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Modernization and female labour force participation in Oman: spatial modelling of local variations

Shawky Mansour ^{a,b}, Talal Al-Awadhi^a, Noura Al Nasiri^a and Ali Al Balushi^a

^aGeography Department, College of Arts and Social Sciences, Sultan Qaboos University, Muscat, Oman; ^bDepartment of Geography and GIS, Faculty of Arts, Alexandria University, Alexandria, Egypt

ABSTRACT

In spite of the fact that labour market structures and mechanisms vary geographically between countries from the same region as the Gulf Cooperation Council (GCC) states, spatial variations of labour force participation can also be identified in every single country. Local variations in women's employment are often influenced by several driving forces particularly modernization characteristics. In this research, advanced GIS algorithms were utilized to model female labour force participation (FLFP) in Oman. Several explanatory variables such as female education, urbanization, private sector jobs, divorce rates and female administrative jobs were used as predictors of FLFP rates. The global Ordinary Least Squares (OLS) and local Geographically Weighted Regression models were fitted to spatially investigate and predict the distribution patterns of FLFP rates over the Omani wilayats. Although the global model fitted the female employment data moderately well, the findings of the GWR model seems inherently more realistic since they allow the impacts of various parameters on FLFP to vary spatially over space. The results of this study revealed that education and urbanism both have significant positive impacts on predictions for the labour force participation of women. The synergy of local spatial modelling with GIS techniques provides insights into improving women's employment shares in Oman. Quantifying spatial variations of FLFP rates and their associations helps further our understanding of the driving forces which are responsible for modernization while at the same time recognizing the factors that increase or decrease women's participation in the local labour.

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Modernization; female labour force; GIS; spatial modelling; Oman

1. Introduction

Although the modernization phenomenon is quite tangled, it generally refers to the deeper socioeconomic changes in any society particularly in human development and in terms of the direction for attaining modernity. As a process, modernization also indicates the transition from traditional to industrial and technical communities. Therefore, numerous socio-economic drivers are associated with the modernity process such as education, female labour force participation (FLFP), urbanization, industrial, technological, and services economies. Modernization in most of the Gulf Cooperation Council (GCC) states has directly positively impacted on women's participation and roles in ongoing socioeconomic development. The rise in FLFP across the GCC states since the boom in oil revenues in the last century is also associated with pronounced social, cultural change and a clear shift towards modernization (Randeree 2012). Women's engagement in the labour market particularly in the public sector has significantly increased in the last decade. Nevertheless and despite a general rising trend in FLFP

rates in the GCC states, there are noticeable variations in the level of women's labour market integration between these countries. This variation holds true not only regionally and among the GCC countries, but also locally within each country. The spatial variations in the mechanism for female employment are more complex since all local communities are not similar in terms of causative, factors and drivers of FLFP. Relying on this assumption, local differences among each country are often explained by variation in modernizations characteristics particularly urbanization, literacy and education.

Despite significant progress in the last few decades regarding FLFP in the GCC, percentages of participation remain low. Besides this, labour markets in the GCC, like many other countries in the world, are still shaped by gender issues. Paradoxically, the women in these countries not only carry out most of the unpaid work but also rely on importing female domestic workers (Zerovec and Bontenbal 2011). This low female participation reduces women's contributions to the economy and consequently, diminish any achievement in terms of local development.

CONTACT Shawky Mansour  shmansour@squ.edu.om  Geography Department, College of Arts and Social Sciences, Sultan Qaboos University, P.O. Box: 42 Al-Khoud P.C. 123, Muscat, Sultanate of Oman

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The GCC states can be classified into three categories in terms of female labour force participation (Figure 1). The first category is those countries that are characterized by 'moderate' percentages of women's participation in the labour market. This category includes only Kuwait which has higher female participation in the labour market (47%). The second category involves Qatar and Bahrain with relatively limited rates of women's participation in the labour market, accounting for approximately 35% of all working-age females. The third and final category consists of three countries (Oman, Saudi Arabia and the UAE) and it is characterized by a low FLFP rate.

Before the discovery of oil in the GCC communities, the separation of family life from paid work was the major pattern of the labour force, with women responsible for domestic tasks and men for the paid work outside the home. The sexual division of labour and the exclusion of woman from the labour market were mainly associated with traditional attitudes and social norms. However, the idea of work division between men and women which is referred to as labour market segregation also exists globally and even in Western countries before the industrial revolution (Hakim 1996).

Since the ascension of His Majesty Sultan Qaboos Bin Said in 1970, the modernization process and socio-economic development have brought enormous improvements in education, technology usage, public health and empowerment of women. The governmental policies played a significant role in the advancement of women's contributions to and participation in the labour force. Al Riyami, Afifi, and Mabry (2004) carried out a bivariate analysis to investigate the impacts of women's autonomy, education and employment on contraceptive use in Oman. The findings indicated that the education factor was a key variable in determining women's employment status. Likewise, the educational level of married women was as a major predictor of fertility rates and family planning.

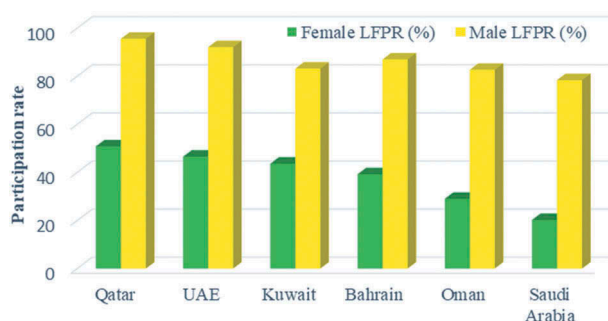


Figure 1. Gender gap in labour participation rate in the GCC countries.

A shrinking gender gap in employment was promoted through government policies shaped around the principles of modernization particularly education, women's empowerment and political participation. Likewise, the government policies stimulate increasing female employment; in particular substantial facilities to wives' labour force participation were enshrined in work law and regulations. The increased percentages of employed women were strengthened by the process of migration from the rural areas to urban agglomerations specially Muscat, 'the capital of the country'. However, still there are some challenges for female participation in the labour markets especially for large groups of women living in rural and desert areas. In specific local communities, the modernization processes are usually blocked by cultural attitudes, social norms, and traditional customs. Further, these areas show lower rates of FLFP due to lack of education and marketable skills as well as unfavourable labour market conditions specifically in the private sector.

From the perspective of the duality of modernization versus tradition, Belwal, Belwal, and Saidi (2014) investigated the motivations and challenges of women entrepreneurs in Al Dhahra governorate in Oman. The findings identified specific barriers which hinder women's success in the business domain primarily in terms of financial resources, knowledge of developing business, and social support. Another study addressed women's entrepreneurship in the Al-Batnah wilayats, in Oman (Al-Sadi, Belwal, and Al-Badi 2011). The authors found that there are many challenges inhibiting women's entrepreneurship in particular in terms of the socio-cultural norms and family chores.

