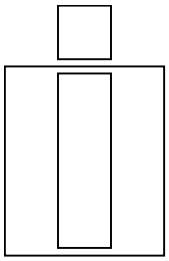

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Hypothetical Integration in a Social Accounting Matrix and Fixed-price Multiplier Analysis

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Editors

Erik Dietzenbacher

Faculty of Economics and Business
University of Groningen
PO Box 800
9700 AV Groningen
The Netherlands

h.w.a.dietzenbacher@rug.nl

Bent Thage

Statistics Denmark
Sejrøgade 11
2100 Copenhagen Ø
Denmark

bth@dst.dk

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Author: Kijong Kim

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Correspondence address:
Kijong Kim
The Levy Economics Institute of Bard College
Blithewood
Annandale-on-Hudson, NY 12504
USA

E-mail: kim@levy.org

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Hypothetical Integration in a Social Accounting Matrix and Fixed-price Multiplier Analysis[1]

by

Kijong Kim

The Levy Economics Institute at Bard College

December 2008

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ABSTRACT

This study proposes a simple modification to a Social Accounting Matrix (SAM) in order to analyze the multiplier effects of a *new* sector. A different input composition, or technology, of the sector makes a conventional analysis of final-demand injections on existing sectors invalid. We show that the modification—so-called hypothetical integration—is an efficient way to incorporate the difference into the SAM, rather than costly full-scale rebalancing. We apply this method to the case of the Expanded Public Works Programme in South Africa, and show that the proposed approach effectively represents the labor intensity requirement of the program and a new-factor income distribution.

Keywords: Hypothetical Integration; Multiplier Analysis; Social Accounting Matrix; Social Sector Intervention; Expanded Public Works Programme, South Africa

JEL Classifications: C67, D57, E24, E62, H51, H52

1. INTRODUCTION

Multiplier analysis based on a social accounting matrix (SAM) is often used for simulation purposes and rests on the supposition that the technical coefficients of production remain constant. Hence, modification of the SAM is necessary if an intended simulation exercise entails, in one form or another, a new technology requirement. This paper explores this particular issue in the context of a policy simulation for South Africa.

As is well known, South Africa is experiencing one of the highest rates of unemployment among middle-income countries, reaching 25 to 30 percent over the last decade. To ameliorate the associated socioeconomic pressures, in 2004 the government introduced a direct job creation initiative, the Expanded Public Works Program (EPWP), which has yielded some positive outcomes, but has been incommensurably small to the scale of needed intervention. Currently the scaling-up of the EPWP is under discussion and much research is under way. It is within this context that a modeling exercise was undertaken to examine the economy-wide results of a substantial expansion of EPWP that brought to light the theoretical and practical issues discussed below.

There are four main EPWP sectors designated for job creation, one of which is the EPWP social sector. This simulation exercise has focused on scaling-up the home and community-based care (HCBC) and early childhood development (ECD) programs, both of which are part of the EPWP social sector. Besides enhancing income and reducing unemployment, such social-sector job creation also results in reducing women's burdens of unpaid care work. HCBC workers perform a variety of tasks needed for the homebound and chronically ill (including HIV/AIDS patients), while ECD workers provide support to childcare centers in tasks that range from sanitation and meal preparation, to mental stimulation and psychological safety for children aged 1–6 years. The original data on types and numbers of proposed jobs—as well as associated implementation costs—are from an extensive study by Freedman et al. (2007) of the Health Systems Trust.[2]

EPWP consists of job opportunities provided to unskilled, unemployed, and marginalized poor individuals who work in projects that are labor intensive. They are hired at a minimum wage and, while receiving training and accreditation, they provide

[2] The full description of data and methodology used in the above study can be found in Antonopoulos and Kim (2008)

services for their communities. These projects are therefore not typical in comparison to the existing South African economic structure and cannot be represented by production conditions of similar sectors in the private or public domain. Along with employment targeting, the effectiveness of the program mandates that technologies be used to maximize their labor content. Obviously any multiplier analysis that aims to investigate the macroeconomic implications of such a program should not rely on simulating an injection of public funds in sectors whose production technology is not subject to this mandate. Rather, to estimate the impact with some accuracy, the injection should introduce the new particularities and features of this government intervention. Hence, the EPWP technology, represented as more labor-intensive input composition in our study, must be introduced anew. Moreover, job targeting requires a separate, new account that is not governed by the existing employment distribution structure of South Africa. Therefore, to integrate these two technical requirements, modification of the existing SAM is required.

A simple hypothetical integration method is suggested in this paper to circumvent a rebalancing of the SAM without sacrificing the accuracy of multiplier-effect analysis. Many examples of previous research that have required SAM modification can be found in the literature. For instance, Khan and Thorbecke (1989) subdivided sectors (mainly agriculture) into modern and traditional ones to make evident technological dualism, namely the difference in technologies used. Cella (1984), Milana (1985), Clements (1990), and Dietzenbacher, van der Linden, and Steenge (1993), in order to estimate the true value of a sector, engaged in hypothetical extraction by replacing the sector's domestic use and supply of goods with imports, thus eliminating an existing sector's linkages to the rest of the economy.

