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The agricultural input elasticity of rural-urban migration in South Africa

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Abstract

The pace of rural-urban migration relative to urban job creation is of particular relevance in relation to the level of urban unemployment and poverty in many developing countries. Faced with high levels of urban unemployment and other socio-economic problems governments in developing countries adopted several policies to ameliorate the situation. Since such policies were mainly urban biased in nature it not only failed in most cases but also in some instance exacerbated the situation by stimulating more rural-urban migration. Rural-urban migration occurs where there is economic disparity between rural and urban areas. Some economists therefore, argue that boosting agricultural productivity and/or income can reduce the incidence of economic problems partially posed by rural-urban migration. In this paper, an attempt is made, using a recursive equation system and a South African data set for the period 1965-2002, to measure the indirect agricultural input elasticity of rural-urban migration. The results indicate that narrowing the urban-rural income differentials can reduce the massive rural-urban migration and high urban unemployment in the country. It is furthermore shown that developing agricultural land and infrastructure and increasing fertilizer use can boost agricultural income, reduce rural-urban migration and is consistent with policies aimed at curbing urban unemployment.

1. Introduction

Classical economists, like Lewis (1954:153) and Fei and Ranis (1964:342), claimed the existence of surplus labour, i.e. the presence of hidden unemployment in rural areas, especially at an early stage of a country's development. Huang (1971:718), Hanson (1971:492), and more recently Ranis (1997:2), proved empirically that a larger proportion (from 50 to 80 percent) of the labour force in some developing countries is located in the traditional agricultural sector during the first phase of industrialisation.

It has been shown by, amongst others, Ranis (1997:4) and Nayyar (1998) that the process of industrialisation and development is associated with the

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transfer of labour from the agriculture sector to the industrial sector where labour's unit productivity is relatively higher, which in turn means higher income. Ranis (1997:4) further argues that when assuming that the reallocation rate exceeds the population growth, and more labour is relocated from the agricultural to the industrial sector, the level of hidden unemployment will shrink and the contribution of labour to economic output will grow. It is therefore not surprising that many development economists, amongst them, Todaro (1969:139) and Norton and Alwang (1993:69), regard rural-urban migration as a natural reflection of the economic transformation from agriculture to industry that occurs during the development process.

However, while rural-urban migration *per se* is not bad, its pace relative to urban job creation is of particular relevance in relation to the level of urban unemployment and poverty. In many African countries, rural-urban migration appears to be accelerating while the so called "industrial pull for rural labour" has been absent, contributing to the level of growing urban unemployment, poverty, and other socio-economic problems, such as increased congestion leading to poor service delivery in terms of water, electricity and sewage, higher pollution and crime (Harris and Todaro, 1970:126; Goldsmith *et al*, 2004:33).

In addition to the aforementioned, it lowers the supply of productive labour in rural areas to such an extent that labour shortages are experienced to maintain production of agricultural production at crucial periods. When this happens, Hayami and Ruttan (1970:907) and Todaro (1997:40) argue that the social cost of migration, in terms of forgone food supplies, exceeds its benefits to individuals.

The well-known Harris-Todaro migration model provides an explanation for the existence of high rural-urban migration rates in the presence of high unemployment (Harris and Todaro, 1970:128). According to this model, rural-urban migration is a function of the expected rural-urban wage differential, i.e. the expected urban wage is defined as the politically determined minimum urban wage times the probability of getting an urban job. Rural-urban migration, therefore, can coexist with high urban unemployment as long as the expected urban income is greater than rural income. Several empirical studies showed that rural-urban migration is primarily influenced by regional wage differentials and can occur in the presence of high urban unemployment (Hazans, 2003:8; Tatsiramos, 2002:12; Fields, 1979:27).

Many developing countries that face increasing socio-economic problems that are partially due to massive rural-urban migration have adopted policies that promoted such migration (Harris and Todaro, 1970:132). Examples of such policies include shadow pricing policy and/or granting payroll subsidies to

private employers in urban areas which aim to equate marginal rates of substitution between rural and urban labour inputs and labour intensive projects in urban areas to reduce urban unemployment. Diverse effects on the economy due to such policies include, amongst others, distorted taxation that compromises the level of discipline necessary for effective fiscal policy governance, inefficient resource allocation and actually inducing increased rural-urban migration due to perceived work opportunities and higher wages.