Utilizing GIS modelling techniques, the overall aim of this research is to examine the spatial variation patterns of FLFP rates. Furthermore, this study seeks to quantify spatially the essential explanatory factors which influence women's employment in Oman. In order to achieve this aim, the following research questions have been raised:

- Is the relationship between FLFP and modernization characteristics spatially stationary or nonstationary?
- To what extent do the impacts of modernization factors on female employment vary geographically?
- What are the main modernization characteristics underlying the geographic variation in FLFP in Oman?

2. Literature review

In the non-spatial literature, strand lines and theoretical frameworks have been introduced to explain the increased trends in FLFP specifically the structural, the

institutional, and the cultural approaches (e.g. Pfau-Effinger 1998; Metcalfe 2011). The structural model explains the rise in FLFP in any community as a result of the rapidly rising use of technology in daily life, higher rates of female education, and lower fertility rates. Furthermore, this theoretical model investigates the link between FLFP and modernization as a U-shaped relationship (Goldin 1994; Mammen and Paxson 2000). According to the model, in the first stage, in spite of the higher rate of fertility in agricultural societies, women participate in unpaid work particularly on household farms and in terms of domestic caring and rearing. The model also explains women's employment due to the economic necessities and low family income (Dixon 1982). Yet, this model is not applicable in terms of women's employment in the agricultural sector. Agriculture has limited contributions to the economy according to climatic conditions and lack of water resources. Consequently, foreign labour and immigrants are generally dominant in agricultural activities. In the second stage of development, FLFP declines since industrial activities are not attractive or preferred for women's work. Similarly, the increase in the family income decreases the necessities for married women to work outside the home. This stage is similar to the period of socioeconomic development and increased investment in infrastructure projects and the service sector. This sector is also not the preferred work domain for females according to various cultural and social norms. Arguably, the proponents of the structural approach believe that changing gender roles are a consequence of the strong association between cultural and attitude changes and modernization (Haller and Hoellinger 1994; Fortin 2005). However, the most important critique of the structural approach is that the model considers the FLFP drivers such as the increased female education rates and fertility decline as exogenous factors (Drobnič, Blossfeld, and Rohwer 1999). In other words, paradoxically, the increase in educational attainments and the decrease in fertility rate have not led to increases in FLFP rates in several countries.

To solve this paradox, the institutional approach investigates the factors and indicators that are responsible for variations in FLFP rates in the modern states (Blekesaune and Quadagno 2003; Kremer 2007). The welfare state, as an employer, is a provider of public services such as childcare and health facilities. Likewise, provision of maternity and parental leave promote women to join the labour market (Meyers, Gornick, and Ross 1999; Mandel and Semyonov 2006). In the GCC states, females prefer to work in the governmental sector, particularly married women (Mansour 2018). Supporting employed

women, the GCC governments provide employed women with child benefits, allowances and paid maternity leave (Belwal and Belwal 2014; Kelly 2009). The provision of such services lessens the financial burdens of private childcare services and induces married women to join the labour market. The institutionalist approach, however, suffers from drawbacks related to global and regional comparisons not only because, apart from Western countries, a rudimentary welfare system may exist, but also cross-sectional ecological studies (e.g. Evertsson and Grunow 2012; Matysiak and Steinmetz 2008; Baranowska-Rataj and Matysiak 2016) come with different conclusions of women employment explanatory. The variation in the explanatory power is mainly due to the differences of socioeconomic characteristics in each country.

The cultural approach explains FLFP based on the dynamism of culture, social norms, and attitudes particularly towards gender roles and equality (Fernández 2013; Pfau-Effinger 2017). The cornerstone assumption of this approach is that human behaviour is significantly influenced and shaped by culture and behavioural customs. Accordingly, women's employment has been influenced by essential causal factors such as modernization, technology and cultural changes (Moghadam 2003). The cultural approach, however, seems to be an appropriate alternative for the explanation of geographical variations of FLFP rates specifically in developing countries. Some regions are described by predominant traditional gender roles where women do not actively participate in employment outside the home (Foroutan 2008). Nevertheless, the cultural approach fails to provide a sufficiently coherent theoretical framework for explaining women's employment. Preliminary work on female labour in developing countries was undertaken by Spierings (2014). In this research, women's employment positions were classified into four major classes. The first group consists of women who have paid (non-agricultural) jobs outside the home. The second group includes women of home paid works. These two groups share economic independence and increase the family income. The third group is economically active but often in unpaid agricultural work in rural areas. The fourth group is women who are housewives and live either in urban or rural places.

Over the last decade, FLFP has been influenced by modernization components, specifically the achieved progress in the transformational socioeconomic development in the GCC states. The increasing reorganization of women's empowerment strengthens the argument

about whether the rise in education, urbanization, technology usage, social mobility, political participation and other elements of modernization are positively associated with women's employment rates. There exists a vast literature on the geographic diffusion impacts of urbanization and education on the entry of women into the labour force (e.g. Verick 2018; Sudarshan and Bhattacharya 2009; Lillydahl and Singell 1985; Ward and Dale 1992; Smits 1999). In other places such as India, for example, significant variations were identified in FLFP rates between rural and urban areas (Klasen and Pieters 2015). Despite the fact that rapid urbanization often leads to a higher percentage of poor populations living in deprived environments, the rates of educated and qualified women are higher in urban compared to rural places. Consequently, the gender gap in the labour market has been shrinking in cities and urban centres. In contrast, the vast majority of women in rural areas are predominantly employed within the family as unpaid workers (Mustafa Kemal and Naci 2009). Nevertheless, in one seminal work (Özbay 1994), the author argued that the participation rates for women living in both cities and villages in the labour markets vary due to social class, education, qualification, marriage, childbearing, rearing and caring. In addition, the decision of woman to participate in the labour force is not dependent and relies on various factors particularly economic wages and benefits, cultural and social norms. The marriage status of women is an important variable to estimate the variations in FLFP in Oman since housewifely duties usually inhibit married women from participating in the labour market. For instance and in most cases, low or uneducated married women prefer unpaid household work and caring activities. Regarding working in the private sector, women in the GCC do not prefer to work in the informal sectors due to social norms and cultural perspectives. Accordingly, the gender gap of employment in the private sector is higher compared to the public sector. In local communities, various restrictions (e.g. hours and times of work) lessen women's participation in the labour force (World Bank, 2012).