This paper focuses on a simple integration of a new *hypothetical* sector, called EPWP social sector (or EPWP in short) from an exogenous injection into the SAM by modifying the scale of the new sector. The scaling-down generates insignificant values for new accounts associated with the sector and, hence, may not violate an acceptable margin of error used in a conventional technical balancing. The insignificant values also preserve backward linkages that generate multiplicative effects of the intervention on the sector. The method is also flexible enough to incorporate policy exercises (in this study, employment targeting for the poor) into the SAM.

The usual practice of SAM rebalancing does not apply in this study, as a prior information basis on which minimum entropy method relies does not exist. The maximum entropy approach that does not require the prior information could be used for rebalancing, but at the cost of abandoning some useful prior information, such as a SAM from a previous time period. Moreover, technical balancing without any reference to compare before-and-after balancing (to evaluate the success of balancing) does not yield valuable knowledge upon which to analyze the impacts of the sector, especially when it comes to the hypothetical sector.

The structure of this paper is as follows: Section 2 provides a general description of the SAM structure and specific features of the South African SAM (SAM-SA) used in this paper; section 3 describes the reformulation of SAM-SA for this exercise; an introduction to the fixed-price multiplier appears in section 4 and comparative analysis of the simulation results obtained by using the original SAM (without EPWP) on the one hand and the reformulated SAM (with EPWP) on the other is done in section 5.

2. SOCIAL ACCOUNTING MATRIX

A SAM is a double-entry table that provides information about the economy. Along its columns and rows there are numeric entries that record the transactions that take place between “institutions” and “agents” during a period of time. The matrix can be organized in many different ways, but essentially it provides information on interactions between:

(1) Production activities (productive sectors of the economy) and commodities used (intermediate goods used in production);
(2) Factors of production (capital and labor);
(3) Institutions (households, firms, and government);
(4) Capital accounts (the financial side of the macroeconomy); and
(5) Rest of the world (imports, exports, and other financial flows)

These accounts are symmetrically arranged (in rows and columns) forming a square matrix that traces the origin and destination of expenditures and income received. In addition to providing a consistent framework of national accounts, a SAM incorporates the distributional and social dimensions of an economy, as shown in the schematic table

below. At an aggregate level, a SAM allows one to see how total income is distributed between capital and labor. At a disaggregated level, a lot more detail can be provided. For example, labor, a factor of production, can be specified as being male or female, skilled or unskilled; each industry can be described by the types and amounts of inputs used, including the female/male intensity of labor employed. A SAM also allows for information on several household types to be constructed depending on specific socioeconomic characteristics, i.e., poor or nonpoor households, the quality and durability of their housing unit, rural versus urban location, ethnicity or racial group, etc.

Table 1. A Schematic Social Accounting Matrix (SAM)

			EXPENDITURES						
			ENDOGENOUS			EXOGENOUS			TOTALS
			FACTORS	HOUSEHOLDS	PRODUCTIVE ACTIVITIES	GOVERNMENT	REST OF THE WORLD	CAPITAL ACCOUNTS	
RECEIPTS OR INCOMES	ENDOGENOUS	FACTORS	0	0	T_{13}	X_{14}	X_{15}	X_{16}	Y_1
		HOUSEHOLDS	T_{21}	T_{22}	0	X_{24}	X_{25}	X_{26}	Y_2
		PRODUCT ACTIVITIES	0	T_{32}	T_{33}	X_{34}	X_{35}	X_{36}	Y_3
	EXOGENOUS	GOVERNMENT	L_{41}	L_{42}	L_{43}	t_{44}	t_{45}	t_{46}	Y_4
		REST OF WORLD	L_{51}	L_{52}	L_{53}	t_{54}	t_{55}	t_{56}	Y_5
		CAPITAL ACCOUNTS	L_{61}	L_{62}	L_{63}	t_{44}	t_{45}	t_{46}	Y_6
	TOTALS		Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	

Source: Defourny and Thorbecke 1984

SAM-SA includes supply and use tables for 26 different sectors and household surveys (income and expenditure, and labor-force survey). Labor factors are disaggregated by educational attainment (a proxy for skill level) and gender to generate four different labor factor groups. The household accounts are elaborated on to the extent that they include location (urban and rural), residence type (formal and informal type of housing), race (African, colored-Asian, white), and income level (nonpoor for above 50 percentile; poor for 25–50 percentile; and ultrapoor for below 25 percentile), which ultimately generates 20 different household types.[3]

[3] For details on the construction of the household accounts, see Antonopoulos and Kim (2008).

