime rates, and FLFP, we make use of the youth male share of the district population as discussed as the instrumental variable. We also add the second lag of the other violent crime rate which is correlated with sex crime rate but not directly related to FLFP (Table A1). The IV-2SLS (control function estimator) results yield little evidence of endogeneity in the relationship between FLFP and regional sex crime rate as indicated by the insignificant Wald test of exogeneity (Table A2). Nevertheless, given the documented unreliability of the IV-2SLS method for binary dependent variable estimation, we present the results of an instrumental variable estimation particularly suited to binary dependent and mismeasured endogenous variables, the special regressor method by Lewbel & Dong (2015). Using age as the special regressor variable, the average marginal effects from average index function (AIF) provide the probabilities associated with a 1% increase in sex crime rate as causing significant decline in FLFP in model (2) in Table 3. The results of the special regressor estimations mirror those of the probit estimations, with the sex crime rate variable retaining its negative relationship with FLFP but becoming insignificant in the presence of the education variable.

The Wu-Hausman test confirms an absence of endogeneity of sex crime rate. The robustness of the negative significant sex-crime-FLFP relationship gains validity in this

Table 2. Probit regression results (dependent variable: FLFP).

VARIABLES	Pooled Probit#	Pooled Probit#	Pooled Probit#	Panel Probit	Panel Probit
Sex crime rate	−143.5*** (46.89)	−81.38 (75.07)	−129.1* (74.39)	−68.20 (63.87)	−145.8** (64.00)
Education		0.082*** (0.00926)		0.091*** (0.0077)	
Age		0.242*** (0.0136)	0.248*** (0.0136)	0.323*** (0.0145)	0.338*** (0.0147)
Age squared		−0.003*** (0.0002)	−0.00309*** (0.000173)	−0.004*** (0.0002)	−0.004*** (0.0002)
African		0.220*** (0.0844)	0.213** (0.0842)	0.0395 (0.0655)	0.0478 (0.0661)
SA citizen		0.310*** (0.102)	0.431*** (0.0976)	0.417*** (0.0900)	0.560*** (0.0899)
Married		−0.402*** (0.0639)	−0.386*** (0.0647)	−0.558*** (0.0540)	−0.540*** (0.0540)
No. young children		−0.0254 (0.0275)	−0.0347 (0.0273)	−0.0457** (0.0218)	−0.0559** (0.0219)
Household labour income		1.54e-06 (3.58e-06)	8.53e-06** (3.85e-06)	4.20e-06 (2.67e-06)	1.22e-05*** (2.63e-06)
Household non-labour income		−1.01e-05 (7.02e-06)	−3.52e-06 (7.29e-06)	−1.07e-05* (6.11e-06)	−1.34e-06 (6.44e-06)
Urban resident		−0.0168 (0.119)	0.0758 (0.113)	−0.158* (0.0864)	0.00633 (0.0865)
Traditional Area resident		−0.132 (0.120)	−0.0841 (0.115)	−0.256*** (0.0914)	−0.175* (0.0922)
No. working age adults		−0.121*** (0.0152)	−0.141*** (0.0149)	−0.166*** (0.0133)	−0.187*** (0.0135)
No. pensioners		0.0712 (0.0727)	0.0729 (0.0753)	0.00377 (0.0546)	−0.00301 (0.0550)
Child grant receipt		−0.0155 (0.0555)	−0.0567 (0.0549)	0.0312 (0.0453)	−0.00991 (0.0455)
Province fixed effects		Yes	Yes	Yes	Yes
Constant	0.331*** (0.0562)	−4.526*** (0.293)	−3.745*** (0.283)	−5.611*** (0.296)	−4.904*** (0.279)
Log likelihood	−9448.21	−4326.95	−4420.7832	−4252.0987	−4336.4725
LR chi2		1754.61***	1628.72***		
Wald chi2	6.42**			743.81***	735.62***
Pseudo R2	0.0003	0.1910	0.1753		
Observations	11 815	8408	8431	8408	8431
Number of pid				5408	5412

Source: Authors' calculations.

Standard errors in parentheses are clustered at the district level.*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

light. A negative causal relationship between sex crimes and FLFP with years of education as a channel seems to stand.

