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DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF MONOZYGOTIC AND DIZYGOTIC TWINS IN THE LABOUR MARKET

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Abstract

The paper accurately determines zygosity in a twins' data set, presents a fairly detailed demographic and socio-economic profile of monozygotic (MZ) and dizygotic (DZ) twins in the Ghanaian labour market and provides evidence of the similarities and differences between MZ and DZ twins. Predictive discriminant analysis is used to classify twins into MZ and DZ groups and descriptive analysis is performed to observe and explore patterns and relationships between socio-demographic variables. The discriminant analysis revealed that 99.2% of the twins were classified correctly into MZ and DZ twins groups. The descriptive analysis indicated that female twins slightly outnumber male twins and the sample of twins was largely youthful. It was also observed that more than half of the twins had completed only elementary schooling. However, MZ twins had higher educational attainment and higher earnings than DZ twins. The association between the educational levels and annual earnings of MZ twins were also found to be greater than that of DZ twins. The findings suggest that genes and environment play a major role in identifying similarities and differences in the socio-demographic characteristics of individuals in the workforce.

Keywords: Socio-demographic, Twins, Genetic, Environment, labour market.

JEL Classification: C19, J01, J10

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1. **Introduction**

There is a general consensus among researchers that socio-demographic and economic characteristics are important for the sustainable development of a country (UNFPA, 2014). Several empirical studies have emphasized the importance of socio-demographic characteristics such as age, gender, marital status, educational attainment, occupational characteristics and annual earnings of the workforce (Habib, J. et al. 2010; Salma et al. 2008; Card, 1994). This is because of the role that socio-demographic factors play in workforce development, policymaking, program planning (Sum, et al. 2006) and for monitoring and improving economic inequality (Mazumder, 2004). However, similarities and differences between the socio-economic outcomes of individuals in the workforce have been observed in a number of studies (Benin and Johnson, 1984; Conley, et al. 2004) which have proposed that such socio-economic differences could come from genetic and environmental influences. Subsequent studies have therefore used sibling data as well as sibling correlations to *explain* similarities and differences in socio-economic outcomes of workers across demographic subgroups (Conley, et al. 2004) and to also provide a measure of sibling "similarity or difference". In addition, sibling correlations have also been used in labour economics studies to measure the importance of environment (family background) as a determinant of economic status. The idea is that, if environment matters very much, siblings will show a strong similarity in economic status; if it matters hardly at all, they will show little more similarity than would randomly selected unrelated individuals. Analyses of sibling correlations across demographic groups also address theoretical concern over parental investment behaviour (Becker and Tomes 1976, 1979; Behrman, Pollak and Taubman 1982, 1989) and over the relative difficulty of environmental and genetic family background factors and inter-sibling effects (Miller et al. 2006, 1995; Ashenfelter and Rouse, 1998). Mazumder (2004) and Conley, et al. (2005) have used variance decomposition methods to estimate sibling correlations. However, Miller et al. (1995; 2006) and Ashenfelter and Krueger (1994) suggest the use of the simple correlation method to provide evidence of the degree of sibling similarity in twins' studies for some socio-demographic characteristics.

In spite of the importance of the use of sibling data in the examination of socio-demographic characteristics in relation to economic status, most studies have not been able to effectively account for genetic and environmental influences. Recent studies have therefore recommended the use of twins' data to account for unobserved differences in socioeconomic outcomes of individuals or the percentage of variance in a population due to genes which contributes to these relationships. The use of twins' data further elucidates the role that genetic and environmental influences play in relation to the socio-demographic statuses of individuals in a population. Twins have been found to have greater similarity in their socio-demographic characteristics and most researchers have attributed the similarity to common genes and environment (Behrman and Taubman (1989); Miller et al. (2001); Miller et al. (1996) and Schnittker (2008)). Thus, data on twins have been used in socio-demographic studies to reveal the importance of genetic and environmental influences in the variation of socioeconomic outcomes in the labour market and also provide an important possibility for demographers to analyze patterns of heritability of individual attributes with respect to earnings (Kohler et al. 2002).

There are two types of twins, namely Monozygotic (MZ) and Dizygotic (DZ) twins. The two types of twins have a shared (family) environment, but unlike the MZ twins who are genetically identical (i.e., share 100% of their genetic material) and are always the same sex, the DZ twins share, only one-half of their genes on average and may be of the same sex or opposite sexes. Greater similarity in socio-demographic outcomes between MZ twins is therefore indicative of the importance of genes in the labour market (Hyytinen, et al. 2013).

Several authors have noted that studies using twin data sets should determine zygosity of a twin pair, since accurate determination of zygosity is a basic and important requirement in any twin study and failing to do so might result in biased estimates (Rietvield et al. 2000). While it has been common practice to apply decision tree algorithms for determining whether a twin pair is either MZ or DZ (Torgersen, 1979, Sarna, et al. 1978) the discriminant function analysis or the logistic regression method has become a preferred approach in zygosity diagnosis studies because of its ability to simultaneously classify each twin as MZ or DZ (Hauge et al. 1989 and Magnus et al. 1983). Moreover, discriminant analysis have been identified as a powerful classification technique in most zygosity diagnosis studies to distinguish MZ twins from DZ twins using multiple attributes (Fernandez, G. C., 2002). For an analysis of this type, (Rietveld et al. 2000; Goldsmith, 1991; Ooki and Asaka, 1993) determined the zygosity of MZ or DZ twins using the discriminant function analysis. It was revealed that 90-95% of twins were identified correctly as MZ or DZ by applying the discriminant algorithm to parent's and children's response on questions dealing with the twins' physical similarity and the frequency with which people confuse them.