Endogenous accounts represent interactive flow of funds, both within and across accounts. Factors of production, households, and production activities belong to this category of accounts. The matrix, T_{13}, shows the flow of funds from production activities (sectors) to factors in terms of payment for capital and labor services that add up to value-added. The factor payments are distributed to owners as household income, as in T_{21}. Then, the households spend on transfers to other households, as well as on purchases of goods and services, as shown in T_{22} and T_{32}, respectively. T_{33} shows intermediate input requirements.

Exogenous accounts are not part of the interactive transactions in endogenous accounts. They present fixed leakages from endogenous accounts, as in matrices L_{ij}, i,j=1,2,3, or injection to endogenous accounts, as in matrices X_{ij} for all i and j. Matrices t_{ij} show internal transactions within exogenous accounts. The exogenous accounts consist of direct and indirect taxes, government's nontax revenues and expenditure, capital stock formation, and international trade transactions.

An outstanding feature of the South African SAM (SAM-SA) is the extremely biased income distribution towards nonpoor households, as shown in table 2. In particular, the wage income distribution matrix (T_{21} in the schematic SAM above) reveals a biased flow into nonpoor households cutting across both gender and skill levels. Overall, 95 percent of wage income ends up in nonpoor households, which represent about 50 percent of the population.

One could speculate that the extreme inequality stems from a highly unequal wage hierarchy, labor market segmentation, and/or income-induced low human capital investment among the vast majority of the poor. In other words, it may be the case that workers from nonpoor households are more educated and skilled and thus, combined with job segregation structures, they end up receiving higher wages than workers from poor and ultrapoor households. True as these reasons may be, the last two columns of table 2 draw attention to another crucial determinant. Unemployment rates for both male and female labor force participants are consistently higher for the poor and ultrapoor on the one hand and for Africans across all income groups (as compared to white and colored-Asian) on the other. For example, the unemployment rate for urban, nonpoor Africans living in formal (durable) housing structures is 23 percent, while for whites (all of who are nonpoor) it is 5.8 percent; for rural, commercial poor households, unemployment for Africans and colored-Asian households stands at 32.9 percent versus

14.9 percent, respectively. For the urban African ultrapoor it reaches as high as 81.1 percent. In the next section, we describe the method of reformulation of SAM-SA to incorporate the specifics of the EPWP's targeted employment policy coupled with poverty reduction.

Table 2. Distribution of Wage Income and Unemployment across Household Type

	Wage Income Distribution (% share of total)				Unemployment (%)	
	Male Unskilled	Male Skilled	Female Unskilled	Female Skilled	Male	Female
Urban Formal African Nonpoor	30.1	27.0	29.2	33.4	23.0	34.0
Urban Formal African Poor	2.9	0.3	5.4	0.5	60.8	58.7
Urban Formal African Ultrapoor	0.4	0.0	1.3	0.0	81.1	74.2
Urban Formal Colored Nonpoor	14.4	13.9	16.1	14.6	16.9	24.7
Urban Formal Colored Poor	0.6	0.0	1.0	0.1	54.2	58.7
Urban Formal Colored Ultrapoor	0.1	0.0	0.1	0.0	62.3	71.5
Urban Formal White	9.8	48.9	9.9	39.8	5.8	11.4
Urban Informal African Nonpoor	10.0	1.4	7.6	1.1	20.0	44.0
Urban Informal African Poor	1.8	0.1	2.4	0.1	48.0	55.4
Urban Informal African Ultrapoor	0.3	0.0	0.8	0.0	69.0	75.1
Rural Commercial African Nonpoor	13.6	1.5	5.9	2.0	12.8	31.1
Rural Commercial African Poor	1.7	0.1	1.9	0.1	32.9	44.7
Rural Commercial African Ultrapoor	0.6	0.0	1.0	0.0	56.2	60.7
Rural Commercial Colored Nonpoor	2.0	0.2	1.7	0.2	12.2	18.3
Rural Commercial Colored Poor	0.4	0.0	0.4	0.0	14.9	30.1
Rural Commercial Colored Ultrapoor	0.1	0.0	0.0	0.0	24.8	58.9
Rural Commercial White	1.4	3.7	0.4	1.9	4.1	10.1
Ex-homeland African Nonpoor	6.8	2.8	8.3	5.7	23.8	28.9
Ex-homeland African Poor	2.4	0.2	4.0	0.3	42.3	41.0
Ex-homeland African Ultrapoor	0.8	0.0	2.5	0.1	59.5	54.3

Source: Social Accounting Matrix of South Africa (2000) by Provincial decision-Making Enabling Project (PROVIDE); based on SSA (2000)

3. REFORMULATION

Three additional accounts are added into the SAM-SA: two EPWP factors (unskilled male and female labor for EPWP), and an EPWP sector[4] that hires them along with other inputs to produce EPWP output. The following assumptions and procedures are made for this purpose. First of all, we assume that the sector does not have any leakages, such as taxes, capital accumulation, or trade. This assumption simplifies the process by keeping

[4] There are four main EPWP sectors designated for job creation, one of which is the EPWP social sector. This exercise has focused on scaling-up home-based care and early childhood development, both of which are part of the EPWP social sector. The original data are from Irwin Freedman et al. (2007); for a detailed description, see Antonopoulos and Kim (2008).

the reformulation within endogenous accounts. In addition, the data to account for leakages are not available.