In realizing the adverse affects of increased rural-urban migration in the absence of sustainable job creation in urban areas many developing countries attempted to restrict such migration, depriving individuals of choices that were in the first place a consequence of the policies implemented (Fields, 1975). Stiglitz (1969:14) and Todaro (1997:31), therefore argue that the best way to manage rural-urban migration is to have policies in place that increase agricultural productivity via increased agricultural investment.

In this paper, the relationship between agricultural productivity and/or income and rural-urban migration in South Africa is investigated. The underlying hypothesis is that investments in agriculture that raise agricultural productivity and thereby income, *ceteris paribus*, reduce rural-urban migration and urban unemployment, and thereby reduce socio-economic problems associated with urban congestion. This hypothesis seems consistent with the view that rural and agricultural development are crucial for developing countries to combat national unemployment and poverty since the majority of people live in the rural areas (FAO, 2003:ch3). Having stated the aforementioned, cognisance should nevertheless be taken of (i) migration between urban and rural areas may in many cases not be voluntary, (ii) increased productivity due to, for example, mechanisation could depress rural employment and (iii) seasonal and part-time jobs could result in oscillating migration which is difficult to capture.

2. Rural-urban migration in South Africa

The proportion of the total population in urban areas increased from 43 per cent in the 1960s to 53 per cent in the 1990s². This high rate of urbanisation is partially due to massive rural-urban migration since the abolition of influx control in South Africa in 1985 (Eckert and Van Rooyen, 1994). The annual average rural-urban migration increased from 15,381 for the period 1962-1985

² Author's own calculations from the number of urban population and total population. See the section for the definition of variables and source of data.

to 230,062 for the period 1986-2002, which is almost 15 times higher than the previous period³.

Approximately, 65 percent of the poor reside in the rural areas (Machethe, 2004). Van der Berg *et al* (2002:2) argue that “rural poverty is strongly linked to the nature of rural-urban interactions”. Rural poverty and better economic opportunities in urban areas therefore appears to have been one of the catalysts for the increasing rate of rural-urban migration in South Africa.

3. Agricultural productivity models

Several empirical studies on cross-country productivity differences and productivity growth employed the Cobb-Douglas type of production function in the log linear form. This functional form permits quantifying the marginal contribution of each category of inputs to aggregate production and mitigates the multicollinearity problem (Hayami and Ruttan, 1970:898; Yamada and Ruttan 1980:13; Mundlak and Butzer, 1997:5; Zepeda, 2001:6). Van Schalkwyk and Groenewald (1992:116) also used Cobb-Douglas type of production functions to analyse regional agricultural productivity differences in South Africa. The variables used in these previous studies included, amongst others, agricultural output as a dependent variable and labour, capital, technology and human capital as explanatory variables. Land and livestock were used to capture capital accumulation, fertilizer and tractors to represent technical aspects in production, and the level of education as a proxy for human capital.

The productivity model used in this paper is similar to previous studies with the exception that agricultural graduates from South African Universities and Technicons are used as proxy for human capital in the agriculture sector instead of the overall literacy rate and the proportion of irrigated and drained land is used as an additional variable to capture agricultural infrastructure. The agricultural productivity equation, therefore, can be written as follows:

$$\text{GDPagr}_t = \beta_0(L_t) + \beta_1(\text{LBR}_t) + \beta_2(\text{FER}_t) + \beta_3(\text{MC}_t) + \beta_4(\text{LS}_t) + \beta_5(\text{EFF}) + \beta_6(\text{IK}_{t-1}) + e_t \quad (1)$$

Where:

GDPagr = Agricultural output
 L = Agricultural land
 LBR = Labour
 FER = Fertilizer

³ Author's own calculations from the number of urban population and total population. See the section for the definition of variables and source of data.