Moreover, for an analysis of the socio-demographic characteristics of a sample of twins Ashenfelter and Krueger (1994); Miller et al. (1995) emphasized the importance of descriptive analysis by carrying out a descriptive study which observed, described and explored patterns and relations in the twins' data. They employed basic descriptive statistical methods to create a clear and complete picture of the characteristics of a typical member of their twins' sample. They concluded that genetics, family background and schooling are all important in determining income in both the male and female labour markets. In addition, they detected little differences between the gender and marital status characteristics of the samples of monozygotic and dizygotic twins. Similarly, they found out that the mean incomes of the MZ and DZ twins are approximately the same and minor differences in mean level of education between the samples of MZ and DZ twins were also observed. On the other hand, using the simple correlation analysis, Baker et al. (1996) and Miller et al. (2001) concluded that MZ twins are more alike in terms of their educational attainments than DZ twins. It is expected that a pair of MZ twins who are genetically identical, will show very similar socio-economic characteristics. A comparison therefore of socio-demographic correlation estimates derived from samples of MZ twins and DZ twins provide indirect evidence of the contribution of the potential influence of genetics and environment to individual socio-demographic differences and similarities in the workforce. Moreover, for decades, social scientists have relied on sibling correlations as indicative of the effects of genes and environment on socio-economic outcomes.

Studies on the socio-demographic profiles of groups of individuals in the labour force remains an important research endeavour because of the role they play in the economic developmental system of a country. There is therefore the need for research to examine the contribution of genetic and environmental influences in the identification of socio-demographic similarities and differences between individuals in the workforce. In this paper, we provide a comprehensive, yet simple, analysis of key socio-demographic characteristics of working-age twins and the contribution of genetic and environmental influences in the labour market. Whereas this paper adds to the growing number of twins studies undertaken globally to determine the relative importance of genetic and environmental influences on socio-economic outcomes (Cesarini, et al. 2009a; Fowler, Dawes, & Christakis, 2009) in the workforce, it is however, one of a few within sub-Saharan Africa. Policy makers, government and organizations could benefit from a comprehensive understanding of the relative importance of genetic and environmental influences potentially impacting the socio-demographic factors of workers as they could adjust workforce developmental programmes and policies to specific worker needs.

The paper provides a mechanism to determine the accuracy of zygosity in the twins' data and further presents a fairly detailed demographic and socioeconomic profile of MZ and DZ twins in the Ghanaian labour market and provides evidence of the similarities and differences between MZ and DZ twins using a number of socio-economic characteristics. The paper also examines the relative contribution of genes and environment to differences and similarities in a number of socio-demographic characteristics in the labour market.

2. **Materials and Methods**

2.1. Data

The data used is obtained from a Ghanaian Twins Survey, which was carried out by a team of 5 interviewees between December 2007 and January 2008 in three metropolitan cities which were over 250km apart in the southern part of Ghana. The cities were Kumasi, Accra and Takoradi **(**Figure 1). The survey utilized a questionnaire which was developed based on experiences gathered and results of previous twin studies and excerpts from Ashenfelter and Krueger's Twinsburg twin's survey questionnaire. The survey collected information on a range of demographic (age, gender, marital status, etc.,), socioeconomic (educational attainment), and labour market characteristics (annual earnings, occupational characteristics, etc.) associated with forms of employment. Adult twins, who were aged between 18 and 65 and gainfully employed at the time of the survey, were identified by the team of interviewees through various channels, including colleagues, friends, relatives, members of twins clubs, twins at various work places, markets, shops and a number of households in Accra, Kumasi and Takoradi. Overall, these channels permitted a roughly equal probability of contacting all of the twins in these cities, and thus the twins sample that was obtained is approximately representative.

Figure 1: Map of Ghana showing the three major cities, namely Accra, Kumasi and Takoradi.

Structured questionnaires were completed through face-to-face personal interviews. Altogether 250 individuals were interviewed and determination of zygosity was based on self-reported answers to specific questions about similarity in physical characteristics and experiences of mistaken identity, which is a well established and valid method in twin populations. A total of 72 and 53 complete pairs of DZ twins and MZ twins respectively, were thus identified.

The various socio-economic, demographic and labour characteristics are described in Table 1. In accordance with a number of studies (Card, 1995; Mincer, 1974; Becker, 1964), number of years of schooling was obtained by summing up all of the actual years of schooling that the twins attended at each educational level. This is the conventional method of counting the number of years in school, and provides a schooling variable that is continuous **(**years of schooling ranges from 0 to 25 years). The representation of an individual's education is provided by their highest level of education attained (degree or higher; diploma or certificate, etc.). Annual earnings were calculated from gross wage or salary income (from all jobs) and the natural logarithm of annual earnings was used in a quest to have a normal distribution of the variable. Age, which was initially recorded in exact years, was then regrouped into 5-year age groups for the purposes of the analyses. Gender was created as a dummy variable whereby females were assigned a value of one and males a value of zero. The response options for marital status were recorded as never married, married, separated, divorced and living together. Occupational categories were drawn and a socio-economic classification was then derived.