Fertility is a substantial factor which is strongly associated with the determination of FLFP rates and willingness to take up a paid job (Engelhardt and Prskawetz 2004; Roudi-Fahimi and Moghadam 2006). Other researchers (e.g. Goldin and Katz 2002; Bailey 2006) argue that the availability of contraceptive methods has offered great opportunities for married women to join the labour force market and maximize the value of paid work. Hakim (2003) argued that women living in patriarchal communities and who believe in the traditional gender roles are more likely to prefer housewifely duties and unpaid work.

3. Study area and datasets

3.1. Study area

The study area is located in the north of Oman and consists of 40 wilayats (states) that are subnational administrative boundaries below governorate level. While the whole country is divided into 11 governorates, the study area is administratively distributed within eight governorates (Muscat, Al Batnah North, Al Batnah South, Al Sharkya North, Al Sharkya South, Al Dakhliyah, and Al Dhahra) (Figure 2). Muscat is the administrative capital of the country and the centre for industrial, commercial and educational endeavour. Most of the socio-economic activities are concentrated in the governorate as well as the prominent sea ports. The Governorate of Muscat is the centre of the population settlements with the highest population density compared to other governorates. It also attracts the highest number of immigrants who work and live in Muscat, Mutrah, Buwshar and ASeeb cities.

Topographically, Al Batnah is divided into two parts: the Coastal Plain, which spans about 270 km, and the East and West Hajar mountain ranges. Across two governorates (Al Batnah North, Al Batnah South), the Al Batnah coastal plain extends in a northeast-southwest direction. The plain is considered as one of the most important coastal plains, not only in Oman, but also in the south-east of the Arabian Peninsula. It stretches between the Oman Mountains and the Gulf of Oman, with a length of about 270 km and a width of 10–30 km. The two provinces are the centre of agricultural activities and fisheries, and they are the second centre for urban communities after Muscat.

3.2. Datasets

The empirical analysis in this research is based on census data from the 2010 Omani census. Several demographic and socioeconomic variables, particularly education, divorce rate, rural residence and female workers in private sectors, were calculated to model spatial variations and effects on female employment. The central and dependent variable is female labour force participation and it was calculated by dividing the number of females in the labour force by the total number of females (of working age) in the population and then multiplied by 100. All variables were created in the form of a ratio scale and developed as percentages with a range 0 to 100. Table 1 illustrates the dependent and independent variables that were used to spatially model the relationship between modernization and FLFP rates in Oman. The dependent variable was created according to a contrast base between females being active in the

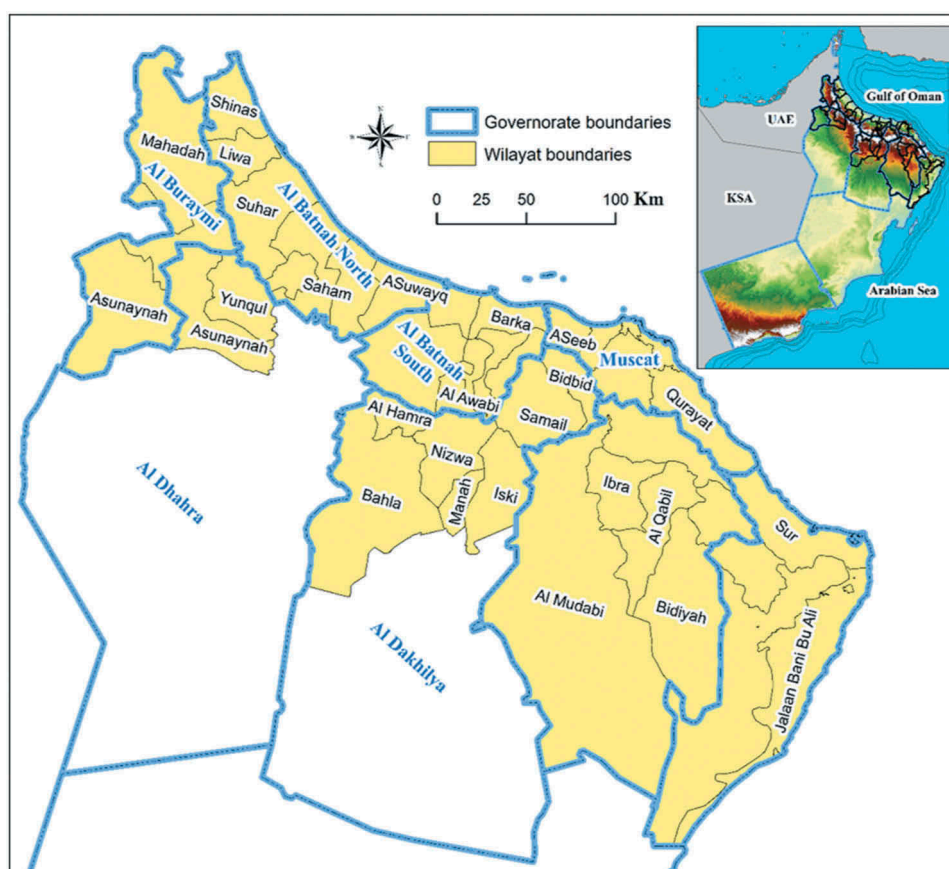


Figure 2. Map of the study area.

Table 1. Descriptive statistics of the dependent and independent variables.

| Variables | Minimum | Maximum | Mean | Std. Deviation |
|---------------------------------|---------|---------|-------|----------------|
| FLFP rate (dependent variable) | 4.71 | 34.07 | 15.58 | 6.82 |
| Education | .00 | 31.75 | 2.50 | 6.45 |
| Divorced female labourer | .62 | 16.67 | 3.20 | 2.55 |
| Female labourer living in urban | 17.2 | 100.00 | 70.57 | 20.59 |
| FLFP in administrative sector | 11.27 | 83.33 | 29.86 | 11.12 |
| FLFP in private sector | .00 | 61.39 | 23.83 | 14.19 |

labour market and being inactive (NCSI, 2019). All females in paid employment, including the self-employed, are counted as active in the labour force. On the other hand, all women who declared themselves as housewives were counted as inactive. Table 2 illustrates the independent variables, their rationale for the effects on the FLFP, and related empirical evidence from the literature.

The spatial data consist of 40 (65.5% of the total number of geographic units) administrative zones (Wilayats) out of 61 used in the regression modelling. Esman et al., (2017) investigated the issue of using minimum sample size in multiple regression models and

pointed out that in behavioural sciences constructing models with small sample sizes generate robust predictions. Similarly, Knofczynski and Mundfrom (2008) utilized Monte Carlo simulations to examine minimum sample sizes for multiple correlation structures and found that in social science research, the regression models that are constructed basically from three independent parameters and squared multiple correlation coefficients between 0.5 and 0.7, sample sizes over 21 produced satisfactory results. In another study, van Proosdij et al. (2016) tested various sample sizes to project tree species' categories in Gabon forest and reported that a low sample size of 25 cases would provide powerful estimates.