It is clear that the interrelationship between sex crime rates and women's education needs to be explored further. Using a Generalised Structural Equation model (GSEM), the next segment of the study explores the pathways and mechanisms of indirect effects of sex crime rates (via the mediating effect of education) on FLFP. The sample for this segment of analysis is smaller as it is restricted to the non-movers: those who continue to reside in the district of their birth. This restriction allows an examination of the relationship between women's education and past crime levels in their current district of residence. While data on sex crime rates is available as far back as 2010, the maximum age in the non-mover sample is 65 years, suggesting that crime rate data further back would

Table 3. Special regressor estimation: (dependent variable: FLFP).

VARIABLES	(1) Coefficient	Avg marginal effects	(2) Coefficient	Avg marginal effects
Age		.0143924		.01021033
Sex crime rate	−1534 (1446)	−22.083259	−3863** (1714)	−39.437884
education	2.303*** (0.0857)	.03314995		
SA citizen	0.0904 (1.190)	.0013012	2.261 (1.409)	.02308398
Married	−9.908*** (0.668)	−.14260461	−15.04*** (0.782)	−.1535641
No. young children	1.472*** (0.311)	.02118298	1.955*** (0.369)	.01995976
Household labour income	−6.36e−05* (3.82e−05)	−9.154e−07	0.000273*** (4.18e−05)	2.785e−06
Household non-labour income	−0.000450*** (9.50e−05)	−6.481e−06	−0.000437*** (0.000110)	−4.458e−06
Urban residence	0.776 (0.817)	.01116837	3.233*** (0.964)	.03301204
Traditional area residence	2.060* (1.218)	.02964137	1.931 (1.449)	.01971263
No. working age adults	−1.554*** (0.172)	−.02236336	−2.586*** (0.202)	−.02640147
No. pensioners	0.487 (0.758)	.00700822	0.211 (0.896)	.00215898
Child grant receipt	4.711*** (0.609)	.06779623	5.715*** (0.722)	.05835047
Year	−0.333** (0.150)		−0.273 (0.178)	−.00279163
Provinces	Yes		Yes	
Constant	−5.403 (3.988)	−.07775889	19.14*** (4.618)	.19544889
Observations	8198		8221	
Wald chi2	1500.77***		624.23***	
R-squared	0.146		0.081	

Source: Authors' calculations.

Notes: Standard errors in parentheses are clustered at the district level. Instrumented: lag sex crime rate. Instruments: SA ID, married No. young children, Household labour income, Household labour income, urban residence, farm residence, No. of working adults, No. of pensioners, child grant receipt, year, provinces (wc ec nc fs kzn gp mp lp,) lag 2 sexcrime rate lag male youth share.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

be required to capture the relationship of interest during older individuals' prime years of education. The analysis therefore builds on the assumption of persistence of crime rates in a region (Stahura & Huff, 1981; Cerro & Ortega, 2012). As a means of checking the validity of the results, the sample was further restricted to those in the age group 15–40 years for the GSEM estimation. The results for the younger sample and the full sample correspond substantially, indicating crime-rate persistence as noted in the literature, and the validity of our results (Table 4). The full non-mover sample reveals a negative but insignificant direct relationship between the sex crime rate and FLFP. However, the sex crime rate has a negative and significant association with education, and, considering the significant and positive effect of education on FLFP, the indirect negative impact of the sex crime rate on FLFP is evident. The sub-sample of non-movers show a significant direct negative effect of the sex crime rate, and this is further compounded by the indirect mediating effect through education. The total effect sex crime rate via the

Table 4. Generalised structural equations model results.

VARIABLES	ALL NON-MOVERS		NON-MOVERS < 40 years	
	FLFP	Education	FLFP	Education
Education	0.189*** (0.0272)		0.260*** (0.0665)	
Age	0.352*** (0.0449)	0.230*** (0.0264)	0.573*** (0.182)	0.425*** (0.0797)
Age squared	−0.00408*** (0.000571)	−0.00412*** (0.000316)	−0.00813** (0.00317)	−0.00772*** (0.00139)
Sex crime rate	−890.5 (572.4)		−1587** (777.1)	
Sex crime rate_lag 2		−968.8*** (157.7)		−771.1*** (171.7)
SA ID	0.178 (0.370)	1.566*** (0.230)	0.317 (0.535)	1.687*** (0.243)
Married	−0.274 (0.201)		−0.0550 (0.353)	
No. young children	−0.0967 (0.0825)		−0.0464 (0.112)	
Urban	0.806** (0.335)	1.422*** (0.120)	0.727* (0.421)	0.613*** (0.129)
Farm	14.10 (351.4)	−0.687*** (0.220)	11.31 (419.9)	−1.349*** (0.233)
No. working age adults	0.0761 (0.0513)		−0.0118 (0.0700)	
No. pensioners	−0.478*** (0.163)		−0.285 (0.219)	
Child grant receipt	0.321* (0.182)		0.515* (0.265)	
Year	−0.0163 (0.0381)		−0.0891* (0.0536)	
Mother's education		0.335*** (0.0141)		0.171*** (0.0137)
Constant	−7.834*** (1.256)	4.481*** (0.546)	−9.835*** (2.565)	3.007*** (1.054)
Log pseudolikelihood	−28117.663		−12580.891	
var(e.yearsedu)	11.25**		5.725***	
Observations	4713	4713	2136	2136
Indirect effect	−183.103		−200.487	
Total effect	−1073.603		−1787.7	
% of tot effect mediated		17.05%		11.21%