Table 1: Description of explanatory variables

Variable	**Description**
Dependent variable Log earnings	Natural log of the annual earnings
Independent Variables	
Number of Years of completed education	No education = 0years, Primary = 1-6years, Middle/JSS = 7-10years, Secondary = 11-17years and Higher = 18-25years
Age	17<age<70
Gender	Male = 0, Female = 1
Marital Status	Not married = 0, (constitutes living together, separated and divorced) Married = 1
Father's education	No education = 0years, Primary = 1-6years, Middle/JSS = 7-10years, Secondary = 11-17years and Higher = 18-25years
Mother's education	No education = 0years, Primary = 1-6years, Middle/JSS = 7-10years, Secondary = 11-17years and Higher = 18-25years

2.2. Data Analysis and Statistical Methods

All analyses were conducted using Statistical Package for Social Sciences (SPSS) version 17 (SPSS Inc, Chicago, IL). The zygosity of the twin pairs in the data was determined using predictive discriminant analysis by Huberty, C.J. (1994) for classifying twins into MZ and DZ groups on the basis of their responses to questions on similarity and mistaken identity. The proportion of correctly classified observations is the estimated classification rate. Prior probabilities of group membership were computed from group sizes. Descriptive analyses were used to present the various socio-economic and demographic characteristics of twins in the labour market. The Independent sample t-test was used to evaluate differences in the means of socio-economic and demographic characteristics of MZ and DZ twins in the labour market. The relationships between socio-economic and demographic characteristics in the labour market were analyzed using Pearson's correlation coefficients.

3. Results

3.1. Zygosity Determination

The accuracy of the zygosity of MZ and DZ twin pairs was determined separately based upon responses to the individual questions provided in Table 2. Accuracy was computed as the percentage of the twin pairs whose zygosity was correctly identified by the responses to the question. Parents, family and strangers were more accurate in identifying the zygosity of DZ twins (accuracy range = 99 to 100%) than they were for MZ twins ((accuracy range = 1 to 57%), Table 2). Overall, the reliability estimate of the responses for accurate classification of zygosity for both MZ and DZ twins using photo identification was very high (r=0.98 Table 2) indicating that photo identification could be one of the best candidates for correct determination of zygosity. In determining zygosity, it is also important to specify prior knowledge of group membership in order to correctly assign individuals as monozygotic or dizygotic twins. The unconditional (prior) probability that an individual is assigned as a dizygotic twin is 15% higher than being assigned as a monozygotic twin, (Table 3).

Table 2: Percentage Accuracy in Determining Zygosity

Questions	Accuracy (%)		Reliability (Pearson's r)
	MZ	DZ	
Peas-in-a-pod (look alike)	98	97	.94
Parents identify	57	100	.55
Family identify	28	100	.77
Strangers identify	1	99	.97
Photo Identification	98	100	.98
N	106	144	

Source: Ghana Twins Survey, 2007/2008

Table 3: Prior Probabilities for Groups

Twin type	Prior	Cases Used in Analysis	
		Unweighted	Weighted
Monozygotic	.424	106	106.000
Dizygotic	.576	144	144.000
Total	1.000	250	250.000

Source: Ghana Twins Survey, 2007/2008

Table 4: Zygosity Classification Results[a]

			Predicted Group Membership		
		twin type	monozygotic	dizygotic	Total
Original	Count	monozygotic	104	2	106
		dizygotic	0	144	144
	%	monozygotic	98.1	1.9	100.0
		dizygotic	.0	100.0	100.0

a- 99.2% of original grouped cases correctly classified.

The accuracy of zygosity diagnosis was evaluated across MZ and DZ twins and a summary of the results of the discriminant analyses is given in Table 4. Correct classification for MZ twins was estimated around 98.1%, whereas 100% of DZ twins were identified correctly demonstrating that the precision of classification was very high across zygosities. Overall, 99.2% of all twin pairs were assigned the correct zygosity by the discriminant function. Out of 250 twins only two cases (i.e., a pair of twins (0.8% of MZ twins)) were incorrectly classified as DZ twins by the discriminant function analysis. Zygosity assignment for the pair of twins was therefore identified as uncertain (i.e., probability of being DZ rather than MZ). Thus, possible biased results due to misdiagnosis of twins are not likely to occur in this study.

3.2. Demographic and Socio-Economic Characteristics

A summary of the general characteristics of twins used in this study is presented in Table 5. The Table highlights information on education, occupational status and other variables including demographic characteristics for MZ and DZ twins. The results are presented at both individual and type of twins (MZ, DZ) levels. This helps to create a larger picture about each respondent and their genetic make-up. It also provides a starting point for research questions, including comparative studies that rely on a comparison between twins in Ghana and other survey samples in other countries.

3.2.1. Demographic Characteristics

Demographic characteristics considered in this study are age, gender and marital status. Our results indicate that, 48.8% of the twins are males and 51.2% are females. Females slightly outnumber males in the sample which might probably be due to high survival rates of females in Ghana. A similar pattern is also depicted in the MZ and DZ twins samples which could bring about exogenous variation in labour force outcomes. The age of twins in the sample ranged from 18 to 65 years with a mean age of 32.8 ± 10.3 years. Only twins from age 18 years were sampled due to the fact that the study was limited to the labour market. About 2.4% of the twins surveyed were found in both the youngest age group **(**$17<age\leq19$ years) and the oldest age group (60-65 years) (Table 5).

