Full Length Research Article

MODELING LABOR MARKET PERFORMANCE IN SUB-SAHARA AFRICA

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| ARTICLE INFO	ABSTRACT
	In this paper, labor market performance in Sub-Sahara Africa has been modeled using convex optimization. Labor market indicators have been adopted as a reliable source of information capable of describing Sub-Sahara Africa labor market condition. We aimed at investigating a set of measures that could explain maximum performance in the labor market using a set of variables categorized as independent (demographic and resource factors), moderating (labor force and its characteristics), intervening (opportunities and qualifications), and dependent (economic attributes and welfare) to model labor market performance. Using linear programming, each category was considered a constraint to labor market performance. Four constraint equations were constructed using factor analysis. The constraints equations were labeled as employment by sector, Labor force participation rate, status on employment, and working poverty. The objective function was determined by fitting a multiple linear regression equation to a set of factors in the constraint equation. The solution revealed that out of the nine selected indicators, only four could explain Sub-Sahara Africa Labor market performance. These were unemployment rate, Labor force participation rate, labor productivity, and working poverty. This predictive model advises anybody concerned with Sub-Sahara Africa labor market on the areas that need more emphasis for realization of maximum performance.

INTRODUCTION

Labor market affected by supply and demand for work force has characteristic features that comprise of rate of employment, extent of unemployment, and availability of vacancies. The whole concept is about employee-employer match (defined by skills, experience and education level of the human capital), earnings distributions, and employment class size description. Labor market performance is thus a product of the effect of skills level of the workforce in relation to the employers needs. Efficient utilization of the accumulated human capital drives economic growth. For example, advanced technology used in a country, makes it easy to adapt to modern ways of production as compared to technologically less advanced countries. New technologies have increased productivity, which in turn accelerates economic growth. This further implies that accumulated stock of human capital associated with productivity defines the wealth of a society (Behrman, 1999). With the advanced technology, job creation has remained a problem for many countries.

This is because many jobs have been mechanized leading to low demand for human capital. Labor force dynamics affecting job specifications, wages distribution, employee-employer benefits, work place locations, hiring trends, and job seeker-employer expectations have experienced significant growth (Stevens, 2002). The changes in technology and labor force dynamics have affected the job concept either due to worker migration in search for better employment terms or change of workstation within the same firm.

There is therefore, a continued exit and entry to employment in search for job satisfaction for the worker and value for money for the employer. The ripple effect to the firms is that hiring rates suffer instabilities as levels of job retention become inconsistent due to employer-employee expectation. Job concept revolves around three levels; job entry, retention, and job exit. These levels are part of the model of labor market behavior, influenced by availability of vacancies, inventory cost, production demand, employment duration, wages, and employee-employer benefits (Chesher and Lancaster, 1983). The specific job concept is multi-level structure demonstrated in figure 1 below. The ideal model for the job market would be one that considers entry to the job market as a youth and exit as an elder.