Source: Authors' calculations. Standard errors in parentheses are clustered at the district level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

education effect is negative¹ and significant at the 90% significance level for the full non-mover sample, and is also negative² and significant at the 95% confidence level in the younger sample.

5. Study limitations and future research recommendations

As discussed, studies of this nature are limited by multicollinearity, measurement error, and endogeneity through multiple, complex channels. Multicollinearity limits our ability to quantify the magnitude of the deterrent effect of the sex crime rate on women's LFP with precision. Endogeneity and measurement error have been addressed by IV-2SLS and Lewbel's special regressions, although instruments in this context are hard to come by and theoretically imperfect. Nevertheless, their statistical validity seems to stand.

¹ −1073.8 calculated as $([-890.5 + (0.189x - 968.8)])$.

² −1787.7 calculated as $([-1,587 + (0.260x - 771.1)])$.

Since the proposed mechanism linking reported crime rates to LFP deterrence relies on individuals' awareness of crime in their area and the accuracy of these perceptions, future studies in the South African context could also account for factors like the media coverage of various crimes and individuals' exposure to this, e.g. crime reports for a particular area in the media using Global Database of Events, Language, and Tone (GDELT). Direct measures of crime perceptions are ideal, while residential area identifiers at a more precise scale than district municipalities, e.g. police precinct, would allow researchers to determine the level at which crime variables best reflect individuals' (perceived) risk exposure. Improved utility and coverage of crime perception variables would benefit future research greatly.

Despite these shortcomings, however, the key finding of sex crimes deterring women from labour force participation (LFP) remains robust and consistent with the literature, and this analysis makes an important contribution due to its unique context, the methodological improvements and by highlighting the mediating role of education.

6. Conclusion and implications

Through estimating the association between sex crime rates and the labour force participation of women residing in each of South Africa's 52 district municipalities in a panel covering two annual periods, 2011/2012 and 2016/2017, this study finds a negative significant relationship between the incidence of sex crimes reported to police in a district and the probability that a woman residing in that district participates in the labour force.

This relationship is robust to the inclusion of a wide variety of controls and persistent in a number of instrumental variable regressions where no evidence of endogeneity is found. We interpret this as evidence that women living in districts with high sex crime rates perceive a higher sex-crime victimisation risk associated with activities outside the home, including work-related risks during commuting, in the form of workplace sexual harassment, or otherwise, and as such are deterred from LFP outside the home. This makes sense given the wealth of evidence that fears of crime prompt South Africans to alter their everyday behaviour to avert the risk of victimisation (Stats SA, 2015) as well as the prominence of sex crimes and crimes against women in South Africa's crime discourse (SAPS, 2023). While multicollinearity prevents precise estimation of the magnitude, our findings suggest that sex crime rates contribute to the participation gap.

Overall, our findings are consistent with similar studies from India – a high crime developing nation like SA (Chakraborty et al., 2018; Siddique, 2018; Chakraborty & Lohawala, 2019). All three find a negative significant effect of the (perceived) sex crime victimisation risk, by various measures, on FLFP in an area. A novel, but unsurprising, finding in our study is the appearance of years of education as a channel through which the negative significant sex-crime-FLFP relationship largely operates. Our analysis suggests that high district sex crime rates deter girls and women from furthering their education, likely accounting for much of the associated lower FLFP as a result of consequently worse prospective labour market outcomes. While establishing causality requires further investigation, this is consistent with interviews by Bhana (2012) where girls living in townships in SA detail a loss of freedom owing to the substantial threat of sex crime victimisation in their schools, including at the hands of male teachers and classmates, and in the neighbourhoods they navigate to get there.