Secondly, it is assumed that the EPWP sector does not hire economy-wide unskilled labor. Instead, it hires unskilled labor exclusively from poor and ultrapoor households. However, skilled labor comes from the economy-wide skilled labor market, i.e., poor and ultrapoor, as well as nonpoor, households. This second assumption is necessary to incorporate employment targeting for the poor and ultrapoor households as mandated under EPWP. We set the earned income from EPWP to be a tiny fraction of total earned income.[5] The purpose of assigning minute values is to construct a distributional scheme in terms of the shares of earned income from EPWP by each household type to total EPWP wage payment. The minute value does not represent the actual earned income from EPWP, however. To derive the multipliers for income effects of EPWP, we only need to use the shares by household type to the corresponding column sums.

The third assumption deals with spending the earned income from EPWP. For convenience, we assume that households spend all their earned EPWP income, which is set to be an insignificant fraction of the original earned income, on purchasing the EPWP services. This assumption seems odd given that the service is delivered for free. It is, however, necessary to keep the original household expenditure data intact and to avoid cumbersome rebalancing of the SAM; total expenditure by household type (the column sum) remains equal to total income by household type (the row sum). The average expenditure propensities of the accounts (the value of consumption on EPWP service divided by the value of total consumption by household type) are fractional compared to total consumption by household type, for instance 0.0000025 at most. Thus, the multiplicative effects of this assumption can be ignored, as the multipliers associated with the accounts become 0.000002 or less. As a result, spending on the service remains insignificant and, thus, effectively only the income effects of EPWP and consequent expenditure on all other goods and services (in addition to the original income-expenditure effects) are accounted for in the multiplier analysis. Thus, the assumption

[5] We used values equivalent to 0.000007 and 0.0001 percent of total earned income by all household types and by poor and ultrapoor households, respectively.

allows us to forgo the rebalancing of household expenditure accounts and to keep the equilibrium in the market.[6]

The forth and the last assumption deals with input-output accounts: the monetary value of goods and services from other sectors used in the production of EPWP matches sector by sector with the monetary value of EPWP output used as intermediate inputs by other sectors. The last assumption keeps the original input-output (I-O) matrix as it is. Given the lack of prior input-output data, this assumption is necessary for balancing without estimating the whole system. Again, the average expenditure propensities and the associated multipliers are extremely small, at most 0.00000019 and 0.00000036, respectively. The miniscule values ensure that the hypothetical input-output part is essentially excluded in the multiplier analysis.

The overall structure of the SAM changes as follows. The EPWP sector is added into the production activities section of the SAM. The column account represents input composition (or technology) of the EPWP sector, from which we derive backward linkages of the sector to the rest of the economy. The row account includes hypothetical demand for EPWP services by other sectors and by households for intermediate use and final consumption, respectively. The forward linkages derived from the row accounts practically become zero, as mentioned earlier. The EPWP factor accounts are inserted into the factor section. The column accounts describe the distribution of earned income from EPWP that exhibit the employment-targeting scheme. The row accounts show total wage payments to EPWP unskilled workers from the EPWP sector. The multipliers from these accounts are accounted for in the analysis, as the average expenditure propensities of the accounts as intended are not close to nil. Thus, the reformulation incorporates the multiplier effects of the earned income from EPWP.

[6] An alternative approach is to distribute the earned EPWP income over all expenditures based on the original average expenditure propensities. The accounting balance is violated in a strict sense, but the result from this approach is approximately the same.

Table 3. A Reformulated Schematic SAM

	Factors	EPWP Factors	Households	Activities	EPWP sector	Exogenous
Factors	0	0	0	Factor Incomes	0	…
EPWP Factors	0	0	0	0	**Factor Incomes**	
Households	Distribution	**Distribution**	Redistribution	0	0	…
Activities	0	0	Demand	Input-Output	**Hypothetical Input-Output**	…
EPWP sector	0	0	**Hypothetical demand**	**Hypothetical Use**	0	…
Exogenous	…	…	…	…	0	…

Source: Author's calculations

Elimination of forward linkages of the EPWP sector by scaling-down the value of the sector is justified by the hypothetical nature of the sector; no information is available as to whether and how the EPWP output would be used in other sectors. The nature of the output is also oriented toward provision of services to households, rather than providing the subsidized intermediate input to the rest of the economy. Another point of argument is related to the scale of injection: a large intervention or a unit change—from a billion to a thousand rand, for instance—would increase the value to nontrivial values in the EPWP account that may invalidate this approach. To address the issue of scale or unit changes (from a billion to a thousand, for instance), one can arbitrarily choose extremely small values for the new account to outweigh the changes.