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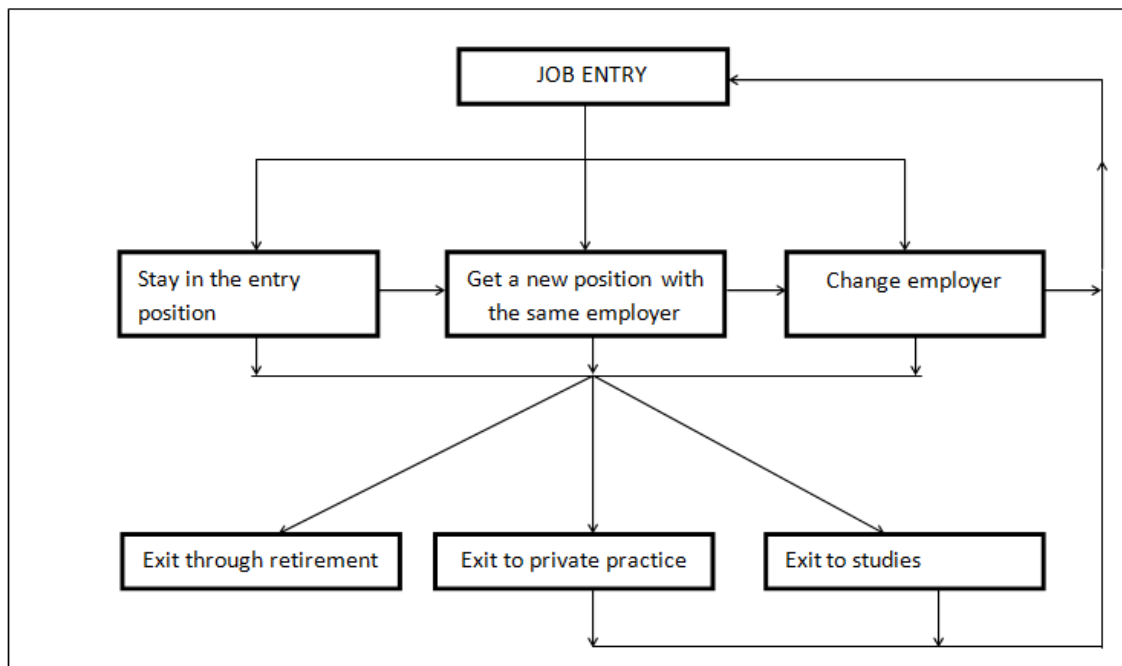
Source (Authors, 2014)

Figure 1. Job concept from entry to exit in the labor market

Unfortunately, the ideal never happens since the youths who should be entering the job market and the elders who should be exiting the market face particular challenges one of them being low labor force participation rates. Youths in particular, have to face a period of unemployment when transiting from education life to working life. However, the periods differ depending on availability of vacancies and individual youth academic qualifications as required by different entry levels in the labor market. An ideal job market concept is a product of vacancies and work force availability. The concept is unique for different occupations, industries, job locations, and salary scales (Toft, 2004). The uniqueness of a job market concept thus influences decisions made by both employees and employers on hiring trends per age category.

For example, the upcoming technology market prefers employing young people willing to keep abreast with new skills. The knowledge on youth and elder population employment trends is important to every government as the main employer. Individual governments take note of the evolving trends in labor market, when planning on public sector management. Therefore, a single action by public sector employment trends influences private sector decision on labor market entry and intervention. For example, while experience remains a mandatory requirement in public sector, ability to apply proper management skills is essential consideration for senior management positions in private sector. It is then highly probable that private sector would employ more young people compared to the public sector. The adoption of innovation and technology has spurred a new wave of intense pressure on resource allocation; more resources allocated to profitable production in developed countries (Sofia, 2011). For example, US industries facing stiff international competition experience production displacement that leads to change of production line or industry closure. The employees thus become jobless for a period before re-employment.

Nonetheless, compared to developing countries, developed countries re-employment period after termination of employment contract happens within 2 years (Ruffer and Knight, 2007). Skilled laborers in developed countries have therefore opted for a change in job contracts from permanent to out sourcing services. Labor markets in developing economies are both urban and rural. According to Behrman (1999), an urban labor market has:

- Diversified production, labor demand and wage variation
- Higher return to education and skills
- Less seasonality dependency
- Higher unemployment due to higher labor migrations from rural to urban market
- Higher policy regulations and union activities due to greater worker diversity

The urban labor market has the highest unemployment rate due to continued population growth. Many workers in urban labor market participate in low-wage and less productive occupations in the informal sector. The informal sector is characterized by ease of entry, production from locally available resources, small-scale production, ease of by passing set regulations like taxes, ease of applying skills learned from school, and household manages the business. In the informal sector, it is difficult to distinguish between a household and a firm, since changes in household welfare directly affects firm production (Ruffer and Knight, 2007). Rural labor market comprises of both agricultural and non-farm activities like mining and quarrying with agriculture dominating the market. For normal Agriculture, tasks like plowing, planting, weeding, and harvesting workers hired on short wage contracts. The market faces wage rigidities that force many workers out of employments to subsistence farming for those who can access farming land. The agriculture industry has been growing faster in Sub-Sahara Africa than in any other part of the world.

