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Financial Crisis and the South African Agricultural Sector: A Computable General Equilibrium (CGE) Analysis

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Abstract

This study examines the impact of financial crisis as a shock on agricultural sector of the South African economy. Agriculture is regarded as a critical source of foreign exchange, employment and poverty alleviation in South Africa. Using a computable general equilibrium model of the South African economy based on the theory of ORANI-G framework, it was discovered that the impact of the financial crisis on agricultural sector was harmful to the economy. Job losses were recorded in the sector as well as decline in household demand. The financial crisis was also found to be harsh on domestic prices and general household consumption levels. The findings have far-reaching implications for research and practice. The results provide evidence of the vulnerability of the South African agricultural sector to any financial shocks.

Keywords: *CGE Analysis, Financial crisis, Agriculture, Employment, South Africa*

1. Introduction

One of the striking features of the global financial crisis was the collapse in international trade (McKibbing and Stoeckel 2009). The decline in world exports was much greater than decline in the world GDP. Interestingly, the decline in exports was larger than what many macro-economic models of trade would have predicted based on changes in supply, demand, and relative prices (Chinn (2009); Levchenko, Lewis, and Tesar (2009); OECD (2009); Strutt and Walmsley (2010)). For a small open economy like South Africa which depends on foreign trade and attracting foreign savings to prop up domestic investment, the country was unsurprisingly not immune to the impact of any financial crisis-induced economic slowdown. Slower economic growth and recessions in key export markets combined with lower commodity prices as well as slowdown in capital flows to developing countries, all had a negative impact on the South African economy (Baxter 2009).

The financial crisis can be seen to be driven by the reversal of the three positive shocks that developing countries experienced during the recent boom, namely: rapid growth of remittances, capital flows and international trade (Griffith-Jones and Ocampo 2009). By 2009, economies around the world had slowed as credit tightened and international trade declined. Many developing countries saw their export income reduced by 43.8 percent (Gurtner 2010). The crisis also spread quickly worldwide due to modern communications and financial markets integration. This created uncertainties which were part of the cause for a

slowing or even freezing of some credit and derivative markets (Shahrokhi 2011). The impacts of the financial crisis on South Africa economy are manifold. There were direct as well as indirect effects. The impact also varied from one sector of the economy to another. Although, at the onset, many thought that the global financial crisis would not have any bearing on South Africa given the negligible connectivity of its markets to the world economy, empirical evidence has now shown that those who made these initial statements were wrong (N'zue 2008).

The crisis resulted in net capital flows to the developing countries shrinking sharply. According to the World Bank, capital flows to the developing countries sank to USD 727 billion in 2008 from USD 1,160 billion in the previous year, which is a 37 percent decrease (World Bank 2010). The heavy toll taken by the financial crisis on trade and global economic performance has contributed significantly to the depreciation of currencies experienced by developing countries, including Sub-Saharan African countries. This in turn has affected agricultural markets significantly (Von Braun 2008).

Before the financial crisis, South Africa experienced rapid economic growth both in the agricultural and non-agricultural sectors as a result of the commodity boom. The economy recorded growth rate averaging 5.2 percent annually between 2004 and 2007 (IDC, 2013). Key drivers of economic development began to show signs of distress at the beginning of 2009 due to global recession. Trade, investment, mining and manufacturing sectors were affected by this crisis. It was estimated that the economy contracted by 2 percent during 2009, with about a million jobs lost in the same period (N'zue 2008; Assubuji & Lukscheriter (2010); Kalula (2012); Verick (2012); Dullien, Kotte, Marquez & Prieue (2014)). Furthermore, economic growth continued to slow down, recording only 1.5 percent GDP growth in 2015, the lowest performance since the global financial crisis. This was attributed to low commodity prices, heightened financial market volatility, as well as diminished consumer and business confidence (South Africa Reserve Bank 2016). The actual extent of impacts of the crisis depends on a number of issues. These are: the degree to which South Africa is integrated into the dynamics of global investment flows, expanded trade, information technology (IT) and vibrant financial security measures (Ngowi 2010).

