A GENERAL EQUILIBRIUM ANALYSIS OF THE TRANSMISSION OF FOOD PRICE SHOCKS TO HOUSEHOLDS IN ZIMBABWE

M.A (ECONOMICS) THESIS

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UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

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Master of Arts (Economics) Thesis

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DECLARATION

I the undersigned hereby declare that this thesis is my own original work which has not been submitted to any other institution for similar purposes. Where other people's work has been used acknowledgements have been made.

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Signature

Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval.

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DEDICATION

A candle loses nothing by lighting another. I dedicate this thesis to you – my love Letwina and O’shea – I see far and wide because you gave me your shoulders to stand on.

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ABSTRACT

The study analyses the transmission of food price shocks to households in Zimbabwe. Studies examining the impact of food price shocks on households, especially in Africa, during the recent global food crisis look at the magnitude and incidence of the impact on either poverty prevalence or cost of living without attempting to decompose impact multipliers into transmission paths for the shocks. The study fills this gap. The study uses a SAM price model based on the 1991 Zimbabwe SAM. Block and path decomposition techniques used in the study clearly identify the paths, magnitude, and incidence of food price shocks to households. The study finds that food price shocks are generally regressive and that cost of living increases by more in rural than in urban areas and for lower income than for higher income households following a shock. The findings of the study substantiate Bennett's and Engel's laws. Of all household groups, smallholder households have the largest cost of living elasticities and that particularly with respect to their own-production cost shocks. Food processors have the greatest transmission effects on cost of living – inducing between 24 percent and 30 percent increase– especially in light of the increasing degree of urbanity in Zimbabwe. The study recommends policies that foster macroeconomic stability and strengthen smallholder production through input subsidies and agricultural technology transfer. A policy strengthening industrial food processing through a resuscitation fund is highly

recommended. Facilitating gainful and stable employment for the low income urban group would doubtlessly be a double-edged sword on both urban and rural food poverty. Lastly, when it comes to seemingly protracted food poverty traps because of price shocks, widening and deepening social safety nets is beneficial. Cash and food transfers, and public works programs are gainful.

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LIST OF ABBREVIATIONS AND ACRONYMS

CCZ	Consumer Council of Zimbabwe
CGE	Computable General Equilibrium
CPI	Consumer Price Index
CSO	Central Statistical Office
CZI	Confederation of Zimbabwe Industries
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GoZ	Government of Zimbabwe
GTAP	Global Trade Analysis Project
OECD	Organization for Economic Cooperation and Development
RBZ	Reserve Bank of Zimbabwe
SAM	Social Accounting Matrix
SSA	Sub-Saharan Africa
USD	United States Dollar
ZWD	Zimbabwean Dollar

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Background

The study unveils the underlying structural features of food price transmission in Zimbabwe. The chief end of the analysis is to derive lessons for cost of living interventions by government. Although the global food crisis overhang has waned in many developing countries, it is still being felt in Zimbabwe. Reserve Bank of Zimbabwe [RBZ] (2011) claims that rising food prices on the world market have stoked inflationary pressures in the economy. Inflationary developments hitherto indicate that there are underlying structural and supply-side bottlenecks in the food sector deep-seated in the economy (Government of Zimbabwe [GoZ], 2009a, 2009b).

Food price shocks have raised concern among policymakers in the world in general, and in Africa particularly. In some cases, rising food prices have caused social unrest. In Africa, for example, food riots occurred in at least fourteen countries, even repeatedly in some, between 2005 and 2010. Examples include Zimbabwe, Mozambique, Cameroon, Egypt, Tunisia, Burkina Faso, Kenya, Senegal, Madagascar, Morocco, and Niger (Food and Agriculture Organization [FAO], 2008). The question of what has been generating global food price shocks that usually culminate in domestic food price crises is a highly contested one. In an indisputably incisive analysis, Headey and Fan (2008) provide a number of stylized facts against which causes of global food price shocks are examined. They identify six such stylized facts. First, that the 2007-2008 price levels are comparably as high as the levels in the 1970s and 1980s. Second, prices have risen sharply in this period's food crisis.

Third, at the eve of the 2007-2008 price increases, prices of staples were at their all-time low levels. Fourth, prices of a wide range of commodities have increased sharply. Fifth, the timing of price increases is somewhat different across commodities and in particular staple foods. Sixth, the United States Dollar [USD] has depreciated against a wide range of currencies, hence causing huge spikes in USD quoted prices of tradable staple grains.

There are a number of contending schools of thought concerning what is behind global and, by analogy, national food price shocks. One school of thought argues that supply-side challenges are at the centre of the shocks given the prolonged nature of the recent crisis. Adverse climatic outcomes in major food producing countries and declining global stocks of food, especially due to biofuel production, are the main causes of price shocks. This school of thought further contends that food production costs have been high due to the fuel crisis resulting in rising fertilizer prices (Headey and Fan, 2008; Ghosh, 2010). Another contestant school argues that demand-side issues are at the epicentre of the global and, by consequence, national food crises in many developing countries. Rising demand for biofuels, which partly rely on food crops such as maize explains food price shocks. Further, this school argues that increasing urbanization, economic development and income growth, and population growth in emerging economies such as China, India, and Brazil are too important to be sidelined. Speculation in global food commodity markets especially through financial derivatives is ardently blamed by this school (Ghosh, 2010). One of the demand side factors is the depreciating USD (FAO, 2008). The third school of thought blames policy decisions in major food producing countries such as banning of food exports hence constraining supply on global food markets and ultimately hurting low income import dependent countries.

Food price shocks, whether domestic or global, have different degrees of pass through to households depending on the level of protection, subsidies, relative shares of domestic consumption met by imports and domestic market structures. Food price shocks are all-important because of their socio-political and economic implications. Studies have been done with, in some cases, full journal supplements being produced just to explain the causes and impacts of global food price shocks of 2005 to 2009 period. Not too well has this subject of food price shock transmission been addressed in Zimbabwe, to the extent that policymakers are currently in search of an explanation of the triggers and drivers of cost of living increases. Although the debate has centred on the causes of food price shocks and possible solutions to their effects, seldom has the question of how the shocks are transmitted to households been examined. Thus, the present study positions itself in this debate by examining, in a multisectoral context, the possible paths through which any food price shock would be transmitted to households in Zimbabwe.

An important source of cost of living increases in Zimbabwe is food price shocks. Currently, Zimbabwean food industry is facing a myriad of challenges that have resulted in low capacity utilization. These supply-side challenges have increased the propensity to import processed food in the economy against a background of a weakening USD and high global food prices. Table 1 depicts the evolution of capacity utilization for the food sub-sectors. It shows persistent supply-side bottlenecks. Such low levels of capacity utilization imply that food imports will remain a predominant component of household expenditure hence enhancing the transmission of global food price shocks to cost of living.

Table 1: Sub-sector percentage utilization of installed production capacity in Zimbabwe

	Capacity Utilization (percent)		
Sectors	2009 actual	2010 estimate	2011 projected
Food stuffs	39	42	45
Drinks, Tobacco and Beverages	50	59	62

Excerpted from Government of Zimbabwe 2011 National Budget (2010)

Given that Zimbabwe currently imports virtually all categories of foodstuffs ranging from grains to processed foods that are indispensable for household consumption, it is deducible that exchange rate shocks and other global developments in agricultural commodity and processed food markets play a major role in influencing cost of living. Figure 1 depicts the cereal import profile for Zimbabwe and the world cereal price index. Although world cereal prices are coming down, they are still high and have pervasively adverse effects on balance of payments and cost of living for Zimbabwe especially in the context of the depreciating USD that Zimbabwe adopted. Lang (2010), Ghosh (2010), and Brinkman, de Pee, Sanogo, Subran and Bloem (2009) argue that the poor are the most affected by such exchange rate shocks.

Domestic supply of cereals has been weak. Such challenges as climatic shocks and poor agricultural performance in the post-land reform era are possible causes. The input sector has been inefficient and in disarray in this period leading to poor agricultural supply response resulting in high cereal imports.

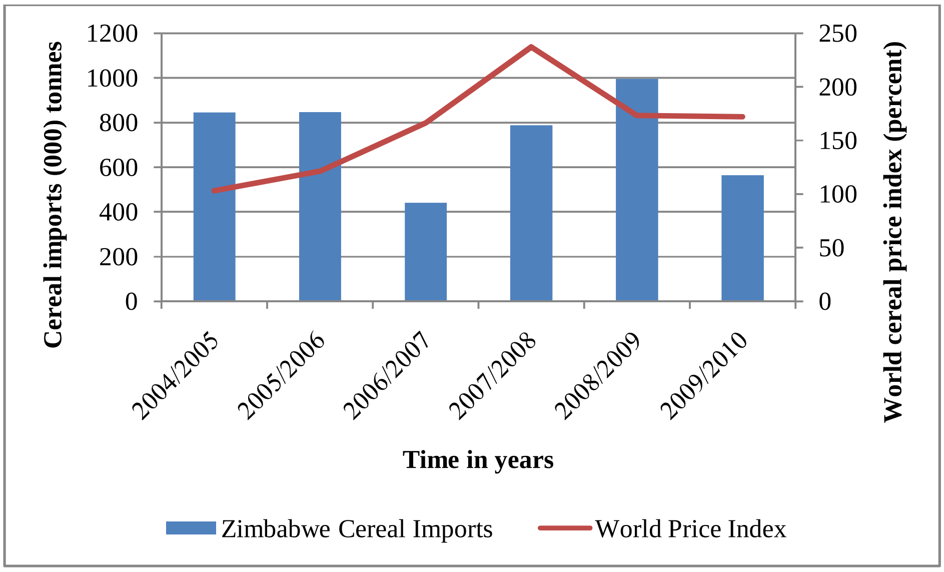

Figure 1: Zimbabwe cereal imports and world cereal price index

Source: Food and Agriculture Organization (2010)

At the peak of the global food crisis in 2008, Zimbabwe's cereal imports were the highest in the period captured by figure 1. In 2008, Zimbabwe had a severe drought that resulted in huge grain imports. As world cereal prices rose sharply between 2005/2006 and 2007/2008, Zimbabwe cereal imports escalated thus culminating in huge food inflation shocks – inflation taking a peak of 231 million percent (CSO, 2008).

1.2 Problem Statement

African studies examining the impact of food price shocks on cost of living and poverty incidence, such as those by Arndt, Benfica, Maximiano, Nucifora and Thurlow (2008), and Dessus, Herrera, and de Hoyos (2008), Parra and Wodon (2008), Wodon and Zaman (2008), quantify poverty and cost of living effects of such shocks. They further simulate the likely impact of potential intervention strategies but do not discuss how such price shocks are transmitted to households. They do not delineate the paths along which food price shocks are transmitted to households. Social accounting matrix [SAM] multiplier decomposition techniques, unlike computable general equilibrium [CGE] methodologies, would enable the ideal focusing of policy interventions by decomposing impact multipliers into transmission paths to households. Such paths would assist in effective targeting of interventions. By concentrating on paths carrying greater proportions of the shocks, effective and efficient outcomes are possible ceteris paribus. The present study fills this gap.

Policy wise, government of Zimbabwe proposes to strengthen price surveillance and assessment of the impact of market reforms underway on consumers (GoZ, 2009b). However, there is no stipulation in the 2010-2012 Budget and Macroeconomic Policy Framework of the analytical process that will underpin the surveillance and impact assessment process. Probably, government will turn to Consumer Council of Zimbabwe [CCZ] for a naïve price watching service. Therefore, empirical analysis of price shock transmission, which this study carries out, is insightful to both academia and policymakers. Relying on rules of thumb for cost of living interventions – as in the past decade (Confederation of Zimbabwe Industries [CZI], 2008) – would not achieve economic optimality. Lack of empirical work on structural path analysis of price shock transmission in Zimbabwe, and Africa at large, to help academia and policymakers better anticipate cost of living effects of food price shocks motivates this study.

1.3 Research Questions and Objectives of the Study

The thesis seeks an answer to the following questions: How are exogenous price or cost shocks in food production, marketing and distribution transmitted to households? Is it possible to measure the magnitude of such shocks *ex ante*? If so, what is the likely magnitude and incidence of sectoral exogenous food price or cost shock pass through to household cost of living? For a comprehensive approach to food price shocks, it is necessary to have an understanding of sectoral transmission potential. So which sectors in Zimbabwe have the greatest potential to transmit price shocks?

1.3.1 General Objective

To analyze transmission of food price shocks to households in Zimbabwe in order to infer cost of living effects and draw lessons for policy interventions

1.3.2 Specific Objectives

i. To delineate the paths along which exogenous price shocks in the agricultural and food-processing sectors are transmitted to households.

ii. To estimate the magnitude of the impact and incidence of food price shocks on different households' cost of living.

iii. To identify and rank food sub-sectors with the greatest price shock transmission potential to households.

1.4 Significance of the Study

The study is significant in a number of ways. First, it is a pioneering study - to the best of the author's knowledge - to examine transmission of food price shocks in Zimbabwe in a multisectoral context.[1] Despite their flexibility and tractability, SAMs have generally not been used to examine price transmission. This is somewhat surprising. Price formation is an essential issue in economic policy. Thus, the study proposes to start filling this gap and demonstrate how a dual perspective on SAM multiplier methods can help shed light on direct and indirect price and cost linkages across an economy. Such an analysis provides a practical framework for shock incidence analysis that should help improve visibility of policy makers seeking to facilitate economic reform and to target intervention efforts. The study stands to make an important contribution by filling the gap of a dearth of empirical work on structural path analysis of price shock transmission in Zimbabwe. Third, the study contributes to knowledge by ranking food sub-sectors in Zimbabwe by their price shock transmission potential, something that other studies have neglected in the past.

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[1] "Surprisingly, application of SAM model for price formation and cost transmission is rather limited. The first attempt for cost effect analyses using a price model can be traced back to Roland-Holst and Sancho (1995). Afterwards, we are not aware of other studies that attempt to apply the price model for the cost effect analyses," (Saari, Dietzenbacher and Los, 2010:7).

Fourth, the structural paths generated by the study could be a possible guide to policy on where and in what form to make cost of living interventions. The results of this study can further be useful for simulating effects of specific price shocks like the introduction of road toll fees, exchange rate movements, fuel price shocks, tariff and other tax reforms, to name a few.

1.5 Organization of the Rest of the Thesis

Chapter Two briefly examines the structure of household food expenditure in Zimbabwe whilst Chapter Three reviews and appraises the relevant literature. Chapter Four presents and discusses the empirical strategy used in this study. Chapter Five presents the results and discusses them and finally Chapter Six concludes and makes recommendations.

CHAPTER TWO

STRUCTURE OF HOUSEHOLD EXPENDITURE IN ZIMBABWE

2.1 Introduction

This chapter describes the structure of household expenditures in Zimbabwe. Much of the analysis builds on the SAM that the study uses. Lack of data reliable enough and an up to date SAM for analysis of the economy inhibits a more current analysis.[2] Even Central Statistical Office [CSO] of Zimbabwe is using similarly somehow old data for benchmarking poverty datum lines.

2.2 Household Expenditure Analysis

Table 2 details important asymmetries in household expenditure across a variety of food product groups or sectors. Important observations from Table 2 stand out. First, that all household types have a higher propensity to consume value added products such as processed food (11 percent to 16 percent). Although there are important asymmetries in the shares, it is clear that there is a high degree of urbanity in Zimbabwe hence huge expenditure shares for processed foods. Second, high income households spend considerably more savings and investment compared to lower income households.

[2] The last Income, Consumption and Expenditure survey was done in 1995/96.

Savings are an important coping strategy in case a shock strikes. The table reports proportions of food and savings accounts only.

Table 2: Household food expenditure shares (percent of total household expenditure) in Zimbabwe

Expenditure category	Large scale farm owner-manager	Large scale farm worker	Smallholder	High income urban	Low income urban
Maize	0	13	2	0	7
Horticultural produce	0	6	0	1	3
Cattle	2	2	1	0	0
Other livestock	2	8	3	0	5
Grain milling and milled products	3	12	3	1	7
Processed food products	16	11	11	15	14
Savings /Investment	15	2	4	17	8
Own-production maize consumption	0	0	11	0	0
Own-production/ subsistence-other cereals	0	0	4	0	0
Own-production/ subsistence-horticulture	0	0	4	0	0
Own-production/ subsistence-groundnuts	0	0	4	0	0
Own-production cattle consumption	0	0	6	0	0
Own-production/subsistence-other livestock and products	0	0	7	0	0
Total	38	54	60	34	44

Source: Author's calculations

Third, low income households namely large scale farm workers, smallholder and urban low income earners spend relatively more on cereals, livestock products, horticultural produce, and milling products. Fourth, large scale farm workers have the smallest expenditure aggregate. Not only do they have high proportions of food, but also have high expenditure shares for most product categories. Ivanic and Martin (2008) raise an important stylized fact that the higher the share of a given product in total expenditure of a household, the greater the vulnerability of the household to shocks in the price of such a product. Thus, one would anticipate that most price shocks would have a greater pass through effect to this group.

