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'Sometimes you don't make enough to buy food': An analysis of South African street waste pickers' income

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Limited opportunities for the unskilled in the formal economy force many into informal street waste-picking activities. The income from these activities is not sufficient to lift them out of poverty. This article analyses income data of 873 street waste pickers to assess how identified factors explain income variations among them and whether they can endogenously influence their earnings. The results of descriptive, ordinary least square regression and quantile regression analyses show that they can do little to improve their income except to use a trolley and to start early in the morning. To improve their income, policy interventions to integrate them into waste management plans are recommended.

Introduction

The labour absorption capacity of the formal economy has fallen dramatically during the past two decades (Von Fintel & Burger 2015). Unemployment rates continued to rise after 1994, despite having one of the longest business cycle upswings in the South African economy during this period (Von Fintel & Burger 2015). The labour market seemingly adjusted to a new high unemployment equilibrium (Burger & von Fintel 2009), pushing more and more people into the informal economy.

In fact, in some transitional economies, large declines in gross domestic product (GDP) were relieved to some extent through the fast growth of the informal economy (Gerxhani 2001). There is therefore an urge to see the informal economy as an 'automatic stabiliser' when there is a shock to the formal economy, given that being self-employed requires low capital requirements and entry barriers (Campbell 2013:14). This is, however, the exception rather than the rule. In most developing countries, labour markets still feature persistent informality, low levels of productivity and wages, insufficient access to social security and employment benefits (Salazar-Xirinachs 2013).

Involvement in the informal economy evidently does not necessarily solve the problem of poverty because of the relatively low income and poor conditions of employment in the informal economy (Ligthelm 2006). This is especially true for participants in the lower tier informal economy activities such as collecting and selling recyclable waste, which for some is their only means of survival. The income earned by waste pickers and the conditions under which this takes place have been the subject of a number of international studies (Benson & Vanqa-Mgijima 2010; Carrasco 2009; Gutberlet & Baeder 2008; Hayami, Dikshit & Mishra 2006; Masocha 2006; UNESCAP 2011). Emerging literature within the South African context mostly consists of localised case studies, which either focus on landfill waste pickers or street waste pickers (McLean 2000a; Medina 2007; Samson 2010; Schenck, Blaauw & Viljoen 2012). This study is the first representative countrywide South African study that focuses on the socio-economic dynamics and vulnerability of street waste pickers. This study therefore makes an important contribution to the existing literature on the vulnerabilities in the informal economy.

A number of national and international studies report on the amounts of income received by small groups of waste pickers and the factors that might influence their income (Langenhoven & Dyssel 2007). Because of the small sample sizes, none of the earlier studies analysed the income to assess the extent to which these factors explain income variations among waste pickers. This study is able to bridge this gap in the literature through its large sample size and countrywide representativeness. There is an ongoing debate around the role of waste pickers in formal waste management strategies and how they can be integrated in these strategies. Without an improved appreciation of the challenges faced by waste pickers, it will be difficult, if not impossible, to

articulate and implement effective institutional interventions. This article adds significant impetus into our understanding of the exogenous nature of waste pickers' income.

To investigate the exogenous nature and possible influential factors regarding street waste pickers' earnings, income data of 873 street waste pickers out of a total of 914 interviewed, in 13 major city centres and surrounding suburbs in South Africa, are used. The next section of the article is a brief literature review and the identification of factors that might influence the income of street waste pickers in general. The 'Methodology and research approach' section discusses the research design and methods used to collect the data. This includes the research population, sampling technique and instruments used, as well as the procedures followed in the analysis of the data. Next the 'Results' section presents the empirical results and interpretation of the findings. Finally, the 'Conclusion' section completes the article with conclusions and recommendations for further research.

Literature review

International studies are almost unanimous in their conclusion that the income earned by most waste pickers in the informal economy is low and in many cases insufficient to meet their basic needs in terms of shelter and regular meals (Benson & Vanqa-Mgijima 2010; Carrasco 2009; Gutberlet & Baeder 2008; Hayami et al. 2006; Masocha 2006; UNESCAP 2011). Their income is also reported to be irregular and uncertain, which subjects them to economic insecurity (Carrasco 2009; Gutberlet & Baeder 2008). Many waste pickers are therefore faced by chronic poverty despite their attempts to generate a livelihood in the informal economy (Masocha 2006).

The existing South African literature concurs with the above findings. An added perspective in the South African literature is the distinction between the dynamics prevailing among the street waste pickers *vis-à-vis* those of the landfill waste pickers. Studies by Medina (2007) and Schenck et al. (2012) found that the income earned by waste pickers on landfill sites is relatively higher than the income earned by street waste pickers. Street waste pickers are therefore seen as the lowest income earners in the recycling chain and one of the most vulnerable groups in the informal economy in terms of poverty and low and uncertain incomes (Carrasco 2009; Gutberlet & Baeder 2008; Schenck et al. 2012). This provides added impetus to the use of a countrywide sample of waste pickers to investigate the income earned by street waste pickers and the factors associated with their income.

The income of street waste pickers is mainly determined by the price of the recyclable waste and the quantity of waste collected. Other factors identified in the literature that might also influence the income of street waste pickers can be categorised by the demographic characteristics of the waste pickers (and their working conditions).

Prices of recyclable waste

The prices of the recyclable waste have a significant influence on the income-earning potential of waste pickers (McLean 2000a; Viljoen, Schenck & Blaauw 2012). Street waste pickers have very little influence over the prices they receive for the waste collected except to properly sort the waste. The price for mixed waste is substantially lower than for properly sorted waste (Viljoen et al. 2012). The price of the recyclable waste is, among other things, determined by supply and demand factors and exchange rate fluctuations, which have a significant influence on the income-earning potential of waste pickers (McLean 2000a; Muller & Scheinberg 2003; Viljoen et al. 2012). The market for some recyclable waste is highly cyclical and any decrease in the price reduces the income potential of waste pickers (Langenhoven & Dyssel 2007; McLean 2000b; Tangri 2010).

The weather also has an effect on the waste pickers' income. Waste pickers usually pick less waste during the rainy season (Agunwamba 2013). The buy-back centres pay lower prices for wet or damp waste than for dry waste as damp waste weighs more (Langenhoven & Dyssel 2007; Sentime 2011). The heavier weight of damp waste might compensate for the lower price but restricts the quantity of waste that a street waste picker can carry over long distances.