Other studies explore the effect and transmission channel of the crisis on economic activity. Kazi (2014) use real GDP data to investigate the transmission channels through which global financial crisis were

transmitted to Tanzania. The author found that the crisis was transmitted through exports and foreign direct investments (FDI). This had a significant negative effect on Tanzania's economic growth. Brinkman et al., (2009) use simulations, regression and risk analysis to determine the impact of global financial crisis on household nutrition. The author argues that many of the vulnerable households in developing countries have reduced quantity and quality of foods they consume; hence, they are at the risk of increased malnutrition. According to the World Bank (2009b), the global financial crisis led to the increase in cost of finance for production and trade. This had an unfavourable impact on producers and consumers in developing countries due to the associated reduction in lending to developing countries (Lin and Martin 2010).

The agricultural sector is critical to South Africa's economy. It plays a significant role in food security, job creation, poverty reduction, export revenue and rural development. The contribution of primary agriculture to GDP is small, and pegged at less than 2.5 percent of the GDP. However, adding all closely related sectors, i.e., agribusiness sectors such as input manufacturing, inputs suppliers, farm operations, food processing, retails, etc., the sector's contribution to the GDP becomes significant. It contributed around 12 percent to South Africa's total export earnings in 2016 at a value of \$9.2 billion.

Statistics on agricultural employment reported differ based on sources and definition. Employment from the sector includes direct farm employment and non-farm-related employment activities such as food processing, transportation and trade. Employment in the sector was reported at 5.59 percent (percentage of total employment) in 2015 (Statistics South Africa, 2016), compared to the mining and manufacturing sectors that represent 8.5 percent and 12.5 percent of the GDP while employing only 2.3 percent and 11.8 percent respectively (Dube, Scholes, Nelson, Mason D'Croz & Palazzo 2013; Fadeyi, Ogundeji & Willemse 2014, Statistics SA, 2016).

However, the sector is influenced by many factors that are often beyond its control. These include global financial systems, exchange rate fluctuations, international pricing levels, foreign direct investments, trade and climate change. The full extent of the global financial crisis and the impact on growth, employment, poverty etc. are still being evaluated. Hence, this paper seeks to quantify the socioeconomic impact of global financial crisis as an external shock on agriculture within a broader perspective of the South African economy. The motivation for

conducting the study is to assist policy makers in understanding the sectoral impacts of the crisis focusing on production, employment and household consumption in the agricultural sector.

2. Material and Methods

To better capture the impact of the financial crisis on the South African economy, the ORANI-G model, a single-country static computable general (CGE) equilibrium framework was used. The CGE model is one of the most rigorous, cutting-edge quantitative methods to evaluate the impact of economic and policy shocks in the economy as a whole. These features make this tool significantly useful for policy design. In the last two decades, CGE models have become a standard tool of empirical economic analysis. The recent improvements in model specification, data availability and advance computational technology have improved the pay-offs as well as reduced the costs of analysis based on CGE models, thereby paving the way for their widespread use by policy analysts throughout the world (Lofgren, Thomas and El-Said 2002).

CGE models are aggregate representations of the economy and are based on the flow equilibrium in product and factor markets in real as well as in nominal terms. According to Menezes, Fortuna, Silva and Veira (2006), CGE explicitly models all key aspects of a given economy, in contrast with partial equilibrium models, which only focus on given important aspects of the economy. A CGE model has fundamental macroeconomic general equilibrium association among different income groups, form of demand, the balance of payments and a multi-sector production structure. The model combines sets of behavioural equations describing the optimizing economic behaviour of the agents identified in the model and the technological, endowment and institutional constraints that these agents encountered (Menezes *et al.* 2006).