4. Methods and analysis

4.1. Ordinary Least Squares (OLS)

The Ordinary Least Squares (OLS) regression is a global model which assumes that the relationships being modelled are stationary. However, when the relationship between a dependent variable and a set of explanatory variables geographically varies over space, the assumption is violated and the model is mis-specified

Table 2. The rationale for the independent variables' effects on the dependent variable.

| Driving forces | The rationale for the factors' effects on female labour force participation | Empirical evidence from the literature |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Education | Education is an important factor in estimating FLFP. As education is an investment in human capital, females with higher education are more likely to join the labour force compared to poorly educated women. The educational level exerts significant positive impacts on FLFP. | – Mansour (2018) – Roudi-Fahimi and Moghadam (2006) – Al Riyami, Afifi & Mabry (2004) |
| Divorced female labourer | Divorced women with low income are more likely to join the labour market and inclined to maintain their connection to the workforce. Divorced women are more likely to have higher wages and higher rates of participation in the labour market. | – Jensen (2017) – Peterson (1989) |
| Female labourer living in urban area | Urbanization is a significant variable influencing women's labour force participation. Women living in urban areas have higher opportunities to join the labour market compared to women living in rural and desert places. The majority of female unpaid workers are found in rural areas. | – Verick (2018) – Sudarshan and Bhattacharya (2009) – Klasen and Pieters (2015) |
| FLFP in administrative sector | The majority of females in Oman as well as the GCC prefer to work in administrative governmental jobs. In the public sector, teaching, nursing, and other jobs are occupied by women. | – Mansour (2018) – Young (2016) |
| FLFP in private sector | There are gender differences in joining jobs in the private sector. Working in the private sector and specific jobs such as manufacturing, agricultural and services are not preferred by women in the GCC states. Several restrictions hinder women from joining private work particularly hours and times of work. | – World Bank, (2012) – Young (2016) – Gallant & Pounder (2008) |

(Fotheringham et al., 2003). In such cases, the relationship is known as spatially non-stationary and the global models, which provide an estimated coefficient for each independent variable across the entire study area, do not consider it. In this research, the relationship between a response variable (FLFP rate) (Y) and a set of explanatory variables ($X_1, X_2, X_3 \dots X_n$) was presented as a line of the best fit. In this linear equation, the Y variable is predicted by X_n variables. The calculation of the model is as follows:

$$y = \beta_0(g) + \beta_1x_1 + \beta_2x_2 + \dots + \beta_nx_n + \varepsilon$$

where y indicates the dependent variable while x_n refers to one or more independent variables. β_0 denotes the intercept and β_1 specifies the slope of the regression line and the parameter estimate for variable 1 and ε illustrates the error term.

The independent variables were created as well as the dependent variable in the same quantitative form of scale. Employing this linear equation in the modelling process, a scientific hypothesis was set based on the assumption that there is a significant relationship between the dependent variable (FLFP rate) and the explanatory variables (the socioeconomic and demographic variables).

The multicollinearity of the OLS model was measured utilizing the variance inflation factor (VIF) where any predictor exceeds the value 7, indicating the existence of a multicollinearity problem. Accordingly, the variable is considered as a linear combination of other independent variables and should be excluded.

Model mis-specification and the spatial autocorrelation of residuals was examined using global **Moran's I** to check for residual clustering. If residuals are clustered, this reveals a mis-specified model. The equation of **Moran's I** is defined as:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\left(\sum_{j=i} \sum w_{ij} \right) \left(\sum_{i=1}^n (x_i - \bar{x})^2 \right)}$$

where n denotes the number of spatial units (wilayats); x_i and x_j indicate the residuals of the two polygons i and j respectively while \bar{x} signifies the mean of x . w_{ij} refers to an element of a matrix of spatial weights.

4.2. Geographically Weighted Regression (GWR)

Unlike traditional global models, GWR allows a local coefficient for each explanatory variable. In other words, changes are allowed locally so that a coefficient is specific to each single location rather than being a global estimate over the entire study area (Kupfer & Farris, 2007). Each spatial unit (wilayats) is calibrated using the target one and its neighbours. Accordingly, the geographical weighting is constructed by fitting a spatial kernel and assigning a spatial weight for each data value based on its distance from the regression point. Following Tobler's (1970) first law of geography, close locations (wilayats) to the target location i (polygon i) have more influence on the calibration than locations further away. Thus, higher weights are assigned to the nearby locations while the weights diminish as a function of distance. The equation of the GWR model is stated as follows:

$$y_i = \beta_0(\mu_i, v_i) + \sum_k \beta_k(\mu_i, v_i)x_{ik} + \varepsilon$$

where $\beta(\mu_i, v_i)$ represents the vector of the location-specific parameter estimates and (μ_i, v_i) indicates the coordinates of location i in space. $\beta_k(\mu_i, v_i)$ indicate a realization of the continuous surface at point i which is a continuous surface of parameter values.

To perform the OLS and GWR modelling process within a GIS environment, ArcGIS software (10 v) was used for data exploration, calculation, modelling and visualization. Spatial statistical and geostatistical modelling were activated and performed to test the spatial autocorrelation and examine the spatial patterns of the relationship between FLFP rate (the response variable) and other socioeconomic parameters (explanatory variables).

5. Results

5.1. Global patterns of FLFP (OLS model)

To select the best model fit with optimal predictors, an explanatory regression tool within ArcGIS was adopted. The passing fitted models were identified and the best one with five parameters and higher R^2 was chosen. Figure 3 shows the geographic distribution of the response variable (Figure 3(a)) and other independent variables over the study area. A large percentage of employed women with master's degrees is primarily concentrated in Muscat governorate in particular ASeeb and Buwshar wilayats. On the other side, very low percentages of educated employed women seem to be in Al Sharkya, Al Dakhliyah, and Al Dhahra governorates (Figure 3(b)). The percentage of employed

women in private sectors increases in urban areas, specifically Muscat and Al Batnah South (Figure 3(c)). The highest percentage of FLFP rate is found among urban females predominantly in Muscat, ASeeb, and Buwshar within the Muscat region. Similarly, a higher percentage of female workers in Al Batnah North (Sohar) lives in urban districts (Figure 3(d)). Large increases in the female share of the administrative jobs appear fundamentally in the northwest of the study areas while the percentage is low in the rest of region (Figure 3(e)). The highest divorce rate among working women is found essentially in Al Burami governorate in the west part of the study area while the percentage of divorced employed women is moderate in Al Sharkya (Figure 3(f)).