However, labor productivity has highly decreased due to unpredictable weather conditions thus increasing poverty levels in both rural and urban labor markets. Labor force distribution and labor market production affect economic growth in a country regardless of class (Topel, 1999). Nevertheless, both distribution and production are a function of population size of which Sub-Sahara Africa has high population growth rate, but less labor force utilization. Underutilization of labor force facilitates continued labor migration between rural and urban markets. Although both markets create resources, the distribution to the two markets has been a challenge in Sub-Sahara Africa, where infrastructure and urban development uses more resources. The level of efficiency and economic growth observed in the urban market thus presents urban market as a better performer than the rural market (Prskawetz *et al.*, 2005).

Measurement of labor market performance

Both rural and urban labor markets have brought out labor market performance as measured by two main rates namely employment and unemployment rates. Job concept cycles drive the overall growth in employment based on long-term

available in labor market. In this study, employment rate comprises of; labor force participation rate, employment to population ratio, status on employment, and employment by sector. Unemployment rate is a function of youth unemployment, and adult unemployment. Nine labor market indicators were used to model the labor market performance (see Table 1 below). According to Fields (2011), developing countries include middle-income countries like South Africa, Brazil, and Thailand as well as low-income countries like Kenya, Tanzania, Pakistan, and Haiti. Developing countries experience a unique labor market with the following features compared to developed countries; relatively lower unemployment rates, low wages and long working hours, irregular working trends and men dominated labor market. Sub-Sahara Africa has the highest level of poverty among the labor force measured through economic growth though it is the richest in both human capital and resources. Structural changes and labor relocation between rural and urban labor market have enhanced labor inequality. About 68% of the human capital in Sub-Sahara Africa engages in agriculture in family farms or on waged contracts. Although urban areas labor market consists of formal and informal employment, informal employment accounts for 60% in urban employment and the

Table 1. Labor Market Indicators

	Indicator	Abbreviation	How it is measured	
1	Labor force participation rate	LFPR	Expressed as a percentage of the total population	
2	Employment to population ratio	EPR	Expressed as percentage of the total population	
3	Status on employment	SE	WSWE_P	Waged and Salaried employment as a percentage of the total employed
				Employers as a percentage of the total employed
			EMPL_P	Own account workers as a percentage of total employed
				Member of producer corporation as a percentage of the total employed
			OAW_ P	Contributing family worker as a percentage of the total employed
			PVE_P	
			CFW_P	
4	Employment by sector	ES	AGR_P	Employment in Agriculture as a percentage of the total employed
				Industrial employment as a percentage of the total employed
			IND_P	Service employment as a percentage of the total employed
			SERV_P	
5	Total unemployment rate	TU	Unemployment as a percentage of the total labor force	
6	Youth unemployment	YU	Youth unemployment as a percentage of the youth labor force	
7	Ratio of youth unemployment to adult unemployment	RYUAU	Youth unemployment as a percentage of adult unemployment	
8	Labor productivity	LP	GDP per person engaged	
9	Working poverty	WP	Percentage of the population living below international poverty line of US$ 1.25	
			Percentage of the persons living below nationally defined poverty lines	

Source: International Labor Organization (2014).