The obvious benefit of the proposed method is the saving of time and resources for rebalancing the SAM. For instance, this approach allows us to forgo rebalancing the SAM-SA, whose construction is based on a generalized cross-entropy method with sequential disaggregation with more than 40,000 equations and 60,000 variables for the first phase alone.

4. DATA

Construction of the EPWP social sector relies on the data from Friedman et al. (2007). They describe detailed input costs for a social service initiative under the EPWP in South Africa. The initiative focuses on two projects: early childhood development (ECD) projects and home and community-based care (HCBC). The projects are more labor-

intensive and employ more women and unskilled labor than existing education and health sectors. Wage payment for unskilled labor is 32 percent of the total expenditure for the initiative, as compared to 4 to 7 percent for relevant sectors in the economy. Wage payments for unskilled women account for 19 percent of the total expenditure vis-à-vis 2 to 5 percent from the relevant sectors. The total size of the injection (9.3 billion rand) is equivalent to 1 percent of the South African GDP at factor costs and 8 percent of the total value of output of the relevant sectors, namely education and health, measured by total production costs.

Table 4 shows the input composition of the EPWP social sector in comparison to the ones of relevant sectors—education and health—in the economy. One of the noticeable differences lies in the new labor inputs, EPWP male and female unskilled workers. The separate accounts are necessary to incorporate an employment-targeting scheme[7] for the bottom 50^{th} percentile that reflects the poverty reduction efforts of EPWP. The payment for capital service (in other words, gross operating surplus) is assumed to be zero. EPWP social sector projects are, in reality, implemented by the relevant sectors using already-existing facilities and equipment. Moreover, the projects are required to use more labor-intensive technology than their counterparts in the economy. I assume that multiplier effects on the sectors pick up the tab.

[7] EPWP jobs are allocated based on unemployment, depth of poverty, and number of households for each type. This leads to a disproportionate distribution for ultrapoor African household types.

Table 4. Sectoral Input Compositions (% of total)

	Education	Health	EPWP
Capital	9.8	9.3	0.0
Male Skilled	20.8	8.7	1.9
Female Skilled	32.0	16.6	3.2
Male Unskilled	2.1	1.9	0.0
Female Unskilled	2.0	5.4	0.0
EPWP Male Unskilled	0.0	0.0	13.4
EPWP Female Unskilled	0.0	0.0	18.6
Agriculture	0.1	0.2	10.5
Mining	0.1	0.1	0.1
Food	0.1	0.3	31.3
Textile	0.5	1.6	0.4
Paper	0.6	1.3	0.5
Petroleum	0.5	1.4	0.4
Nonmetal	2.7	10.4	2.3
Metal	0.2	0.0	0.2
Machinery	1.0	0.3	0.7
Communication Equipment	1.4	4.8	1.1
Transportation Equipment	4.6	0.6	2.5
Other Manufacturing	0.5	3.0	0.5
Electricity	0.2	0.6	0.1
Water	0.1	0.3	0.1
Building	0.3	0.5	0.5
Construction	0.3	0.1	0.3
Trade, Hotels, and Catering	0.4	2.1	0.4
Transportation and Communication	2.1	4.7	3.0
Financial Service	0.7	1.1	0.5
Business Service	3.8	12.9	2.9
Education	9.7	0.8	0.2
Other Government Service	0.0	3.3	3.8
Health	1.1	0.1	0.1
Social Service	0.5	0.0	0.3
Other Service	0.3	0.5	0.1
Exogenous Accounts	1.5	7.1	0.0
Total	**100.0**	**100.0**	**100.0**

Source: Author's calculations based on SAM-SA and Friedman et al. (2007)

Distribution of wage income from the EPWP sector is determined by allocation of EPWP jobs among the poor. As the table below shows, reducing unemployment and depth of poverty (the key aims of EPWP) results in a complicated configuration of job allocation among the various types of households.[8]

[8] Developing a fair targeting scheme is not straightforward given the lack of a clear pattern between unemployment and poverty across households as shown in table 5. For example, if the policy target is to minimize the poverty headcount, most jobs should be allocated to the poor households and then ultrapoor households. If indigence is the primary social ill that must be combated, then one should choose the reverse strategy.

Table 5. Household Characteristics

Household Type	Number of HHs	Depth of Poverty[9]	Unemployment (expanded)
Urban Formal African Poor	636,365	-480	60%
Urban Formal African Ultrapoor	303,893	-10,952	77%
Urban Formal Colored Poor	101,738	-429	57%
Urban Formal Colored Ultrapoor	39,931	-8,861	67%
Urban Informal African Poor	308,500	-860	52%
Urban Informal African Ultrapoor	160,865	-8,496	65%
Rural Commercial African Poor	304,773	-1051	39%
Rural Commercial African Ultrapoor	282,574	-10,794	59%
Rural Commercial Colored Poor	41,620	-203	22%
Rural Commercial Colored Ultrapoor	8,783	-8,100	42%
Ex-homeland African Poor	835,859	-1,333	42%
Ex-homeland African Ultrapoor	924,313	-10,354	57%