The regression parameters' estimates of the OLS model are reported in Table 3. The coefficients of all independent variables are statistically significant ($P < 0.05$). Examining the multicollinearity, all VIF values are less than 7.5 which shows that redundancy and overlapping among the predictors do not exist. The regression coefficients' signs of working women with higher education, FLFP in the private sector, employed females living in urban areas, and divorced employed women are positive indicating a positive linear relationship between these variables and FLFP rates. The percentage rise in employed women in the private sector is strongly associated with an increased percentage of FLFP rates. Likewise, the increase

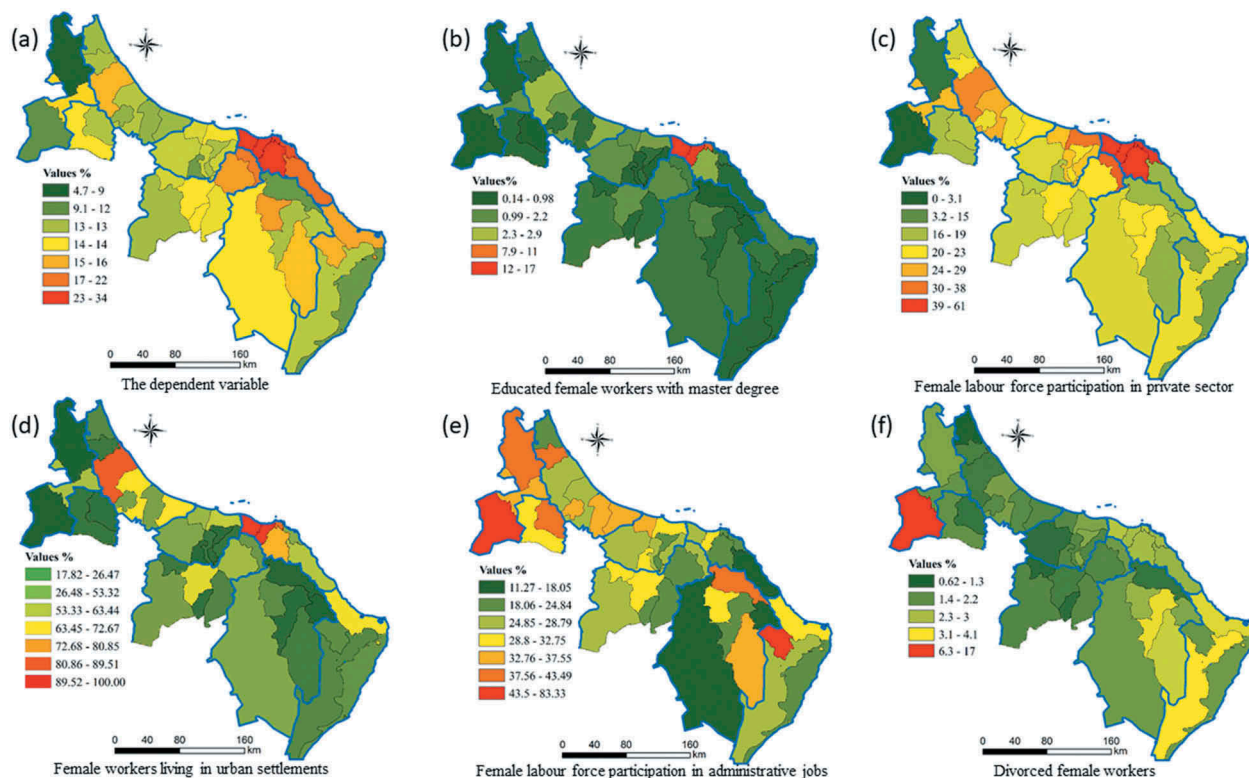


Figure 3. Geographical distribution of the dependent and independent variables.

Table 3. Summary statistics of the OLS model.

| Variable | Coefficient | Std Error | t-Statistic | Probability | VIF |
|----------------------------------|-------------|-----------|-------------|-------------|------|
| Intercept | 14.13 | 3.20 | 4.41 | 0.000* | |
| Education | 0.01 | 0.00 | 3.16 | 0.003* | 1.41 |
| FLFP in private sector | 0.19 | 0.05 | 3.36 | 0.001* | 2.25 |
| FLFP in administrative jobs | -0.12 | 0.06 | -1.84 | 0.073 | 1.98 |
| Employed females living in urban | 0.05 | 0.03 | 1.55 | 0.128 | 1.74 |
| Divorced female labourer | 0.45 | 0.27 | 1.61 | 0.115 | 1.69 |

in the percentage of educated females, particularly those with master's degrees, increases the likelihood of being employed. In addition, urban women have greater chances of getting jobs and being employed compared to those females living in rural areas and villages. Although the relationship between divorce risk and employment is quite complex, the sign of this explanatory variable is positive suggesting that divorced women are often financially independent or being divorced encourages females to join the labour market.

To evaluate the model performance and examine how well the linear equation fits the data, R^2 , adjusted R^2 and other tests were gauged. The Joint F-Statistic and Joint Wald Statistic are diagnoses of the model significance. For both tests, the null hypothesis is that the predictors are not effective. Accordingly, any p-value smaller than 0.05 (95% confidence level) designates a good fit and significant model. It is noteworthy that if the Koenker (BP) test is significant, the value of the Joint Wald test is consulted to diagnose the model fit. The Jarque-Bera test diagnoses the model residuals distribution and a small p-value (lower than 0.05 in 95% confidence level) indicates that the residuals are not normally distributed. The OLS model diagnosis in Table 4 shows that the predictors explain 0.70 of changes in FLFP rates across the study area. Consequently, the model performance is considered satisfactory and the independent variables have satisfactory predictive power for FLFP rates.

The distribution of the standardized residuals is another key indicator of model structure. Spatial clustering of residuals refers to one or more missing independent variables in the fitted model. Figure 4 shows a random pattern of the over and under prediction which denotes a properly specified model. Similarly, the output of *Moran's I* autocorrelation test confirms

Table 4. Diagnostic statistics of the OLS model.

| Parameters | Value | P-value |
|-----------------------|---------|---------|
| Joint F-statistic | 19.427 | 0.000 |
| Joint Wald-statistic | 172.003 | 0.000 |
| Koender statistic | 16.053 | 0.000 |
| Jarque-Bera statistic | 1.339 | 0.041 |

$R^2 = 0.73$ Adjusted $R^2 = 0.70$.

the rejection of the null hypothesis (the residuals are clustered). The P-value is not statistically significant (0.30).

5.2. Local patterns of FLFP (GWR model)

The statistical tool of the variance inflation factors (VIF) was used to diagnose the multicollinearity in the fitted GWR regression (Wheeler and Tiefelsdorf, 2005). The values for VIF for all explanatory variables were less than 7 and no multicollinearity was detected. The findings of local modelling indicate a significant better performance of the GWR model compared with the OLS. The adjusted R^2 value (73.5) of the local model is greater than OLS (0.70) while the Akaike Information Criterion (AICc) is lower (as a rule the lower value indicates a better model) (Table 5). This means that the explanatory power of the GWR is influential in explaining the variance of the FLFP rate. These outputs also confirm the local spatial variation in the relationships between the response variable and the predictors (spatial non-stationary).