The price of each recyclable waste product differs, which makes certain waste products more valuable than others. The mean price for white paper, for example, was R1.85 per kilogram in Pretoria and R0.91 in Bloemfontein in 2012. The mean price for polyethylene terephthalate (PET) and glass was R1.17 and R0.25, respectively, in Pretoria and R1.48 and R0.22, respectively, in Bloemfontein. The prices also differed from one buy-back centre to another. The maximum price for white paper was R2.30 per kilogram in Pretoria and R1.00 per kilogram in Bloemfontein and for PET it was R2.00 per kilogram in Pretoria and R1.90 per kilogram in Bloemfontein (Viljoen et al. 2012). The higher the volume of the more valuable recyclable waste collected by a street waste picker, the higher the income will be.

Quantity of recyclable waste collected

The income of waste pickers also depends on the quantity of recyclable waste available to them, which, in turn, depends on the quantity of waste generated in the area in which the waste pickers collect waste. More waste is generated in areas where the incomes of those who generate the waste are high (Medina 2007).

Human capital

Standard human capital theory suggests that there is a positive relationship between the level of and *income earned and job experience and earnings* (McConnell, Brue & MacPherson 2013). It is highly questionable whether this relationship holds for waste pickers as education does not form an entry barrier for their waste-picking activities.

The 'methodology and research approach' section discusses the research methodology that was followed in this article to analyse the extent to which the other factors, apart from price and quantity, explain income variations among the street waste pickers within a South African context and whether street waste pickers can endogenously increase their earnings.

Methodology and research approach

A quantitative analysis was applied to analyse and explain income variations among street waste pickers in terms of factors that might influence the income of waste pickers in general.

Data collection

Primary quantitative data collected from a national survey consisting of 914 street waste pickers across 13 major city centres and surrounding suburbs in South Africa were used, of which 873 revealed the income earned. The data were collected between 19 April 2011 and 28 June 2012. A face-to-face survey approach with structured interviews was used to collect the data. The questionnaire used consists of nine sections. Section 1 contains questions on the personal background and demographic characteristics of the street waste pickers. Sections 2–5 comprise questions on the street waste pickers' level of human capital development, employment history, working activities, income patterns, additional sources of income and the number of people who depend on their income. Sections 6–9 comprise questions on the street waste pickers' consumption patterns; access to basic needs such as housing, food and drinking water; their relationship with other groups or organisations such as the municipality, police or metro police, the public, buyers, family members and co-waste pickers; and lastly, work-related injuries and the health risks faced by the street waste pickers.

The fieldwork team that administered the structured survey interviews comprised the research team with three members and five additional fieldworkers. One fieldworker was appointed for the full duration of the project. Four additional fieldworkers were appointed to assist in the different cities. All the fieldworkers received in-depth training and were well informed about the objective of the study before they started the fieldwork. The questionnaire was discussed with them. Members of the research team joined the fieldworkers on several occasions in all provinces to assess the situation in the field and to take part in the data collection process.

Research sample

A non-probability sampling technique, namely, snowball sampling, was used to collect data as no sampling frame on the number of street waste pickers in South Africa was available. From the 873 street waste pickers who revealed their income, the majority (751) earned their income on the same day on which they have picked the waste, whereas 122 received their income after collecting recyclable waste for a week. For this analysis, the income for the latter group of street waste pickers will be divided by 5 to transform their weekly income into a daily income.

Data analysis

A descriptive analysis reveals a substantial difference between the mean (R72.11) and median (R50) incomes of street waste pickers. This might be an indication of outliers that can violate the assumption of normality which is common in large samples (Pallant 2010). The kernel density plot for the usual income proves that the usual-day income of street waste pickers does not have a normal distribution (see Appendix 1). For this reason, an ordinary least square (OLS) regression model will serve as the benchmark for the income analysis, and a median (a 0.50 quantile) regression is used as a robust alternative to the OLS, which estimates conditional mean functions. To gain an in-depth understanding of the relationship between income and the other independent variables, at different points in the distribution of income such as the mid-point, quantile regressions are performed. Quantile regression is often used to identify factors that determine wages and to measure discrimination effects and trends in income inequality (Koenker 2000:1). The quantiles model used will include the 0.5 (median) as well as the 10th, 25th, 75th and 90th percentiles of income. A quantile regression provides information about the relationship between the regressors and outcome at different points (quarters) (Zietz, Zietz & Sirmans 2007:31). It might be interesting to see what factors affect the street waste pickers' income at the median, bottom and top 10 percentiles.

The median (quantile = 0.5) uses symmetric weights, whereas all other quantiles (0.1, 0.25, 075 and 0.9) use asymmetric weights (Zietz et al. 2007:320).

The OLS and quantile regression analyses were performed using the STATA version 14.0 software package. The results of the quantile regression models are compared with an OLS regression model.

Results

This section is divided into four sections. The first section reports results on the income of the street waste pickers. This is followed by an analysis of the income differences relating to the demographic characteristics and working conditions and/or practices of the street waste pickers. The last section reports and discusses the factors influencing the income.

Income of street waste pickers

Because of the uncertainty and variation in the income earned by street waste pickers, as observed from other studies, income data were collected for three different income scenarios: the income usually earned, the income earned on a good day and the income earned on a bad day. The analysis

TABLE 1: Minimum, maximum, mean and median incomes usually earned for a day's waste in the different cities (n = 873).

Cities	N	Min (R)	Max (R)	Mean (R)	Median (R)	SD
Bloemfontein	45	10	250	59.38	40	50.81486
Cape Town	153	10	300	63.90	50	44.76403
Durban	80	2	200	55.68	42	45.43594
East London	36	5	175	44.58	32.50	36.98214
Johannesburg	272	2	500	94.11	70	91.21892
Kimberley	14	9	95	40.79	40	23.42969
Mafikeng	6	40	175	79.17	65	49.84142
Nelspruit	2	65	70	67.5	67.5	3.535534
Pietermaritzburg	5	25	120	80	75	40.77377
Polokwane	11	45	100	66.82	70	19.52853
Port Elizabeth	19	4	125	42	30	34.26855
Pretoria	224	3	300	67.97	50	48.15412
Upington	6	12	150	84.5	90	66.22311
Total	**873**	**2**	**500**	**72.11**	**50**	**65.21625**

R, nominal income in ZAR; SD, standard deviation.

of this study is based on the income earned on a usual day, unless stated otherwise.