Fifth, smallholder farm households have substantial non-marketed proportions of cereals, groundnuts, livestock and its products, and horticultural output they consume at subsistence level. This would ideally act as a buffer against shocks in prices of agricultural produce such as occurred between 2005 and 2008 during the global food crisis. In fact, such huge proportions of non-marketed consumption reduce the degree of pass through of food price shocks to such households as argued by Benson, Mugarura and Wanda (2008).

2.3 Household Income by Source Analysis

It is informative to understand how each household category earns its income. It is important because it reflects on the levels of inequality and means available for survival and coping in the event of shocks striking. Table 3 summarizes household income by source as a proportion of household group's total income. More interestingly, large scale farm workers earn all their income from unskilled labour services – both formal and informal – rendered. In fact, this ties well with their low expenditure. The highest source of income for low income urbanites is informal unskilled labour yielding 57 percent of total income whilst unskilled formal labour services yield half as much. Smallholder households also earn most of their income, about 38 percent, from informal unskilled labour.

Table 3: Household income by source as a proportion (percent) of total income in Zimbabwe

Income source	Large scale farm owner/ manager	Large scale farm worker	Smallholder	High income urban	Low income urban
Unskilled labour	0	100	0	0	0
Unskilled labour formal	0	0	0	0	29
Unskilled labour informal	0	0	39	0	57
Skilled labour	9	0	0	72	0
Capital large scale	18	0	0	0	0
Capital smallholder	0	0	14	0	0
Other capital	0	0	0	0	5
Land large scale	5	0	0	0	0
Land smallholder	0	0	7	0	0
Enterprises	60	0	0	27	0
High income urban	0	0	4	0	0
Low income urban	0	0	10	0	0
Government	7	0	26	1	9
Remittances	1	0	0	0	0
Total Percent	100	100	100	100	100
Total Household Group Income (ZWD millions)	9,250	100	1,829	12,398	2,601

Source: Author's calculations

Low income urbanites earn about 72 percent of their income from skilled labour. However, large scale farm owner-managers earn all of their income from enterprises. Surprisingly, large scale farm owner-managers get some of their income from government in the form of production subsidies, but government does not assist large scale farm workers. Government transfers are a huge source of income for smallholder and low income urbanites – amounting to 26 percent and 9 percent of their incomes respectively. Smallholder households also receive transfers amounting to 10 percent and 4 percent from low and low income urban households respectively. This is because most urban wage earners, especially the low income, are dual homeowners.

In conclusion, this preliminary analysis reveals that most low income households have higher shares of food in their expenditure. Such outcomes point to Engel's law, which states that the proportion of food expenditure in a household's budget goes up as income declines, otherwise it declines. In line with the stylized fact that households with huge food shares in expenditure are likely to be more vulnerable to food price shocks, the study anticipates the same for Zimbabwe. Ivanic and Martin (2008) make a similar argument. In terms of income, they largely earn it from unskilled labour services. The implication is that they have less means for consumption smoothing, worse so during and in the aftermath of a food price shock.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

Literature on food price shocks and their transmission has significantly increased recently. This chapter gives a review of the relevant literature on food price transmission. First, theoretical literature is analyzed and then empirical. The empirical literature is organized by similarity in empirical framework and research issues.

3.2 Theoretical Review

3.2.1 Introduction to Inflation Thought

In a survey of the theory of inflation, Bronfenbrenner and Holzman (1963) identify three types of inflation namely demand-pull, cost-push, and mixed inflation. In the context of the current study, focus is on cost-push inflation since the analysis is on price transmission from food producers to households. Second, with adoption of *dollarization* – the adoption of the USD as official legal tender in all matters of commerce in the domestic economy – in Zimbabwe, monetary policy was lost and so monetarist views of inflation is out of question. Third, given a cash budgeting framework in Zimbabwe, there is little or no scope for fiscal discretionary expenditure, thus ruling out Keynesian views of expenditure-induced inflation, that is, demand-pull inflation. Consequently, section 3.2.2 reviews cost-push inflation theory and 3.2.3 the SAM price model.

3.2.2 Cost-Push Inflation Theory

Cost-push inflation is a supply-side induced problem. Supply-inflation theory maintains that in societies of oligopolies, labour unions, and some other pressure groups, aggregate supply contracts, as shown in Figure 2, through haggling (Bronfenbrenner and Holzman, 1963). This leads to higher prices and therefore cost of living. To maintain full employment income (Y_0), prices have to rise from P_0 to P_1, before settling at P_2 as aggregate supply shifts up from S_0, S_1 to S_2 no matter what happens to aggregate demand. Unemployment is the cost of holding prices closer to P_0. If aggregate demand is held at D_0, real income falls to Y_1 and Y_2 and the price level rises from P_0 to P_{11} to P_{22}. If the government is committed to full employment, the path of temporary equilibrium points will be $a \rightarrow b \rightarrow c \rightarrow d \rightarrow e$ with the corresponding price path in the process of adjustment $P_0 \rightarrow P_{11} \rightarrow P_{22} \rightarrow P_1 \rightarrow P_2$.

In an open economy, cost-push effects can arise from increasing import prices mainly due to a depreciating exchange rate. This notion, moreover, applies in a *dollarized* economy like Zimbabwe. For cost and profit-push to occur, the assumption is that labour and firms have considerable market power in negotiating an increase in their incomes (Bronfenbrenner and Holzman, 1963). Therefore, factor and product market structures are at the heart of cost-push inflation.

Duesenberry (1950) and Holzman (1950) generalize cost-push inflation as income inflation. These models show that at full employment (Y_0) each income group attempts to raise its real income by bargaining for a further increase in its nominal income. Suppose output does not expand, then prices will increase leading to erosion of real incomes. The resulting dissatisfaction leads to further demands for higher nominal incomes – and this becomes an income-price spiral (a to e). Supposing this to happen in the food sector, then food prices would increase. The cost of living would ultimately increase.

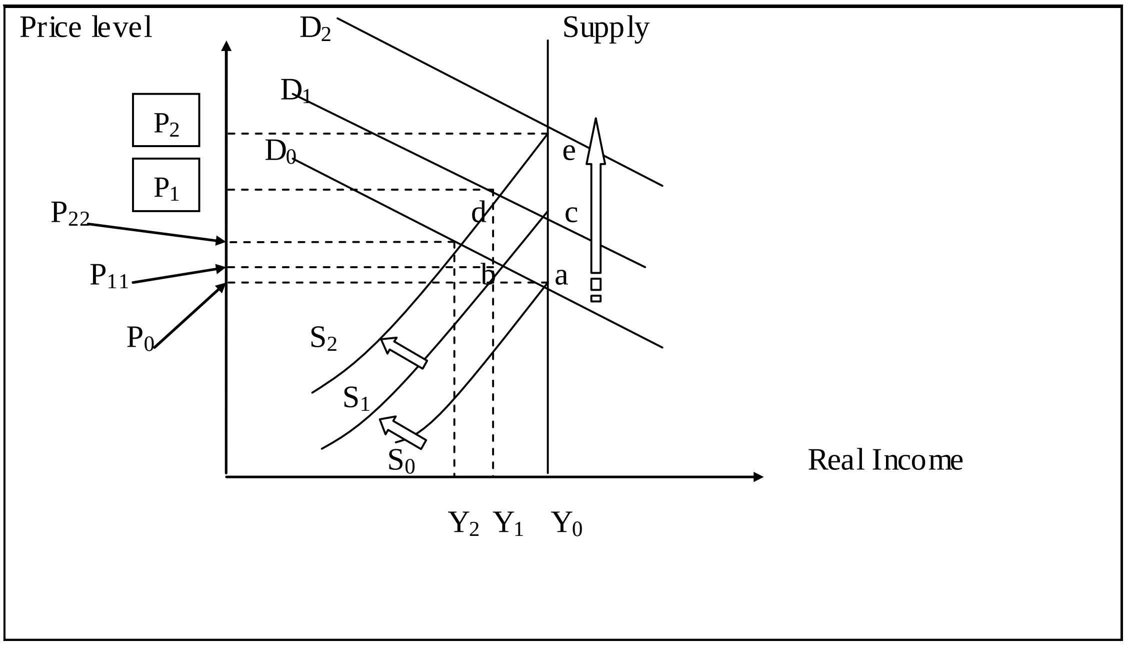

Figure 2: Evolution of cost-push inflation

Figure 3 depicts an alternative presentation of the same dynamics. All points along the OO’ locus represent the same level of real income, that is, nominal wages and prices increase at the same rate along that locus. Suppose OB (= F) is the fixed income claims of rentiers (receiving rent and long-term interest), W is the wage claim of labour and L is gross profit claims of entrepreneurs. Then gross total claims C = F+W+L = OC_1ZP_1 exceed real income OY_1XP_1. Consequently, price increases from P_1 to P_2. The increase of prices at income OY_2 by OP_2 resolves these conflicting claims. Once the C locus has converged on OO' prices cease to rise further. In this model, businesses use mark-up pricing over their labour and raw material costs. However, labour marks-up its wage over cost of living increases. Therefore, agent behaviour in the market initiates cost build-ups and Zimbabwe is no exception to this phenomenon especially in light of industrial actions that are frequently occurring since the beginning of 2010. The effect is to increase food production costs among other costs transmissible to households in the form of higher prices.

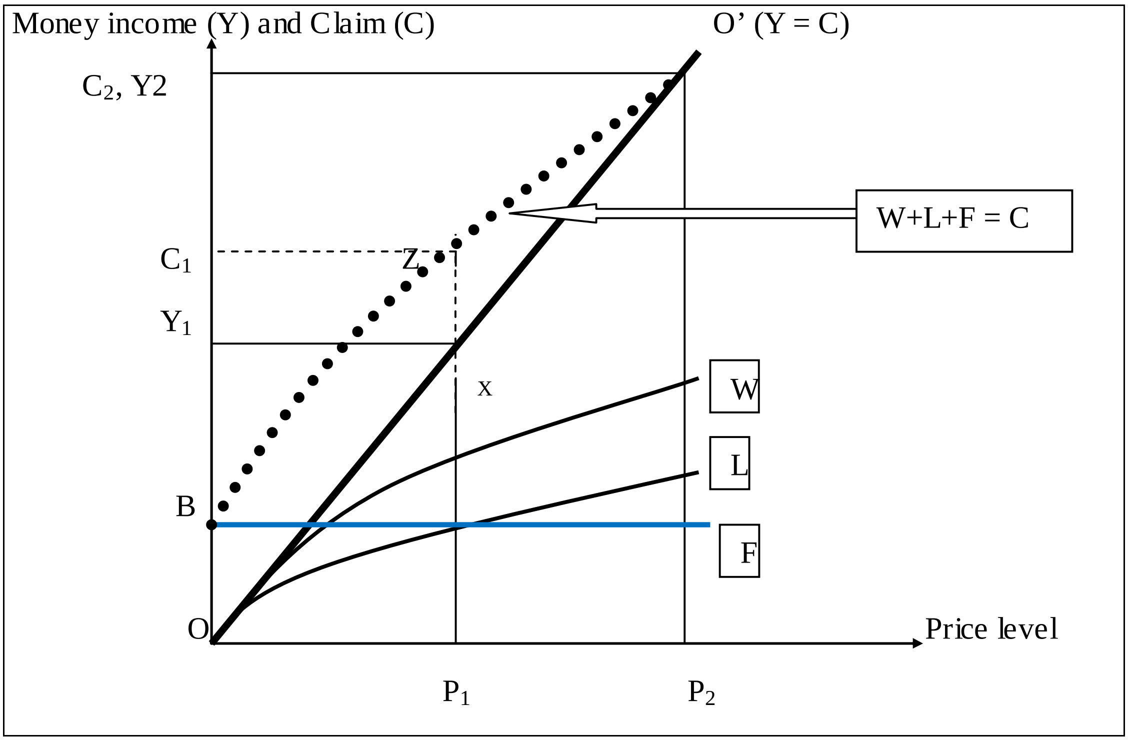

Figure 3: Cost-push inflation dynamics

3.2.3 Conceptual Framework: SAM Price Model

Roland-Holst and Sancho (1995) first proposed the SAM price model, which is an extension of the Leontief price model. A standard SAM represents a disaggregated view of value flows in a given base period, detailing direct linkages among its component sectors, factors of production, and domestic institutions. It also points out the scope of indirect linkages. Table 4 depicts a partitioned simplified Macro SAM with four groups of accounts, namely production, factors, households, and a consolidated account of the remaining sectors, which are government, capital, and foreign accounts. Columns *(j)* of the SAM indicate expenditure and rows *(i)* tally income.

Table 4: A Macro SAM with four accounts

Account	Production	Factors	Households	Rest	Total
Production	T_{11}	0	T_{13}	T_{14}	Y_1
Factors	T_{21}	0	0	T_{24}	Y_2
Households	0	T_{32}	T_{33}	T_{34}	Y_3
Rest	T_{41}	T_{42}	T_{43}	T_{44}	Y_4
Total	Y_1	Y_2	Y_3	Y_4	

Economic agents undertake economic transactions. Producers pay for raw materials (T_{11}) and factors (T_{21}) which are combined to generate output; factors make use of household endowments (T_{32}) to provide firms with labour and capital services. Finally, households purchase output (T_{13}) from production to obtain consumption. Additionally, each group pays taxes or import costs (T_{41} to T_{43}) to the consolidated group Rest as depicted in Table 4.

3.2.3.1 Assumptions of the SAM Price Model

First, there are no substitution possibilities in production, factor markets, and consumption. Second, the model assumes away time delay effects and stickiness problems in price transmission (Dan and Rencheng, 2009). Thus, the impacts of price shocks transmit through the economy-wide chain smoothly. The smooth transmission mechanism gives the maximum impact of price shocks. Additionally, demand is perfectly price inelastic by assumption. The assumption of excess capacity and unused resources in production activities buttress the partitioning of the SAM (Roland-Holst and Sancho, 1995). In price modelling, prices are assumed to be responsive to costs but not to activity levels. The justifying assumption, in addition to the excess capacity condition, is generalized homogeneity and fixity of coefficients in activities. This assumption not only guarantees constancy of physical technical coefficients, but also the constancy of the price ratio (Parra and Wodon, 2008). These are non-trivial assumptions because they imply that the classical dichotomy between prices and quantities holds, that is, prices are computable independent of activity levels (Parra and Wodon, 2008; Roland-Holst and Sancho, 1995).

3.2.3.2 Caveats and Attractions of SAM-Based Price Modelling

A number of caveats against SAM-based price modelling exist. Ideally, it assumes a rigid price formation system such that there is no possibility of substitution between the elements that define the price level in the economy. This is an unrealistic assumption because agents rely on relative prices to substitute the cheaper for the more expensive. This model provides upper-bound estimates when used to compute price effects. SAM models typically measure the first-order price impact hence they are relevant for short run analysis implying that they are static models.

Despite their limitation compared to CGE models, SAM price models have some distinct advantages that include transparency and the ability to estimate absolute price variations, providing information of immediate use to policymakers (Roland-Holst and Sancho, 1995). More importantly, the linear structure of the SAM price model allows the breaking up of the price transmission matrix through block and structural path decomposition techniques. Path analysis discloses in detail the networks of price transmission paths and produces direct estimates of all the linkages connecting any two SAM accounts – the origin and destination poles. Besides, an additional advantage of these models is that they can help empirical researchers and policymakers to measure the adjustment burdens that distortions such as administered food prices, and exchange rates imply and elucidate the detailed paths that eventual adjustments would take. The product of all such analysis is a clearer identification of affected household groups and the paths transmitting greatest cost of living effects to them.