Mc	= Tractors
LS	= Livestock
EFF	= Agricultural human capital
IK	= Agricultural infrastructure
e _t	= error term

4. Rural-urban migration models

In a broad sense, migration models are divided into macro and micro approaches. While the macro approach is concerned with where migrants move and what triggers migration, the micro approach attempts to answer questions such as who moves and why (Martin, 2002:1). The popular macro-based migration model is that of Harris-Todaro in which migration is explained by expected urban-rural wage differentials and the probability of getting a job in the urban sector. Godfrey (1973:72) extended the Harris-Todaro model by including the gap in social and infrastructural assets between urban and rural areas, an educational variable and the number of kinsmen already in urban areas. Hart (1973:67), Fields (1975:174) and more recently Bhattacharya (2002:956) argue that since a dynamic and productive urban informal sector is capable of attracting and sustaining labour in its own right, income from the urban informal sector must be included in the migration model. Bhattacharya (2002:957) further argues that the more urbanised a state is, the greater, *ceteris paribus*, would be the number of people in the rural areas of the state who would have contacts in urban areas, and therefore, the lower is the cost of migration and the higher is the rate of rural-urban migration. The migration model, therefore, can be written as follows:

$$M_t = \alpha_0(W_u) - \alpha_1(W_r) - \alpha_2(U_e) + \alpha_3(E_t) + \alpha_4(S_u/S_r) + \alpha_5(C_{nt}) + \alpha_6(INF_y) + U_t \quad (2)$$

Where:

M _t	= Rural-urban migration
W _u	= Urban wage
W _r	= Rural wage
U _e	= Urban employment rate
E _t	= Level of migrant education
S _u /S _r	= Social assets and infrastructural assets in urban areas
C _{nt}	= Number of contacts in urban areas
INF _y	= Income from the urban informal sector
U _t	= error term

Todaro (1969:141) argues that education is implicitly incorporated in his framework without defining it explicitly on the grounds that the propensity to

migrate, the average urban income earned by the migrant and the probability of securing a salaried urban wage are all higher, the higher the level of educational achievement. Based both on Todaro's argument and lack of time series information on migrants educational background, the educational variable for migrants will not be explicitly included in the migration model used in this paper. Due to a lack of adequate information pertaining to the variables S_u/S_r and $INFY$ they were also excluded.

Other determinates of migration such as demographic, psychic and distance factors merely reflect the existence of economic disparity (Goldsmith *et al*, 2004:37), whilst sociological factors such as marriage can also be a reason for migration (Bhattacharya, 2002:960-61). Nevertheless, the econometric technique adopted and the variables included in this paper are similar to that of Godfrey (1973:67), Harris and Todaro (1970:129), and Bhattacharya (2002:956).

5. Definition of variables and source of data

Agricultural output (GDP_{agr}) - agricultural GDP expressed in Rands at constant price with 1965 as base year. The South African Reserve Bank Quarterly Bulletin reports data on real GDP and gross agricultural output for a given period of years (usually eight years) using different base years. Therefore, real GDP is re-calculated for the whole period 1965-2002, using 1965 as a common base year. Real GDP is estimated using the basic annual growth rate formula, $I_t = (r_t * I_{t-1}) + I_{t-1} = I_{t-1} (r_t + 1)$, where r_t is real GDP growth rate of the current period, I_t is real GDP in the current period and I_{t-1} is real GDP in the previous period.

Labour (LBR) - the economically active population in the agriculture sector as sourced from the FAO.

Tractor (Mc) - the total number of tractors in use for agricultural production as sourced from the FAO.

Land (L) - the sum total of arable land, permanent cropland, permanent pastures, forestland and woodland as sourced from the FAO.

Fertilizer (FER) - total fertilizer (nitrogenous, phosphate and potash) consumption in metric tons as sourced from the FAO.

Livestock (LS) - the unit sum total of cattle, sheep, goats, pigs, chickens, ducks, gees, turkeys, horses, asses, mules, and beehives. Agricultural animals contribute to agricultural production in many ways. Apart from milk, meat, skin and organic fertilizer production, they serve as a source of financial

liquidity in the form of savings and investment. They also serve as a source of draught power. Data was sourced from the FAO.

Agricultural human capital (EFF) – as mentioned the number of agricultural graduates from South African Universities and Technicons is used as a proxy for this variable. Government expenditure on research and extension, the number of workers involved in extension and training services, and the level of education of farmers can also be used as a proxy. The sources of the data for the period 1982-2000 are the Race Relations Survey and the South African Survey.