Based on a robust and widely accepted modeling, CGE models are able to provide a detailed description of the impact of shocks on the economy. It is an acceptable method used to study the impacts of economic crises. CGE model had been used extensively to study impacts of price shocks, economic crises, and price volatility, among others. Yeldan (1998) employed CGE to study the structural source of the Turkish economic crisis, Bourguignon et al. (2003) on the impacts of 1997 financial crisis in Indonesia, while Ahmed & O'Donoghue (2010) took on changes in the level of remittance under a prolonged global

financial crisis. CGE models are categorized based on regional accounts possessed by the model.

Model Description

The model used in this application is a static CGE framework of the South African economy based on theory of the ORANI-G model. With a static CGE model, the changes in the economy can be analyzed either for a short-run or long-run time period. The time dimension of the model is created by certain assumptions in the closure of the model. For short-run, we assume capital stocks to be unaffected by the economic shock under enquiry. The underlying principles of the ORANI-G model and the structure of the model's database are well documented in Horridge (2003).

The system of equations in ORANI-G contains theory describing the behaviour of various agents in the economy. Industries are faced with a nested production technology. Constant elasticity of substitution (CES) functions describes substitution possibilities between domestic and imported intermediates, and between different types of primary factor. At the top nest, composite intermediates and primary factor composite are combined according to industry-specific Leontief functions, i.e. fixed proportions. Separability assumptions also govern the composition of industry output. In choosing between inputs, industries are assumed to minimise cost. Constant elasticity of transformation (CET) functions was used to transform industry-specific activity into commodity-specific outputs destined for the local and export markets. In deciding on the nature of their product transformation across commodities and markets, industries are assumed to maximise revenue. In general, commodity markets are assumed to clear and to be competitive. Imported and domestic commodities were treated as imperfect substitutes using the CES assumption of Armington.

We assume investors to minimize the cost of producing new units of industry-specific capital. Choices on the quantity of new capital to be created in each industry are based on expected rates of return. A single representative household is assumed to maximize a Klein-Rubin utility function subject to a budget constraint. Commodity-specific government demands can either be assumed to be exogenous or determined through the relationship with private consumption. Commodity-specific export volumes are inversely related to international pricing levels.

For calibration purposes, the model database distinguishes 34 industries and commodities, and 11 occupation groups. Agricultural

sector was disaggregated into unprocessed agriculture (field crops, horticulture, livestock, poultry & piggery, forestry, fishery) and processed agriculture (processed meat, processed field crops, horticulture, sugar, dairy, alcohol drinks, soft drinks and tobacco). The database of the model represents the South African economy for the base year 2011. This was compiled from national supply and use tables, social accounting matrix, data on agricultural production, and general household survey. The data sources were Statistics South Africa (Statistics SA), Department of Agriculture, Forestry and Fisheries (DAFF) and South Africa Reserve Bank (SARB). Household expenditure elasticities were adapted from the GTAP database. GEMPACK software package was used to solve the model and analyze the results (GEMPACK, 2013).

Scenario and simulation design

The full extent of the recent global financial crisis is difficult to accurately ascertain for South Africa. Therefore, the study aims to mimic the behavior of the crisis to assess the impact on agricultural production, employment and household consumption. Two crisis scenarios and one public policy scenario were modelled. The crisis scenario seek to replicate the main transmission channels of the financial crisis to the South African economy: (1) collapse in global trade and (2) reduction in foreign capital flows to developing countries. The policy response scenario is composed of policies implemented by the South African government during the crisis: a fiscal stimulus package that is aimed at boosting domestic demand and creating jobs, while the South African Reserve Bank loosened the monetary policy.

Closure

The closure of the model determines which variables are endogenous and variables that are exogenous. The sectoral treatment of factor market is such that in agricultural sector, capital and land are fixed and in non-agricultural sector, only capital is fixed. Unskilled labour is allowed mobility across sectors, while skilled labour can only move between non-agricultural sectors. The supply of land, labour and farmers are all fixed. Supply in commodity market is equated with sum of intermediate demand, household and government consumption to give market equilibrium. Total investment is equal to total savings and this includes household, firm, and government savings. Real government consumption was fixed, and this enables government income and savings to vary, while firm's savings are fixed. The weighted value added price is considered as a numeraire. The nominal exchange rate is allowed to be flexible; implying foreign savings measured by the domestic currency is flexible. Thus,

the external account is cleared by the exchange rate given that the foreign savings in terms of foreign currency is fixed. In these simulations, a standard short run closure was used.