Figure 5 illustrates the spatial distribution of the observed values versus the predicted values of the response variable for the GWR model. The concentration of the scatter points and the linear R^2 value reveals better model performance.

Similarly, considering the values of standardized residuals of the GWR, it seems that the distribution displays a random pattern of over-under-prediction (Figure 6(a)). The distribution of the spatial smoothing local R^2 displays the explanatory power of the model prediction and performance in different areas (Figure 6(b)). In general, it is obvious that the explanatory power of the GWR model was higher (local R^2 values 0.75 to 0.78) in the northwest part of the study area and along the wilayats of Al Batnah coastal plain. The model demonstrates best fits and better prediction of FLFP rate across those wilayats. On the other hand, a low trend was observed in the wilayats located in the southeast of the study area where local R^2 values are lower (between 0.70 and 0.73). Hence, the resultant spatial variation of the local R^2 patterns shows that the strength of the model performance increases in the north and the west of Al Batnah and Al Burami governorates.

5.3. Driving factors of FLFP

The local modelling process has produced surface maps which show the influence of each independent variable on female employment rates. Figure 7 represents spatial variations of the GWR local parameters variability. The map of intercept (Figure 7(a)) illustrates the variability of the intercept where higher values are mostly located in

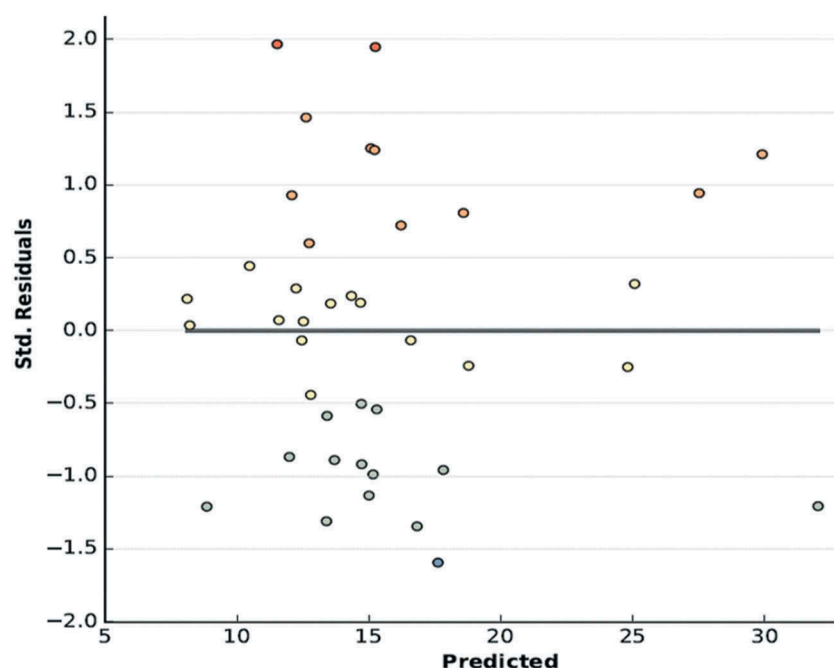


Figure 4. Random pattern of standardized residuals of the OLS model.

Table 5. Comparison between the fitness parameters of GWR and OLS models.

| Fitness parameters | OLS | GWR |
|--------------------|--------|--------|
| AICc | 223.02 | 211.70 |
| R ² | 0.73 | 0.76 |
| Adj | 0.70 | 0.73 |

the east and south parts of the study area. For instance, higher intercept values are found in Muscat, Al Sharkya, Al Dakhliyah, and Al Batnah South governorates. This spatial pattern indicates that accounting for the five explanatory variables, the FLFP rates increase in those

places. The education variable was found to be positively correlated with women's employment. Wilayats with a higher percentage of educated females tend to show a higher FLFP rate (Figure 7(b)). Higher education as a predictor has substantial influence on FLFP particularly in the southern wilayats of the study areas. These places involve rural and semi urban settlements and thus higher education is a key driver for joining the labour market. On the other hand, the impact of higher education is a margin in the middle and southeast while higher education is a weak predictor in Muscat governorate and the surrounding wilayats.

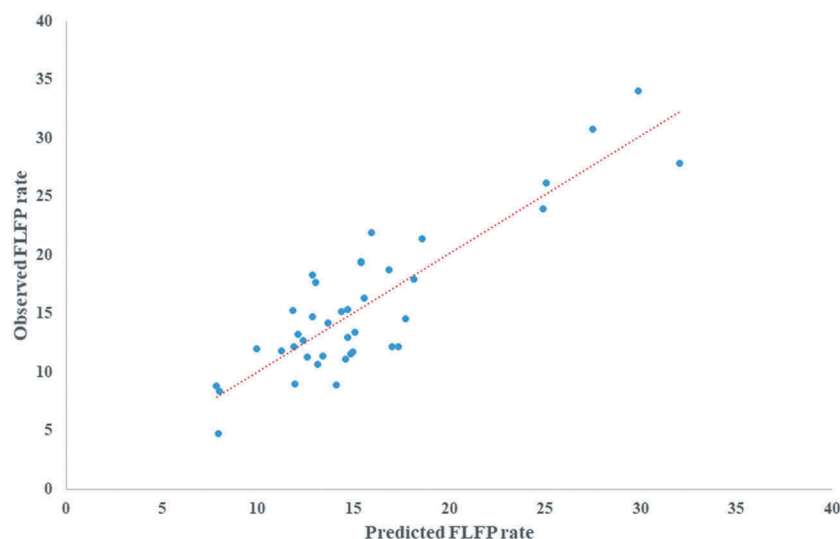


Figure 5. The observed versus the predicted values of the response variable (GWR model).