Table 5: Socio-demographic Characteristics of Twins in Ghana

Characteristics	All Twins (%)	Monozygotic Twins (%)	Dizygotic Twins (%)	Chi-square	p-value
Sex					
Male	48.80	21.60	27.20	0.3384	0.5608
Female	51.20	20.80	30.40		
Age					
<17	2.40	0.80	1.60	7.9642	0.5378
20-24	18.40	8.00	10.40		
25-29	29.60	12.80	16.80		
30-34	12.00	6.40	5.60		
35-39	14.40	7.20	7.20		
40-44	8.00	3.20	4.80		
45-49	7.20	1.60	5.60		
50-54	4.00	0.80	3.20		
55-59	1.60	0.80	0.80		
60-65	2.40	0.80	1.60		
Highest level of education					
	2.40	0.00	2.40	20.8892	0.0003
No education (0)	4.40	1.20	3.20		
Primary (1-6)	53.20	19.60	33.60		
Middle/JSS (7-10)	8.80	2.40	6.40		
Secondary (11-17)	31.20	19.20	12.00		
Higher (18-25)					
Occupation					
Professional	26.00	13.20	12.80	8.1176	0.0874
Clerical	6.00	3.20	2.80		
Business	35.60	13.20	22.40		
Agriculture	6.80	1.20	5.60		
Production & Labourer	25.60	11.60	14.00		
Marital Status					
Married	44.00	13.60	30.40	13.5740	0.0088
Living together	0.80	0.80	0.00		
Separated	1.60	1.20	0.40		
Divorced	0.80	0.40	0.40		
Never married	52.80	26.40	26.40		
Mothers Age					
15-19	4.00	1.60	2.40	3.2447	0.6623
20-24	24.00	8.80	15.20		
25-29	16.00	6.40	9.60		
30-34	34.40	14.40	20.00		
35-39	17.60	8.80	8.80		
40-44	4.00	2.40	1.60		

Source: Ghana Twins Survey, 2007/2008

The largest proportion of the survey population were in the younger age groups, with age group 25-29 years having the greatest number of people for males (32.0%) and (27.3 %) for females. Additionally, the age distribution was found to be more skewed to the left portraying a pyramidal age structure for the Ghanaian twins' population (Figure 2). The number of twins who survive to old age was about the same for both males and females, (Figure 2). The mean

age of MZ twins was 31.9 ± 9.3 years, while the mean age of DZ twins was, on average, almost 2 years older than that of MZ twins (Table 6). However, trivial differences (t=-1.23, d.f.=248, p>0.05) were observed for the age factor and the 0.4-point difference in the mean of the proportion of MZ and DZ male twins could likely have occurred by chance (Table 7). The highest proportion of twin births was found amongst mothers in the age group (30-34years) (Table 5). A similar trend was also found for mothers aged between 30-34 years who gave birth to MZ and DZ twins, however, the incidence of DZ twin births was about 5.6% higher than MZ twin births. This may probably be due to the fact that dizygotic twin pregnancies are slightly more likely for women who fall within age group 30 to 40 because they usually face age-specific fertility issues and the administration of ovulation-inducing hormones by medical doctors as a fertility treatment option may result in dizygotic twin births.

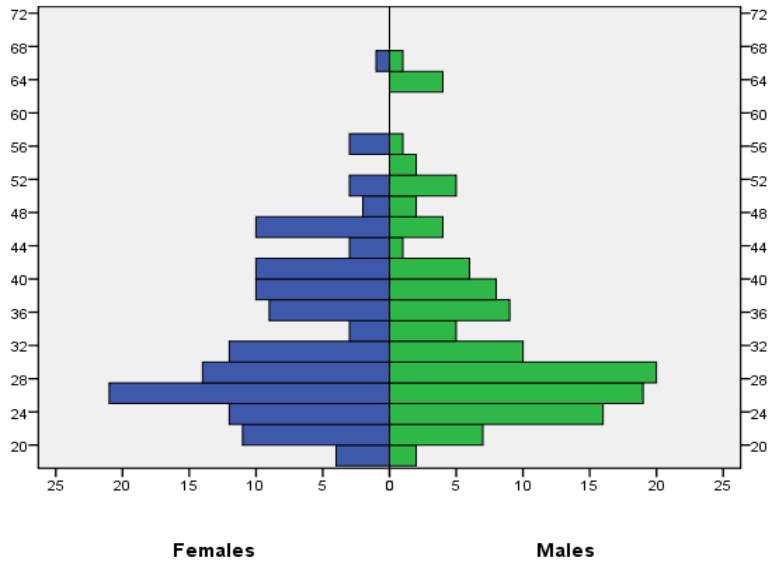

Figure 2: Population age pyramid of twins in Ghana

The twins' sample split by marital status show that 44% were married and 56% were not married, (Table 5). This marital pattern is expected in this sample, where over 76% of the sample is below 40 years of age (Table 5). On the other hand, 30.4% of DZ twins are married, whilst only 13.6% of MZ twins are married (Table 5). Significant differences (t=3.09, d.f=248, p<0.01) were nevertheless found in the mean marital status of MZ and DZ twins (Table 6). This suggests that MZ twins share demographic and lifestyle factors that might influence their marital status to a greater degree than do DZ twins and this could result from genetic influences.

3.2.2. Socio-Economic Characteristics

All the twins were employed on a full-time basis. Looking at the occupational classification, the business category emerged with the highest percentage (35.6%) followed closely by the professional and the production and labourer category (26% and 25.6% respectively). The percentage of MZ twins who are in the professional category was slightly higher than that of the DZ twins by about 0.4% (Table 5). With an average exchange rate of GH¢0.92 to the US *dollar* prevailing in June 2006, the average annual earnings is US$781(Table 6), where earnings include wages, bonuses, and subsidies. Differences were observed between the mean annual earnings of MZ and DZ twins (Table 6). MZ twins were found to earn more on average than DZ twins and a t-test (independent samples) analysis showed a significant difference ($t=3.34$, $d.f=248$, $p<0.01$) between the mean annual earnings of MZ and DZ twins (Table 6.). This might probably be due to the fact the MZ twins in this study were better educated and were therefore, more likely to earn higher salaries than DZ twins in the labour market.