Table 1 shows the results of the income of the street waste pickers at a national and city level. The results indicate that half of the street waste pickers nationally earn a usual-day income of R50 or less. The minimum income earned was R2 and the maximum was R500. For some of the street waste pickers, the income is enough to survive materially, but for the majority of street waste pickers it is low. As one of the street waste pickers said: '… sometimes you don't make enough to buy food'.

The results from the four major cities with the most street waste pickers reveal that the street waste pickers in the city of Johannesburg are relatively better off in terms of the mean and median income than those in Cape Town, Durban and Pretoria. The income of street waste pickers in cities with few street waste pickers tends to be relatively higher than in cities with more street waste pickers, except in Johannesburg.

The next section provides a breakdown of the street waste pickers' income according to their demographic characteristics and income differences that relate to their working conditions.

Income differences according to the demographic characteristics and working conditions and/or practices of the street waste pickers

The data presented in Table 2 reveal that male street waste pickers tend to earn a R23.00 higher income on average than female street waste pickers do.

The income potential for younger street waste pickers is also higher than for older street waste pickers. The age category of 25–34 earns the highest mean and median usual-day income of R91.79 and R70, respectively, followed by the younger street waste pickers aged 14–24 with a mean of R89.44 and a median of R60. The age category of 35–44 also earns a higher mean (R72.05) and median (R60) than the national mean and median income. For the older age groups, the mean and median fall below the national mean and median income. The age group with the lowest mean and median are the very old (65 + years) street waste pickers. Their mean income is a mere R37.31 and the median is R25, which is only half the national median.

The marital status of street waste pickers may also have an influence on their income. Those living with a partner earn the highest mean (R82.30) and median income (R70), followed by those who are single and those who are married with a mean of R78.16 and R70.15 and a median of R55 and R60, respectively. The widowed, separated and divorced street waste pickers earned the lowest median income.

Street waste pickers who completed their secondary schooling earn the highest mean income (R85.92) and median income (R65), except for the one street waste picker who has a post-school qualification who earns R80 per day. The street waste pickers with no schooling, some primary and completed primary schooling all earn the national median of R50.

It further appears that foreign-born street waste pickers earn higher median incomes than the South Africa-born street waste pickers. The 756 South Africa-born street waste pickers' mean (R65.93) and median income (R50) is nearly half of that of the 116 foreign-born street waste pickers' mean (R112.78) and median income (R80).

Only 227 of the street waste pickers indicated that they work in a group and the majority work on their own. The street waste pickers who work in a group earn a higher income, on average, than those who do not work in a group. The street waste pickers who sell their recyclable waste on the day that they have collected it earn an average income of R67.54 as opposed to the R101.75 income of street waste pickers who store their waste and sell it once a week.

Street waste pickers who use a trolley to collect the recyclables rather than bags, wheelbarrows and their heads earn a median income of R60 (almost 50% higher than the median income of R40 for street waste pickers not using a trolley).

TABLE 2: Income differences according to the demographic characteristics and working conditions and/or practices of the street waste pickers.

Usual-day income	*N*	%	Min	Max	Mean	Median	SD
Gender (*n* = 873)							
Male	797	91.3	2	500	74.11	55	66.88425
Female	76	8.7	4	200	51.08	40	38.36726
Age (*n* = 865)							
14–24	123	14.2	5	400	89.44	60	82.1076
25–34	242	28.0	2	500	91.79	70	81.44744
35–44	216	25.0	2	400	72.05	60	55.75121
45–54	165	19.1	3	200	50.05	40	35.25642
55–64	103	11.9	5	200	48.07	45	32.18551
65 +	16	1.8	7	100	37.31	25	28.73956
Marital status							
Never married or single	402	-	2	500	78.16	55	74.68781
Separated or divorced	81	-	9	200	54.85	45	36.46269
Married (traditional or western)	271	-	10	420	70.15	60	56.72527
Widowed	47	-	10	200	51.26	40	38.62724
Living with a partner	63	-	2	400	82.30	70	75.42132
Education							
No schooling	55	-	10	190	57.2	50	33.30187
Some primary	261	-	3	400	73.92	50	80.07634
Primary completed	97	-	5	420	76.17	50	71.6641
Some secondary	387	-	2	400	70.40	60	51.76163
Secondary completed	61	-	2	500	85.92	65	82.2825
Post school	1	-	-	-	-	80	-
Country of origin (*n* = 872)							
South African	756	86.7	2	500	65.93	50	54.16335
Foreign	116	13.3	10	420	112.78	80	105.1608
Work in a group or not	Yes	227	3	400	84.56	60	82.47295
	No	640	2	500	67.76	50	57.57356
Income interval	Day	756	2	500	67.54	50	55.2684
	Week	117	3	400	101.75	60	105.2056
Use trolley	Yes	598	2	500	79.10	60	71.36559
	No	266	2	250	55.83	40	45.21137

SD, standard deviation.

Some street waste pickers start as early as 02:00 in the morning with their waste-picking activities and have long working hours. Approximately 39.3% of the street waste pickers' days start at 05:00 or earlier. The mean and median time of starting the recyclable waste collection is 06:00. At 07:00, the majority of street waste pickers (86%) are already picking waste. A street waste picker works on average 9 h a day.

The next section examines the factors that influence the street waste pickers' income.

Regression analysis

An OLS regression was applied to test which of the selected factors had an influence on the income of street waste pickers. Five quantile regressions were also estimated to assess whether different factors influence different income points. All variables identified that might cause differences in the street waste pickers' income are included in this full model. The coding of the variables included in the full model are summarised in Table 3.

To identify the factors that might cause differences in the street waste pickers' income, the following equation is used:

$$Y = \beta 0 + \Sigma i=1..p\ \beta iXi + \varepsilon \qquad \text{[Eqn 1]}$$

where Y represents the dependent variable which is the usual-day income of an individual street waste picker; β0 is the intercept of the model; X is the vector containing the variables for the city, gender, age, marital status, grade, foreign, partofagroup, day or weeku, trolley, expftjob, duration and starttime; and ε is the random error.