state of the labor market. These cycles are highly affected by population size, size of the employable class, and market absorption rates. Thus, using employment as the only measure of labor market performance is misleading since employment rate only cannot capture the changes in the source population. On the other hand, unemployment rate when used alone creates an unjustifiably positive image of the market especially during recession. Unemployment rate also fails to account for people working part-time but preferring to work full-time. When employment and unemployment rates are used to measure Labor Market performance, employment rate covers the inadequacies experienced. Labor force participation rate measures the labor supply from the sum of employable population. It is a percentage of the total working population. This works as a good measure of the job opportunities

rest remain in formal employment (Bigsten and Horton, 1997). Oya (2010) conducted research on the unreported source of inequality and poverty in the rural labor markets in Africa. The researcher observed that there are wrong assumptions made on the labor market such as inexistence of rural wage employment. Another underreported area is in the change from small-scale farming to waged labor necessitated by low yields when applying traditional export crop. Labor migration and its consequences have also been highly underreported. For example, reporting on seasonal waged workers who move from disadvantaged parts of the country during different seasons has been under looked. These workers encounter poor pay and poor working conditions than homegrown workers who have already established terms for their wages. Such oversights could miss direct rural wage policies.

Cramer, *et al.* (2008), indicates that policy debate on labor performance supported by development, employment, and poverty reduction in Sub-Sahara Africa needs more attention. This is because, a number of surveys indicate that poverty reduction in rural African is dependent on the labor market performance. However, there are great diversities not captured in many surveys especially on employment in rural labor markets. Mozambique Rural Market Survey (MRLS) (2003) captured a wide range of occupations such as farming, bar and hotel service and market stalls, export and imports of goods among others. The oversight in capturing every aspect of the labor market leads to simplistic theoretical models that do not account for the power practiced in labor relations. Cramer, *et al.* (2008) thus recommends employment of research tools capable of capturing information on job quality, gender dimensions, and social status. For example, inclusion of gender dimension in MRLS was able to capture that women participate in rural labor market unlike in standard surveys that indicate that women are either unpaid or self-employed workers.

The role of labor market indicators in describing the situation of labor market in Sub-Sahara Africa is very important. However, the empirical questions remain on the magnitude of an indicator in describing the market; does investment on human capital as advised by policies improve the state of poverty in Sub-Sahara Africa? Gray *et al.* (1996) studied labor market signals and indicators in Zimbabwe, Costa Rica, Bangladesh, and Cambodia.

By use of case studies, the researchers were able to identify signals and indicators as Labor market information components. Paula *et al.* (2005) accessed social security coverage and labor market in developing countries by considering the reasons behind the low uptake of social security programs. Using standard normal distribution, the analysis of household surveys from Latin America showed that contribution to social security coverage highly depended on education, earnings, employer size, age, and household characteristics. Prskawetz *et al.* (2005) explored the changes in size and composition of crude labor force over time. They applied the investigation on five OECD (Organization for Economic Co-operation and Development) countries (France, United Kingdom, Germany, Spain, and United States of America) to investigate crude labor force rate and mean age of the labor force.