Source: Author's calculations based on PROVIDE (2007)

The employment-targeting scheme in this paper uses the relative size of household type, household-level unemployment rate, and depth of poverty to generate an index system for targeting. A functional form for the index is as follows:

$W_i = A \cdot H_i \cdot U_i^{\alpha} \cdot P_i^{1-\alpha}$, for i=1,...12 (for all poor and ultrapoor households types)

where, A: constant to normalize, A= $1 \Big/ \sum_{i=1}^{12} W_i$

H_i: ratio of number of households of type i to total number of households;

U_i : unemployment rate of type i;

P_i : depth of povert of type i; and

α: choice parameter, $0<\alpha<1$.

H_i with an exponent of 1 implies that EPWP jobs are allocated to household types proportionate to the numeric representation. The proportionate representation of households seems fair. The trade-off between unemployment and depth of poverty requires a policy choice denoted by the choice parameter α. The higher the value of α, the more importance is assigned to the reduction of unemployment in policymaking. This system is designed to apply a kind of penalty to household types at the either end of the spectrum, but rewards the households in the middle (α=0.3 is used in this exercise). Table 6 shows the allocation of EPWP unskilled jobs among bottom 50th percentile.

[9] Depth of poverty in household level is a product of an average number of adult equivalent household members and per capital poverty line (R4,000) used in the SAM-SA.

Table 6. Employment Targeting: Shares of EPWP Unskilled Jobs

Household Type	Shares of EPWP Jobs
Urban Formal African Poor	3.5%
Urban Formal African Ultrapoor	16.3%
Urban Formal Colored Poor	0.5%
Urban Formal Colored Ultrapoor	1.8%
Urban Informal African Poor	2.5%
Urban Informal African Ultrapoor	6.8%
Rural Commercial African Poor	2.6%
Rural Commercial African Ultrapoor	13.8%
Rural Commercial Colored Poor	0.1%
Rural Commercial Colored Ultrapoor	0.3%
Ex-homeland African Poor	8.5%
Ex-homeland African Ultrapoor	43.3%

Source: Author's calculations

5. FIXED-PRICE MULTIPLIER ANALYSIS

A SAM-based fixed-price multiplier analysis assumes that any increase in exogenous demand is to be satisfied by a corresponding increase in output, not prices. It also suggests a world in which excess capacity and unused resources prevail and prices remain constant. This assumption coincides with the fact that South Africa displays a high level of unutilized, unskilled labor resources that can be directed to the public works program. Thus, the price of labor service (wage rates) and, consequently, output prices would not change significantly enough to invalidate our analysis. As a result, the magnitudes we derive in the experiments can be treated as useful first approximations.

The starting point for an analysis based on this SAM is the exogenous nature of the increased demand leading to a sectoral output increase. The set of fixed-price multipliers can then be used to ascertain the impact of this increase in output on the incomes of specific household groups. Let's set the value of output (y_n) to be equal to endogenous accounts (n) and exogenous accounts (x). Using the property of an average expenditure propensity matrix (A_n), the values of endogenous accounts (n) equal the product of the propensity and the value of output, as shown in equation (1).

$$y_n = n + x = A_n y_n + x \quad (1)$$

The average propensity matrix A_n is partitioned as follows:

$$A_n = \begin{bmatrix} 0 & 0 & A_{13} \\ A_{21} & A_{22} & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix} = \begin{bmatrix} 0 & 0 & \text{Factor incomes paid by sectors} \\ \text{Factor incomes distributed to households} & \text{Interhousehold Transfer} & 0 \\ 0 & \text{Household Consumption} & \text{Input-Output} \end{bmatrix}$$

where, (1, 2, 3) denote (household, factor, production activities).

After rearranging the terms in the equation, we can derive the matrix of accounting multipliers in equation (2).

$$y = (1 - A)^{-1}x = M_x \qquad (2)$$

The matrix (M_x), when computed, can account for the results (e.g., income, consumption, etc.) obtained in the SAM without explaining the process that led to them. One limitation of the accounting multiplier matrix as derived in equation (2) is that it implies unitary expenditure elasticity; however, it would be unrealistic to assume that consumers react to any given proportional change in their incomes by increasing expenditures on different commodities by exactly that same proportion.