3.2.3.3 Derivation of the SAM Price Model

Given the structure of the SAM in Table 4, a price model is easy to formulate. Summing down the SAM columns for endogenous accounts, that is, production, factors, and households yields:

$$Y_j = \sum_{i=1}^{n} T_{ij} + \sum_{m=n+1}^{r} T_{mj} \tag{3.1}$$

Where n is the number of endogenous accounts and r-n is the number of exogenous accounts, and where Y_j denotes the total expenditure for sector j. However, T_{mj} denotes total payments to the m^{th} exogenous account made by sector j. Let P_j and P_i be the prices of the goods produced by sector j and i respectively, and Q_j be sector j's total output. Let, also, q_{ij} be output from sector i used by sector j as input and π_m be the price for exogenous services q_{mj} offered by the exogenous accounts such as government, then

$$Y_j = P_j Q_j = \sum_{i=1}^{n} P_i\, q_{ij} + \sum_{m=n+1}^{r} \pi_m\, q_{mj} \tag{3.2}$$

Dividing both sides by Q_j the result is:

$$P_j = \sum_{i=1}^{n} \frac{P_i q_{ij}}{Q_j} + \sum_{m=n+1}^{r} \frac{\pi_m q_{mj}}{Q_j} \tag{3.3}$$

Defining $a_{ij} = \frac{q_{ij}}{Q_j}$ for i = 1,…., n as the value technical coefficient or the average propensity to spend, and $v_j = \sum_{m=n+1}^{r} \frac{\pi_m q_{mj}}{Q_j}$, for j = 1, 2 and 3, as the value of total payments to exogenous accounts per physical unit of sector *j*'s output, equation (3.3) is reducible to:

$$P_j = \sum_{i=1}^{n} P_i \, a_{ij} + v_j \tag{3.4}$$

for *j* =1, 2, 3 since there are three endogenous account groups. Equation (3.4) means that the price of sector *j's* output is a weighted average of the prices of all the goods that sector *j* buys from other sectors *i* – with weights given by value technical coefficients – and added to exogenous payments per unit of sector *j's* output. However, to make the algebra less clumsy the three price indices P_1, P_2, P_3, represented by (3.4), are expressible as a system of equations represented by (3.5), following partitions in Table 4. Defining a matrix $A_{ij} = \left[\frac{T_{ij}}{Y_j}\right] = \left[a_{ij}\right]$ of normalized column coefficients, the system becomes

$$P_1 = P_1 A_{11} + P_2 A_{21} + \quad 0 \quad + \pi_4 A_{41}$$

$$P_2 = \ 0 \quad + \quad 0 \quad + P_3 A_{32} + \pi_4 A_{42}$$

$$P_3 = P_1 A_{13} + \quad 0 \quad + P_3 A_{33} + \pi_4 A_{43} \tag{3.5}$$

The prices generated by the model have an intuitive interpretation. Prices of activities are producer prices. The producer price index P_1 is a weighted sum of inter-industry input purchase cost per unit ($P_1 A_{11}$), per unit factor payments [to labour, land

and capital] (P_2A_{21}) and per unit payments made to exogenous accounts for example taxes to government (π_4A_{41}). Prices of commodities, however, represent consumer prices but they are a subcomponent of P_1. On the other hand, P_2 is the factor-price index – for example wage index, capital price index, and land rental index – which are weighted sums of all per unit factor income payments made to households (P_3A_{32}) and per unit factor-use tax payments to government (π_4A_{42}) such as labour, capital, and land taxes. Prices of households, P_3, represent cost of living indices computed as averages of all goods households buy including tax payments. The cost of living index P_3 is a weighted sum of per unit price payments for consumer goods (P_1A_{13}), per unit transfers to other households (P_3A_{33}) and per unit factor-income payments by households to government for example pay-as-you-earn tax (π_4A_{43}).

Define a matrix A of normalized coefficients:

$$A = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix} \qquad (3.6)$$

Let $V = \pi_4A_{(4)}$ be a vector of exogenous costs where $A_{(4)} = (A_{41}\ A_{42}\ A_{43})$ is the sub-matrix of the SAM composed by the column adjoining A_{41}, A_{42} and A_{43}. Suppose further that $P = [P_1\ ,\ P_2\ ,\ P_3]$ is a price vector for the endogenous accounts of the SAM. In matrix notation, system (3.5) is represented compactly as:

$$P = PA + V \Longrightarrow V(1 - A)^{-1} = VM \qquad (3.7)$$

In a price model, M is read column wise hence the need to transpose it to reflect that. So defining $M' = (I - A)^{-1}$ as the price multiplier matrix and is the transpose of the traditional income multiplier matrix (M) used in quantity models, then

$$P = M'V \tag{3.8}$$

This model is called a cost-push model.[3]

3.3 Empirical Literature Review

The seminal work on SAM price modelling is due to Roland-Holst and Sancho (1995). They develop a SAM price model and report a full set of accounting prices, decompose them and apply structural path analysis to the 1987 Spanish SAM. The purpose of their study is to demonstrate how to operationalize a SAM into a price model. Although they report results for all sectors, they find that price shocks from agriculture are transmitted indirectly to households through the food-processing sector. The cost of living elasticities for the low income are 20 percent and 30 percent with respect to agricultural and food-processing industry cost shocks respectively. Subsequently, Llop (2007) in a study of the Catalan economy using a 1994 SAM finds similar results. However, Llop (2007) endogenizes the capital account – which the former exogenize – arguing that the Catalan economy has high savings rates and that investment prices may have a huge effect on price transmission. They find that shocks in investment prices explain a significant component of the global price effect particularly for rich households. Production cost shocks, they find, have regressive price effects – the poorer the

[3] In this study, the words "price" and "cost" are used interchangeably.

household is, the greater the price impact on cost of living. Nonetheless, Llop (2007) does not decompose the price indices into the relevant transmission paths for the shocks.

3.3.1 Global Food Prices and Cost of Living or Poverty in Poor Countries

Recently, many studies examined the impact of the recent global food crisis between 2005 and 2009 on least developed countries and households in them. Examples are Arndt, et al. (2008); Benson et al. (2008); Brinkman et al. (2009); Conforti, Ferrari and Sarris (2009); Ghosh (2010); Headey and Fan (2008); Ivanic and Martin (2008); Levin (2010); Parra and Wodon (2008); Ruel, Garett, Hawkes and Cohen (2010); Warr (2008); Webb (2010); and Wodon and Zaman (2008). Benson et al. (2008), using statistical analysis, find that the degree of pass through of rising global food prices was low in Uganda because of a high proportion of non-tradable staple crops in households' consumption baskets. However, they find a high contemporaneous correlation between Ugandan maize and rice prices, and the world food price index – about 0.7 and 0.9 respectively. These grains are tradable hence a high correlation with world food price index. Thus, they find that maize and aid-dependent households are more vulnerable to maize price shocks than non-dependent households are.

A related result is reported by Headey and Fan (2008), using statistical analysis and synthesis of literature, that international price pass through was low particularly because some currencies were overvalued against the USD. However, Ghosh (2010) makes a diametrically contrary argument believing that the pass through to poor countries was extremely high. Justifiably, they argue, financial speculation in global agricultural commodity markets and the global financial crisis spurred the commodity price boom. Agricultural commodity price booms, they envisage, raised food and nutrition poverty prevalence since most households are net food buyers and could not afford, at the time, to buy enough food at such rising prices. Nonetheless, this forceful argument builds on value judgments and does not attempt to measure empirically the degree of pass through or the extent to which the speculative bubbles in global agricultural commodity markets and the global financial crisis propagated and amplified the pass through effects of rising food prices. They are quick to point out, albeit disputably, that the rural community might have felt little impact of the shocks due to huge marketing margins that insulate them.

Similarly, Conforti et al. (2009) using a static CGE model in their study of the impact of a commodity price boom on Malawi report mixed welfare effects. They report that smallholder farmers' welfare would increase by about 1 percent and 2 percent for large scale farmers. It, however, decreases for rural non-farm households by 3 percent and for major urban centres by 2 percent. Land constraints, huge marketing margins, infrastructural rigidities, and poor supply response, they find, reduce the size of the income effect hence a price boom has a negative effect overall. However, FAO (2008) reports contrary results using a partial equilibrium analysis framework. It finds that a 10 percent increase in the price of a staple reduces the welfare of both rural landowners and non-landowners across all income quintiles in Malawi. On average, welfare declines by 1.3 percent and 1.5 percent for landowners and non-landowners respectively. Including urban households would have made the welfare outlook worse. Welfare losses estimated based on compensating variation assuming away substitution possibilities as in the FAO study are upper bound unlike those of Conforti et al. (2009). Conforti et al. (2009), therefore, underestimate negative welfare effects especially in light of the fact that they run a static CGE model that lacks the requisite dynamism.

Ivanic and Martin (2008), on the other hand, focus on the poverty impact of the global food price crisis. Applying Deaton's expenditure function – which is a partial equilibrium analysis framework for computing net benefit ratios – and GTAP model to Zambia, Malawi, Peru, Madagascar, Nicaragua, Bolivia, Vietnam, and Cambodia, find that poverty increases by about 4 percent and 3 percent in urban and rural areas respectively. Their results are contradictory to Conforti et al. (2009), who perform a long run analysis, which allows for full adaptive substitutionary responses by households, but they perform a short run analysis. Although they find that many households are net food buyers in these countries as in Uganda as argued by Benson et al. (2008), the pass through of international prices is substantially higher in these countries because their staple grains like maize, wheat, and rice are globally tradable commodities. The higher share of market-purchased staples in household consumption indisputably provides a huge first price impact field. After controlling for positive wage effects of the price increases, they find that poverty changes become less adverse.

On the contrary, Levin (2010) reports a reduction in poverty for rural Kenya. They use a CGE model and Deaton's expenditure function to assess the poverty effects of rising international maize prices. Assuming full pass through of maize prices to farmers, they find that poverty increases in urban areas by 4 percent (as found by Ivanic and Martin, 2008) and falls considerably, unlike Ivanic and Martin (2008) but like

Conforti et al. (2009), in rural areas by 14 percent due to a huge income effect. Nonetheless, their result is very sensitive to the degree of pass through assumption. Reducing the pass through to 60 percent, rural poverty falls by about 2 percent only. Further, a domestically induced maize price shock would reduce poverty in rural areas by 3 percent but increase poverty in urban areas by 9 percent. Nevertheless, failing to control for possible poor supply response by smallholder farmers due to rigidities in the inputs sector that ultimately would reduce or eliminate the positive income effect and lead to poverty increases is a major weakness of their result. Neither do they control for the import channel, since Kenya, especially in the period 2002 to 2008, supplemented its maize supplies by imports (Benson et al., 2008) nor for positive wage effects in rural labour markets of rising maize prices. They largely conclude that the poorest of the poor suffer most especially urbanites.

On the contrary, Wodon and Zaman (2008) argue and empirically attest that the net effect of rising food prices in Sub-Saharan Africa (SSA) has deleterious effects on poverty. Observably, the majorities of poor people in SSA are net food buyers and outweigh the net sellers. As such, the net effect is the entrenchment of food poverty. Their analysis bases on Deaton's expenditure function. They find that, controlling for wage effects, poverty increases by about 2 percent and 3 percent when not controlling for wage effects in rural areas. The result is worse for urban areas where poverty would increase by about 4 percent without wage effects and 3 percent with wage effects. Overall, they find that the lower bound and upper bound estimates of poverty increases for all the countries in their sample are at least 1 percent and at most 8 percent respectively. However, their sample does not include Kenya making it difficult to judge if Levin's (2010) estimates are too generous. Nonetheless, their methodology is a short run framework that does not capture second and higher order effects of food price shocks. The countries in their sample include Ghana, Liberia, Sierra Leone, Togo, Nigeria, Guinea, Mali, Niger, Gabon, and Democratic Republic of Congo.

Dessus et al. (2008) also examine the poverty impact of food inflation on urban households in seventy-three least developed countries. They find that headcount poverty adds between 1 and 6 percentage points depending on country initial poverty prevalence conditions. Those countries with the highest headcount poverty initially experience the highest increase of urban poverty prevalence. Although this result is on the lower side of Wodon and Zaman (2008), it confirms their finding that poverty would increase following food price increases. Their study focuses on urban poverty only. The result would be much worse, *ceteris paribus*, if rural households were included.

Using a CGE model, Warr (2008) analyses the poverty incidence effects of global food price shocks in Thailand, a net exporter of rice in particular. Their findings indicate that poverty incidence would increase more in rural than urban areas. They find that poverty incidence, as measured by the headcount ratio, rises by about 0.3 percent in urban and 0.8 percent in rural areas. Surprisingly, the positive wage effect of increases in the price of rice – an exportable staple – in Thailand is outweighed by the cost of living effect. Brinkman et al. (2009) argue likewise but Ivanic and Martin (2008) argue for the contrary. This result is quite revealing given that Thailand is a major rice exporter and terms of trade have been favourable yet they cursed many poor rice farmers instead of blessing them. They point to slow supply response due to land, input, and credit constraints as a major reason why the cost of living effect dominates the income effect. However, they report that poverty decreases for households owning agricultural land and capital, thus substantiating, for instance, Conforti et al. (2009) and Ghosh (2010).

Similarly, Webb (2010) makes a synthesis of current literature on the impact of food prices and concludes that many rural households are functionally landless and food insecure. Food price shocks compromise nutrition and supply response outcomes, they argue. Ruel, et al. (2010) who ostensibly argue that the most affected are the poorest urban, non-farm, large, less educated households, and poorly served by infrastructure and with land constraints also support this view.

Rising oil and food prices are negative terms of trade shocks for Mozambique argues Arndt, et al. (2008). Using both the Deaton expenditure function and CGE methodologies, they find that global food price shocks are highly passed through to the domestic economy. Although there are spatially asymmetrical price effects, they show that net food sellers, unlike Conforti et al. (2009) and Warr (2008), benefit whilst net food buyers lose out. Urban households are the most vulnerable and urban poverty rises by 8 percent but only by about 2 percent in rural areas. Similarly, Parra and Wodon (2008) in a study that closely relates to what the present study does, analyze the impact of rising food and oil prices in Ghana using a SAM price model based on the 2005 Ghana SAM. They find that increases in prices of cereals raise the cost of living by 3 percent in urban and 4 percent in rural areas. Further, a 34 percent overall food price increase raises cost of living by 12 percent and 13 percent in urban and rural Ghana respectively. Hence, rural households lose more. Parra and Wodon (2008), however, do not decompose the price multipliers into transmission paths, something that could guide policy in terms of where and how best to intervene for maximum impact. The current study bridges this gap in an application to Zimbabwe.

Roland-Holst and Xu (2006), in a study that is similar to what the present study does, examine the link between price transmission and rural poverty in Anhui province of China using a SAM price model and decomposing the multipliers into transmission paths. Rural households equally dependent on both raw and processed foods, they find. The cost of living elasticities for the rural households are 35 percent (crops), 36 percent (processed food), and 14 percent (livestock). For urban households the elasticities are 26 percent (crops), 36 percent (processed foods), and 16 percent (livestock). However, consumer price index (CPI) risk, in terms of food prices, is higher for urbanites because they do not have access to farming land and rely on open market food purchases. Their findings differ from Parra and Wodon (2008) because China is less food insecure than Ghana and that it has extensively urbanized hence higher vulnerabilities for the urbanites than rural folks have. Nevertheless, the SAM price models used are short run frameworks of analysis that do not control for substitution possibilities in consumption, production, and factor markets. As such, they yield upper bound cost of living estimates.

The Commission of European Communities (2009) performed a statistical analysis of the pass through of agricultural prices to food processor prices and consumer prices using monthly panel data from 2000 to 2009 in European communities. They find that the immediate pass through rate from agricultural prices to food producer prices was about 11 percent during the 2005 to 2009 global food crisis. However, considering the lagged effects, they report a pass through of 32 percent. Moreover, pass through to consumer prices is rather low standing at about 40 percent inclusive of six-months lagged effects. The low pass through can be explained in terms of a limited share of agricultural commodities in final food prices. Further, they argue that inefficiencies in the market structure along the chain, contractual obligations, and anti-competition laws explain the low pass through.

3.3.2 Exchange Rate Pass Through to Consumer Prices

Bacchetta and van Wincoop (2003) and Campa and Goldberg (2006) examine the pass through of exchange rates to consumer prices. Bacchetta and van Wincoop (2003) develop a theoretical optimization auto parts model to analyze why domestic consumer prices react less than import prices do to exchange rate movements. They find that intermediates importing firms pay in foreign currency but sell in local currency hence limiting the pass through to consumer prices to zero. Their analysis ignores the possibility of intermediaries marking up prices on exchange rate risk, which would raise the degree of pass through. However, Campa and Goldberg (2006) empirically examine the extent to which pass through of exchange rates to consumption prices has changed. They use a fixed effects model – controlling for time, country and industry fixed effects – for eighteen Organization for Economic Co-operation and Development [OECD] countries. Using quarterly data from 1975 to 2004 and focusing on both manufacturing and non-manufacturing sectors, they find that pass through to import prices has declined. However, pass through to retail prices has increased significantly due to higher use of imported inputs. Therefore, they conclude that with increased distributional efficiency, consumer prices have become more sensitive to exchange rate movements. Pass through rates of exchange rate shocks to domestically produced food are between 0 percent and 40 percent whereas they are between 60 percent and 90 percent for imported foodstuffs. These two studies are at variance. The former is a theoretical model that performs comparative statics but the latter is a dynamic empirical analysis yielding better results using real world data.

Finally, the literature has clearly demonstrated the magnitude of the impact of domestic and global food price shocks on food poverty and cost of living. In terms of policy insight into where and how to intervene path decomposition would give microscopic details, which these studies have not revealed. In light of this gap in empirical work in Africa in general and Zimbabwe in particular, the present study attempts to contribute and demonstrate the wealth of policy wisdom that the decompositions afford researchers and policymakers.