Satchi and Temple (2006) investigated labor market contribution to economic growth. Using data from Mexico, they used a general equilibrium to investigate labor migration, chances of self-employment and effects of growth on wages in the informal sector, and matching friction of urban labor market. Dubra (2007) lead a team of researchers to study the labor force and the labor market in sectors of national economy. They investigated Labor force demand and supply on different sectors of economy in Latvia. The results showed that there was an imbalanced demand and supply of labor force by sectors.
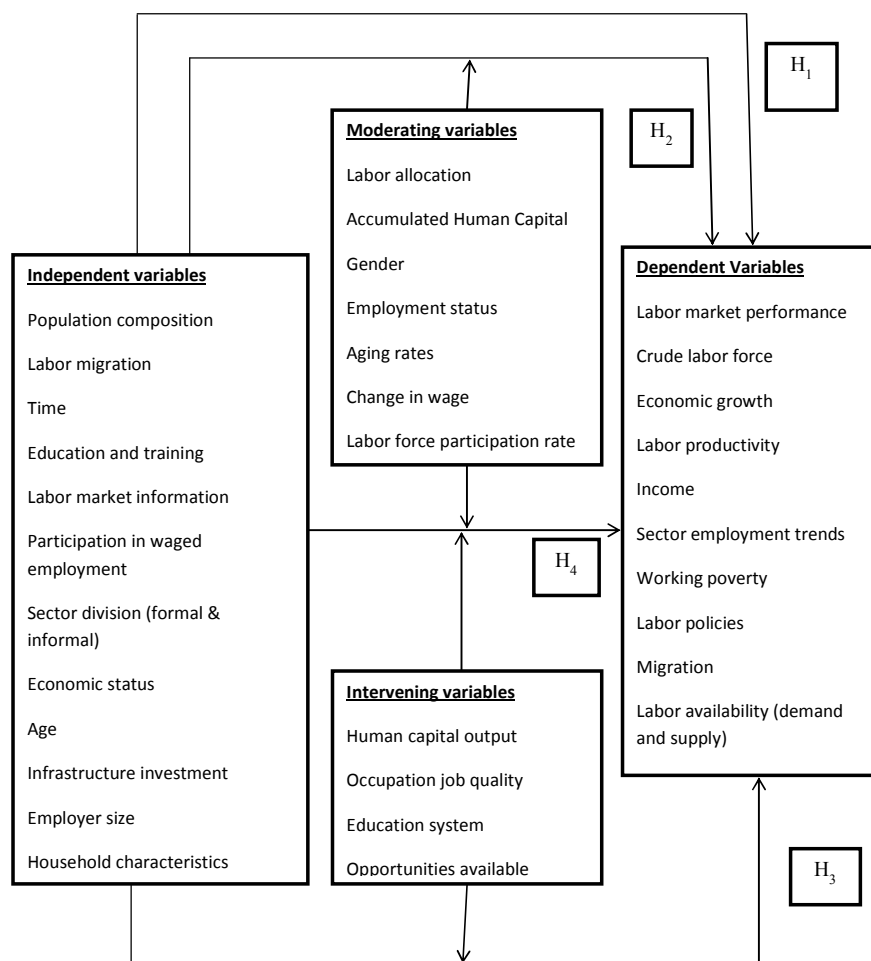
Source (Authors, 2014)

Figure 2: Labor market conceptual framework

This was due to low prestige of some jobs affected by low wages and society acceptance of the profession. Demographic processes that affect labor force migration also influence balance in the labor market. Winters *et al.* (2008) investigated rural wage employment in developing countries using 14 developing countries. To analyze the determinants of labor market participation, the researchers applied probit regression analysis, where productivity was either high or low based on labor force participation in waged employment. The analysis showed that poverty reduction was not entirely dependent on sector employment or overall household livelihood strategy. Instead, education and infrastructure investment contribute to opportunity creations that are of higher wages thus helping in fighting poverty. Gender differences in the labor market was explored, where analysis suggested that gender participation and wages earned need to be given extraordinary attention in that women participation should be encouraged. The conceptual framework in Figure 2 explains how the various variables relate to each other.

Modeling labor market indicators

We obtained the data used in this study from International Labor Organization organization's website. Countries report data on labor market in an inconsistent manner. International Labor Organization (ILO) therefore applies econometric models that assist in producing estimates of labor market indicators in the countries and years where real data is not available (ILO, 2014). According to International Labor Organization (2014) report, the models use multivariate regression to assign missing values. They use country specific information on "per capita income, GDP growth rates, demographic trends, country membership in the highly indebted poor country initiative (HIPC), geographic indicators, and country and time dummy variables" (ILO, 2014). The information is relevant in capturing the interdependency between labor market indicators and microeconomic variables. Sub-Sahara Africa faces social economic problems related to labor market performance. The growth of poverty index could be due to low performance caused by inadequate labor capacity and ill interpretation of policies in the specific countries. To develop policies applicable to Sub-Sahara Africa labor market performance, we need well-documented data. This paper models labor market indicators using convex optimization. The nine indicators summarized as LFPR, EPR, SE, ES, TU, YU, RYUAE, LP, and WP, with SE having WSWE_P, EMPL_P, OAW_P, PVE_P, and CFW_P. Further, we split ES into AGR_P, IND_P, and SERV_P (c.f. Table 1) are variables considered in the modeling.