Agricultural infrastructure (IK) – the proportion of irrigated and drained land is used as a proxy for this variable. Government expenditure on agricultural infrastructure can be used as an alternative proxy. Data was sourced from the FAO.

Rural-urban migration (Mt) – time series data pertaining to rural-urban migration is not freely available. Therefore, in estimating rural-urban migration in South Africa for the period 1965-2002, rural-urban migration is defined as the total urban population change less the portion of urban population due to the natural population increases. Goldsmith's *et al* (2004) estimated rural-urban migration in Senegal as $Mt = P_{ut} - (1+g)P_{ut-1}$, where Mt is rural-urban migration, P_{ut} is the total of the population in the present year, g is the natural growth rate of the total population, and P_{ut-1} is the population in the previous year. Time series data for P_{ut} was obtained from FAO.

Urban wage (Wu) - the ratio of non-agricultural output to urban population is used as a proxy for urban wages, where non-agricultural output is defined as GDP minus agricultural GDP. Data pertaining to the urban population was sourced from the FAO and GDP and agricultural GDP from the South African Reserve Bank Quarterly Bulletin.

Agricultural wage (Wr) – is defined as the ratio of agricultural GDP to rural population, which was obtained from the South African Reserve Bank Quarterly Bulletin and FAO respectively.

Probability of getting an urban job (Ue) – The proxy in this case is the national employment rate. Data was sourced from Statistics South Africa and the Year Book of Labour Statistics.

Cost of rural-urban migration (Cnt) – urbanisation (the proportion of urban population to total population) is used as a proxy to measure the cost of rural-urban migration. Bhattacharya (2002) states that the more urbanised a state is, the greater, *ceteris paribus*, would be the number of people in the rural areas of the state who would have contacts in urban areas, and therefore, the lower is the cost of migration and the higher is the rate of rural-urban migration.

6. Empirical results

Table 1 presents the Cobb-Douglas type of production functions of South African agriculture for the period 1965-2002 and 1982-2002 respectively, which estimates the elasticity of agricultural output to a set of agricultural inputs. The results in column (1) indicate positive and significant coefficients (5.6 and 1.8 respectively) for land (L) and agricultural infrastructure (IK_{t-1}). The coefficient of labour (LBR) is negative and significant at the 10 per cent level, reflecting a shift to labour-saving techniques and a declining demand for labour. The coefficient for fertilizer (FER) is positive and significant at the 17 per cent level, which is satisfactory considering the fact that fertilizer is used only for crop production but the dependent variable used is the sum total of all agricultural production.

Table 1: Estimates of the production function of South African agriculture

Independent variable	Dependent variable: GDPagr	
	(1)	(2)
Const	-26.1966 (-0.76204)	-28.6056 (-0.72855)
La	5.6257 (2.2114)**	3.1648 (0.99179)
Mc	0.1514 (0.92533)	-0.2294 (-0.54342)
LBR	-0.8430 (-1.7615)**	0.2835 (0.11917)
LS	-1.2202 (-2.4474)*	-0.2089 (-0.23641)
FER	1.8439 (1.5023)***	0.1787 (0.44374)
IK_{t-1}	1.8439 (4.0136)*	0.1535 (0.10526)
EFF		0.3577 (1.01680)

Notes: T-Ratios in brackets, *Significance at the 1 per cent level, ** Significance at the 5 per cent level, ***Significant at 15 per cent level

The coefficient for tractors (Mc) is not significant at commonly accepted levels, which is in line with the finding by Van Schalkwyk and Groenewald (1992:117). There are three possible reasons for this result: (i) the over mechanization of South African agriculture as mentioned by Van Schalkwyk and Groenewald (1992), Brotherton and Groenewald (1982), and Hancke and Groenewald (1972); (ii) the number of tractors used for agricultural production was almost stagnant for the period considered at around 1.35 tractors per

thousand hectare of agricultural land; and (iii) it may be a measurement error, i.e. it is not the number of tractors *per se* that matters for production but the horsepower utilized. In this case, the horsepower utilized would be the best proxy to tractor (capital), but such information over the time series used in this study is not available.