Results and Discussion

Results for the wide range of effects and sectoral impacts of the financial crisis on selected macroeconomic variables are presented in Table 1. All results shown in the table are presented as percentage change. The results suggest a reduction in export had a harmful effect on the South African economy. The key impact expected from the crisis is a lower GDP and the result shows a decline of 0.35 percent in the GDP. Overall employments declined by more than one percent (1.13 percent), while the terms of trade and return on capital experienced a significant fall, at 12.44 and 8.29 percent respectively relative to what it would otherwise have been.

Turning to the declines in exports at a more detailed sectoral level, the first thing we observed was that agricultural production declined as a result of the financial crisis. We find in Figure 1 that relatively strong export declines tend to be associated with fairly strong output declines. This crisis led to the decline in factor demand in primary agricultural exports, as well as in the food and light manufacturing industries. Thus, it emphasized the importance of trade to the agricultural sector output. The results showed that fruit and vegetable, fisheries, processed food and alcoholic drinks were significantly affected. Production output for fruit and vegetables declined by 2.18 percent, fisheries fell by 1.38 percent, processed food went down by 0.94 percent, while alcohol slumped by 1.72 percent.

Fall in exports have led to substantial job losses in agriculture, forestry and fishing, and manufacturing sectors. Figure 2 illustrates, within agricultural sector, that the hardest hit in terms of job loss are fisheries losing 4.12 percent, fruit and vegetables 3.73 percent, forestry 2.98 percent and poultry 1.01 percent jobs. Manufacturing lost 5.75 percent jobs. It is clear from the simulation results that the South African economy is not creating jobs, except in textile and cereal which added 2.4 percent and 1 percent respectively during this period (Figure 2). Employment increases only in the sector where production increases, such as textile and cereal which added more jobs during the period. The results corroborate the findings by Verick (2012) who in a study on the impact of global financial crisis on South African labor market argued

that global financial crisis deeply impacted the labour market resulting in loss of over a million jobs.

We see a fall in domestic price as a result of the decline in export. Field crops, fruits and vegetables, cereals, sugar, and forestry declined by 6.88 percent, 9.51 percent, 5.51 percent, 7.69 percent, and 11.13 percent respectively. Domestic price of processed meat, poultry, fisheries and livestock also fell by 6.53 percent, 6.39 percent, 13.05 percent and 6.20 percent respectively (Figure 3). The prices of coal and electricity are important to the agricultural sector, decreased by 16.41 percent and 8.54 percent respectively. Prices of manufactured items decreased by 7.25 percent.

The sector-wise analysis showed a fall in household demand due to the financial crisis. Demand for field crops, fruit and vegetables, poultry, fisheries, meat, cereal and dairy products slumped by 3.61 percent, 5.43 percent, 4.32 percent, 6 percent, 4.12 percent, 3.57 percent and 4.30 percent respectively (Figure 4). The fall in household demand can be associated with the rise in unemployment. Fall in household consumption expenditure reflects the rigorous pressure on the financial status of households due to the decline in market fundamental drivers of household income. Households that faced the highest fall in consumption are the rural poor that spend a larger percentage of their income on food items. The most immediate and direct effects are estimated to be on employment, household income and consumption, thereby increasing the level of poverty.