Employment, unemployment, and vacancy availability affect Labor market indicators that measure performance. Nine indicators listed in Table 1 above best-explained labor market conditions in this study. A well performing labor market is made of nine indicators (c.f. Table 1) each optimal at 100%. We can construct such a labor market problem by considering nonnegative quantities x_j, j=1,…, n that contribute to the definition of the indicators. A unit of quantity x_j contains an amount a_j of factor j and has an overall effect b_i to the labor market performance. The problem is to determine feasible measures of the factors using linear programming techniques. The canonical form of the linear programming problem is

$$\text{maximize } Z = B^T x.$$

Subject to

$$Ax \leq 100$$
$$x \geq 0.$$

To formulate the constraints in the four categories (dependent, moderating, intervening, and independent variables), factor analysis technique was used. The technique describes correlations between a set of observed variables through linear combinations with a few unknown number of latent random factors (Timm, 2002). That is the dimension of the system will be less than p, if the observed variables $x_1, x_2, \ldots, x_p$, are correlated moderately. In this study, we fitted variables from the conceptual framework whose data is available into the model. The available independent variables were time measured in years, participation in waged employment measured as a percentage of total waged and salaried workers, and employer size measured as percentage of the total employers. We split Sector division into agriculture, industrial and service sectors all measured as a percentage of the total employed. On running the factor analysis, the correlation matrix showed that all the variables were sufficiently correlated but waged and salaried workers, employment in industrial sector and total employed had a correlation coefficient 1. To remove redundancy, we dropped waged and salaried workers variable and rerun the analysis. The independent variables yielded two factors namely, production and service sector whose equation was named as employment by sector. A well performing labor market has all laborers absorbed in any of the sectors. This implied that employment by sector should account for 100% absorption.

The moderating variables available included labor allocation divided into rural (agriculture sector employment) and urban employment (service sector employment). To measure accumulated human capital, we used status on employment, which comprised of self employed, own account workers, waged and salaried workers, contributing family workers and members of producer cooperatives. The other variables were gender measured as male and female, Labor Force participation rate and aging rates measured as a ratio of youth unemployment to adult unemployment. There was medium correlation between all variables, but contributing family worker was highly correlated with waged and salaried workers, employers, and members of producer cooperatives. Employers were highly correlated with own account workers. Contributing family workers and own account workers were dropped from the analysis as a way of reducing redundancy. After a second run, the moderating variables yielded two factors namely employment and unemployment rate whose equation we named labor force participation rate (LFPR). The estimation is that a well performing labor market has 100% LFPR. The intervening variables available included human capital measured in terms of labor productivity, job quality measured as a function of status in employment divided into self employed, own account workers, waged and salaried workers, contributing family workers and members of producer cooperatives. We measured opportunities available in terms of employment to population ratio. There was medium correlation between all variables, but employers, members of producer society and contributing family workers were highly correlated with waged and salaried employers.

Thus, we dropped employers, members of producer society and contributing family workers from this analysis. The intervening variables thus, yielded one factor namely status on employment. The estimation is that at least all employable persons should belong to any of the bolded employment status. Thus, the constraint should not exceed 100%. The dependent variables available include crude labor force measured in terms of total participants, labor productivity and working poverty measured as a percentage of the population living below international poverty standards. Labor availability measured in terms of total unemployed was also available for the analysis. The dependent variable yielded two factors namely labor utilization and unemployment rate. We named the equation as working poverty. We measured working poverty as a percentage, thus it should be much less than 100%. We fitted the objective function of labor performance as a function of all factors. These are production and service for the first constraint, employment rate, and unemployment rate for the second constraint, status on employment for constraint three, labor utilization, and unemployment rate for constraint four. The objective function is thus a function of production sector, service sector, employment rate, total unemployment rate, status on employment, and labor utilization. Let x_1 denote production sector, x_2 denote service sector, x_3 denote employment rate, x_4 denote unemployment rate, and x_5 denote status on employment and x_6 denote labor utilization. To validate the model we freshly determined variables x_1 to x_6 using the original data set collected with minimal adjustments using factor analysis.