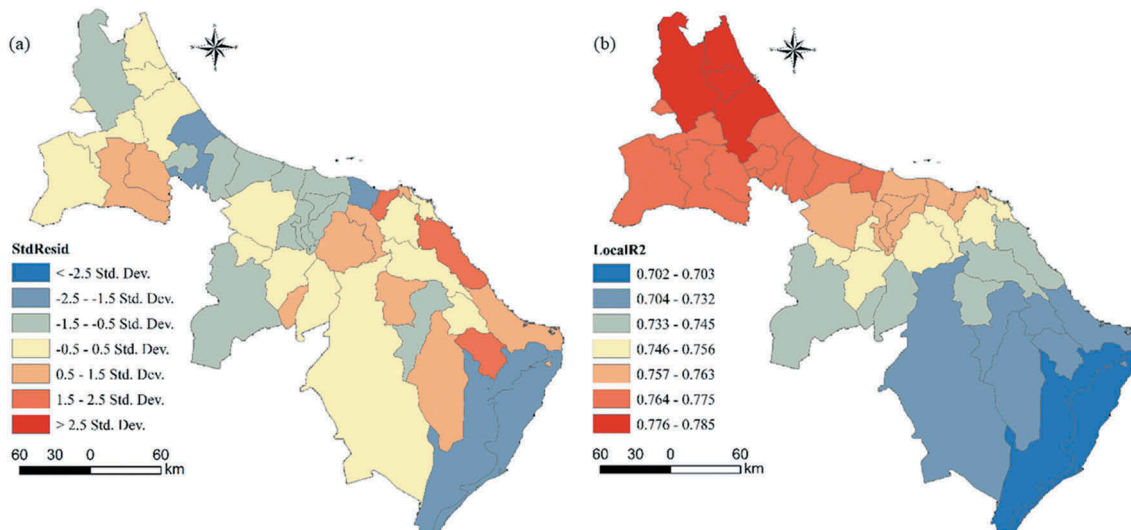


Figure 6. The geographical distribution of standardized residuals (a) and local coefficients (b) (GWR model).

In general, women living in urban areas are more likely to join the labour market and paid work because of the diversity of economic structure and favourable work conditions. Jobs in the private sector as an explanatory variable have greater influence in estimating FLFP rates in Al Batnah North governorate as well as Al Burami governorate (Figure 7(d)). Interestingly, this variable has weak influences on women's employment across Muscat governorate and the wilayats that are located in the east and southeast of the study area.

The variable of employed women in the administrative sector is significant in the southern east wilayats particularly Jaalan Bani Bu Ali governorate suggesting that it has a major impact on FLFP rate. In contrast, the variable showed lower effects in the wilayats of Al Batnah North, Al Batnah South, Muscat and Al Dakhliyah governorates (Figure 7(e)). This pattern of spatial variation suggests that the administrative jobs especially in the governmental sector are a preferable choice for females in rural and desert places. In contrast, this variable is relatively unimportant in the rest of the study area. The local parameter estimate for divorced employed women (Figure 7(f)) clearly shows that in the eastern part of the study area, the majority of divorced women are joining the labour market. An explanation of this spatial pattern distribution perhaps is that the social circumstances of women, such as family separation and divorce, persuade them to seek financial independence through labour force participation. The effects of this variable were mainly less pronounced in Al Batnah and Muscat governorates and clearly lower across the wilayats of Al Dakhliyah and Al Burami governorates.

6. Discussion and conclusions

In this research, we built two (global and local) models to spatially investigate and predict the distribution patterns of FLFP rates across the Omani wilayats. Although the OLS model fitted the women's employment data moderately well, the findings of the GWR model seem inherently more realistic since they allow the influences of various parameters on FLFP to vary gradually over space. Thus, and accounting for the spatial parameter variations identified by the GWR, local modelling should be the preferred approach for forecasting FLFP at sub-national boundaries.

The most influential variables for both models are related to modernization characteristics where females with higher education degrees and female urban residents were significant predictors of female employment. Additionally, female jobs in the private sector were also an essential explanatory variable of female's shares in paid work. The selected variables in the fitted GWR local model illustrated significant spatial variations at the sub-national geographic scale. Nevertheless, education and urbanism showed a very high variability and considerable relationships with the FLFP rate as a response variable.

The findings of this study indicated that the coefficients of education and urbanism are both significant and positive in explaining the labour force participation of women. These measures have also been shown in the literature to be significant in explaining FLFP rates (Verick 2018; Sudarshan and Bhattacharya 2009). Interestingly, the observed spatial variation patterns of both predictors (education and female urban residents) in impacting FLFP rates show two clear divisions and directions. While the