The equation for the quantile regression is:

$$Y_i = X_i^{'}\boldsymbol{\beta} + \boldsymbol{\varepsilon}_i, \qquad \text{[Eqn 2]}$$

The quantile regression for a specified quantile $\theta \in]0,1[$ is obtained by minimising the objective function F over βθ. The quantile $q \in (0; 1)$ is referring to the y that splits the data into proportions q below and 1-q above: $F(y_q) = q$ and $y_q = F^{-1}(q)$: for the median, q = 0.5 (Baum 2013):

$$F = \sum_{i\in\{i:y_i\geq x'_i\beta_\theta} \theta \mid y_i - x'_i\beta_\theta \mid + \sum_{i\in\{i:\ y_i<x'_i\beta_\theta} (1-\theta) \mid y_i - x'_i\beta_\theta \mid \qquad \text{[Eqn 3]}$$

The objective is to estimate the median of the dependent variable, conditional on the values of the independent variables using the quantile regression. This method is similar to the OLS, where the objective is to estimate the conditional mean of the dependent variable. While the OLS measures the sum of the squares of the residuals, the median

TABLE 3: Coding for variables used in the full regression model.

Variable	Dummy/ categorical variable	Continuous variable	Coding
Usual income	-	Usualincome	-
City code	Citycode	-	Nelspruit =1, Upington =2, Kimberley = 3, East London = 4, Mafikeng = 5, Port Elizabeth = 6, Bloemfontein = 7, Cape Town = 8, Pietermaritzburg = 9, Durban =10, Polokwane = 11, Pretoria = 12, Johannesburg =13
Gender	Male	-	0 = Female, 1 = Male
Age	-	Age	-
Marital status	Married		0 = All other, 1 = Married
Education	Grade	Grade	-
Country of origin	Foreign	-	South African = 0, Foreign = 1
Work in group	Group	-	No = 0, Yes = 1
Income interval	Day	-	Day = 0, Week = 1
Equipment used	Trolley	-	No = 0, Yes = 1
Experience in previous full-time job	-	Expftjob	-
Number of hours worked	-	Duration	-
Starting time	-	Starttime	-

regression minimises the sum of the absolute residuals (Cameron & Trivedi 2005; Gould 1992).

The OLS is therefore concerned with predicting the mean rather than the median. With a normal distribution of the usual income, both the OLS and median regression (quantile 0.50) will give the same results. The OLS is sensitive to outliers, and the data on the usual income contain outliers (see Appendix 1), which could lead the OLS to produce results that do not reflect the central tendency (median) well, which in turn justifies the use of quantile regressions. The effects of the independent variables may vary over the distribution of income that makes the quantile regression a better choice over the OLS (mean) regression (Chamberlain 1994).

Appendix 2 shows the quantile plots for the selected variables. Table 4 presents the quantile regression estimates and the OLS regression estimates to make comparison of the coefficients and standard errors of the regressions easier and to see the effects of the explanatory variables over the full income distribution.

All the regressions were statistically significant. The results of the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity with Ho: Constant variance variables: city_code_new, male, age, married, grade, foreign, partofagroup, dayorweeku, trolley, tenure months ftimejob, duration, and starttime produce a chi^2 (12) = 24.03 and Prob > chi^2 = 0.0201. These results indicate that there is heteroscedasticity and justify the use of quantile regressions.

A second model with another set of OLS and quantile regressions, applying the robust variance-covariance estimation (VCE), which will be computed under the assumption that the residual density is continuous and bounded away from 0 and infinity at the specified quantile (1), is presented in Table 5 (Koenker 2005). In this model, the city

TABLE 4: Summary results of the quantile and ordinary least square regression analysis (full model).

Independent variables	Model I 0.1 Quantile regression		Model I 0.25 Quantile regression		Model I Median regression		Model I 0.75 Quantile regression		Model I 0.90 Quantile regression		Model I OLS	
	Coefficient	Prob	Coefficient	(Prob)	Coefficient	Prob	Coefficient	Prob	Coefficient	Prob	Coefficient	Prob
City code	-0.3583716	0.6557383	-0.1760575	0.8503579	-0.1664724	0.9559233	-0.8845247	1.961549	0.2406673	5.212752	-0.2614506	1.247877
Male	0.5179761	7.091142	8.140088	9.195755	6.780092	10.33734	0.6835187	21.21215	9.913198	56.37061	10.35458	13.49452
Age	-0.2087786+	0.162217	-0.6003052***+	0.2102385	-0.818972***+	0.236338	-1.770473***+	0.484964	-2.653061**	1.288777	-1.332146***	0.308519
Married	1.715166	3.240176	3.75461	4.201844	0.6978088	4.72347	4.132256	9.692531	-7.769719	25.75759	3.225935	6.166091
Grade	0.7833886*	0.5261352	0.8774495	0.6822894	0.1102971	0.7669903	-0.4656865	1.573859	-1.835786	4.182481	0.0501707	1.001241
Foreign	8.068829	5.765828	-0.8918561+	7.477096	21.5825**	8.405319	25.44923	17.24766	-1.24515	45.83511	16.13329	10.97243
Work in group	-0.9462896	3.611245	-4.672895	4.683043	4.398449	5.264407	7.220572	10.80253	-8.330456	28.70738	-0.6385085	6.872239
Daily or weekly income	5.556919	5.130958	2.46645	6.653799	1.028298	7.479817	-8.279213	15.34854	37.52986	40.78824	6.54021	9.764269
Trolley	3.822269+	3.727169	11.89711***	4.833372	10.79231**	5.433398	13.95627	11.1493	2.330831	29.6289	15.27262**	7.092843
Months in previous full-time job	-0.0034806+	0.0208235	0.0056699	0.0270038	0.0124957	0.0303561	0.0557693	0.062291	0.0716621	0.165535	0.0337374	0.039627
Duration	-0.8522567	0.8100829	-1.149255	1.050511	-1.243479	1.180924	0.0845084	2.423249	3.167501	6.439706	-0.9776567	1.541597
Starttime	-2.955729**+	1.392841	-4.965718***+	1.806229	-4.485375**	2.030458	-7.117642*	4.166488	-14.51937	11.07231	-8.37897***	2.650592
Cons/Intercept	50.0204**	20.42526	80.58661***	26.48737	112.4363***	29.77557	197.6733***	61.09928	300.6757*	162.3694	161.9984***	38.86949
Obs	409		409		409		409		409		409	
Pseudo R^2	0.043		0.0744		0.0898		0.1194		0.1449		-	
R-squared	-		-		-		-		-		0.1673	
Adj *R*-squared	-		-		-		-		-		0.1421	

SE, standard error; OLS, ordinary least square.
*, ** and *** represent the statistical significance at the 90%, 95% and 99% confidence level, respectively.