The coefficient for livestock (LS) is negative and significant at 1 per cent level. This finding vindicates the statement made by Minnaar and Groenewald (1990) and Groenewald and Nieuwoudt (1979) that overgrazing is rampant in many parts of the country thus lowering the rate of productivity of grazing land.

An attempt was made to estimate when agricultural human capital (EFF) is included. All the coefficients, however, turned out to be insignificant. This could be due to the relatively small size of the time series considered. When EFF is included, the sample size reduces to 21 (1982-2002) from 38 (1965-2002) due to the limited time series available on agricultural human capital.

Table 2 presents the empirical test on the Harris-Todaro migration hypothesis using South Africa's dataset for the period 1965-2002. Results reported in column (1) seemingly indicate the inadequacy of the model to explain rural-urban migration in South Africa. That is, rural-urban migration (Mt) in the country seems to be inversely related to the expected urban-rural wage differentials (EWRATIO). The reason could be due to the influx control exercised in the country until the end of 1985. In Column (2) a dummy variable (DUMMYINFLUX) is included to capture the effect of the influx control exercised in South Africa. With the inclusion of the dummy variable the coefficient of the wage ratio (EWRATIO) improved, i.e. the wage ratio elasticity of rural-urban migration is positive and significant at the 12 per cent level. That is, for each 1 per cent increase in the expected urban-rural wage ratio migration increases by 0.47673 per cent.

This result is consistent with the Todaro hypothesis, i.e. rural-urban migration is a positive function of the expected urban-rural wage differentials. The positive sign for the dummy for influx control in column (2) can be interpreted as a rise in the level of rural-urban migration following the abolition of influx control. DUEWRATIO is the differential slope coefficient, which indicates by how much the coefficient of EWRATIO for the period after the abolition of influx control differs from the preceding period. The result indicates that the coefficient of EWRATIO for the period after the abolition of influx control is 0.7048 greater than the period when influx control was effective in the country.

Table 2: Regression analysis of migration for the period 1965-2002

Independent variable	Dependent variable: Mt		
	(1)	(2)	(3)
Constant	12.6172 (14.1369)	8.5095 (14.4336)	37.3511 (9.3060)
EWRATIO	-1.2386 (2.4214)**	0.4767 (1.5794)****	-
DUMMYINFLUX		5.8175 (4.5484)*	2.1751 (6.6903)*
DUEWRATIO		0.7048 (-2.3746)**	
Wu			-2.6994 (-1.8002)***
Wr			-0.0735 (-0.2983)
Ue			3.1804 (2.3338)**
Cnt			12.2539 (4.0299)*

Notes: T-Ratios in brackets, *Significance at the 1 per cent level, ** Significance at the 5 per cent level, ***Significance at the 10 per cent level, ****Significant at 12 per cent level

Column (3) regresses the dependent variable on several components of Todaro's model of migration separately: urban wage, rural wage, the probability of getting an urban job and cost of migration. While the urban wage coefficient (Wu) is negative, the coefficients for the probability of getting urban employment (Ue) and cost of migration (Cnt) are positive as expected and significant at 5 per cent and 1 per cent levels respectively.

The positive elasticity of migration to the probability of getting urban employment implies that any urban biased policies of the government to reduce urban unemployment can act as a catalyst to increase migration from rural to urban saving markets. Such policies therefore, might increase the level of unemployment as it happened in Kenya in 1964 following the establishment of a "tripartite agreement" between the government of Kenya, private employers and saving unions to promote more urban employment.

The coefficient of Cnt is positive and significant at the 1 per cent level. This result indicates that the cost of migration was actually lowered by the fact that many rural people have contacts or relatives living in urban areas, which lowered their cost of moving to urban areas.

As in column (2), the positive sign for the dummy for influx control in columns (3) can be interpreted as a rise in the level of rural-urban migration following the abolition of influx control.