A more realistic alternative is to specify a matrix of marginal expenditure propensities (C_n, below) corresponding to the observed income and expenditure when prices remain fixed. Expressing the changes in income (dy) resulting from changes in injections (dx), i.e., EPWP expenditure, one obtains,

$$\begin{aligned} dy_n &= C_n dy_n + dx \\ &= (I - C_n)^{-1} dx = M_c dx \end{aligned}$$

M_c can be termed a fixed-price multiplier matrix and its advantage is that it allows *any* non-negative income and expenditure elasticities, including unitary elasticity, to be reflected in M_c. Thus, changes in consumer expenditure over commodities can be disproportionate to changes in their incomes. For instance, a poor consumer may spend a

larger proportion on food as income increases; meanwhile, a nonpoor consumer may do otherwise. The marginal expenditure propensity (MEP) can be readily known from one of its properties: MEP_i is equal to the product of expenditure (income) elasticity (Ey_i) times the average expenditure propensity[10] (APE_i) for any given good (i), i.e.:

$$MEP_i = Ey_i \cdot AEP_i \text{ for any good } i$$

In this study, A_{32} (household consumption propensity) is replaced by marginal expenditure propensity M_{32}.

Fixed multiplier analysis using a SAM can articulate any multiplicative effects of economic policy instruments and can provide valuable insights to policy makers as to effective and efficient policy interventions, such as sectoral development, job creation, and targeted poverty reduction.

6. RESULTS

I compared the results of the simulation with a 9.29 billion rand injection and the same input composition. The original simulation is based on the SAM without the EPWP social sector and EPWP factors accounts. The difference in the structure of the SAM leads to noticeable changes in some accounts.

Table 7. Total Household Income and GDP at Factor Costs

	w/o EPWP	**with EPWP**	**w/o EPWP**	**with EPWP**
	(in million rand)		*(% growth)*	
Nonpoor	10,862	8,496	1.70	1.30
Poor	850	983	2.20	2.60
Ultrapoor	309	2,620	1.90	16.40
GDP	14,897	15,167	1.78	1.81

Source: Author's calculations

The modification of the SAM lifts aggregate incomes of poor and ultrapoor households by 151 and 374 percent, respectively, as seen in table 7. The income of nonpoor households, however, is smaller by 21 percent under the modification. The

[10] The average expenditure propensities come directly from the SAM, which is the ratio of expenditure on good i to total expenditure. The expenditure elasticities provide changes in consumers' expenditure on good i due to their income increase. This information comes from PROVIDE. See table 16 for detailed estimation results.

enhancement of the income of the poor and ultrapoor comes from EPWP job targeting for the households in a way that EPWP wage payments for unskilled workers (32 percent of total budget) are directed to them. Otherwise, most of the wage income for unskilled male and female labor (87 and 78 percent of each) would be destined to nonpoor households. The favorable outcome of job targeting illustrates that the labor intensity requirement of EPWP itself would not be enough to ensure the income growth of the poor. Without reformulation of SAM-SA, the multiplier analysis would underestimate the effect of EPWP. Although GDP growth rates are similar for both approaches (1.78 and 1.81 percent), income distribution and poverty reduction are much better captured when the modeling itself allows for employment targeting.

Decomposition of changes in GDP with EPWP provides another point of justification for reformulation of the SAM. GDP at factor costs is higher by 1.9 percent (R14,896 to R15,187 million), as value-added for labor and capital go up by 1.2 and 3.2 percent, respectively. The multipliers determining payments to capital services are displayed with initial injection on factors for both the original and reformulated cases. It should be noted that payments to EPWP unskilled male and female workers are reallocated to regular unskilled male and female workers without any changes in other factor accounts. Then, the corresponding factor multipliers (written in italic) would make differences: the higher values of EPWP workers multipliers on capital (0.641, 0.641), compared to (0.574, 0.573), would definitely increase payments to capital.

Table 8. Capital Multipliers Comparison

Multipliers	Capital	M.Unskilled	M.Skilled	F.Unskilled	F.Skilled	M.EPWP	F.EPWP
w/o EPWP	1.246	*0.574*	0.536	*0.573*	0.539	0.000	0.000
w/ EPWP	1.247	0.575	0.539	0.574	0.542	*0.641*	*0.641*
Injection							
w/o EPWP	0	1248	180	1733	296	0	0
w/ EPWP	0	0	180	0	296	1248	1733

Source: Author's calculations

This difference accounts for 79 percent of the changes in GDP. The remaining can be explained by a minor increase in overall labor factor payments. It should be emphasized that the GDP change is not significant and it implies that reformulation of the SAM would not cause a radical change in overall output level.

As a result, the reformulation correctly represents the changes in income distribution without any significant changes in total income level, as shown in table 9. Initially, the nonpoor households receive 92.2 percent of total income; meanwhile, the poor and ultrapoor households' shares are only 5.5 and 2.3 percent, respectively. The targeted injections of 9.3 billion rand without reformulation yields only marginal changes on poor households' share from 5.5 to 5.6 percent and on nonpoor households' share from 92.2 to 92.1 percent. The analysis based on reformulated SAM, however, increases both poor and ultrapoor households' shares to 5.6 and 2.6 percent from 5.5 and 2.3 percent, respectively, as the share of nonpoor households declines from 92.2 to 91.8 percent. The extent of changes may seem trivial due to the small size of intervention, however, the attention should be given to the relative changes and, in particular, to ultrapoor households.