TABLE 5: Summary results of the quantile and ordinary least square regression analysis [city-fixed-effect VCE (robust)] model.

Independent variables	Model II - 0.1 Quantile regression		Model II - 0.25 Quantile regression		Model II - Median regression		Model II - 0.75 Quantile regression		Model II - 0.90 Quantile regression		Model II - OLS	
	Coefficient	(SE)	Coefficient	(SE)	Coefficient	(SE)	Coefficient	(SE)	Coefficient	(SE)	Coefficient	(SE)
Male	8.091748	5.19589	8.120279**	4.073895	19.2213***	0.1800425	15.85688	12.73263	49.53169	54.50985	16.8521*	9.591818
Age	-0.28695***+	0.0808198	-0.6268512***+	0.1514956	-0.858557***+	0.1800425	-1.80228***+	0.3318081	-2.665031***	0.7679402	-1.304224***	0.3314913
Married	-1.088279	1.967554	2.423496	3.201369	-0.0806446	3.918533	1.051746	5.989538	-19.42292	16.3513	2.917344	5.87759
Grade	0.4872103	0.3190498	0.9641655*	0.5119254	0.3872335	0.6121363	-0.852659	0.924797	-1.787689	3.03718	0.0892198	1.041702
Foreign	6.118914	10.65743	0.2160965+	5.473171	19.79163***	9.840772	24.28518	16.37933	-3.86342	64.84265	14.16007	14.11904
Work in group	0.0767423	1.819405	-5.941696	4.16298	4.854758	6.288186	11.29043	7.784352	-7.008449	19.46794	1.199693	7.407524
Daily or weekly income	6.831616	5.866715	3.165722	5.928159	2.830057	6.780445	-5.181701	12.87182	39.78269	52.31554	5.894347	13.21026
Trolley	7.046174***+	2.480229	13.63078***	93.499573)	13.08337***	4.922027	26.09049***	5.711507	14.03931	22.46013	19.20825***	5.95834
Months in previous full-time job	-0.001372+	0.7598302)	0.0061201	0.0195463	0.0247531	0.0204167	0.0664455**	0.0308757	0.1076434	0.1178273	0.0352323	0.0297054
Duration	-0.7598302	0.5912886	-0.7901243	0.7632184	-0.8373605	1.006519	0.1656779	1.589085	0.0437868	4.802065	-1.141043	1.59404
Starttime	-2.14049***+	0.8157991	-4.561713***+	1.258512	-4.531764***	1.656879	-6.167257***	2.267078	-15.81749**	6.671239	-8.37696***	2.57185
City code 3	-28.72092	44.20363	-34.96952	26.78903	-24.24268	91.59104	-46.2226	37.68871	-25.32248	231.2863	-56.23221**	23.44886
City code 4	-17.00908	47.16262	-33.3493	24.12646	-2.486724	96.8139	-24.07755	38.83516	-63.62567	234.0822	-50.44539**	24.76817
City code 5	21.13243	55.12317	10.1321	30.82257	28.52052	91.14059	-2.830139	67.57337	-3.313488	232.1218	-14.3137	22.75324
City code 6	-7.788204	44.00012	-17.21778	25.45464	-10.16633	90.69671	10.72242	70.37318	25.28058	230.9436	-36.13	26.52076
City code 7	-9.795153	44.09205	-21.06728	23.63753	-11.30702	90.79118	-21.15994	65.19521)	34.65804	231.8831	-28.81686	25.9099
City code 8	-10.59422	43.93534	-18.57533	23.17356	-4.737768	90.42935	-28.18834	37.83587	-21.05272	228.5458	-44.53898**	44.53898)
City code 10	-37.49732	52.11855	-6.466343	41.25873	42.38129	94.10881	22.05973	42.03139	96.48822	240.3678	-18.3633	29.68
City code 11	7.832395	45.31675	-15.3226	23.43317	8.168053	92.41553	-43.29938	41.03381	-35.79387	232.4575	-46.83211**	23.23274
City code 12	-20.30551	43.93633	-24.67458	22.87076	-6.945521	90.38858	-20.43376	38.37668	-3.374167	229.3897	-45.88406**	21.82106
City code 13	-14.53273	43.87891	-22.52496	22.92166	-8.33216	90.42859	-29.94987	37.94742	4.56125	228.6826	-40.62084*	21.60604
Cons/Intercept	53.3295	45.52503	95.80788	38.01122	92.84722	92.84722	186.1308	52.82512	300.8999	256.1587	191.888	59.04773
Obs	409		409		409		409		409		409	
Pseudo R^2/R-squared	0.0698		0.0873		0.1017		0.1352		0.1723		0.1766	

OLS, ordinary least square; SE, standard error.

*, ** and *** represent the statistical significance at the 90%, 95% and 99% confidence level, respectively.

in which the street waste pickers operate is included as a fixed effect.

The next section will discuss the results obtained from the regression models.

Discussion

The different combinations of recyclable waste collected and the weight of each type of waste product collected by an individual street waste picker differ from day to day and the street waste pickers have no control over these. The capturing of data on the exact combination and weight of each recyclable product collected by each individual street waste picker was not part of the national study. A focused micro-study is necessary to collect these data.

The quantity of recyclable waste collected and the price received for each recyclable waste product have an influence on the income of street waste pickers (Viljoen 2014). Despite the price difference between the recyclable waste products and the fact that street waste pickers have no control over the price, few specialise in collecting only the more valuable recyclable waste. Those who do specialise do not necessarily earn higher incomes than those who collect a larger volume of mixed recyclables. This might be an indication of the scarcity of the higher valued recyclable waste (Viljoen 2014).

The difficulty in measuring the varying combinations and weight of recyclable waste collected by each individual street waste picker makes the assessment of the impact of this on large numbers of the street waste pickers' income impossible. Although the street waste pickers have no control over their demographic characteristics, it influences their earnings.