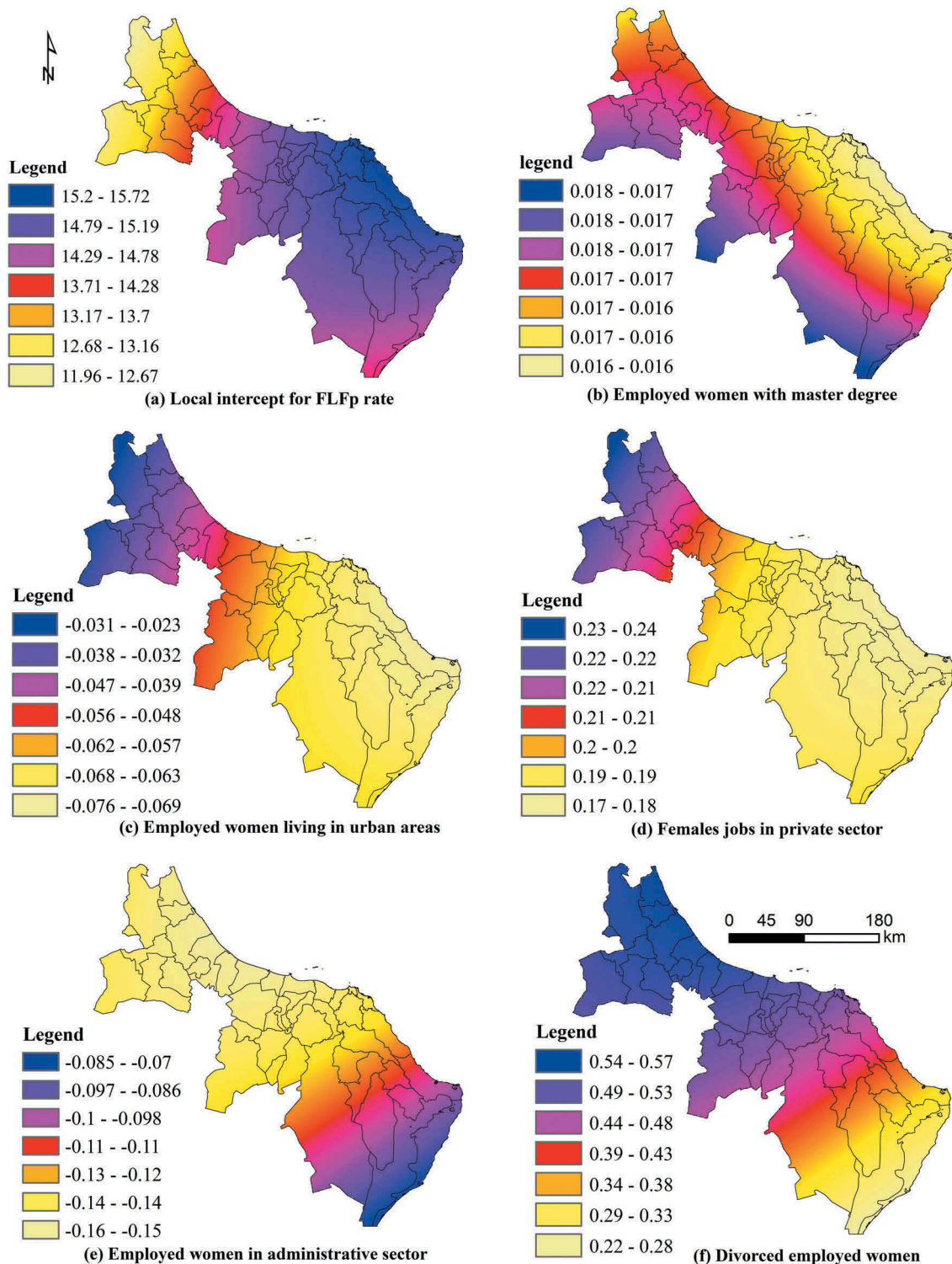


Figure 7. The geographical distribution of local coefficients for the GWR model.

education variable illustrates north-south division, urbanism demonstrates a west-east direction. The influence of the higher education variable on the FLFP rate was higher in the north-eastern part of the study area particularly across Al Batnah coastal plain and Al Burami governorate. The inner suburbs, which are located away from the

capital and greater Muscat, have high concentrations of higher labour force participation and higher percentages of women living in urban areas. Thus, the results have all the expected signs: wilayats with higher percentages of educated women as well as female urban residents are those characterized by higher female labour force

participation. Another interesting pattern was observed in the southern part of the study area and within the interior wilayats where education seems to have the highest influence on female employment. Although higher education may delay entry to the labour force, families in these areas may recognize the importance of post-graduate and higher education in increasing women's access to good jobs (especially in the public sector) and achieving equal opportunities with males.

Like other traditional societies, the development of Omani women's roles and contributions in the labour market have been linked to the continuous modernization of the society and its economy. Obviously, the explicit positive associations between education and FLFP may be attributed to the significant changes in the educational attainment of Omani females during the last two decades. Indeed, higher education and training, which is sustained by the government, provide women with the necessary knowledge and skills required by the labour market. Despite the late start to women's education, as in most neighbouring countries, the achievements of Omani women in this field have been clearly distinct.

Marking a significant departure from its traditional patriarchal dominated decision-making situation, the latest governmental policies in Oman provide women with equal opportunities for public jobs, positions and empowerment without any discrimination or obligations to their male counterparts (Al-Lamky 2007).

The variable of private sector jobs was also found to be influential in explaining women's employment particularly across the Al Batnah wilayats. However, and specifically in the entrepreneurship environment, women face several challenges and obstacles such as funds and financial support, knowledge management, technical support, training opportunities (Belwal, Belwal, and Saidi 2014; Al-Sadi, Belwal, and Al-Badi 2011). In Oman as well as other GCC states, women's participation as entrepreneurs is still low due to a number of social barriers particularly traditional customs, cultural values, and gender bias. The impacts of the administrative work variable were clearly high in the eastern wilayats of the study area (e.g. Al Sharkya governorate) while they were less influential in the rest of the governorates. This may be due to the fact that women in rural, desert and semi-urban areas prefer governmental administrative jobs so that they can reconcile their family roles and their career success. Such influence points to the effect of living in predominantly traditional small communities where the relationship between social norms and women's employment in public institutions is significantly positive (Kremer 2007; Mansour 2018; Belwal and Belwal 2014; Kelly 2009). These findings enrich our argument that in spite

of increasing female educational participation and decreasing fertility rates, the increasing rates of FLFP are still lower compared with other countries within the same region (e.g. Qatar, UAE and Kuwait). There was also a relationship between divorced employed women and the increased rates of female labour force participation. In some communities, divorced women have a higher degree of autonomy and mobility. When a woman is unexpectedly divorced, she is highly likely to have engaged in joining the labour market. Similar social circumstances induce women to join the labour market. For example, those households headed by females are more likely to have been engaged in temporary jobs compared with their counterparts from male-headed households.

Besides the variables that showed a significant relationship and influence on female employment, traditional cultural and religious identity play an important role in explaining FLFP rates. It is also noteworthy that in spite of the importance of these explanatory factors (especially culture, religiosity, social norms) in modelling the FLFP, they are quite difficult to quantitatively form and measure. Furthermore, the causative relationship between these variables and women's employment is not only tangled but also exogenous to other variables particularly education, women's fertility, and traditional cultural manifestation.

For Omani women, their labour market participation is also influenced by fertility and family size. For instance, in rural and desert areas, married women prefer child caring, rearing, and domestic unpaid work to joining the labour market. ON the other hand, a higher percentage of households in urban areas hires foreign female domestic workers (particularly from south Asian countries) and thus, married women have a good opportunity to be career oriented. Consequently and because of this phenomenon in Oman and other GCC states, while the fertility rate and FLFP have an inverse relationship, it appears that a higher fertility rate is somewhat associated with a higher FLFP rate.

Living in a rural or desert area does not necessarily mean that women cannot have access to the labour market. Similar to any other country, urban places often witness a higher percentage of unemployed women as a result of a large population size and immigrants from other regions. Policy and decision makers who are interested in improving women's employment should pay attention to the low FLFP rates locally and within each small area across both urban and rural settlements. Similarly, higher education and lower fertility rate are not always key factors in changing the rate of FLFP and thus increasing the share of Omani women in the private sector should be a potential target of the Omani labour force to implement successful development policies.

This research faced inevitable limitations such as lack of statistical and spatial datasets on culture and social norms. Collecting such a dataset in the future could provide more insights into the interaction between female employment and cultural structure at a local level. Likewise, another drawback is linked to the collected census data where it might have been difficult, during the census, to measure the employment status of females accurately. There are specific types of work (work in a family business, on farms, and in the informal sector) which were probably were not reported. This might have led to an underestimation of the FLFP rates across the Omani wilayats. However, this paper contributes to understanding the spatial variations in FLFP rates and their determinants at subnational boundaries.

A global regression model (OLS) was employed firstly to investigate and predict FLFP across the Omani wilayats. However, this stationary model and global regression approach seem to be insufficient to appropriately explain the underlying FLFP rates, because all variables selected exhibited significant spatial variations at the local scale according to the GWR model. Briefly, the veiled geographical patterns and determinants of women's labour force participation across the study area have been clearly identified. In particular, the determinants of modernization characteristics, such as higher education and urbanism, demonstrate north-south (females with higher education) and east-west (female urban residents) divisions.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Shawky Mansour  <http://orcid.org/0000-0001-6969-9188>

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