The deterrent effects of the perceived sex crime victimisation risk on women's education and LFP could trap them in high-crime contexts, increasing their vulnerability to victimisation in a vicious cycle, in part since FLFP contributes to women's financial independence, empowerment, and bargaining power in the home, among other key policy considerations including child health outcomes, human capital, and overall economic growth and development (Verick, 2014; Heath & Jayachandran, 2017). Our findings are therefore of interest to economists, activists, and policymakers alike, highlighting the need to consider the important and often overlooked costs of sex crimes beyond harm to victims themselves.

In particular, this analysis points to the risk-averting behaviour that extends to women in the general population who, perceiving a high risk of victimisation, face restricted freedoms and worse educational and economic outcomes.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix

Table A1. Probit results: other violent crimes on women's LFP.

VARIABLES		(1) Lfp	(3) Lfp
Lag 2 violent crime rate	−4.743 (8.449)	2.475 (3.953)	−1.753 (3.902)
Age yrs		0.245*** (0.00857)	0.252*** (0.00846)
Age squared		−0.00293*** (0.000110)	−0.00315*** (0.000107)
Black African		0.0344 (0.0443)	0.068 (0.0443)
Education		0.0685*** (0.00524)	
Household labour income		3.04e−06 (2.00e−06)	9.83e−06*** (1.94e−06)
Household non-labour income		−8.33e−06* (4.70e−06)	−1.14e−07 (4.91e−06)
SA ID		0.310*** (0.0686)	0.423*** (0.0672)
Married		−0.446*** (0.0379)	−0.430*** (0.0374)
No. young children		−0.0292* (0.0165)	−0.0364** (0.0164)
Urban resident		0.000948 (0.0394)	0.0769** (0.0385)
No. working age adults		−0.128*** (0.00926)	−0.142*** (0.00915)
No. of pensioners		−0.0113 (0.0407)	−0.0177 (0.0404)
Child grant receipt		0.0236 (0.0342)	−0.00978 (0.0339)
Constant	−.2613	−4.423*** (0.167)	−3.814*** (0.158)
Observations	13 659	8408	8431

Standard errors in parentheses, are clustered at the district level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2. IV-2SLS regression results.

IV-2SLS VARIABLES	(1) LFP	(First-stage) Lag sex crime rate
Lag sex crime rate	−37.06 (65.77)	
Age	0.245*** (0.00857)	7.88e−07 (1.69e−06)
Age squared	−0.00293*** (0.000110)	−2.31e−08 (2.18e−08)
Education	0.0687*** (0.00530)	−7.64e−06*** (1.06e−06)
Household labour income	3.13e−06 (2.02e−06)	−2.77e−09*** (3.96e−10)
Household non-labour income	−8.07e−06* (4.71e−06)	−5.27e−09*** (9.75e−10)
SA ID	0.312*** (0.0687)	−2.18e−05 (1.34e−05)
Married	−0.447*** (0.0380)	2.67e−05*** (7.57e−06)
No. of young children	−0.0290* (0.0165)	−2.91e−06 (3.38e−06)

(Continued)

Table A2. Continued.

IV-2SLS VARIABLES	(1) LFP	(First-stage) Lag sex crime rate
Urban resident	0.00436 (0.0383)	−2.90e−05*** (7.84e−06)
No. of working adults	−0.128*** (0.00928)	5.90e−06*** (1.86e−06)
No. of pensioners	−0.0125 (0.0407)	3.19e−05*** (8.18e−06)
Child grant receipt	0.0241 (0.0343)	−1.45e−05** (6.83e−06)
Lag 2 violent crime rate		0.0594*** (0.000787)
Lag males youth share		0.00190*** (0.000207)
Constant	−4.444*** (0.180)	0.000983*** (4.95e−05)
athrho2_1	−0.0344 (0.0243)	
Insigma2	−8.171*** (0.00771)	
Wald test of exogeneity	1.49	
Observations	8408	8408

Source: Authors' calculations.

Notes: Standard errors in parentheses are clustered at the district level. Instrumented: Lag sex crime rate. Instruments: Age squared, Education, Household labour income, Household labour income, SA ID, Married. No. young children, urban, No. of working adults, No. of pensioners, child grant receipt, Lag 2 other violent crime rate, lag male youth share.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.