6.1 The agricultural input elasticity of rural-urban migration

Together, equations (1) and (2) form the recursive model linked by the agricultural output variable. The agricultural output variable appears both in equations (1) as a dependent variable and as an independent variable in equation (2). The agricultural output enters in equation (2) as a component of rural wage (income), where the rural wage is defined as per capita agricultural output. Equation 1 estimates the elasticity of agricultural output to a set of different agricultural inputs. Equation 2 provides estimates of the per capita agricultural output and/or income elasticity of rural-urban migration. Following the transitivity principle, it is therefore possible to estimate the indirect elasticity of rural-urban migration in response to agricultural inputs and/or investment. Goldsmith *et al* (2004:41) estimated the indirect agricultural input elasticity of migration ($\eta_{m,xi}$) by multiplying the *per capita* agricultural output (income) elasticity of migration ($\eta_{m,wr}$) by the elasticity of agricultural output in response to agricultural input ($\eta_{ya,xi}$). That is, he used the following equation to estimate $\eta_{m,xi}$.

$$\eta_{m,xi} = -(\eta_{m,wr})(\eta_{ya,xi}) \quad (3)$$

The derivation for equation (3) is shown in Appendix A. Since migration is inversely related to agricultural output and/or income, any agricultural investments that raise agricultural output and/or income are inversely related to rural-urban migration. In other words, the coefficient for the indirect elasticity of migration in response to agricultural investment is negative (see Appendix A).

The size of the land, investment in agricultural infrastructure (enhancing land resources) and the amount of fertilizer used exert a positive and significant impact on agricultural production and/or income (see Table 1). Therefore, policies aimed at reducing rural-urban migration can do so by increasing the size of agricultural land, investment in agricultural infrastructure and the use of fertilizer. Though the coefficient for agricultural human capital turned out to be insignificant, Hayami and Ruttan (1970) indicate that a given percentage increase in resources allocated to boost the efficiency of the farmer has the same effect as an equal percentage increase in saving itself. Hence, boosting the human capital of the farmer is equally important in reducing rural-urban migration.

The indirect agricultural input elasticity of rural-urban migration is given in Table 3. The land elasticity of rural-urban migration is -2.684. This means that for one per cent increase in the size of the agricultural land, rural-urban migration, *ceteris paribus*, would decrease by 2.684 per cent. That is, if average agricultural land were increased from its present level 105,212,000ha to 106,264,120ha, the annual average rural-urban migration would decrease from 230,062 to 223,887⁴.

Table 3: The agricultural input elasticity of rural-urban migration

Agricultural inputs (Xi)	$(\eta_{ya, xi})$	$(\eta_{m, wr})$	$\eta_{m, xi}$
Land	5.626	0.477	-2.684
Agricultural infrastructure	1.844	0.477	-0.880
Fertilizer	0.254	0.477	-0.121

However, in the long-term land intensification as a means of reducing rural-urban migration may not be sustainable since the supply of land is fixed. Therefore, in this respect, improving land utilization and enhancing its productivity, especially in the communal areas, becomes imperative. Developing agricultural land and/or infrastructure, promoting fertilizer use and upgrading agricultural human capital are preferable policies to slow down rural-urban migration.

The indirect elasticity of rural-urban migration to agricultural infrastructure (enhancing land resource) is -0.880. This means that for a 1 per cent increase in resources devoted to develop agricultural infrastructure, *ceteris paribus*, rural-urban migration would decrease by 0.880 per cent, i.e. the average rural-urban migration will fall from 230,062 to 209,817. Similarly, the fertilizer elasticity of rural-urban migration is -0.121. This implies that a 10 per cent increase in fertilizer (from 6.9kg/ha to 7.6kg/ha), *ceteris paribus*, reduces rural-urban migration by 1.21 per cent, which means a reduction in the average annual rural-urban migration from 230,062 to 227,278.

Assuming the impact of agricultural inputs on agricultural output is additive, a 10 per cent cut in rural-urban migration requires a 2.17 per cent increase in land, the proportion of irrigated and drained land and fertilizer simultaneously. This means that agricultural land should increase to 107,495,100 ha, the proportion of irrigated and drained land (which is a proxy to agricultural infrastructure) to 0.01124, and fertilizer to 7.04 kg/ha. Where

⁴ The averages of rural-urban migration, agricultural land, fertilizer consumption per hectare and the proportion of irrigated and drained land were calculated from the data for the period 1965 to 2002.

increasing agricultural land is practically impossible, the problem to some extent can be captured by improving the utilisation of existing agricultural land and enhancing its productivity, particularly in the communal areas.