The fitted model was

$$Maximize \; Z = -0.336x_1 - 0.46x_2 + 1.97x_3 + 1.173x_4 - 2.092x_5 + 0.323x_6$$

Subject to

$3.12x_1 + 1.68x_2 \leq 100$ Employment by sector
$4.8x_3 + 1.75x_4 \leq 100$ Labor force participation rate
$3.23x_5 \leq 100$ Status on employment
$2.45x_6 + 1.24x_4 \leq 100$ Working poverty
$x_i \geq 0, i = 1, \ldots \ldots, 6.$

The adjustments were as follows:

We redefined x_1 by performing factor analysis on employment in agriculture and industrial sectors. For x_3 was defined af teFactor analysis on employment rate was refitted using employment in agriculture, industrial and service industry the resultant factor was renamed employment rate. Using information on waged and salaried workers, employers, own account workers, contributing family workers, and members of producers' cooperatives we refitted x_5. Employers and contributing family workers were removed since they had a higher correlation with the rest of the variables. All other variables remained as before. We obtained the following constraint equations by fitting linear regression equations on the variables.

Labor productivity $0.509x_1 - 0.081x_2 = 6.209$
Labor force participation rate $1.677x_3 + 10.296x_4 = -12.54$
Employment to population ratio $5.837x_5 = -64.37$
Working poverty $3.727x_4 + 5.509x_6 = 22.247$

From the above constraints, labor productivity is below a hundred percent. Labor force participation rate and employment to population ration have registered a negative figure. This could be due to LFPR and EPR being dependent on population size. From literature, Sub-Sahara Africa population has been increasing despite the decreasing job creation initiatives. The increase has caused a higher population of the employable class that is not absorbed by the market. The inverse relationship between the population size and employment rate has caused a negative effect to labor market performance. However, the absolute values of the two constraints are still below 100% threshold. Working poverty also registered a below a 100% effect on labor market performance. Previously, the formulated model had all the constraints given as less than or equal to a hundred. The observed model agrees that all the parameters are less than 100%, since none of the parameters is equal to a value greater than a hundred. This model is thus valid for any analysis of labor market performance using labor market indicators.

Data Analysis

The data used for this paper contained indicators on annual unemployment flow for 70 countries. International labor organization input the data into the calculations of unemployment rate. Majority of the data are from labor force survey datasets in OECD database, EUROSTAT (Statistical office of the European Communities) and national statistical officers, which often provide detailed and standardized data across countries on unemployment duration and labor market status (ILO, 2014). Unemployment by duration determined the country coverage for unemployment indicators. The formulated model was

$$Maximize \; Z = -0.336x_1 - 0.46x_2 + 1.97x_3 + 1.173x_4 - 2.092x_5 + 0.323x_6$$

Subject to

$3.12x_1 + 1.68x_2 \leq 100$
$4.8x_3 + 1.75x_4 \leq 100$
$3.23x_5 \leq 100$
$2.45x_6 + 1.24x_4 \leq 100$
$x_i \geq 0, i = 1, \ldots \ldots, 6.$

To solve this problem, we used simplex method. The standard form of the problem is

$$Maximize \; Z = -0.336x_1 - 0.46x_2 + 1.97x_3 + 1.173x_4 - 2.092x_5 + 0.323x_6$$