Table 9. Changes in Household Income Distribution

w/o EPWP	Nonpoor	Poor	Ultrapoor
Before	92.2%	5.5%	2.3%
After	92.1%	5.6%	2.3%
with EPWP	Nonpoor	Poor	Ultrapoor
Before	92.2%	5.5%	2.3%
After	91.8%	5.6%	*2.6%*

Source: Author's calculations

Table 10 shows that low regular employment multipliers across poor and ultrapoor households are compensated by higher EPWP employment ones. For instance, the wage income multiplier of "urban formal African ultrapoor" household type from the original SAM is 0.01and 0.02 for men and women, respectively. However, it increases to 0.17 for both men and women in the reformulated SAM. This implies that the original mapping of employment and income distribution would be misleading, i.e., underestimating the impact of the proposed employment targeting. The finding supports the idea of modifying the SAM to incorporate certain specifications of intervention that are not present in the prior original structure.

Table 10. Fixed Price Multipliers of Unskilled Labor on Household Income

Unskilled Labor	Male	Female	EPWP Male	EPWP Female
Urban Formal African Nonpoor	0.52	0.51	0.23	0.23
Urban Formal African Poor	0.05	0.07	0.05	0.05
Urban Formal African Ultrapoor	0.01	0.02	0.17	0.17
Urban Formal Colored Nonpoor	0.25	0.26	0.11	0.11
Urban Formal Colored Poor	0.01	0.01	0.01	0.01
Urban Formal Colored Ultrapoor	0.00	0.00	0.02	0.02
Urban Formal White	0.41	0.41	0.33	0.33
Urban Informal African Nonpoor	0.13	0.11	0.03	0.03
Urban Informal African Poor	0.03	0.03	0.03	0.03
Urban Informal African Ultrapoor	0.01	0.01	0.07	0.07
Rural Commercial African Nonpoor	0.17	0.10	0.04	0.04
Rural Commercial African Poor	0.02	0.03	0.03	0.03
Rural Commercial African Ultrapoor	0.01	0.01	0.14	0.14
Rural Commercial Colored Nonpoor	0.03	0.02	0.01	0.01
Rural Commercial Colored Poor	0.01	0.01	0.00	0.00
Rural Commercial Colored Ultrapoor	0.00	0.00	0.00	0.00
Rural Commercial White	0.05	0.04	0.03	0.03
Ex-homeland African Nonpoor	0.12	0.13	0.05	0.05
Ex-homeland African Poor	0.04	0.06	0.10	0.10
Ex-homeland African Ultrapoor	0.02	0.04	0.44	0.44

Source: Author's calculations

REFERENCES

Antonopoulos, Rania, and Kijong Kim. 2008. "Impact of Employment Guarantee Program on Gender Equality and Pro-Poor Economic Development in South Africa: Scaling up the Expanded Public Works Program." Annandale-on-Hudson, NY: The Levy Economics Institute of Bard College and UNDP. Available at: http://www.levy.org/pubs/UNDP-Levy/EGS.html

Cella, Guido. 1984. "The Input-Output Measurement of Interindustry Linkages." *Oxford Bulletin of Economics and Statistics* 46(1): 73–84.

Clements, Benedict J. 1990. "On the Decomposition and Normalization of Interindustry Linkages." *Economics Letters* 33(4): 337–40.

Dietzenbacher, Erik, Jan A. van der Linden, and Albert E. Steenge. 1993. "The Regional Extraction Method: EC Input Output Comparisons." *Economic Systems Research* 5(2): 185–206.

Friedman, Irwin, L. Bhengu, N. Mothibe, N. Reynolds, and A. Mafuleka.. 2007. *Scaling up the EPWP*. Health Systems Trust, November, Volume 1–4. Study commissioned by Development Bank of South Africa and EPWP.

Khan, Haider A., and Erik Thorbecke. 1989. "Macroeconomic Effects of Technology Choice: Multiplier and Structural Path Analysis within a SAM Framework." *Journal of Policy Modeling* 11(1): 131–56.

Milana, Calro. 1985. "Direct and Indirect Requirements for Gross Output in Input-Output Analysis." *Metroeconomica* 37(3): 283–92.

PROVIDE. 2007. "An Input-Output Social Accounting Matrix for South Africa and Labour Use and Time Use Satellite Accounts for 2000." PROVIDE Technical Paper 2007:2. Elsenburg, South Africa: Provincial Decision-Making Enabling Project (PROVIDE).

Pyatt, Graham. 1988. "The SAM Approach to Modeling." *Journal of Policy Modeling* 10(3): 327–52.

————. 2001. "Some Early Multiplier Models of the Relationship between Income Distribution and Production Structure." *Economic Systems Research* 13(2): 139–63.

Pyatt, Graham, and Jeffery I. Round. 1979. "Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework." *The Economic Journal* 89(356): 850–73.

SSA. 2002. *Labour Force Survey, September 2000.* Pretoria: Statistics South Africa.