About 53% of the twins' have completed elementary or basic education (MSLC/JSS), and slightly above 30% have tertiary school qualifications (Table 5). Twins with virtually no educational qualifications are the smallest group (2.4%). This same trend is identified in both the monozygotic twins group and the dizygotic twins group. On average the twins have almost 13 years of education (Table 6). This indicates that a good number of the twins' in this study do not have very high educational qualifications. MZ twins have 14 years of education, which is about three extra years of education on average than DZ twins (Table 6). More than 70% of the twins report identical education levels, so that many within-twin education differences are zeros (Figure. 3). Nevertheless, there is also some amount of variability in the reported wage differences of twins with the same educational levels. Higher earnings were also found to be associated with high education levels.

Table 6: Means and Standard Errors of Selected Variables

Variable	**Pooled sample**	**Monozygotic twins**	**Dizygotic twins**
Own education (years)	12.576 (0.343)	14.009 (0.535)	11.521 (0.427)
Co-twins education (years)	12.692 (0.345)	13.840 (0.550)	11.847 (0.429)
Male (proportion)	0.488 (0.032	0.509 (0.049)	0.472 (0.042)
Age (years)	32.816 (0.649)	31.887 (0.905)	33.500 (0.907)
Married (proportion)	0.432 (0.031)	0.321 (0.046)	0.514 (0.042)
Log of annual income	GH¢7.184 (0.054)	GH¢7.368 (0.084)	GH¢7.049 (0.068)
Sample size	250	106	144

Note: Figures in parentheses are standard errors

Table 7: Independent Samples Test for Equality of Means of Socio-Economic and Demographic Characteristics of Monozygotic and Dizygotic Twins

T-test for Equality of Means							
	t	df	Sig. (2-tailed)	Mean Difference	Std error Difference	95% Confidence Interval of Difference	
						Lower	Upper
Own education (years) a, b	3.343 3.308	248 217	0.001 0.001	2.266 2.266	0.678 0.685	0.931 0.916	3.602 3.617
Co-twins education (years)	3.478 3.425	248 213	0.001 0.001	2.406 2.406	0.692 0.703	1.044 1.021	3.769 3.791
Male (proportion)	0.580 0.580	248 226	0.563 0.563	0.037 0.037	0.064 0.064	-0.089 -0.089	0.164 0.164
Age (years)	-1.23 -1.23	248 242	0.220 0.209	-1.613 -1.613	1.312 1.281	-4.197 -4.137	0.970 0.910
Married (proportion)	-3.09 -3.12	248 234	0.002 0.002	-0.193 -0.193	0.062 0.062	-0.316 -0.315	-0.070 -0.071
Log of annual income	2.977 2.950	248 219	0.003 0.004	0.319 0.319	0.107 0.108	0.108 0.106	0.530 0.532

a - Equal variances assumed; b - Equal variances not assumed

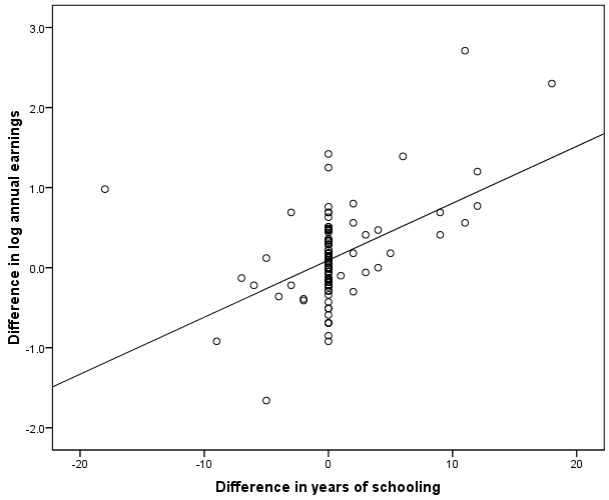

Figure 3: Within-twin pair differences in years of schooling and annual earnings

Higher earnings were also found to be associated with high education levels. Significant differences ($t=3.34$, $d.f=248$, $p<0.01$) were thus found between the mean educational levels of MZ and DZ twins (Table 7). This suggests that MZ twins are more likely to acquire more schooling and work in prestigious occupations compared to DZ twins.

3.2.3. Sibling correlations across socio-economic characteristics

In an attempt to substantiate the degree of sibling similarity in a number of components of socioeconomic status, analysis on sibling correlations across socio-economic characteristics was performed. The correlations among the (logarithmic) income, (self reported and co-twin reported) education levels and mother's and father's education levels are reported in Table 8 for Monozygotic twins and in Table 9 for dizygotic twins. In this analysis the twin who was the first to come out of the womb was chosen to be twin 1 in each pair. The correlation between the self-reported educational attainments of MZ twin pairs is (0.963) and only (0.339) for DZ twin pairs (Table 8). This indicates that MZ twins are more alike in terms of their educational attainments than DZ twins a finding that would be expected on the basis of their greater genetic similarity. The correlation between the self-reported measure of educational attainment and the report on this educational attainment by the co-twin is the same for both MZ twins and DZ twins (0.999). The simple correlation coefficient between the self-reported and co-twin-reported measures of educational attainment shows the extent of variation in reported measures of schooling.

The correlation between the self-reported measure of educational attainment and co-twin-reported education of the same twin, that is $corr(S_1^1, S_2^1)$ and $corr(S_2^2, S_1^2)$ is (0.999) and (0.999) for MZ twins, (Table 8). The association between the educational levels of MZ twins is positive and very high indicating that MZ twins are more likely to report the same own-level of educational attainment and are characterized by having a greater similarity between the own-report on educational attainment and the co-twin's report. On the other hand $corr(S_1^1, S_2^1)$ and $corr(S_2^2, S_1^2)$ for DZ twins are (0.999 and 0.697, Table 9). They indicate that between 1% and 30% of the measured variation in educational attainment for DZ twins' is error and allows for direct estimates of the extent of measurement error in (the cross-sectional) reported schooling in the twins' data. The simple correlation coefficients between the self-reported and co-twin-reported levels of education for both MZ and twins provide a measure of the reliability ratio of the measure of educational attainment.