3.4 Summary of Literature Review

The literature generally agrees that food price shocks have deleterious effects on cost of living, poverty prevalence, and food and nutritional security. It shows that poverty incidence is more prevalent among poor urban, non-farm and assetless households. However, literature reports mixed results pertaining to geographical magnitude of cost of living or poverty effects between urban and rural areas. Although there are mixed findings, a good number of studies largely focuses on the degree of pass through of food price shocks and conclude that it has increased over the years as driven more by distribution efficiency in the food chain and speculative shocks in agricultural commodity prices. Therefore, they also demonstrate the importance of agriculture especially tradable cereals, in light of the vagaries of global commodity markets speculative shocks, in transmitting food price shocks to poor households. However, of all the studies reviewed here, especially those focusing on African countries, none has attempted to decompose structurally pass through multipliers into paths along which price shocks are transmitted to households. This constitutes an empirical knowledge gap that the current study seeks to bridge.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

In order to obtain a comprehensive description of the effect of linkages on prices there is need to analyze intersectoral linkages between individual accounts of the SAM. Block and structural path decompositions put forth by Pyatt and Round (1979), and Defourny and Thorbecke (1984), and applied to price modelling by Roland-Holst and Sancho (1995), demonstrate the rich information structure that can be derived using these approaches in a SAM framework. This study closely follows the methodology in these studies. The use of block and path analysis to investigate price-linkages is a natural extension of the SAM price multiplier model reviewed in chapter 3 and a promising way to enrich the understanding of the price transmission mechanism.

4.2 Block Decomposition of Price Multiplier Matrix

Following Llop (2007), and Roland-Holst and Sancho (1995), the study decomposes the price multiplier matrix M' presented in equation (3.8) under the conceptual framework in chapter three. Block decomposition gives a global summary of price shock transmission and particularly reveals the extent of economic integration and interdependencies among sectors and institutions in the SAM. Such information is important for understanding the magnitudes of cost of living elasticities of different household groups.

In order to decompose the price transmission matrix M' one can use equation (3.8), recalling that $P = M'V$. The price multiplier matrix M' can be decomposed additively or multiplicatively leading to the same information. In its decomposed form it would be:

$$M' = M_1' M_2' M_3' = I + T + O + C \qquad (4.1)$$

Where I=I

T=$M_1' - I$

O=$M_1'(M_2' - I)$

C=$M_1' M_2'(M_3' - I)$

The middle matrix in the first decomposition in equation (4.1) is the multiplicative decomposition and the last matrix is the additive decomposition. The matrices in the second decomposition are defined as follows:

I = **identity multiplier** which shows the effect of a shock into one account that amounts to an increase in prices identical to the original shock;

T=$M_1' - I$ is the **net transfer multiplier,** which measures the net intra-group or direct effects or within account effects where the original shock took place, that is, additional effects coming out of M_1'. If the shock takes place into households it measures the inter-household effects, or if the shock is applied into production activities it measures the inter industry cumulative effects, better known from the conventional (classic and non-classic)

Input-output models as the Leontief inverse. This holds if and only if the main diagonal is different from zero O=$M_1'(M_2'-I)$ is the **open-loop multiplier** measuring the net extra--group effects or net cross-effects arising out of an initial shock when it has completed a tour outside the original account without returning to it, that is, additional effects coming out of M_2'. For instance if the initial shock takes place into households it measures the effects into factor-prices via demand expenditures, commodities and activities;

C=$M_1'M_2'(M_3'-I)$ is the **closed-loop multiplier**, which measures the net contribution of circular effects or net inter-group effects, which arise after the original shock has completed a tour through all groups of accounts and returned to the one where it originally started. These are the additional effects coming out of M_3'. It measures the effect of a shock on household cost of living after going through expenditures, commodities, activities, and factor-prices.

To get the actual entries of the decomposed matrices, one can pick a matrixA_0, which satisfies all standard algebraic requirements.[4] This matrix A_0 is a diagonal matrix composed of average expenditure propensities of all the production accounts in the SAM (A_{11}) and the households(A_{33}). Therefore, A_0 can be expressed as:

$$A_0 = \begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix} \qquad (4.2)$$

[4] A_0 must be conformable to A and $(I - A_0)$ must be invertible.

Then by definition M_1' is computed as:

$$M_1' = (I - A_0)^{-1} = \begin{bmatrix} (I - A_{11})^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I - A_{33})^{-1} \end{bmatrix} \qquad (4.3)$$

The first column of the multiplicative transfer matrix M_1' shows how an exogenous cost increase affecting the production activities multiplies itself through the inter-industry cost linkages (Leontief inverse) but exerts no effects on factors and households. It measures the transfer or direct effects.

In order to define M_2' one has to first distill the intra-group average expenditure propensities A_0 from the full SAM of average expenditure propensities A for endogenous accounts and define a new matrix A^* as:

$$\begin{aligned} A^* &= (I - A_0)^{-1}(A - A_0) \\ &= M_1'(A - A_0) \qquad (4.4) \end{aligned}$$

The second term in this equation on the right hand side has a null main diagonal given that A_0 is a diagonal matrix. Using (4.4) one can derive the open loop effects matrix as follows:

$$\begin{aligned} M_2' &= [I + A^* + A^{*2}] \\ &= \begin{bmatrix} I & (A_{13}^* A_{32}^*) & A_{13}^* \\ A_{21}^* & I & (A_{21}^* A_{13}^*) \\ (A_{32}^* A_{21}^*) & A_{32}^* & I \end{bmatrix} \qquad (4.5) \end{aligned}$$

Open loop or extra-group price effects are measured by (4.5). This matrix indicates how the same exogenous cost affecting production impacts factor-input costs and other accounts, without coming back to the production account where the exogenous cost effects took place first. In other words, one can calculate and analyse how an exogenous shock, which affects households, transmits itself into production activities and vice versa. For example, the first column of this matrix shows how a shock in production costs ends up having an impact on factor-input prices A^*_{21} after rebounding from households' cost of living increases $(A^*_{32}A^*_{21})$. Closed loop effects, on the other hand, can be calculated as in:

$$M'_3 = (I - A^{*3})^{-1}$$

$$= \begin{bmatrix} (I - A^*_{13}A^*_{32}A^*_{21})^{-1} & 0 & 0 \\ 0 & (I - A^*_{21}A^*_{13}A^*_{32})^{-1} & 0 \\ 0 & 0 & (I - A^*_{32}A^*_{21}A^*_{13})^{-1} \end{bmatrix} \quad (4.6)$$

Where $A^*_{13} = A_{13}(I - A_{33})^{-1}$, $A^*_{21} = A_{21}(I - A_{11})^{-1}$, $A^*_{32} = A_{32}$

The first column of the closed-loop matrix M'_3 captures the impact on production prices of the exogenous increase in producer costs after first affecting household cost of living indicesA^*_{13}, then moving onto factors $A^*_{13}A^*_{32}$ and from these back to producers $A^*_{13}A^*_{32}A^*_{21}$. The final value shows the overall impact after this price adjustment process has converged.

Any given element of the price transmission matrix M' can be studied using either multiplicative or additive decomposition, which yield the same information in a different format. In a generally disaggregate SAM, *n+m* individualised sectors are detailed, *n* being taken as endogenous and *m* exogenous. Let *I* and *J* denote the indexing sets for the exogenous and endogenous accounts respectively.

From (4.3), (4.5) and (4.6) and indices i and j, the individual impact on price P_j of an exogenous price shock in sector *i* can be written as:

$\frac{\partial P_j}{\partial n_i} = m_{ji} = I + n_{ji}^1 + n_{ji}^2 + n_{ji}^3$, corresponding to (4.1) with

$$n_{ji}^1 = T_{ji}$$

$$n_{ji}^2 = O_{ji}$$

$$n_{ji}^3 = C_{ji} \qquad (4.7)$$

4.3 Structural Path Delineation

The block decomposition in section 4.2 shows that the SAM offers a convenient structure for detailed examination of price transmission. Prices can be computed and, furthermore, price changes can be decomposed according to three different categories of interdependence namely the transfer, open loop and closed loop effects, which provide a global view of the extent and magnitude of price-linkages as they work their way through the economic system. Path analysis also builds on the conceptual framework presented in chapter three and extends block decomposition to yield microscopic details on price transmission. Each pair <*i, j*> of indices in the SAM accounts is called an arc. A path is a sequence *s* of indices *s* = <*i*, *k*, *l*,...,*m* ,*j*> which can be decomposed into consecutive arcs <*i, k*>, <*k*, *l*>,...,<*m*, *j*>. A path with non-repeating indices is termed an elementary path. A circuit of influence is a path *s* where the first and last indices coincide. The influence of account *i* on *j* through a path *s* is represented by

$(i \rightarrow j)_s$. From equations (3.4) and (3.8), the cost influence of account i on account j along $\langle i, j \rangle$ is estimated as:

$$\frac{\partial P_j}{\partial P_i} = a_{ji} \in M' \tag{4.8}$$

Thus any exogenous cost increase affecting i gives rise to a direct price increase in j measured by entry $(j,\ i)$ of M'. It is imperative to highlight the technical meaning of (4.8), which is a global price effect. The global price effect is the responsiveness of an account's price index to changes in another sector's price or cost index. Equation (4.8) defines the global price effect $\frac{\partial P_j}{\partial P_i} = a_{ji}$ with prices are normalized to one, then $\frac{\partial P_j}{\partial P_i} . \frac{\bar{P}_i}{\bar{P}_j} = a_{ji}$ which is elasticity (defining $\bar{P}_i$ and $\bar{P}_j$ as base prices both equal to one). In fact, it is inflation or cost of living elasticity. Further, the global price effect not only reports percentage changes in account price index but also gives absolute monetary changes in prices since base prices are normalized to one (Roland-Holst and Sancho, 1995). Besides, the global price influences measure the extent to which nominal income must increase if the household is to remain on its pre-price shock consumption level. The greater the global price effect, the greater the deterioration of household welfare and so the greater the compensation package (compensating variation) needed to alleviate the resulting food poverty.

Due to the linear structure of the model, the direct price influence along an elementary path $s = <i, k, m, j>$ is the composite effect of the direct influences along the constituent arcs, that is,

$$D^P_{(i \rightarrow j)s} = a_{ki}.a_{mk}.a_{jm} \qquad (4.9)$$

The direct influence is the product of the indices of the arcs constituting the path. In any given path *s*, there may exist feedback effects among its indices. Account *i* influences *k* however, *k* in turn may influence *i*, either directly or through other intermediary indices. Accounts can influence themselves through loops as well. All of these feedback effects taking place along circuits in the path work to amplify the magnitude of the direct influence transmitted over that path. The expanded influence is the total price influence. Figure 4 shows a typical path diagram in price transmission analysis.

In most structures, there exists a multitude of interactions among poles such as in figure 4, and even more complex ones than this. In particular, poles along any elementary path are linked to other poles and paths forming circuits that amplify, in a complex way, the direct influence of that same elementary path. To capture these indirect effects, the concept of total influence is introduced (Defourny and Thorbecke, 1984). Given an elementary path $s = <i, k, m, j>$ with origin *i* and destination *j*, the total influence is the influence transmitted from *i* to *j* along the elementary path *s* including all other indirect effects within the structure imputable to that path.

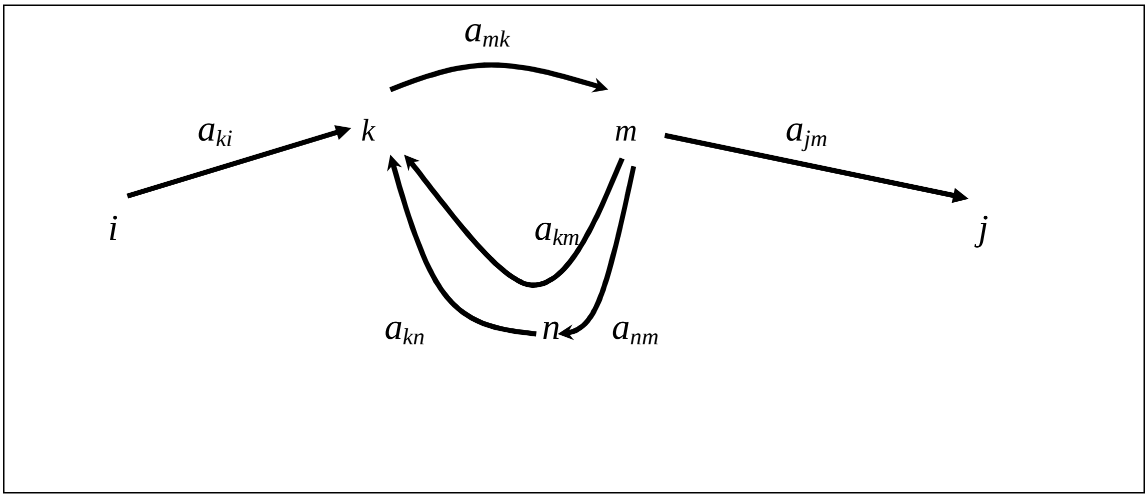

Figure 4: Price path linkage diagram

Therefore, the total influence cumulates, for a given elementary path *s*, the direct influence transmitted along the latter and the indirect effects induced by the circuits adjacent to that path (that is these circuits have one or more poles in common with the elementary path *s*). It can be readily seen that between poles *i* and *m* the direct influence is $a_{ki}.a_{mk}$ which is then transmitted back from *m* to *k* through the two loops yielding an effect $a_{ki}.a_{mk}(a_{km} + a_{nm}.a_{kn})$which in turn has to be transmitted back from *k* to *m*. This process yields a series of dampened impulses between *k* and *m:*

$$a_{ki}.a_{mk}.I\{I + a_{mk}(a_{km} + a_{nm}.a_{kn}) + [a_{mk}(a_{km} + a_{nm}.a_{kn})]^2 + \cdots\}$$

$$= a_{ki}.a_{mk}[I - a_{mk}(a_{km} + a_{nm}.a_{kn})]^{-1} \qquad (4.10)$$

where *I* is an identity taking a value of one.

In order to complete the transmission of influence along the elementary path in figure 4, the effects (in equation 4.10) have to travel along the last arc (*m, j*).

Thus, these effects have to be multiplied by a_{jm} in order to get the total price influence along the path:

$$T^{p}_{(i\rightarrow j)s} = a_{ki}.a_{mk}.a_{jm}[I - a_{mk}(a_{km} + a_{nm}.a_{kn})]^{-1} \qquad (4.11)$$

The first term, $a_{ki}.a_{mk}.a_{jm}$ is the direct price influence but the second term $[I - a_{mk}(a_{km} + a_{nm}.a_{kn})]^{-1}$ is the path multiplier μ^{p}_{s}.

Hence $T^{p}_{(i\rightarrow j)s} = D^{p}_{(i\rightarrow j)s}.\mu^{p}_{s}$ (4.12)

The path multiplier captures the extent to which the direct price influence along path *s* is amplified through the effects of adjacent feedback circuits. It is clear, on the other hand, that more than one elementary paths, each one with its respective feedback circuits, may span two indices i, j. Therefore, the total price influence along a path does not capture the full or global price influence in the network of itineraries linking *i* and *j*. Let *S={s/i, j}* be the set of all elementary paths joining *i* and *j*, then by additivity the global price influence is defined as:

$$G^{p}_{(i\rightarrow j)s} = m_{ji} = \sum_{s\in S} T^{p}_{(i\rightarrow j)s} = \sum_{s\in S} D^{P}_{(i\rightarrow j)s}.\mu^{p}_{s} \qquad (4.13)$$

The last equality, where $G^{p}_{(i\rightarrow j)s} = m_{ji} \in M'$ is the (*j*, *i*) entry in the price-transmission matrix M'follows from the fact that *S* includes all connecting paths between accounts *i* and *j*. Direct, total and global price influences are three distinct but related concepts of influence that supply precise information on the transmission mechanism underlying price formation in an economy. The study, therefore, makes use of this technique.

4.4 Data Analysis

In terms of estimation, all the price computations and decompositions are executed using SimSIP_SAM (Parra and Wodon, 2010). It is a Microsoft excel-based application with Matlab running in the background that can be used to conduct policy analysis under a Social Accounting Matrix framework. As a precursor to the actual results, household expenditure shares by product or product category are computed using base data in the SAM. The idea is to identify the possible sources of household resilience or vulnerability to price shocks. The preliminary analysis also looks at income sources and income shares by source. This kind of preliminary analysis, already done in chapter two, is important because it helps highlight possible household survival, coping, adaptive and accumulative strategies that they use to overcome impoverishing food price shocks.