3. Conclusion

The global financial crisis had a profound impact on the South African economy. Although there are positive signs of recovery, the economy remain fragile with much uncertainties. This paper analyses the impact of the crisis as an external shock on the South African agricultural sector within a computable general equilibrium framework. Our finding suggests that the fall in trade due to the financial crisis resulted in the decline of agricultural output and increase in unemployment. The crisis affected domestic prices and general household consumption levels leading to further increase in poverty and inequality. The study suggests that the agricultural sector is highly vulnerable to external shock due to its integration with global financial systems. The global nature of the financial crisis also proved that financially integrated markets have benefits, and associated risks that have real economic consequences. These findings have important policy implications. The result is vital in informing policy makers on strategies to adopt to mitigate against the impact of external shock on the

agricultural sector. Policy makers need to protect the agricultural sector from direct impact of external shock of this nature and magnitude; hence the sector needs government interventions during crisis such as the global financial crisis. Likewise, short term policy responses involving fiscal and monetary policies and better restructuring frameworks should be in place as these tend to be more effective by offsetting the contractionary effects of the crisis. In addition to fiscal stimulus packages, economic decline can put more pressure on policymakers to assist affected industries. These interventions are necessary in a way to protect the poor and vulnerable.

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Table 1. Simulation results of macroeconomic variables. All results are reported as %-change

Variable	% change
Real GDP from expenditure side	-0.35
Imports	-8.39
Employment	-1.13
Terms of trade	-12.44
Consumer Price index	-6.02
Return on Capital	-8.29

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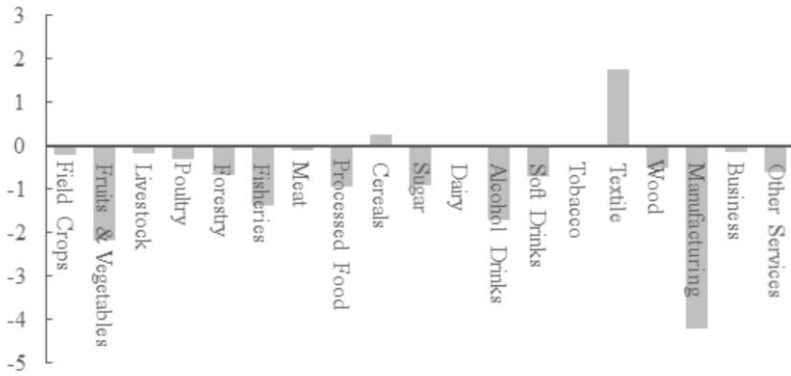
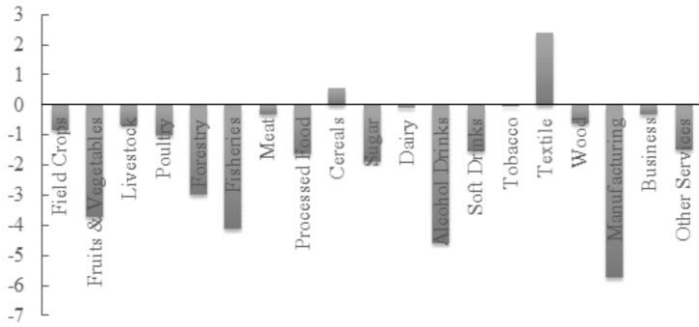