Table 8: Correlation coefficients between selected variables for MZ twins

A. Pearson Correlation Coefficients for Monozygotic twins, N = 53 Prob > |r| under H0: Rho=0										
Parameter	S_1^1	S_2^2	S_1^2	S_2^1	M_1	M_2	F_1	F_2	Y_1	Y_2
S_1^1	1.0000									
S_2^2	0.9628 <.0001	1.0000								
S_1^2	0.9632 <.0001	0.9997 <.0001	1.0000							
S_2^1	0.9999 <.0001	0.9628 <.0001	0.9632 <.0001	1.0000						
M_1	0.2960 0.0314	0.2571 0.0631	0.2565 0.0638	0.2960 0.0314	1.0000					
M_2	0.4655 0.0004	0.4820 0.0003	0.4812 0.0003	0.4655 0.0004	0.6028 <.0001	1.0000				
F_1	0.4808 0.0003	0.4791 0.0003	0.4777 0.0003	0.4808 0.0003	0.4585 0.0006	0.4165 0.0019	1.0000			
F_2	0.5436 <.0001	0.5565 <.0001	0.5563 <.0001	0.5436 <.0001	0.4324 0.0012	0.6524 <.0001	0.8326 <.0001	1.0000		
Y_1	0.6396 <.0001	0.6101 <.0001	0.6058 <.0001	0.6396 <.0001	0.1027 0.4645	0.1913 0.1701	0.3300 0.0158	0.3820 0.0048	1.0000	
Y_2	0.6385 <.0001	0.6625 <.0001	0.6547 <.0001	0.6385 <.0001	0.0608 0.6657	0.2175 0.1177	0.3504 0.0101	0.4009 0.0029	0.8829 <.0001	1.0000

Notes: S_1^1 = total years of schooling of twin 1; S_1^2 = sibling 1 reported years of schooling of sibling 2;
S_2^2 = total years of schooling of twin 2; S_2^1 = sibling 2 reported years of schooling of sibling 1;
M_1 = twin 1's report of mother's educational level; M_2 = twin 2's report of mother's educational level;
F_1 = twin 1's report of father's educational level; F_2 = twin 2's report of father's educational level;
Y_1 = twin 1's earnings; Y_2 = twin 2's earnings.

On the whole, the high correlations suggest that the co-twin-reported level of education could be a good instrumental variable for self-reported level of education for further analysis. The correlation coefficients between parental education and twin education for both MZ and DZ twins were also very significant ($p<0.05$) though lower than the estimates for the twins themselves (Tables 8 & 9). The significant ($p<0.05$) level of parental educational attainment could be a good predictor for the schooling success of children and shows the relevance of family background level effects of education on earnings and the returns to education. Furthermore, the within-twin pair earnings among MZ twins are more highly correlated than that of dizygotic twins.

Table 9: Correlation coefficients between selected variables for DZ twins

B. Pearson Correlation Coefficients for Dizygotic twins, N = 72 Prob > |r| under H0: Rho=0										
Parameter	S_1^1	S_2^2	S_1^2	S_2^1	M_1	M_2	F_1	F_2	Y_1	Y_2
S_1^1	1.0000									
S_2^2	0.3391 0.0036	1.0000								
S_1^2	0.5860 <.0001	0.6970 <.0001	1.0000							
S_2^1	0.9999 <.0001	0.3391 0.0036	0.5860 <.0001	1.0000						
M_1	0.3366 0.0038	0.4460 <.0001	0.5250 <.0001	0.3366 0.0038	1.0000					
M_2	0.3283 0.0049	0.3233 0.0056	0.4520 <.0001	0.3283 0.0049	0.6362 <.0001	1.0000				
F_1	0.3496 0.0026	0.3807 0.0010	0.4843 <.0001	0.3496 0.0026	0.7377 <.0001	0.6008 <.0001	1.0000			
F_2	0.3470 0.0028	0.3272 0.0050	0.4770 <.0001	0.3470 0.0028	0.6267 <.0001	0.7250 <.0001	0.7849 <.0001	1.0000		
Y_1	0.5123 <.0001	0.3163 0.0068	0.4033 0.0004	0.5123 <.0001	0.4355 <.0001	0.3873 0.0008	0.2868 0.0146	0.3050 0.0092	1.0000	
Y_2	0.3612 0.0018	0.4898 <.0001	0.6190 <.0001	0.3612 0.0018	0.4209 0.0002	0.3726 0.0013	0.2726 0.0205	0.2968 0.0114	0.7103 <.0001	1.0000

Notes: S_1^1 = total years of schooling of twin 1; S_1^2 = sibling 1 reported years of schooling of sibling 2; S_2^2 = total years of schooling of twin 2; S_2^1 = sibling 2 reported years of schooling of sibling 1; M_1 = twin 1's report of mother's educational level; M_2 = twin 2's report of mother's educational level; F_1 = twin 1's report of father's educational level; F_2 = twin 2's report of father's educational level; Y_1 = twin 1's earnings; Y_2 = twin 2's earnings.