City

From the OLS and quantile regression model 1 results of the other factors that may influence the street waste pickers' income, there seems to be a negative relationship between the size of the cities and the income earned by the street waste pickers. The highest negative effect is at the 75th percentile. This relationship turns positive at the 90th percentile level. None of these results are statistically significant. In the city-fixed-effect model, none of the quantile results are statistically significant, but according to the OLS results, there is a statistically significant negative effect for cities 3, 4, 8, 11, 12 and 13.

The fact that the income of street waste pickers in smaller cities with fewer street waste pickers tends to be higher relative to larger cities with more street waste pickers might be ascribed to the higher level of competition for recyclable waste between street waste pickers in the larger cities.

Gender

According to the OLS and quantile regression, male street waste pickers earn higher incomes than female street waste pickers do. The largest gaps in income between males and females are recorded at the 90th percentile, followed by the 25th and 50th percentiles, where the difference is R9.91, R8.14 and R6.78, respectively. These results are lower than the OLS results of R10.35. None of these results are statistically significant. The coefficient changes in the more robust model are because of the city as a fixed effect. The positive coefficients for males are much larger than in the first model with a gender difference in the 90th percentile of R49.53. The VCE (robust) OLS results in a difference of R16.85 between male and female incomes.

This gender result corresponds with the results of a study by Sentime (2011), who reported that male waste pickers earn higher incomes than female waste pickers in Braamfontein, Johannesburg. The finding is also supported by a study in the Free State by Schenck et al. (2012) in which the average earnings of male landfill waste pickers were found to be greater than that of their female counterparts. This finding is logical, given the physical effort needed to collect and transport waste over long distances.

Age

The income potential for younger street waste pickers is higher than for older street waste pickers. A study by McLean (2000a) in Durban identified age as a factor that might influence a waste picker's income-earning potential, with younger waste pickers earning higher incomes than older waste pickers. The results show a negative relationship between age and the income of street waste pickers. Every one year added to age decreases the income of street waste pickers by between R0.21 in the 10th quantile and R2.65 in the 90th percentile. The age effect strengthens as the income moves from the lower to the higher income range. The results for the robust model with city as a fixed effect only slightly differ from the first model and are statistically significant at all percentiles and the OLS regression.

These results are statistically significant except for the bottom 10th percentile. The reasons why younger street waste pickers are earning more than the older street waste pickers might be related to the fact that they are usually physically more able to move quicker and might be able to collect and manage larger and heavier volumes of waste.

Marital status

The income of street waste pickers who are married is higher than their unmarried counterparts at all quantile levels except for the 90th percentile income earners. The positive effect ranges from R0.70 in the median quantile (50th) to R4.13 in the 75th percentile level. The positive effect of marriage also resembles that of the OLS results. The income of married street waste pickers at the top percentile (90th), however, is negatively affected. This negative effect is much higher (R7.77) than the positive effect at the lower income levels. With city as a fixed effect, the negative relationship is

evident at the 10th, 50th and 90th percentiles, with a much higher negative effect of R19.42 at the 90th percentile. Marriage can therefore be seen as a constraint, especially for the high-income earners. None of these results are statistically significant.

Education

The results for a one-unit increase in education are positive in the OLS model but mixed in the quantile model. At the lower end of the income distribution (quantiles 0.1, 0.25 and 0.50), an additional grade has a slight positive effect on income but negatively influences the income of street waste pickers in the 75th and 90th percentiles. With the city as a fixed effect, the differences in the income of street waste pickers with additional education resemble that of the first model and none of the results are statistically significant. Therefore, for high-income earning street waste pickers, the relationship is negative, which contradicts the theory of a positive relationship between the level of education and income (McConnell et al. 2013). The differences in the income of street waste pickers with additional education are not statistically significant and, for high-income earning street waste pickers, contradictory to the theory of a positive relationship between the level of education and income (McConnell, Brue & MacPherson 2013).

Foreign born

According to the results of the OLS regression, foreign-born street waste pickers earn on average R16.13 more than the South Africa-born street waste pickers. This relationship is also true at the 0.1, 0.5 and 0.75 quantiles. The foreign-born street waste pickers in the 50th and 75th quantiles earn R21.58 and R25.45, respectively, more than the South Africa-born street waste pickers in that income range. The incomes of foreign-born street waste pickers in the 0.25 and 0.90 quantiles, however, are lower than that of their South Africa-born counterparts. The reason for the positive relationship might be that the foreign-born street waste pickers tend to live and work together. South Africa-born street waste pickers in the 25th and 90th quantiles earn R0.89 and R1.25, respectively, more than the foreign-born street waste pickers in those quantiles, which is much lower than the income difference in the other quantiles. These results are, however, only statistically significant for the 50th quantile (median). In the city-fixed-effect model, the coefficients are slightly higher, and positive for all percentiles and the OLS, but also negative at the 90th percentile.

Working in group

The descriptive statistics on the factors relating to the working conditions and/or practices of the street waste pickers reveal that working together in a group might influence the income positively. According to the OLS results, it seems as if working in a group negatively affects the income of street waste pickers. Looking at the results of the different quantiles, it seems as if the negative effect holds for the street waste pickers in the 10th, 25th and 90th percentiles. In the 0.5 and 0.75 quantiles, working in a group has a positive effect on income. The city fixed effect results in a positive effect in the 10th, 50th and 75th quantiles as well as the OLS. The results are therefore mixed and not statistically significant. The higher incomes of those who belong to a group might be explained by the type of support they receive from one another, whether work related or support on a social level. Social support, such as the sharing of food and the caring for one another, might increase their morale and productivity.

Day or week

The street waste pickers who store their recyclables and only sell it once a week earn higher incomes of R6.54 on average according to the OLS model. The highest difference in the income between those selling on the same day of collection and those selling only once a week is found in the top end of the income distribution (90th percentile) in both the models and amounts to R37.53 in the full model and R39.78 in the city-fixed-effect model. There is, however, a negative relationship between selling once a week at the 75th percentile income level in both models. The majority of the street waste pickers who sell their recyclable waste once a week therefore earn higher incomes than those who sell their waste on the same day it was collected. The lack of storage space might prevent many street waste pickers from selling their recyclable waste once a week. Few buy-back centres have storage space and storage facilities for the street waste pickers (Viljoen 2014). None of these results are statistically significant.