Subject to

$3.12x_1 + 1.68x_2 + s_1 = 100$
$4.8x_3 + 1.75x_4 + s_2 = 100$
$3.23x_5 + s_3 = 100$
$2.45x_6 + 1.24x_4 + s_4 = 100$
$x_i \geq 0, i = 1, \ldots \ldots, 6.$

The initial simplex tableau is as below;

Simplex tableau

x_1	x_2	x_3	x_4	x_5	x_6	s_1	s_2	s_3	s_4	Z	
3.12	1.68	0	0	0	0	1	0	0	0	0	100
0	0	4.8	1.75	0	0	0	1	0	0	0	100
0	0	0	0	3.23	0	0	0	1	0	0	100
0	0	0	1.24	0	2.45	0	0	0	1	0	100
0.336	0.46	−1.97	−1.17	2.09	−0.323	0	0	0	0	1	0

After a number of iterations, we obtained the final table as below;

Final simplex tableau

x_1	x_2	x_3	x_4	x_5	x_6	s_1	s_2	s_3	s_4	Z	
3.12	1.68	0	0	0	0	1	0	0	0	0	100
0	0	2.74	1	0	0	0	0.571	0	0	0	57.1
0	0	0	0	3.23	0	0	0	1	0	0	100
0	0	−1.39	0	0	1	0	−0.289	0	0.408	0	11.9
0.336	0.46	0.799	0	2.09	0	0	0.577	0	0.132	1	70.9

The solutions were

$(x_1, x_2, x_3, x_4, x_5, x_6, s_1, s_2, s_3, s_4)$ = (0, 0, 0, 57.1, 0, 11.9, 100, 0, 100, 0) and Z= 66.84

The results from the above calculations indicate that the overall labor market performance in Sub-Sahara Africa is at 66.84%. Unemployment rate, which is at 57.1% and labor utilization, which is at 11.9% of the total population measures labor market performance. The results thus indicate that of the nine labor market indicators, labor market performance is determined by four indicators namely unemployment rate, and labor utilization defined by labor force participation rate, labor productivity, and working poverty. The general results are realistic for Sub-Sahara Africa compared to other Labor Market performance surveys done. For example, Mexico being a developing country like many of Sub-Sahara Africa countries registered a performance of 60.1% in 2011 and Canada being a developed country performed at 80.6 % in 2011. Sub-Sahara Africa having a performance of 66.84% is in between the two economies. However, the greatest contributor to the performance is unemployment rate. This raises the question of the effect of unemployment rate to labor market performance. Compared to developed countries, literature exposed the market as having prolonged unemployment durations since job creation rates do not match up to the current global trends. This means that the market's ability to react to external pressures on unemployment contribute to performance.

Conclusion

• Labor market performance can be termed as a function of all the labor market indicators with employment and unemployment trends acting supreme in the definition. However, the indicators vary in effect on market performance in different countries. For Sub-Sahara Africa, not all indicators of labor market conditions define labor performance. This could be a product of indicator measurements that make some of them highly correlated thus having a chance of higher elimination due to redundancy. For example, total employment, nested employment by sector, total unemployment nested youth unemployment and employment to population ratio nested ratio of youth unemployment to adult unemployment. The three indicators thus lacked cognizable values in defining labor market performance. There is therefore need to consider cases of redundancy when projecting outcome based on a set of measures. Nonetheless, the results above portray Sub-Sahara Africa labor market as a good performer. The performance of 66.84% is above average though with 57.1% unemployment rate. The confusion in the two figures paves way for several questions. Among the questions are the direct effect of unemployment rate in Sub-Sahara Africa and the effect of such a higher performance to economic growth. We would expect such a higher performance to reduce poverty and mortality rates in the region when distributed among all the countries. Collective effect of data from many countries may have caused the disagreement between results and reality. The individual differences in country's performance and delivery of data thus caused neutralizing effect on Sub-Sahara Africa performance.

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