4. Discussion

4.1. *Zygosity Determination*

Accurate zygosity assessment by questionnaire remains an important component of recent twin studies. It is therefore important to perform an appropriate analysis of respondents' answers to questions about zygosity and in so doing, provide a test for sample duplication which will prevent false identification of a dizygotic pair as monozygotic. In the absence of DNA data, the use of self-report questionnaires for zygosity assessment in adult twins yields good results. Since the Ghanaian twins sample is made up of both dizygotic and monozygotic twins, estimates could in part reflect genetic differences between twins. Therefore, one of the objectives of this study was to determine the accuracy of zygosity in twins between the ages of 18 to 65 based on questions relating to the similarity of physical characteristics and the confusion of identity. The use of discriminant analysis as a tool for classification in determining zygosity in twins, in this study, resulted in 99% correct classification of both MZ and DZ twins. Only a pair of twins was classified as DZ twins instead of MZ twins by photo

identification. Nevertheless, reports from both twins signified that they were monozygotic twins and were therefore treated as such. This level of accuracy is comparable to previously reported accuracy rates in zygosity classification using questionnaires among twin pairs which range from 91-98% (Song et al. 2010; Christiansen et al., 2003; Jackson et al. 2001; Peeters et al. 1998; Sarna and Kaprio, 1980). Thus, for many profiles of responses to zygosity questions, zygosity can be assigned with relatively high probability ((better than 95%), Heath, et al. 2003; Rietveld et al. 2000). Furthermore, on the basis of zygosity diagnosis by self-report of twins, the MZ-to-DZ ratio of the twins in this study was 2:3. These values are similar to the general overall ratio population twinning rate which is two thirds dizygotic twinning to one third monozygotic (Mosby, 2009).

4.2. Socio-Demographic Characteristics

Socio-demographic characteristics have been observed globally to play a significant role in workforce development. We presented a demographic and socioeconomic profile of MZ and DZ twins in the Ghanaian workforce and in so doing provided a deeper understanding of the influence of genes and environment in the workforce by establishing areas of similarities and differences based on employee socio-demographic characteristics. The results revealed that about 74% of the twins were young and were between 20-39 years old and 44% were married. This relatively large youthful twin's working-age population could potentially create opportunities for a more rapid economic growth. This is consistent with previous findings by Roubaud and Torelli (2013) who observed that sub-Saharan's working-age population is predominantly youthful and presents opportunities for the socio-economic development of the country. The results further showed that female twins outnumber their male counterparts in the labour market which might probably be as a result of high survival rates of female twins. This is similar to findings in the GLSS 5 report and by World Bank, (2011) that females form a greater percentage of the working force in Ghana and sub-Saharan Africa respectively. The higher female proportion in the labour market may be the result of women's traditional participation in petty trading and market production in agriculture (World Bank 2007). This however appears to differ with results from the New Zealand labour market whose findings indicate that the proportion of females in the labour force are markedly lower than male proportions for those aged between 25–39. The authors attributed this phenomenon to the fact that women could be caring for children in the house and are more likely not to be actively involved in the labour force. The results further showed that less than 50% of the twins in the Ghanaian labour market were married. The analysis is in conformity with findings by World Bank (2011) which detected that marriage rates had dropped precipitously among young adults ages 25 to 34 in U.S. during the past decade suggesting that more young couples are delaying marriage or foregoing matrimony altogether, likely as an adaptive response to the economic downturn. Additionally, about 30% of DZ twins were married, whilst only 13.6% MZ twins were married suggesting that there might be a stronger bond between MZ twins than DZ twins and therefore MZ twins tend to remain single for much longer than DZ twins. This is consistent with Johnson et al. (2004), whose findings suggest that marital status is mainly explained by genetic factors. However, contrary to this view,

Neyer, 2002 asserts that differences in marital status were unrelated to twins' status, but largely due to sex differences.

Education is widely believed to play an important role in economic development. Studies conducted worldwide on the economic benefits of additional schooling have confirmed that investing in differing amounts of schooling affects individual earnings. These studies have consistently shown that more schooling is associated with higher individual earnings. The results revealed that a higher proportion (53%) of the twins had attained junior secondary school or middle school education (9-10 continuous years of schooling) while about a third had acquired tertiary or higher level education (18-25 continuous years of schooling). The twins labour force has therefore a low level of human capital with more than half of the people having completed only elementary schooling. This pattern is similar to findings by Ackah, et. al. (2014) who reports that about 70 per cent of Ghanaians with education have only up to the junior secondary level with just 24 per cent of Ghanaians with secondary school or higher education. Although, OECD, (2012) reports similar tertiary educational attainment results in comparison with the twins educational structure, less than a third of adults across OECD countries now have only primary or lower secondary levels of education. Research evidence shows that the educational level attained have essential net effects (controlling for several relevant social background variables) on the occupational status of an individual (Card, 1998).

The descriptive analysis indicates that the majority of the twins are employed in the business sector, followed closely by professionals and production & labourer sectors. Twins employed in the agriculture sector account for only 7% as well as 6% for the clerical occupation. This is not surprising, since agricultural employment is overwhelmingly rural and the survey was conducted in city centres. GSS (2013) however, reports that about a fifth (17%) of the Ghanaian urban workforce (i.e. all those who are employed) are employed in the agricultural sector. More than 70% of the twins were also found to be employed in the informal sector. This is consistent with findings by Kuepie et al. (2006) who observed that about 50% of those with completed middle school educational level are working in the informal sector in some African countries like, Abidjan, Bamako, Cotonou, Dakar, Lomé**,** Niamey and Ouagadougou. Baah (2007) and Kuepie, et al. (2006) also confirms that there is a high rate of informal sector participation in Ghana. The lack of formal qualifications makes workers vulnerable in securing decent employment and this clearly indicates that the human capital development is still low in Africa and rigorous evaluation of educational policy interventions are required to meet its developmental goals. Contrary to these results, most workers in the developed world are employed in the formal sector of the economy (Pianta, 2006) and thus contribute immensely towards the economic development of their countries through an effective and efficient taxpaying system.