7. Conclusion

Massive rural-urban migration can be a cause for economic problems such as high urban unemployment and poverty. This means that urban biased policies that increase the expected urban-rural income differentials tend to exacerbate the situation. Since the abolition of influx control in 1985, rural-urban migration in South Africa proceeded at a higher rate despite the apparent high urban unemployment. The empirical result, using the South African data set, supports Todaro's conjecture that rural-urban migration is a function of urban-rural income differentials. Narrowing the urban-rural income differentials via increasing agricultural productivity, therefore, can reduce the massive rural-urban migration and high urban unemployment in the country.

In this article, an attempt was made to estimate the impact of agricultural investment on agricultural output and/or income and thereby on rural-urban migration. The results indicate that agricultural investments such as the provision of adequate physical infrastructure, enhancing land resource and the adoption of technology such as irrigation and fertilizer can boost agricultural income, reduce rural-urban migration and are consistent to policies meant to fight urban unemployment. Enhancing agricultural productivity is particularly imperative at the communal areas where the majority of the poor South African farmers reside and low productivity is a major challenge. The fact that upgrading agricultural human capital was not significant in the analysis does not mean that it would not contribute to the problem at hand, but is rather a consequence of limited data on this variable.

Equally important to an increase in agricultural productivity is rural development strategies such as rural non-agricultural employment. Such policies can reduce rural-urban migration directly by creating off-farm jobs to rural people and indirectly by reducing the urban-rural wage differentials and thereby the incentive to migrate to urban areas.

It is recommended that more in depth research is undertaken into rural-urban migration trends in South Africa since this study is largely based on the *ceteris paribus* principle and hence may conceal important rural-urban migration dynamics important for efficient policy formulation.

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Appendix A

Given that $M = f(WR)$, $WR = g(Y_a)$, and $Y_a = h(X_t)$ it follows that

$$\eta_{m, xi} = \left\{ \frac{\partial M}{\partial WR} \frac{\partial WR}{\partial Y_a} \frac{\partial Y_a}{\partial X_i} \right\} \frac{X_i}{M} \tag{1}$$

$$= \left\{ \left(\frac{\partial M}{\partial WR} \frac{WR}{M} \right) \frac{M}{WR} \left(\frac{\partial WR}{\partial Y_a} \frac{Y_a}{WR} \right) \frac{WR}{Y_a} \left(\frac{\partial Y_a}{\partial X_i} \frac{X_i}{Y_a} \right) \frac{Y_a}{X_i} \right\} \frac{X_i}{M} \tag{2}$$

$$= \left\{ \left(\eta_{m, wr} \frac{M}{WR} \right) \left(\eta_{wr, ya} \frac{WR}{Y_a} \right) \left(\eta_{ya, xi} \frac{Y_a}{X_i} \right) \right\} \frac{X_i}{M} \tag{3}$$

$$= (\eta_{m, wr})(\eta_{wr, ya})(\eta_{ya, xi}) \left(\frac{M}{WR} \frac{WR}{Y_a} \frac{Y_a}{X_i} \frac{X_i}{M} \right) \tag{4}$$

since the parameters in the second parentheses cancel each other it follows that

$$= (\eta_{m, wr})(\eta_{wr, ya})(\eta_{ya, xi}) \tag{5}$$

$$WR = \left(\frac{Y_u/P_u}{Y_a/P_a} \right) = \left(\frac{Y_u Pa}{Y_a Pu} \right) \tag{6}$$

By assumption

$$\eta_{wr, ya} = \left(\frac{\partial WR}{\partial Y_a} \frac{Y_a}{WR} \right) = \left(\frac{\partial \left(\frac{Y_u Pa}{Y_a Pu} \right)}{\partial Y_a} \right) \left(\frac{Y_a}{\frac{Y_u Pa}{Y_a Pu}} \right) = -1 \tag{7}$$

substituting -1 in equation 5 it follows that

$$\eta_{m, xi} = -(\eta_{m, wr})(\eta_{ya, xi}) \tag{8}$$