4.5 Data Types and Sources

The study uses the 1991 SAM for Zimbabwe published by International Food Policy Research Institute in 1999.[5] The SAM is an 88 X 88 Micro SAM. There are 36 activity accounts of which 24 are agricultural showing that Zimbabwe is an agrarian economy. There are also 30 commodity accounts, 9 factor accounts of which 4 are for labour, 3 more for capital and 2 for land. There are also five socio-economic household groups namely low income urban, low income urban, smallholders, large scale farm worker and large scale farm owner-manager households. Lastly, government has four

[5] The data set can be accessed on the link: http://www.ifpri.org/publications/1991-social-accounting-matrix-sam-zimbabwe.

sub-accounts, enterprises and rest of the world have one each, and the capital account has two. In order to operationalize the SAM into a price model, the study exogenizes all the government accounts, the capital account and the rest of the world following standard economic theory. The rest of the accounts are endogenized. With this, a price model is easily developed by using a reduced form SAM.

In conclusion, the above analysis has shown how a SAM is operationalized into a price model by assuming quantities to be fixed. The price multiplier matrix gives the magnitudes of cost of living effects of a 1 percent (or linearly a 100 percent or 100 cents) exogenous cost shock to production and factor markets.

The data used is somehow old and as such, the results of the study would need to be interpreted with caution. Nevertheless, "…1991 can be considered a 'normal' year in at least one important respect: unlike the subsequent years, agricultural production and trade were not disrupted by the severe droughts of 1992 and 1995" (Thomas and Bautista, 1999, p.1).

Furthermore, the latest available rudiments of data show that between 2000 and 2008, the agricultural sector contributed 16.6% to GDP and the non-agricultural sector contributed 83.2% (GoZ, 2009b). Comparing these figures with 15.3% and 84.7% in the 1991 SAM shows little change in the composition and so structure of the economy. Further, regarding exports and imports between 1995 and 2006, agriculture's share averaged 34.5% and 6% respectively compared to 41.9% and 0.6% in the SAM. The land reform and frequent droughts between 2002 and 2008 may explain the drop in agricultural exports. However, agricultural imports increased showing greater incidence to import, grain in particular. On the contrary non-agricultural share in exports rose from 58.1% in the SAM to an average of 65.5% for the period 1995-2006. However, the share in imports fell from 99.4% in the SAM to an average of 94% for the same period. Acute foreign currency shortages may account for the drop in non-agricultural imports. Overall, it seems a reasonable, though naive, assumption that the structure of the economy has not changed significantly.

It is typical in SAM and CGE modelling to use such old data sets because data limitations make it difficult to have up-to-date SAMs, for example, Llop (2007) uses a 1994 SAM for the Catalan economy, Defourny and Thorbecke (1984) use a 1968 SAM for South Korea. Studies done for Zimbabwe in other research issues have utilized this 1991 SAM examples include Juana (2006), Chitiga and Mabugu (2008) and Chitiga (2000).

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

The chapter presents the major findings of the study.[6] The study set out to analyze structural transmission of food price shocks to households and derive implications for cost of living interventions in Zimbabwe. More importantly, in line with the specific objectives, the study has delineated the structural paths that transmit the price shocks to households. The study has estimated the magnitude and incidence of shock impacts on households. Cost of living elasticities reported in Table 5 address the specific objective on the magnitude of the impact of price shocks on households. The size of the elasticities varies with household groups hence capturing the incidence dimension of the shocks. Lastly, the size of the cost of living elasticities with respect to price shocks arising from any of the food sectors or commodities guides in identifying sectors with the greatest price transmission potential to households.

The study reports transmission effects of maize, cattle, other livestock, milling, and processed food price shocks. Food has a weight of 31.9 percent in the Zimbabwe CPI of which maize has a weight of 6.4 percent, processed foods a weight of 37 percent and

[6] Additional results such as the inverse price matrix can be obtained from the author upon request.

all meat 11.3 percent hence the study's focus on them (CSO, 2010). Other products such as horticultural constitute about 2 percent of household consumption hence the study focuses on major product heads. The results of the study would not differ much by including them. Since the global price effects can be interpreted as cost of living elasticities, a 100 percent (100 cents) increase in the price of a commodity leads to an x percent (or x cents) increase in cost of living, defining x as some numerical value. All the estimated coefficients are multiplied by 100 percent for convenience's sake.

5.2 Results of Block Decomposition of Price Transmission

Table 5: Block decomposition results for price transmission

(All figures in percent)

	Large Scale Maize Production			Smallholder Maize Production			Large Scale Cattle Production			Smallholder Cattle Production		
	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'
Hlsupp	1	25	75	1	8	92	4	61	39	3	42	58
Hlslow	8	90	11	7	74	26	4	51	49	3	52	47
Hshhld	3	44	56	16	74	26	4	43	58	10	69	31
Hurbupp	1	17	83	1	12	87	3	47	53	2	41	59
Hurblow	5	83	17	5	69	31	3	42	58	3	42	58
Rural CPI Elasticity[7]	4			8			4			5		
Urban CPI Elasticity	3			3			3			3		
Poor CPI Elasticity	5			9			4			5		
Rich CPI Elasticity	1			1			4			3		
CPI All	3			6			4			4		
Average Loop Effects		52	49		47	52		49	51		49	51

[7] The CPI elasticities are unweighted averages.

Table 5: Block decomposition results of price transmission (continued)

(All figures in percent)

	Large Scale Other Livestock Production			Smallholder Other Livestock Production			Grain Milling			Food Processing		
	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'	M'	O/ M'	C/ M'
Hlsupp	4	56	44	0	-	100	4	56	44	26	53	47
Hlslow	10	75	25	1	13	88	9	76	25	29	42	58
Hshhld	7	46	55	9	78	23	5	40	60	30	36	64
Hurbupp	2	30	70	0	13	88	2	39	61	24	54	46
Hurblow	7	69	31	1	45	55	6	69	32	29	49	51
Rural CPI Elasticity	7			3			6			28		
Urban CPI Elasticity	5			1			4			27		
Poor CPI Elasticity	8			4			7			29		
Rich CPI Elasticity	3			0			3			25		
CPI All	6			2			5			28		
Average Loop Effects		55	45		30	71		56	45		47	53

Source: Author's calculations

5.2.1 Interpretation and Discussion of Block Decomposition Results

For each sector, four block components are reported: total multiplier effect (M'), direct effect (T), open loop linkages (O), and closed loop effects (C) as proportions of the total multiplier (M'). The last item (C/M') is particularly revealing, since it indicates a general equilibrium transmission effect, incorporating the longer chains of price linkages that might not be discernible to casual observers. Looking at Table 5, one gets the impression that price shocks are regressive because low income groups have the highest cost of living elasticities across the five food sub-sectors.

5.2.2 Maize Price Shocks and Cost of Living Effects

Large scale farm workers have 8 percent cost of living elasticity with respect to large scale maize price shocks. Low income urban households have 5 percent and smallholder households have 3 percent in elasticities. Urban households have 3 percent cost of living elasticity whereas rural households have 4 percent with respect to large scale production cost shocks. Thus, rural households are more vulnerable than urban households. By affluence, higher income (rich) households have a lower elasticity of 1 percent compared to 5 percent for the poor. Hence, poor households are more vulnerable to price shocks. Overall, the cost of living increases by 3 percent for all households combined following a 100 percent price shock.

The cost of living outlook is more adverse if cost shocks hit the smallholder maize sector. Smallholder household cost of living increases by 16 percent, farm worker households by 7 percent, and low income urban households by 5 percent. Spatially, rural cost of living increases by 8 percent compared to 3 percent in urban areas. Measuring the cost of living effects by affluence, the study finds that the poor have the greatest cost of living increase standing at 9 percent compared to 1 percent for the rich households. Overall, cost of living increases by 6 percent for all households combined if smallholder maize prices are shocked. These findings agree with Parra and Wodon (2008) who report that the cost of living in Ghana increases by 4 percent and 3 percent for rural and urban households respectively due to a 34 percent increase in cereal prices – linearly, their result implies 12 percent and 10 percent cost of living increases due to a 100 percent price shock. Their estimates are higher than the current study's findings because they include all cereals in their cost of living estimate.

The question that naturally arises is why maize price shock pass through to low income households is higher. Most vulnerable households have a higher proportion of maize in their total expenditure, the study notes (see Table 2). Since the open loop effects measure the degree of dependence of one account on another, the larger they are the more vulnerable a household is to price shocks arising out of that account. With respect to large scale maize production cost shocks, farm workers and low income urban households, have the largest open loop effects – about 90 percent and 83 percent. However, smallholders have 44 percent only. This explains why farm workers and low income urban households have higher cost of living elasticities than smallholders. The closed loop effects (11 percent and 17 percent) are small except for smallholders (56 percent). This indicates that price shocks in large scale production take complex chains to reach smallholders compared to the other two households hence a low cost of living effect transmitted to smallholder households.

However, farm workers and smallholders have the largest open loop effects with respect to price shocks in smallholder production – about 74 percent each. For low income, urban households the open loop effects equal approximately 69 percent. In this case, the study concludes that the three low income households heavily depend on smallholder maize and as such, price shocks from this sector need to be closely monitored for food inflation stability. On average, open loop effects dominate closed loop effects for shocks in large scale production - about 52 and 49 percent respectively whereas the converse holds for price shocks in smallholder maize production, with open loop effects at about 47 percent and closed loop effects 52 percent. All price transmissions are largely indirect for all cases.[8]

The findings point to Engel's and Bennett's laws. First, Bennett's law states that the starchy staple ratio declines [increases] as household income increases [decreases] mainly because households are [are not] able to diversify away from starchy foods such as grains and root crops to higher-priced caloric foods (Timmer, Falcon and Pearson, 1983). Second, Engel's law, in general, states that the proportion of a household's budget devoted to food declines [increases] as its income increases [decreases] over a certain range. This law implies that the income elasticity of food is less than one. However, lower income households may have an income elasticity of food in excess of unity, that is, Giffen's paradox in which case they buy more of maize as its price increases. However, as the maize price rises so also does low income households' incomes, assuming access to land, inputs and good weather, and this may mitigate against such negative shocks. Taken together, these two laws help in explaining why costs of living effects induced by maize price shocks are larger for the lower income than for

[8] Transfer effects or direct effects are not reported in Table 5 because they are zero. Households and production accounts belong to different SAM institutions so there are no intra-account effects.

higher income households. In general, the higher the share of a commodity in a household budget, the greater the cost of living elasticity with respect to its price shocks. Ivanic and Martin (2008) who argue that controlling for the share of staple grains in poor households' consumption makes the effect of price shocks more adverse on them also support the present study's findings.

However, there is one outstanding aspect in Table 5 that smallholder households have the highest cost of living elasticities in spite of a huge proportion of their own-production consumption of maize (about 11 percent) in total expenditure as indicated in Table 2. Benson et al. (2008) find a diametrically contrary result in Uganda. In their findings, own-production consumption acts as a buffer against price shocks, which it is not the case in Zimbabwe. The difference arises from the fact that they examine the role of non-tradable staples but the current study looks at a tradable staple (which they also find causes vulnerabilities to households dependent on it). Increased conversion of hectrage from maize to cash crops explains thin maize markets in Zimbabwe that end up propagating monopolistic pricing tendencies in rural markets. Apart from that, rural households are ordinarily larger with larger dependency ratios hence larger proportions of maize in consumption. Ruel, et al. (2010) who make a similar argument support the current study's findings. Price effects become more pervasively adverse in such cases.

More importantly, urbanization increases demand for maize for producing animal feed. However, the huge conversion factor between feed grain and meat, coupled with low income elasticities of demand for meat among the urban and low income groups, means that Zimbabwe with her highly skewed income distributions in favour of urbanites has the potential for very rapid increases in grain demand. Hence increasing vulnerability of poor households to induced maize price shocks as Maxwell (1999) argues. This result confirms the demand-side school of thought on origins of food price shocks. Figure 5 summarizes the foregoing discussion.

However, the study does not control for positive income effects of rising maize prices. If it did, cost of living effects would possibly be dampened. Instead, the study argues, like Warr (2008), that the input sector has been inefficient in Zimbabwe (Doré, 2009; GoZ, 2009a) hence that would reduce supply response and so positive income effects. Thus, adverse outcomes would largely hold. The study assumes away substitution possibilities, which in the case of maize is not an absurd assumption given that maize is a staple with very few cheaper substitutes in Zimbabwe. It is also worth noting that adjustments in crop production are not possible in the very short term (they will take at least a cropping season to materialize), and that on the consumption side, the very poor are likely to have already exhausted most possibilities of substitution towards cheaper calories. Hence, these estimates are reasonable.

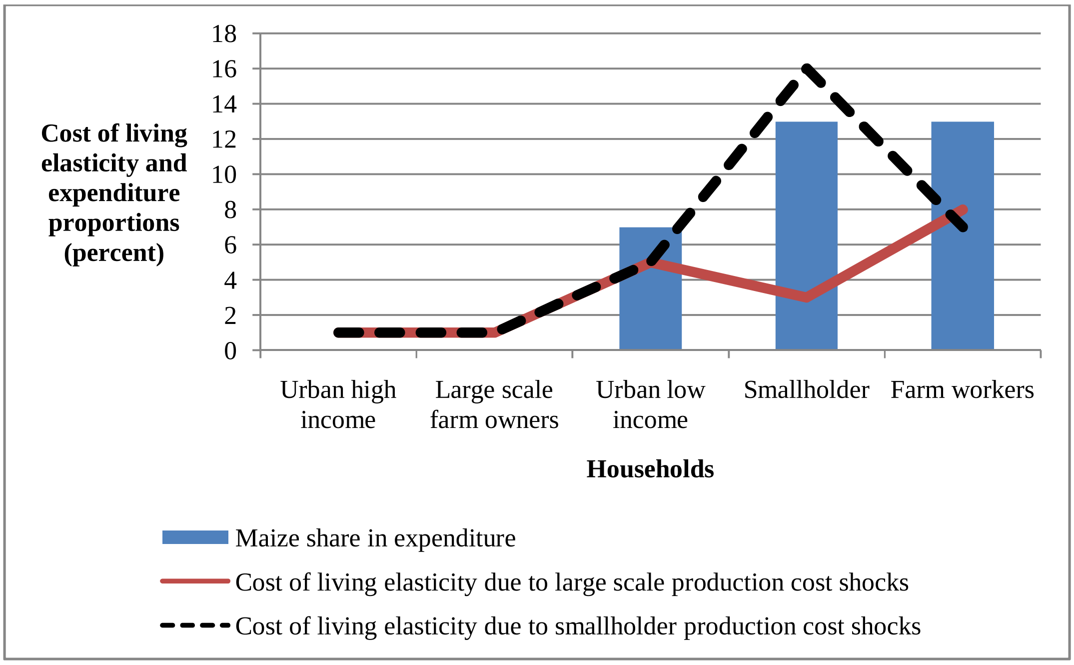

Figure 5: Cost of living elasticity to maize price shocks in Zimbabwe

Source: Author's calculations

The study concludes that smallholder production cost shocks have greater potential to increase cost of living than large scale production costs have. The poor suffer more than the rich and the rural more than the urban. The study infers that the low income urban and farm worker households are more vulnerable to price shocks originating from large scale production because they are landless and heavily rely on open market maize purchases unlike the majority of smallholder households. Conforti et al. (2009) for Malawi, Ghosh (2010), and Headey and Fan (2008) who make a similar conclusion that land constrained and urban poor households are more vulnerable to food price shocks also support this argument although poor land-rich households are not part of their conclusion. The results suggest existence of urban bias in food and agricultural policies of the country.

5.2.3 Cattle Price Shocks and Cost of Living Effects

Cost of living effects of large scale cattle price shocks are nearly uniform, about 4 percent across all household groups and more so for the lower income as observed from Table 5. Even in terms of shock incidence by geography and affluence, the cost of living elasticities exhibit uniformity – about 4 percent. However, the outcomes are more adverse and regressive in the case of shocks arising out of smallholder production. Smallholders are more vulnerable to own-production price shocks than shocks from large scale production. The rural and poor households have 5 percent cost of living elasticities whereas the urban and rich households have 2 percent elasticities with respect to price shocks in smallholder production. The average cost of living effects are the same for shocks arising out of the two production systems - about 4 percent. The study, therefore, concludes that lower income groups suffer more than higher income groups, and the rural more than urban households do.

In order to explain the magnitudes of the elasticities, the study recourses to loop effects. Generally, closed loop effects dominate open loop effects. Thus, price shocks have a strong general equilibrium effect on inflation transmission – passing through complex chains. Open loop effects range between 42 percent and 69 percent across smallholder and large scale production. Judging by these open loop effects, it can still be argued that low income households have a moderate degree of dependence on cattle production (a source of meat and milk) hence the moderately large cost of living elasticities. Higher cost of living effects on the smallholder compared to low income urban households suggest existence of urban bias in agricultural and welfare policies. Subsidy interventions have highly favoured urban compared to rural households. Closed loop effects range between 31 percent and 58 percent indicating that there is a moderate general equilibrium price effect passing through a number of sectors before reaching households. On average, the closed loop effects (51 percent) dominate the open loop effects (49 percent).