Figure 1: Percentage change in agricultural production

Figure 2: Percentage change in agricultural sector employment



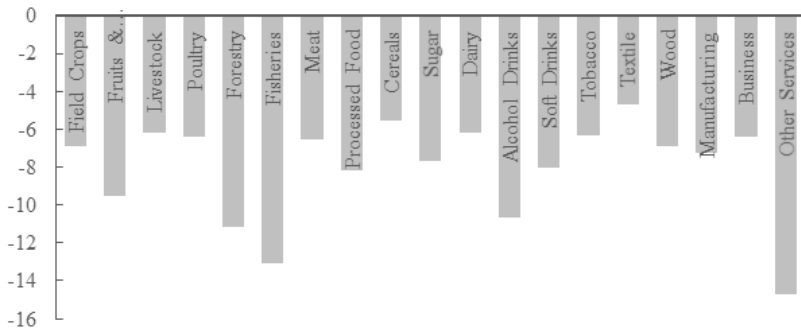


Figure 3: Percentage change in domestic price

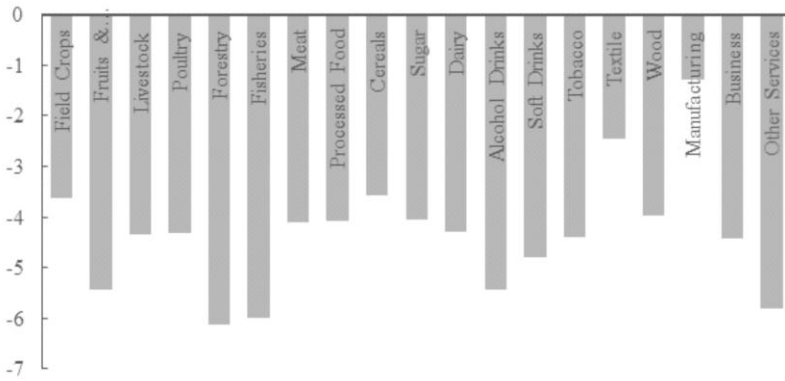


Figure 4: Percentage change in household demand

Appendix A

The simulation results for decrease in export scenario. All results are reported as %-change.

Sector	Output	Domestic price	Employment	Household demand	Factor cost
1. Field crops	-0.20	-6.88	-0.83	-3.61	-0.20
2. Fruit & vegetables	-2.18	-9.52	-3.74	-5.43	-2.18
3. Livestock	-0.16	-6.21	-0.66	-4.35	-0.16
4. Poultry	-0.32	-6.39	-1.01	-4.32	-0.32
5. Forestry	-0.67	-11.13	-2.98	-6.12	-0.67
6. Fisheries	-1.39	-13.06	-4.13	-6.00	-1.39
7. Processed meat	-0.12	-6.53	-0.32	-4.12	-0.12
8. Processed food	-0.94	-8.19	-1.62	-4.08	-0.94
9. Cereals	0.24	-5.52	0.55	-3.57	0.24
10. Sugar	-0.90	-7.69	-1.87	-4.06	-0.90
11. Dairy	-0.05	-6.18	-0.09	-4.30	-0.05
12. Alcoholic drinks	-1.72	-10.64	-4.62	-5.43	-1.72
13. Soft drinks	-0.70	-8.06	-1.53	-4.78	-0.70
14. Tobacco	-0.03	-6.36	-0.05	-4.40	-0.03
15. Textile	1.76	-4.72	2.40	-2.46	1.76
16. Wood	-0.50	-6.87	-0.61	-3.96	-0.50
17. Manufacturing	-4.21	-7.26	-5.75	-1.29	-4.21
18. Coal	-4.46	-16.42	-9.73	-7.10	-4.46
19. Crude gas	1.08	-4.11	2.72	-1.07	1.08
20. Mining	-3.73	-24.16	-9.66	-0.25	-3.73
21. Petroleum	0.04	-7.42	0.23	-2.96	0.04
22. Plastic rubber	0.91	-5.96	0.99	-2.98	0.91
23. Metal steel	-0.37	-6.90	-0.68	-3.95	-0.37
24. Chemicals	-0.30	-8.65	-0.44	-2.55	-0.30
25. Electricity	-0.09	-8.55	-0.25	-5.23	-0.09
26. Water	-0.05	-7.05	-0.23	-4.83	-0.05
27. Construction	-0.06	-5.65	-0.14	-4.31	-0.06
28. Retail	0.19	-5.03	0.39	-2.15	0.19
29. Hospital	-0.68	-8.38	-1.70	-3.25	-0.68

30. Transport	-0.05	-6.18	-0.15	-2.96	-0.05
31. Business	-0.13	-6.37	-0.30	-4.42	-0.13
32. Telecom	-0.34	-7.18	-1.01	-4.41	-0.34
33. Government	-0.04	-5.89	-0.05	-4.40	-0.04
34. Other services	-0.62	-14.73	-1.48	-5.81	-0.62