4.3. Sibling Similarities and Differences

The study also examined the degree of sibling resemblance in labour market earnings, educational attainment and parental education of monozygotic and dizygotic twins. The results revealed that, the correlation between the educational attainments of MZ twin pairs is

(0.963) and only (0.339) for DZ twin pairs, an indication that monozygotic twins are more alike in terms of their educational outcomes than dizygotic twins. Similarly, the correlation between annual earnings outcome of MZ twins were found to be higher than that of DZ twins. This might be attributed to a combination of common heredity, common environment, and the influence of one sibling over the other. The results are broadly in line with the findings of Miller et al. (1995) and Ashenfelter and Krueger (1994) who used sibling correlations to determine the importance of genetic differences to variation in earnings. Conceptually, the sibling correlation in economic outcomes provides a summary statistic that captures all of the effects of sharing a common family (Mazumder, 2004). The high correlation between MZ twins might be due to the fact that MZ twins are genetically identical and more often than not share the same family and neighborhood environment confirming studies by Miller et al. (1995) and Ashenfelter and Krueger (1994) that MZ twins bear a closer similarity than DZ twins.

In addition, the results disclosed a clear and positive relationship between parental education and the educational attainment levels of both MZ and DZ twins which supports evidence by (Gödde and Schnabel, 1998) that there is a strong and positive correlation between the educational levels of parents and their children. Behrman and Rosenzweig (2002) also observe positive effects of paternal education in twins studies and consistent findings by (Björklund and Salvanes, 2011) also indicates that there is a large correlation between the education level of parents and their children. This implies that the level of parental educational attainment could be a good predictor for the schooling success of children and shows the relevance of family background level effects of education on earnings. Thus, highly educated parents can provide a favorable environment for the educational levels of their children than parents with little or no education.

5. Conclusion

This study employs recent data obtained from a 2007/2008 Ghanaian Twins Survey to provide a fairly detailed socio-demographic profile of MZ and DZ twins in the Ghanaian labour market. The main objectives were to determine the accuracy of zygosity in twins between the ages of 18 to 65, present a profile of key socio-demographic characteristics of MZ and DZ twins in the Ghanaian labour market and to provide evidence of the degree of sibling resemblance using a number of socio-economic characteristics and in so doing, highlight the effect of genetic and environmental influences on key socio-demographic characteristics in the labour market. The study suggests the use of predictive discriminant analysis to determine the accuracy of zygosity of the twin pairs. The Independent sample t-test is used to evaluate differences in the means of socio-economic and demographic characteristics of monozygotic and dizygotic twins in the labour market and the relationships between socio-economic and demographic characteristics in the labour market is analyzed using Pearson's correlation coefficients.

The use of discriminant analysis as a classification tool in determining zygosity in twins, in this study, resulted in 99% correct classification of both MZ and DZ twins. The working-age twins sample is largely young and presents opportunities for the socioeconomic development of the country. Both MZ and DZ female twins form a greater percentage of the

working force. The high female working-age proportion may be the result of women's traditional participation in petty trading, subsistence farming and market production in agriculture. About 30% of DZ twins were married, whilst only 13.6% of MZ twins were married suggesting that there might be a stronger bond between MZ twins than DZ twins and therefore MZ twins tend to remain single for much longer than DZ twins. These results indicate that a significant proportion of the twins sample is not married. The results also revealed that a higher proportion (53%) of the twins had attained junior secondary school or middle school education while about a third had acquired tertiary or higher level education. The twins labour force has therefore a low level of human capital with more than half of the people having completed only elementary schooling. The descriptive analysis indicates that the majority of the twins are employed in the business sector and as such, more than 70% of the twins were found to be employed in the informal sector. The correlation between the educational levels and annual earnings outcome of MZ twins were found to be higher than that of DZ twins confirming the fact that MZ twins are more similar than DZ twins because they are genetically identical and more often than not share a common environment. Significant differences were also identified between the mean educational levels and annual earnings of MZ and DZ twins, revealing that MZ twins are more likely to acquire more schooling, work in high-status occupations and earn higher incomes than DZ twins. Parental education has positive effects on the educational attainment and the labour market earnings received by both MZ and DZ twins. The influence of genetic and environmental factors could therefore help to identify the role of important socio-demographic characteristics in the labour market.

5.1. Implications of results for the Ghanaian labour market

This study which focused on the demographic and socio-economic profile of the working age population of twins has important implications for policy formulation and decision making in the Ghanaian labour market. The youthful population in the Ghanaian labour market has implications for job creation and economic stability. Creating productive, well-paying jobs through the development of new industries related to the green economy concept will be vital to boost economic growth and improve the well being of the youth in the labour market. The slightly high female working-age proportion should prompt the government to provide policy choices that exploit potentials of women to harness applications of science, technology, and innovation for sustainable and diversified livelihoods and socio-economic development. The attainment of basic education by more than half of the twins sample offers an opportunity for economic and social development, yet lower educational levels will not raise earnings substantially. Therefore, there is a need to develop deliberate policies that will encourage individuals to acquire secondary and tertiary education since higher economic returns is usually associated with higher educational attainment. Our results also indicate that earnings and educational levels of individuals in the labour market are closely linked to genetic and environmental factors and therefore, education and training should form the cornerstone of policies aimed at reducing income inequality in the labour market.

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