A very important dimension hidden behind these results is the degree of urbanization, which is increasing in Zimbabwe. About 36 percent of the population was living in urban areas by 2006 (World Bank, 2007). Urbanization is associated with rising incomes particularly of the middle to low income groups. Such degrees of urbanity increase the demand for livestock products (Cranfield, Eales, Hertel and Preckel, 1998) and ultimately reduce food intake for the poor through induced price effects. Figure 6 gives a pictorial view of the foregoing analysis.

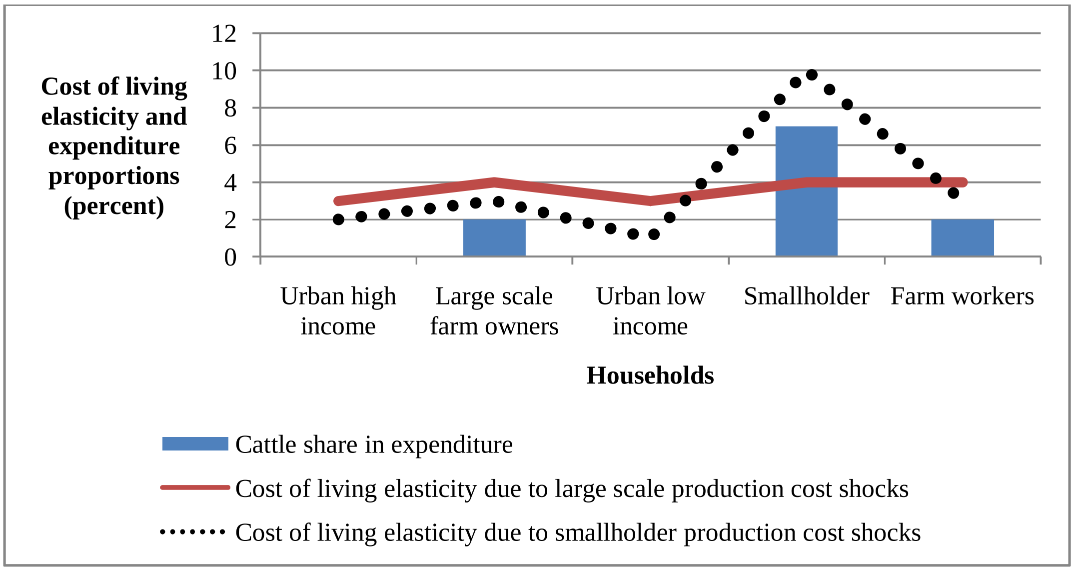

Figure 6: Cost of living elasticity due to cattle production cost shocks in Zimbabwe

Source: Author's calculations

5.2.4 Other Livestock Price Shocks and Cost of Living Effects

Following a price shock in other livestock large scale production, cost of living increases by more in rural (7 percent) than urban areas (5 percent). The magnitudes are lower in the case of shocks arising out of smallholder production – about 1 percent (urban) and 3 percent (rural). By affluence, cost of living increases by more for poor than for rich households – the elasticities being 8 percent for the poor and 3 percent for the rich. In terms of specific groups, farm worker households are more vulnerable to large scale production than smallholder price shocks with elasticity magnitudes of 10 percent and 1 percent respectively. On the contrary, smallholders are more vulnerable to own-production than to large scale production price shocks with elasticity magnitudes of about 9 percent and 7 percent respectively. Urban households, however, are more susceptible to shocks arising from large scale than smallholder production with elasticity magnitudes of about 7 percent and 1 percent respectively. Overall, shocks arising out of large scale production are three times more adverse than smallholder production shocks, with an elasticity of 6 percent attributable to them. Roland-Holst and Xu (2006) report 14 and 16 percent elasticities for rural and urban households respectively in China's Anhui province. These elasticities are larger than found in the present study given that China is more urbanized than Zimbabwe and therefore has higher meat demand (Headey and Fan, 2008; Ghosh, 2010). The poor suffer more than the rich and the rural more than the urban. The study concludes that price shocks in large scale production are regressive.

Looking at the open loop effects one deduces that all the urban low income and farm worker households highly depend on large scale other livestock production hence high cost of living elasticities to shocks arising out of this sector. The same conclusion arises if one looks at expenditure shares in Table 2. The open loop effects range between 46 percent for the smallholder and 75 percent for farm worker households. However, smallholders bear the price shock after it has travelled through more economy-wide chains given a large closed loop effect (55 percent). Open loop effects with respect to smallholder production cost shocks are the highest for the smallholder households indicating their heavy reliance on this sector hence the highest cost of living elasticity. Low income urban and farm worker households rather feel the price shocks arising out of smallholder production after they have travelled through many sectoral linkages in the economy. Their closed loop effects are larger – about 55 percent and 88 percent respectively - hence the low cost of living elasticities with respect to shocks in smallholder production.

However, smallholder production cost shocks are largely transmitted in long and complex chains since closed loop effects (71 percent) dominate open loop effects (30 percent). On the contrary, open loop effects (55 percent) dominate closed loop effects (45 percent) in the case of large scale production hence explaining the higher elasticities attributed to the large scale production sector. In this case, the study notes that for food price stability, large scale production of other livestock has to be strengthened and monitored closely. Secondarily, smallholder production should be strengthened. Figure 7 summarizes the foregoing discussion.

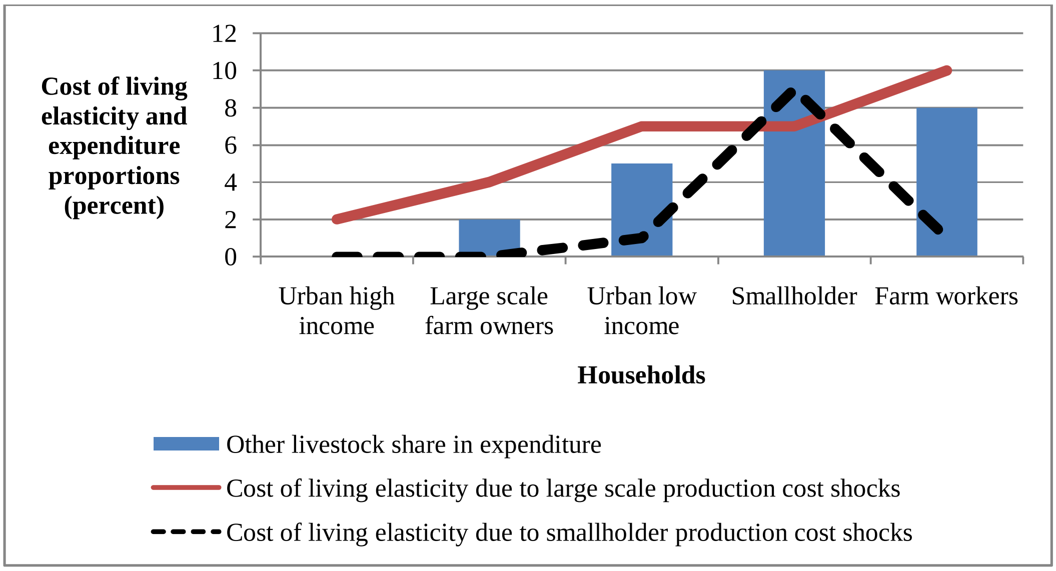

Figure 7: Cost of living elasticity due to other livestock price shocks in Zimbabwe

Source: Author's calculations

5.2.5 Value Added Food Price Shocks and Cost of Living Effects

The case of value added products is dramatic. Cost of living elasticities are almost uniform for all household groups especially in the case of processed food price shocks but with huge elasticities. Elasticities range between 25 percent and 29 percent. Urban households suffer less than rural households do – with elasticity about 26 percent and 28 percent respectively. Similarly, rich households suffer less welfare losses than rural households do – with elasticity of about 25 percent and 29 percent respectively. Individually, smallholder households experience the worst loss in welfare with cost of living increasing by 30 percent compared to 29 percent apiece for farm worker and low income urban households. Roland-Holst and Sancho (1995) find a similar magnitude (30 percent elasticity) in Spain for low income households. Parra and Wodon (2008) also find elasticities in that range - about 36 percent and 40 percent for urban and rural households respectively in Ghana due to overall food price increase.[9] Roland-Holst and Xu (2006) find cost of living elasticities in the neighbourhood of the present study's findings - about 36 percent for both rural and urban households in China's Anhui province. It is not surprising because Zimbabwe is quite urbanized and markets are well integrated. On average, cost of living increases by 28 percent. The study concludes that processed food price shocks are regressive. Of the low income groups like the smallholder suffer the most. The case of milled products is similar to processed foods but has lower

[9] They find 13 percent and 12 percent cost of living elasticities for a 34 percent increase in overall food prices in Ghana. Due to linear structures of SAM models, these effects can be converted to those of 100 percent price shock.

elasticities attributed to it. Urban cost of living increases by 4 percent and 6 percent for rural households. It increases by 3 percent for the rich and 7 percent for the poor. Overall, it increases by 5 percent. In the case of individual groups, it increases by 9 percent for farm workers, 5 percent for the smallholder, and 6 percent for the low income urban households.

Farm worker and low income urban households heavily rely on milled products judging by the high open loop effects relating to them – about 76 and 69 percent respectively. As a result, any price shock in this sector highly passes through to their cost of living indices. This explains their high cost of living elasticities with respect to this sector's price shocks. On the other hand, smallholder households bear the effects of these shocks after they have passed through many other sectoral linkages in the economy. The closed loop effect relating to them is 60 percent hence explaining their low cost of living elasticity compared to the other two low income groups. In the case of shocks arising in food processing, closed loop effects (53 percent) dominate open loop effects (47 percent). Given the strong forward linkages this sector has with the rest of the economy, it is obvious that its shocks are multiplied through many sectoral interactions before reaching households. The result is a more adverse cost of living impact on all households compared to what other sectors can transmit. This sector requires a close watch if cost of living is not to be destabilized. The proportions of milled products in total spending generally increase with declining income. This confirms Bennett's law of starchy staple ratio explained before. The exception is for the smallholders who consume less of value added milling products. Regarding processed foods, it is clear the pattern reverses and the proportion in total spending increases with income, in general. The highest income group (high income urban) commits 15 percent of total spending in processed food but the lowest (large scale farm worker households) spends 11 percent (see Table 2). Both are quite high indicating a moderate to high degree of urbanity in Zimbabwe.

Far less visible, but not less important, are the difficult choices that households, especially the poorest ones, have to make because of their rapidly declining purchasing power induced by food price shocks. The risk of increased food insecurity and malnutrition is high among these population groups, as households have to give up expensive sources of protein and other nutrient-rich foods and depend on low-cost high-energy foods to maintain a minimum level of productivity. Malnutrition becomes prevalent and attainment of Millennium Development Goals is likely to be compromised. Poor households find themselves having to compromise on health care, education and other non-food expenditures.

Clearly, price transmission effects mimic expenditure proportions of milled foods in household consumption. Smallholder households have a lower share in spending but have some of the highest cost of living elasticities. Perhaps, trade inefficiencies – especially oligopolistic behaviour – in the country’s food marketing and distribution sector explain (Thomas and Bautista, 1999). Huge transport costs to rural areas also explain. The study concludes that price effects from this sector are regressive. Figure 8 gives a pictorial view of the above-explained results.

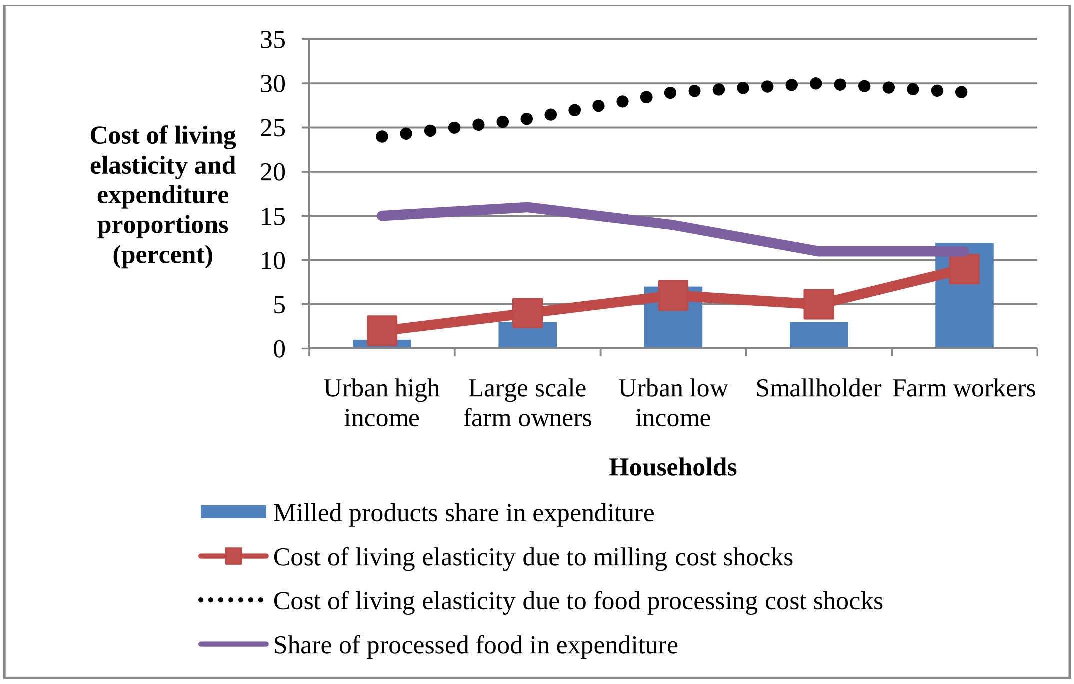

Figure 8: Cost of living elasticities due to food processing and milling price shocks in Zimbabwe

Source: Author's calculations

5.3 Path Decomposition Results

5.3.1 Introduction

This section presents results of path decomposition. It is important to note that all the structural paths reported in this study are those whose elementary paths transmit at least one percent of the global price effect. The proportion of global price effect transmitted by an elementary path was predetermined in order to minimize the number of reported paths. In result Appendices 1, 2, 3 and 4, the arrow (->) signifies direction of transmission. The first column captures the structural paths. The number of accounts in a path defines the length of the path. The second column is the global effect and is the price multiplier, which captures the full impact of a price shock on households. On the other hand, the total effect, reported under the third column, is the marginal effect of a shock that a particular path carries. It also measures the cost of living elasticity attributable to that path. This effect is always less and in the limit equal to the global price effect. The fourth column expresses the total effect as a proportion of the global effect and the fifth column cumulates the proportions according to the number of paths linking the origin and destination poles. The larger the total effect as a proportion of the global effect, the more crucial it is to intervene on that path – such paths are italicized and emboldened in Appendices 1, 2, 3 and 4. Discussion of results largely centres on poor households since they are the most vulnerable and have limited means for consumption smoothing.

5.3.2 Interpretation and Discussion of Path Decomposition Results

Appendices 1, 2, 3 and 4 report the results of transmission of price shocks in farm production, milling, and food processing to household cost of living in Zimbabwe, respectively. Although the SAM used is somehow old, the validity of the transmission paths reported here cannot be discounted. Price shocks in agriculture, especially smallholder production and food processing, have the majority of longest paths – with about seven accounts. This indicates the importance of these sectors in the food value chain as they can trigger series of price reactions in many sectors of the economy because of their strong forward linkages.

5.3.2.1 Path Linkages from Maize Producers to Households

Shocks from large scale maize production are transmitted through two paths to farm worker households and three paths to low income urban households (see Appendix 1). The two paths to farm workers transmit 92 percent of the global effect with the key path inducing 7 percent cost of living increase, which is quite moderate and is about 86 percent of global effect. The three paths to low income urbanites transmit 95 percent of the global effect with the key path transmitting 86 percent of the global effect. This path induces 4 percent cost of living increase. There is one consumption linkage where consumption cost shocks for smallholders feed into the consumption cost for the low income urban households. Since many low income urban households are dual homeowners, hence their consumption functions nest those of smallholder households. To the smallholders, ten paths transmit 81 percent of the global effect induced by large scale maize production. Only one path is crucial, transmitting 50 percent of the global effect. A series of consumption linkages on eight paths transmit 25 percent of the global effect and this is huge. A shock in large scale maize prices raises cost of living for the low income urban households, which raises factor-price inflation content in the consumption basket for smallholder households.

Transmission of price shocks arising from smallholder maize production is very direct. Only three paths transmit 83 percent of the global effect to farm workers. Two paths transmit 95 percent to smallholders whereas five paths transmit 88 percent of the global effect to low income urban households. The path crucial for intervention induces 5 percent increase in cost of living for farm workers. However, it induces 15 percent increase for the smallholders, which should be very worrisome to policy makers. Two paths are crucial for the urbanites and they both induce a 4 percent increase in cost of living. Consumption linkages from smallholders to low income urban households raise factor-price inflation content in the urban consumption basket – transmitting about 25 percent of the global effect.