Trolley

The type of equipment used to carry the recyclable waste can potentially influence the income. Using a trolley to collect, store, carry and move the recyclable waste rather than other equipment such as bags, wheelbarrows and their heads has a positive and statistically significant influence on the earnings of street waste pickers according to the OLS model.

A closer look at the influence of a trolley on the income of street waste pickers over the whole income distribution reveals that a trolley has a positive effect at all quantile levels in both the full model and city-fixed-effect model. The positive influence of a trolley in the full model in the middle-income quantiles (25th, 50th and 75th) is the highest and ranges from R10.79 to R13.96 more income. For the city-fixed-effect model, the highest effect is in the 75th quantile at R26.09, much higher than in the full model. The results for the OLS are also much larger. The results are statistically significant for the 25th and 50th percentile for the full model and all percentile levels and the OLS for the city-fixed-effect model.

A trolley makes it easier to carry higher volumes of waste over longer distances. These results conform to the results of a study by McLean (2000a) in Durban in 1998, who also

found that waste pickers who use a trolley to carry the recyclable waste collected earned more than those using other equipment.

Experience in a previous full-time job

As with the level of education, the months of experience in a previous full-time job have a small positive effect on income in the OLS model as well as all the quantiles for the full model and the city-fixed-effect model, except for the small negative effect in quantile 0.1. These results are not statistically significant for the full model and only statistically significant for the city-fixed-effect model at the 75th quantile. These results confirm that street waste pickers do not require special skills or previous experience to do their work as waste pickers. They just need to be physically able to carry the recyclable waste over long distances.

Duration

A survey in Kampot, Cambodia, in 2009 and a study in Dhaka City, Bangladesh, in 2008 found a positive correlation between the income of waste pickers and their daily working hours (Ullah 2008; UNESCAP 2011). According to Benson and Vanqa-Mgijima (2010), this correlation might not necessarily be positive.

An interesting observation is that the number of hours worked in a day has a negative influence on the income of street waste pickers in the OLS model as well as at the lower income distribution (10th, 25th and 50th percentiles) but a positive influence at the higher income distribution (75th and 90th percentiles) in both models. These results are not statistically significant and confirm the results by Benson and Vanqa-Mgijima (2010) that longer hours of work do not consistently translate into high incomes.

Starting time

Studies by Benson and Vanqa-Mgijima (2010), McLean (2000a) and Sentime (2011) suggest that the time at which a waste picker starts picking waste might also influence the income-earning potential as the recyclable waste available is limited and benefits the waste picker who finds it first.

Recyclable waste is not freely available throughout the day. More recyclable waste is usually available before the municipal trucks empty the dustbins and not freely available throughout the day. Therefore, the street waste pickers benefit most by starting collection of waste early in the day as they have to collect as much recyclable waste as possible before the municipal trucks collect the waste. They also need to get to the more valuable waste, such as clothing and shoes that households put out next to their garbage bins, first.

The results of the OLS regression and all percentile levels confirm the negative relationship between the starting time and income. This implies that the later a street waste picker starts collecting waste, the lower the income will be. The negative influence of starting 1 h later results in a decrease in income of between R2.96 at the 10th percentile and a high of R14.52 at the 90th percentile for the full model and between R2.14 at the 10th percentile and R15.82 at the 90th percentile. The starting time has a larger impact moving across the quantiles from bottom income earners to top income earners. Starting early therefore has a greater effect on the income of the high earners. These results are statistically significant for all quantiles in both models except for the 90th percentile level in the full model.

The results of the OLS regressions reveal that the independent variables included in the full model explain between 14.21 and 16.73 per cent of the income variance and 17.66 per cent in the city-fixed-effect model. The quantile regressions, however, reveal that very little (less than 10%) of the income variance for quantiles 0.1, 0.25 and 0.5 is explained by the variables included in the respective models. This calls for more in-depth analyses of the factors affecting the income of street waste pickers, specifically at the bottom-end income levels.

For the full model, the only factors that have a statistically significant influence on the income of street waste pickers according to the OLS are age (negative effect), using a trolley (positive effect) and the starting time (negative effect). Age is also statistically significant at all quantile levels except at the bottom-end income distribution (10th percentile level). Using a trolley is only statistically significant at the 25th and 50th percentile income levels. The starting time is statistically significant at the lower half of the income distribution (10th, 25th and 50th percentiles) and not statistically significant at the upper income distribution.

For the city-fixed-effect model, the gender effect is statistically significant at a 10% level, whereas age and using a trolley are statistically significant at a 1% confidence level and the starting time at a 5% confidence level.

Most of the variance is therefore caused by the prices of the recyclable waste collected and the volume and mix collected.

Conclusion

The high unemployment rates and limited opportunities for the unskilled and semi-skilled in the formal economy force many to venture into informal street waste-picking activities as these activities have few or no entry barriers. These activities in their current form are a survival mechanism yielding incomes that are not enough to lift the street waste pickers out of poverty.

The OLS model provides the results of the relationship between the independent variables and the conditional mean of the street waste pickers' income. The quantile results provide valuable insights into the relationships that the explanatory variables have with the income of street waste pickers over the whole income distribution. The effect of the

different independent variables behaves differently across the different income levels (quantiles).

The OLS and quantile results show that these activities yield relatively higher income-earning opportunities for males and younger street waste pickers than for females and older street waste pickers. The first variable with the potential to increase the street waste pickers' income endogenously is to use a trolley to collect recyclable waste. The starting time is another factor that most strongly influences the income of street waste pickers. The earlier a street waste picker starts with the collection of recyclable waste, the higher the potential income will be.

The results of the OLS and quantile models reveal that street waste pickers themselves can do very little to increase their income. This means that approximately 35 000–70 000 street waste pickers in South Africa are trapped in persistent and chronic poverty.

Street waste pickers rely heavily on the value and mix of the recyclable waste they collect and the prices paid for the recyclable waste products by the buy-back centres that are not included in the models. This study does therefore have important limitations as a result of the use of cross-sectional data in the absence of panel data. We therefore are extremely careful to allude to any suggestion of causality when discussing the results. However, identifying supply-side wage determinants opens up the possibility for further research into equilibrium wage determinants and the role of competition. One possibility noted by a reviewer is the investigation into a market model, where entry costs and expected profitability determine the number of waste pickers in an area. The influence of the mix, weight and recyclable product prices on the earnings of street waste pickers is one aspect of the equilibrium wage determinants that necessitates further research in the form of micro-studies.