5.3.2.2 Cost of Living Effects Induced by Cattle Producers

A very interesting finding is that all crucial paths transmitting price shocks from both smallholder and large scale production induce 1 percent cost of living increase except for the path for own-production for the smallholders, which induces 7 percent increase. Transmission from smallholder is more complex with long and many paths – between three and nine paths (see Appendix 2). This reflects that closed loop effects dominate open loop effects. An important result is that there is a series of seven paths in consumption linkages between low income urban and smallholder households. The consumption linkages transmit 29 percent of the global effect. Thus, price shocks in smallholder consumption function raise factor-price inflation content in the urban consumption basket. It is a powerful linkage with the ability to destabilize urban households' welfare. Lastly, transmissions from cattle price shocks are moderately complex – lying between 51 and 89 percent of the global effect for both the production systems.

5.3.2.3 Cost of Living Effects Induced by Other Livestock Production

Other livestock are also important sources of livelihoods and protein. This account includes poultry, piggery, goat, and sheep rearing. Appendix 3 details the results. Total transmissions generally lie between 42 and 100 percent of the global effect. Thus, price shocks arising out of this sector are transmitted in less complex ways. The cost of living elasticities attributable to the key paths are, however, high. The key transmission path for shocks arising in large scale production induces 7 percent increase in cost of living for farm workers, 3 percent for smallholder, and 5 percent for the low income urban households. These elasticities are huge and intervention on these paths would be gainful. In terms of smallholder production-induced price shocks, only the smallholder farm households have an outstanding cost of living elasticity of 9 percent attributed only to one key path transmitting about 100 percent of the global effect. This path has a worrisome potential to destabilize smallholder household welfare.

Again, important consumption linkages exist between low income urban and smallholder households. Six paths carry large scale production cost shocks passing through low income urban households to the smallholder households' consumption function. They transmit about 11 percent of the global effect. On the other hand, seven paths carry 35 percent of the global effect to farm workers from smallholder production through the smallholder consumption function. The effect is to increase the factor-price inflation content in the farm worker households' consumption basket. The case is more pronounced for consumption linkages with urbanites, transmitting 72 percent of the global effect. These kinds of linkages have to be watched. In most cases, policy interventions miss these hidden linkages hence the pass through of interventions remains weak.

5.3.2.4 Cost of Living Effects Induced by Food Processors and Millers

Appendix 4 reports results for transmission effects from food processors and grain millers to households. Generally, between 52 and 79 percent of the global effect is transmitted regardless of whether one looks at milling or food processing price shocks. Key paths that deserve intervention attention have huge elasticities attributed to them. For example, the crucial paths induce cost of living increases of 7 percent for farm workers, 3 percent for smallholder and 5 percent for low income urbanites following a cost shock in the milling industry. The elasticities are even higher in the case of processed food – about 11 percent for the farm worker, 13 percent for the smallholder, and 15 percent for low income urban households. These elasticities make grounds for a convincing need to intervene along the paths defining and transmitting them.

In conclusion, the study notes that in most cases intervention is made easier because only one path carries the greater proportion of the global effect. Maximum concentration of intervention effort on such paths can pay a good dividend in terms of better welfare outcomes even in the adversity of price shocks. The emboldened and italicized paths could serve to guide policy on where and how to make interventions.

5.3.3 Sectoral Rankings by Price Transmission Potential[10]

From the analysis made in this study, Table 6 provides a ranking of food sector accounts by their price transmission potential to vulnerable groups. This ranking directly addresses the third specific objective, which sought to identify sectors or products that trigger cost of living increases most. The rankings do show the central role played by agriculture in cost of living shocks. Value added commodities top the list, a situation reflective of the degree of urbanization in Zimbabwe. However, even the food-processing sector relies on agricultural output along the food value chain and as such, agriculture remains the key sector to target for containment of harmful cost of living effects arising out of exogenous price shocks to the food sector.

[10] The rankings are obtained from the price multiplier matrix, which is obtainable from the author.

Table 6: Account rankings by price transmission potential to low income households in Zimbabwe

Rank	Account	Average cost of living elasticity (percent) for households: All households	Average cost of living elasticity (percent) for households: Three low income households[11]
1	Food processing industries	27.6	29.2
2	Smallholder maize production	6.0	9.3
3	Other livestock large scale production	6.1	8.0
4	Milling industry	5.3	6.8
5	Large scale maize production	3.4	5.3
6	Smallholder cattle production	3.9	5.0
7	Large scale cattle production	3.5	3.8
8	Large scale horticulture production	2.7	3.7
9	Other livestock smallholder production	2.3	3.5
10	Smallholder groundnuts production	1.5	2.3
10	Smallholder horticulture production	1.5	2.3
12	Other grain smallholder production	1.4	2.2
13	Wheat production	1.4	1.8
14	Sugar production	1.3	1.4
15	Fish production	0.6	0.7
16	Other grain large scale production	0.4	0.5
17	Tea production	0.4	0.4
17	Coffee production	0.3	0.4
19	Large scale groundnuts production	0.1	0.1

Source: Author's analysis based on results

[11] These are: smallholder, farm worker and low income urban households.

On average, the overall increase in cost of living is 4 percent for all groups combined. However, the cost of living elasticity is 5 percent for the three low income groups combined. In terms of the rural-urban divide, the study finds that the average cost of living elasticity (assuming equal weights to all food sub-sectors and averaging the global price effects by urban and rural categories) for rural households is 13 percent and 6 percent for urban households. Parra and Wodon (2008) in their study of Ghana also report results in the neighbourhood of the current study's findings as explained before. On average, food price shocks hurt the rural more than they do to urban households.

Maize, beef, other meat and processed foods constitute about 6.4 percent, 4.7 percent, 1.7 percent and about 14 percent of the CPI in Zimbabwe, respectively (RBZ, 2005). From the above results and the fact that about 65 percent of the population is rural, a case can be advanced that maize, in particular, is underweighted in the CPI. FAO (2010) estimates that cereal share in household dietary requirements is about 56 percent in Zimbabwe. This is about 8 times larger than the CPI weight of cereals. A huge inference is that the current CPI structure under weights cereals and so under-reports inflation. The average household size of five used by Central Statistical Office to compute the CPI is mostly drawn from urban, peri-urban and growth centres (quasi-urban centres) whose consumption patterns greatly differ from the real rural household who have close to 60 percent expenditure on maize in household consumption. Ideally, government policy would improve if the cost of living index or the consumer price index is calculated for the rural, for the poor and for the rich unlike the current situation in which CPI are for provincial, district and national level. Such a family of CPI helps sharpen the quality of welfare policies. However, Zimbabwe is yet to have such statistics.

5.3.4 Conclusion

Briefly, the findings show that price shocks are regressive in the majority of cases. Smallholder households are the most vulnerable of all the three low income groups and they are mostly vulnerable to own-production price shocks. Food value addition cost shocks are highly passed through to all household types. Further, smallholder food production has the most complex transmission to households. The results suggest the importance of strengthening smallholder production because it has a great potential to trigger chains of price reactions in many sectors with the possibility of making lower income households worse off, holding income effects fixed. Rural factor markets play a central role in price transmission, a situation indicating the need to strengthen and deepen these factor markets. A series of consumption linkages between low income urban and smallholder households have the potential to destabilize welfare through the influence on factor-price inflation content in each other's consumption basket.

CHAPTER SIX

CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 Introduction

This chapter summarizes the empirical findings of the study. Further, it concludes the study and derives policy lessons and recommendations. The study highlights areas deserving further empirical examination as well.

6.2 Summary of Empirical Findings

The study set out to analyze how food price shocks are transmitted to households in Zimbabwe. Studies on this issue in Africa have examined the magnitude of the impact of food price shocks and simulated possible results of various policy interventions. However, they have not looked into the question of where and how the intervention should be made for most efficacious and efficient results. The study has filled this gap. The study used a SAM price model and decomposed the price multipliers into paths that transmit the shocks to households in Zimbabwe. The study finds that the complexity of transmission channels from food producers and processors varies considerably. For the higher income groups, transmission passes through the longer food value chain unlike for the lower income in most cases. For the lower income households, transmissions are more direct and the paths carrying greater proportions of shocks are shorter. The role of smallholder agriculture and rural factor markets – land, labour, and capital – is substantiated especially for their multifaceted shock propagation potentialities.

Furthermore, the study sought to examine the magnitude and incidence of cost shocks on households and established that cost of living effects of price shocks are generally regressive. Lower income groups suffer most from price shocks. Staple grains like maize transmit significant cost of living effects to lower income groups especially because they have a higher share of grains in their consumption expenditure. The findings confirm Engel's and Bennett's laws. Moreover, the study established that food processors have the greatest transmission effect to households as high as at least three times the other sectors. Smallholder maize production, other livestock, and milling are among the most able transmitters.

6.3 Lessons and Recommendations for Policy

A number of lessons are derived from the findings of the study. First, food price shocks have regressive effects in that lower income groups – namely farm worker, smallholder, and low income urban households – suffer most during and in the aftermath of a price shock. Of these three household groups, smallholder households are the most vulnerable particularly to their own-production price shocks. In rural areas, cost of living increases faster than it does in urban areas. Thus, relative food poverty would be higher in rural areas post-food-production-price shock. Lower income households are not quite capable of consumption smoothing and as such, they might be stuck in food poverty traps. These groups that are most vulnerable to food price shocks need to be protected from nutritional deprivation, asset shedding and reductions in their real purchasing power. Such protection not only saves lives, it can also strengthen livelihoods and promote longer-term development. Safety nets can provide the required protection. This would prevent distress sales of assets, and allow investments in education and health that food price shocks make more difficult, all of which help keep households from falling into poverty traps. Examples of such interventions include direct food transfers, targeted food subsidies, nutritional programs such as school feeding, cash transfers, and immediate input or input voucher distribution to prop up production and suppress adverse price effects.

Direct food transfers were attempted by the central bank of Zimbabwe in 2008 under a program called Basic Commodities Supply Side Intervention (BACOSSI). It was a nationwide program where needy households would receive a basket of consumer goods for monthly but this program failed in the month of inception. Although it was modified to finance food processors, again it failed to produce good results (RBZ, 2009). Nutritional programs are mainly advanced by non-governmental organizations but are not widespread. Such programs need to be widened and that particularly by government in the absence of donors. Since donors mainly focus on rural areas, a focus by government on the urban low income would have a trickle down effect through the consumption linkages found by the study. Input subsidy programs have not been effectively targeted on the need and the efforts are not broad as may be socially desirable.

A second crucial lesson is that price shocks in smallholder production have more adverse effects on cost of living than those in large scale production have. Besides, smallholder production cost shocks have the most complex transmissions to households with the ability to destabilize prices in most sectors and markets of the economy. In the medium to long term, policy can target at strengthening sustainable production increases on farms. In the medium-term, there is a need for renewed attention to the agricultural sector – with a sharper focus on smallholder households. Productivity increases and food price containment will require significant and sustained improvements in long neglected areas such as research, extension, agricultural and general infrastructure along with credit and risk management instruments. To some extent, own-production cost shocks for smallholder households have a direct and huge impact on their cost of living.

In a similar line of argument, policy makers can invest resources in educating farmers to grow non-tradable grains that use less modern inputs and so are less costly to produce. Such non-tradable staple crops as millet, sorghum, and rapoko would help dampen food cost shocks emanating from input market speculative tendencies. Although government has encouraged the growing of these crops, it has done so in terms of their ability to resist droughts but not in terms of their ability to act as a buffer against food price shocks. Of course, government's approach lies in the domain of the supply-side school. Therefore, government should incentivize agri-businesses, especially millers, to finance grain production. Tax allowances could be given for businesses participating in grain contract farming. This can raise national, regional, and household food security and reduce vulnerability to price shocks.

Third, an additional lesson from the study is that food value addition cost shocks, in the food sector as a whole, have the greatest cost of living effects. Government, from 2002 through 2008, has had a tendency to impose price controls on the final product. Such policies have had the devastating impact of wiping out working capital reserves and forcing the food-processing sector out of step with replacement prices. Consequently, capacity utilization levels have remained low. Government would do best by guiding business with a broad pricing framework that is cost-based, within which the sector can contextualize its own pricing formulae. Business has lamented lack of working capital, and ageing equipment that has raised maintenance costs and so production costs, a high corporate tax regime and costly supportive economic infrastructure such as electricity, water, and fuel (CZI, 2010). Thus, the study recommends introduction of an industrial development and rehabilitation fund to enable business to resuscitate their production plants. The benefits will trickle down to the final consumer in the form of lower prices given competitively efficient production technology. Collaborating with the private sector in the provision of electricity and water may improve efficiency, reduce costs of production, and ultimately costs passed through effects to households.

Fourth, a series of consumption linkages exist between smallholder and low income urban households. Rural and urban economies are deeply intertwined especially through the flow of remittances from cities back to family members living in rural areas. The study has shown that price shocks that negatively affect livelihood outcomes of low income urban households will ultimately impoverish the smallholder households because the latter's consumption function is nested in the former. Thus, at a macroeconomic level, policymakers have to create conditions for stable, dignified, and gainful employment for the urban poor – this is the hard side of policy. This option has many benefits for both the rural and urban poor households because it can be a long-term strategy to contain shock pass through by enhancing consumption smoothing.

In conclusion, food subsidies at the border as a short-term policy, albeit with huge long-term negative implications for the fiscus and balance of payments, can be implemented. Alternatively, policymakers can liberalize food imports by removing tariffs on all food tariff lines. The fiscus will then benefit through value added tax. However, at the same time, the stance is likely to be inopportune because it can lead to a policy-induced shutdown of some food processing factories (CZI, 2010). The influx of cheaper imports would kill the food-processing sector that is already grappling with low capacity utilization challenges. The prudent way forward is likely to involve incremental liberalization and thus commensurately smaller gains for consumers.

In terms of a broad sequential approach to reduce prevalence of food price shocks, policymakers should first ensure a stable macroeconomic environment, and then work on strengthening producers both farmers and food manufacturers and processors – especially to improve capacity utilization. Lastly, government would need to intervene through widening and deepening of social safety nets as a last resort in the event of some households falling into food poverty traps, after a price shock, which may seemingly be protracted.

6.4 Limitations of the Study

The study, first, does not control for substitution possibilities in consumption and production. It uses a static model hence it does not cater for long run adjustments that households and producers would undertake in response to food price shocks. This, of course should not be surprising given that SAM price models are typically short run in nature and only capture first order price effects. However, studies elsewhere such as Saari et al. (2010) introduce substitution possibilities in the model by first estimating elasticity of substitution coefficients econometrically and then inputting them into the SAM price model but they find marginal differences in cost of living estimates from those of the static model. Of course, this requires huge and well-managed databases that apparently are currently hard to come by in Zimbabwe. It would as well be more interesting to redefine household groups in terms of gender and age of household head. The study did not control for intra-household price shock vulnerabilities. Studies have established that within households price effects have greater impact on females than males. One could perform such an analysis but data availability may be a major challenge.