To improve their incomes, street waste pickers need exogenous interventions such as increasing their access to higher volumes and higher valued recyclable waste. Local governments can, through waste management initiatives such as separation at source projects, facilitate increased access to waste for street waste pickers. Increased access to waste is one of the key issues that can improve the income and livelihood of street waste pickers. Local governments should further facilitate infrastructure such as material recovery facilities (MRFs), sorting facilities and buy-back centres that might assist street waste pickers to collect and sell higher volumes of waste.

The street waste pickers' endeavour, self-reliance and determination deserve to be nurtured through consultative and inclusive policies to include them in formal waste management strategies. Only then will they be able to '… make enough to buy food'.

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Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

K.V. assisted in the conceptualising of the research project, participated in the fieldwork and acted as the first author on various drafts of the article. D.B. assisted in the conceptualising of the research project, participated in the fieldwork and acted as the second author on various drafts of the article. R.S. assisted in the conceptualising of the research project, participated in the fieldwork and acted as the third author on various drafts of the article.

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Appendix 1

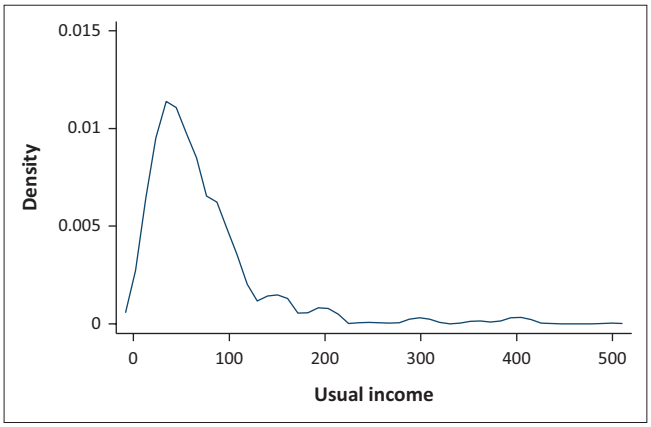

FIGURE 1-A1: Kernel density estimate.

Appendix 2

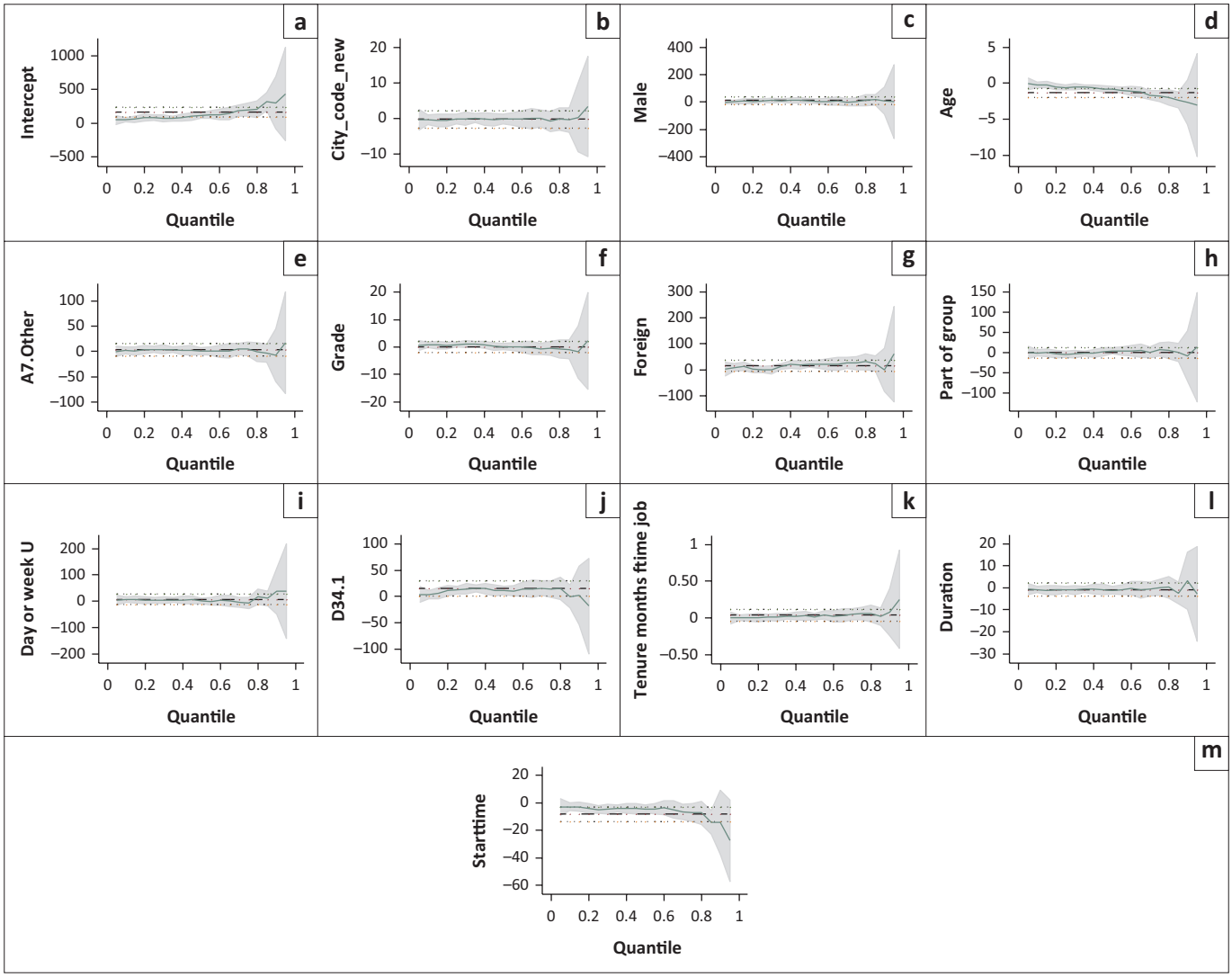

FIGURE 1-A2: Quantile plots for the selected variables.