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APPENDICES

APPENDIX 1: LIST OF SOCIAL ACCOUNTING MATRIX ACCOUNTS

Label Definitions

Acatlc	Activities –Cattle Large Scale
Acatsh	Activities –Cattle Smallholder
Acof	Activities – Coffee
Acons	Activities –Construction
Acotlc	Activities –Cotton Large Scale
Acotsh	Activities –Cotton Smallholder
Aelwa	Activities –Electricity and Water
Afert	Activities – Fertilizer and Agricultural Chemicals
Afish	Activities –Fish
Aforlc	Activities –Forestry Large Scale
Aforsh	Activities –Forestry Smallholder
Agrmil	Activities –Grain Milling
Agrntlc	Activities –Groundnuts Large Scale
Agrntsh	Activities –Groundnuts Smallholder
Ahortlc	Activities –Horticulture Large Scale
Ahortsh	Activities –Horticulture Smallholder
Amin	Activities –Mining
Amzlc	Activities – Maize Large Scale

Amzsh	Activities –Maize Smallholder
Aocrplc	Activities –Other Crops Large Scale
Aocrpsh	Activities –Other Crops Smallholder
Aofdp	Activities –Other Food Processing
Aogrnlc	Activities – Other Grain Large Scale
Aogrnsh	Activities – Other Grain Smallholder
Aolgt	Activities –Other Light Manufacturing
Aolvklc	Activities –Other Livestock large scale
Aolvksh	Activities –Other Livestock smallholder
Aoman	Activities –Other Manufacturing
Apriv	Activities –Private Services
Apub	Activities –Public Services
Asug	Activities – Sugar
Atdtp	Activities –Transport and Trade
Atea	Activities –Tea
Atext	Activities –Textiles
Atob	Activities –Tobacco
Awt	Activities –Wheat
Capls	Capital Large Scale
Capot	Capital Other
Capsh	Capital Smallholder
Ccat	Commodities –Cattle

Ccof	Commodities – Coffee
Ccons	Commodities –Construction
Ccot	Commodities –Cotton
Celwa	Commodities –Electricity and Water
Cfert	Commodities –Fertilizer and Agricultural Chemicals
Cfish	Commodities –Fish
Cfor	Commodities –Forestry
Cgrmil	Commodities –Grain Milling
Cgrnt	Commodities –Groundnuts
Chort	Commodities – Horticulture
Cmin	Commodities –Mining
Cmz	Commodities –Maize
Cocrp	Commodities –Other Crops
Cofd	Commodities –Other Food Processing
Cogrn	Commodities –Other Grain
Colgt	Commodities –Other Light Manufacturing
Colvk	Commodities –Other Livestock
Coman	Commodities – Other Manufacturing
Cpriv	Commodities –Private Services
Cpub	Commodities –Public Services
Csug	Commodities –Sugar
Ctdpp-E	Commodities –Transport and Trade Export Marketing Margins

Ctdtp	Commodities –Transport and Trade
Ctdtp-D	Commodities –Transport and Trade Domestic Marketing Margins
Ctdtp-M	Commodities –Transport and Trade Import Marketing Margins
Ctea	Commodities –Tea
Ctext	Commodities –Textiles
Ctob	Commodities –Tobacco
Cwt	Commodities –Wheat
Dstock	Changes in Stock
Dtax	Direct Taxes
Ent	Enterprises
Gov	Government
Hlslow	Large Scale Farm Worker Household
Hlsupp	Large Scale Farm Owner/Manager Household
Hshhld	Smallholder Household
Hurblow	Low Income Urban Household
Hurbupp	High Income Urban Household
Imptar	Import Taxes
Itax	Indirect Taxes
Labsk	Skilled Labour
Labuskf	Formal Unskilled Labour
Labuskif	Informal Unskilled Labour Smallholder
Labuskls	Unskilled Labour Large Scale

Landls	Land Large Scale
Landsh	Land Smallholder
Row	Rest of the World
Savinv	Savings and Investment

APPENDIX 2: PATH DECOMPOSITION RESULTS FOR MAIZE PRODUCTION COST SHOCKS

Path	Global effect	Total effect	percent of global	cum %
Amzlc->Cmz->Agrmil->Cgrmil->Hlsupp	0.0076	0.0018	23.5	23.5
Amzlc->Cmz->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0005	6.8	30.3
Amzlc->Cmz->Aofdp->Cofdp->Hlsupp		0.0004	5.2	35.4
Amzlc->Cmz->Hurblow->Labuskif->Aolgt->Colgt->Hlsupp		0.0003	4.5	39.9
Amzlc->Cmz->Hurblow->Labuskif->Atdtp->Ctdtp->Hlsupp		0.0002	2.2	42.1
Amzlc->Cmz->Hurblow->Labuskif->Acatsh->Ccat->Hlsupp		0.0001	1.9	44.0
Amzlc->Cmz->Hurblow->Labuskf->Apriv->Cpriv->Hlsupp		0.0001	1.8	45.8
Amzlc->Cmz->Hurblow->Labuskf->Aolgt->Aolgt->Hlsupp		0.0001	1.3	47.1
Amzlc->Cmz->Hurblow->Labuskif->Atext->Ctext->Hlsupp		0.0001	1.2	48.3
Amzlc->Cmz->Hshhld->Labuskif->Apriv->Cpriv->Hlsupp		0.0001	1.1	49.4
Amzlc->Cmz->Hlslow	***0.0813***	***0.0700***	***86.1***	***86.1***
Amzlc->Cmz->Agrmil->Cgrmil->Hlslow		0.0050	6.1	92.2
Amzlc->Cmz->Hshhld	***0.0285***	***0.0143***	***50.0***	***50.0***
Amzlc->Cmz->Agrmil->Cgrmil->Hshhld		0.0018	6.2	56.2

APPENDIX 1 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Amzlc->Cmz->Hurblow->Labuskif->Amzsh->Hshhld		0.0017	6.0	62.2
Amzlc->Cmz->Hurblow->Labuskif->Aolvksh->Hshhld		0.0014	4.8	67.0
Amzlc->Cmz->Hurblow->Labuskif->Acatsh->Hshhld		0.0011	4.0	71.0
Amzlc->Cmz->Hurblow->Labuskif->Agrntsh->Hshhld		0.0007	2.3	73.3
Amzlc->Cmz->Hurblow->Labuskif->Ahortsh->Hshhld		0.0006	2.2	75.5
Amzlc->Cmz->Hurblow->Labuskif->Aogrnsh->Hshhld		0.0006	2.1	77.6
Amzlc->Cmz->Hurblow->Labuskif->Aforsh->Hshhld		0.0006	1.9	79.5
Amzlc->Cmz->Hurblow->Labuskif->Aolgt->Colgt->Hshhld		0.0004	1.3	80.8
Amzlc->Cmz->Agrmil->Cgrmil->Hurbupp	0.0062	0.0008	13.3	13.3
Amzlc->Cmz->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0005	7.9	21.2
Amzlc->Cmz->Aofdp->Cofdp->Hurbupp		0.0004	6.6	27.8
Amzlc->Cmz->Hurblow->Labuskif->Aolgt->Colgt->Hurbupp		0.0003	4.8	32.6
Amzlc->Cmz->Hurblow->Labuskif->Atdtp->Ctdtp->Hurbupp		0.0001	2.3	34.9
Amzlc->Cmz->Hurblow->Labuskf->Apriv->Cpriv->Hurbupp		0.0001	2.1	37.0
Amzlc->Cmz->Hshhld->Hurbupp		0.0001	2.0	39.0
Amzlc->Cmz->Hurblow->Labuskif->Atext->Ctext->Hurbupp		0.0001	1.5	40.5
Amzlc->Cmz->Hurblow->Labuskf->Aolgt->Colgt->Hurbupp		0.0001	1.4	41.9

APPENDIX 1 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Amzlc->Cmz->Hshhld->Labuskif->Apriv->Cpriv->Hurbupp		0.0001	1.2	43.1
Amzlc->Cmz->Hurblow	***0.0479***	***0.0414***	***86.3***	***86.3***
Amzlc->Cmz->Agrmil->Cgrmil->Hurblow		0.0032	6.7	93.0
Amzlc->Cmz->Hshhld->Hurblow		0.0011	2.2	95.2
Amzsh->Cmz->Agrmil->Cgrmil->Hlsupp	0.0117	0.0013	10.8	10.8
Amzsh->Hshhld->Labuskif->Apriv->Cpriv->Hlsupp		0.0008	7.0	17.8
Amzsh->Hshhld->Labuskif->Aolgt->Colgt->Hlsupp		0.0006	4.7	22.5
Amzsh->Cmz->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0004	3.1	25.6
Amzsh->Cmz->Aofdp->Cofdp->Hlsupp		0.0003	2.4	28.0
Amzsh->Hshhld->Capsh->Acatsh->Ccat->Hlsupp		0.0003	2.4	30.4
Amzsh->Hshhld->Labuskif->Atdtp->Ctdtp->Hlsupp		0.0003	2.3	32.7
Amzsh->Cmz->Hurblow->Labuskif->Aolgt->Colgt->Hlsupp		0.0002	2.0	34.7
Amzsh->Hshhld->Labuskif->Acatsh->Ccat->Hlsupp		0.0002	1.9	36.6
Amzsh->Hshhld->Labuskif->Atext->Ctext->Hlsupp		0.0001	1.3	37.9
Amzsh->Hshhld->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0001	1.1	39.0
Amzsh->Cmz->Hlslow	***0.0657***	***0.0500***	***76.1***	***76.1***

APPENDIX 1 (Continued)

Path	**Global effect**	**Total effect**	**percent of global**	**cum %**
Amzsh->Cmz->Agrmil->Cgrmil->Hlslow		0.0035	5.4	81.5
Amzsh->Hshhld->Labuskif->Aolgt->Colgt->Hlslow		0.0008	1.2	82.7
Amzsh->Hshhld	***0.1629***	***0.1453***	***89.2***	***89.2***
Amzsh->Cmz->Hshhld		0.0095	5.8	95.0
Amzsh->Hshhld->Labuskif->Atext->Ctext->Hlsupp		0.0001	1.3	37.9
Amzsh->Hshhld->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0001	1.1	39.0
Amzsh->Cmz->Hlslow	***0.0657***	***0.0500***	***76.1***	***76.1***
Amzsh->Cmz->Agrmil->Cgrmil->Hlslow		0.0035	5.4	81.5
Amzsh->Hshhld->Labuskif->Aolgt->Colgt->Hlslow		0.0008	1.2	82.7
Amzsh->Hshhld	***0.1629***	***0.1453***	***89.2***	***89.2***
Amzsh->Cmz->Hshhld		0.0095	5.8	95.0
Amzsh->Hshhld->Hurbupp	0.0106	0.0013	12.1	12.1
Amzsh->Hshhld->Labuskif->Apriv->Cpriv->Hurbupp		0.0008	7.3	19.4
Amzsh->Cmz->Agrmil->Cgrmil->Hurbupp		0.0006	5.5	24.9
Amzsh->Hshhld->Labuskif->Aolgt->Colgt->Hurbupp		0.0005	4.5	29.4
Amzsh->Cmz->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0003	3.2	32.6
Amzsh->Cmz->Aofdp->Cofdp->Hurbupp		0.0002	2.8	35.4
Amzsh->Hshhld->Labuskif->Atdtp->Ctdtp->Hurbupp		0.0002	2.1	37.5

APPENDIX 1 (Continued)

Path	**Global effect**	**Total effect**	**percent of global**	**cum %**
Amzsh->Cmz->Hurblow->Labuskif->Aolgt->Colgt->Hurbupp		0.0002	1.9	39.4
Amzsh->Hshhld->Labuskif->Atext->Ctext->Hurbupp		0.0001	1.4	40.8
Amzsh->Hshhld->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0001	1.1	41.9
Amzsh->Cmz->Hurblow	***0.0501***	***0.0293***	***58.6***	***58.6***
Amzsh->Hshhld->Hurblow		***0.0109***	***21.8***	***80.4***
Amzsh->Cmz->Agrmil->Cgrmil->Hurblow		0.0023	4.5	84.9
Amzsh->Cmz->Hshhld->Hurblow		0.0007	1.4	86.3
Amzsh->Hshhld->Labuskif->Aolgt->Colgt->Hurblow		0.0006	1.3	87.6

APPENDIX 3: PATH DECOMPOSITION RESULTS FOR CATTLE PRODUCTION COST SHOCKS

Path	Global effect	Total effect	percent of global	cum %
Acatlc->Ccat->Aofdp->Cofdp->Hlsupp	0.0373	0.0149	39.8	39.8
Acatlc->Ccat->Hlsupp		0.0142	38.2	78.0
Acatlc->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hlsupp		0.0005	1.2	79.2
Acatlc->Ccat->Apriv->Cpriv->Hlsupp		0.0004	1.1	80.3
Acatlc->Ccat->Hlslow	***0.0429***	***0.0123***	***28.6***	***28.6***
Acatlc->Ccat->Aofdp->Cofdp->Hlslow		***0.0090***	***20.9***	***49.5***
Acatlc->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hlslow		0.0017	4.1	53.6
Acatlc->Ccat->Aolgt->Colgt->Hlslow		0.0005	1.2	54.8
Acatlc->Ccat->Hshhld	***0.0405***	***0.0107***	***26.5***	***26.5***
Acatlc->Ccat->Aofdp->Cofdp->Hshhld		***0.0105***	***25.9***	***52.5***
Acatlc->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hshhld		0.0007	1.8	54.3
Acatlc->Ccat->Aofdp->Cofdp->Agrntsh->Hshhld		0.0005	1.2	55.5
Acatlc->Ccat->Aofdp->Cofdp->Hurbupp	0.0245	0.0154	62.8	62.8
Acatlc->Ccat->Aoman->Coman->Hurbupp		0.0004	1.7	64.5
Acatlc->Ccat->Apriv->Cpriv->Hurbupp		0.0004	1.6	66.1
Acatlc->Ccat->Aolgt->Colgt->Hurbupp		0.0003	1.2	67.3

APPENDIX 2 (Continued)

Path	**Global effect**	**Total effect**	**percent of global**	**cum %**
Acatlc->Ccat->Aolgt->Colgt->Hurbupp		0.0003	1.2	67.3
Acatlc->Ccat->Aofdp->Cofdp->Hurblow	***0.0307***	***0.0124***	***40.3***	***40.3***
Acatlc->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hurblow		0.0011	3.6	43.9
Acatlc->Ccat->Hshhld->Hurblow		0.0008	2.6	46.5
Acatlc->Ccat->Aofdp->Cofdp->Hshhld->Hurblow		0.0008	2.5	49.0
Acatlc->Ccat->Aolgt->Colgt->Hurblow		0.0004	1.4	50.4
Acatsh->Ccat->Aofdp->Cofdp->Hlsupp	0.0246	0.0088	35.6	35.6
Acatsh->Ccat->Hlsupp		0.0084	34.2	69.8
Acatsh->Hshhld->Labuskif->Apriv->Cpriv->Hlsupp		0.0004	1.7	71.5
Acatsh->Hshhld->Labuskif->Aolgt->Colgt->Hlsupp		0.0003	1.1	72.6
Acatsh->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hlsupp		0.0003	1.1	73.7
Acatsh->Ccat->Hlslow	***0.0302***	***0.0073***	***24.0***	***24.0***
Acatsh->Ccat->Aofdp->Cofdp->Hlslow		***0.0053***	***17.6***	***41.6***
Acatsh->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hlslow		0.0010	3.4	45.0
Acatsh->Hshhld->Capsh->Amzsh->Cmz->Hlslow		0.0006	1.9	46.9
Acatsh->Hshhld->Labuskif->Amzsh->Cmz->Hlslow		0.0005	1.6	48.5
Acatsh->Hshhld->Landsh->Amzsh->Cmz->Hlslow		0.0004	1.5	50.0

APPENDIX 2 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Acatsh->Hshhld->Labuskif->Aolgt->Colgt->Hlslow		0.0004	1.3	51.3
Acatsh->Hshhld	***0.0945***	***0.0719***	***76.1***	***76.1***
Acatsh->Ccat-> Hshhld		0.0061	6.5	82.6
Acatsh->Ccat->Aofdp->Cofdp->Hshhld		0.0060	6.3	88.9
Acatsh->Ccat->Aofdp->Cofdp->Hurbupp	0.0172	0.0091	52.7	52.7
Acatsh->Hshhld->Hurbupp		0.0006	3.7	56.4
Acatsh->Labuskif->Apriv->Cpriv->Hurbupp		0.0004	2.2	58.6
Acatsh->Ccat->Aoman->Coman->Hurbupp		0.0003	1.5	60.1
Acatsh->Hshhld->Labuskif->Aolgt->Colgt->Hurbupp		0.0002	1.4	61.5
Acatsh->Ccat->Apriv->Cpriv->Hurbupp		0.0002	1.3	62.8
Acatsh->Ccat->Aolgt->Colgt->Hurbupp		0.0002	1.0	63.8
Acatsh->Ccat->Aofdp->Cofdp->Hurblow	***0.0265***	***0.0073***	***27.5***	***27.5***
Acatsh->Hshhld->Hurblow		***0.0054***	***20.5***	***48.0***
Acatsh->Ccat->Aofdp->Cofdp->Aolvklc->Colvk->Hurblow		0.0006	2.4	50.4
Acatsh->Ccat->Hshhld->Hurblow		0.0005	1.7	52.1
Acatsh->Ccat->Aofdp->Cofdp->Hshhld->Hurblow		0.0004	1.7	53.8
Acatsh->Ccat->Hshhld->Hurblow		0.0004	1.7	55.5

APPENDIX 2 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Acatsh->Hshhld->Capsh->Amzsh->Cmz->Hurblow		0.0003	1.3	56.8
Acatsh->Hshhld->Labuskif->Aolgt->Colgt->Hurblow		0.0003	1.2	58.0
Acatsh->Hshhld->Labuskif->Amzsh->Cmz->Hurblow		0.0003	1.0	59.0

APPENDIX 4: PATH DECOMPOSITION RESULTS FOR OTHER LIVESTOCK PRODUCTION COST SHOCKS

Path	Global effect	Total effect	percent of global	cum %
Aolvklc->Colvk->Hlsupp	0.0409	0.0207	50.5	50.5
Aolvklc->Colvk->Aofdp->Cofdp->Hlsupp		0.0096	23.6	74.1
Aolvklc->Colvk->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0006	1.4	75.5
Aolvklc->Colvk->Hlslow	*0.1018*	*0.0724*	*71.1*	*71.1*
Aolvklc->Colvk->Aofdp->Cofdp->Hlslow		0.0058	5.7	76.8
Aolvklc->Colvk->Hshhld	***0.0653***	***0.0317***	***48.6***	***48.6***
Aolvklc->Colvk->Aofdp->Cofdp->Hshhld		0.0069	10.5	59.1
Aolvklc->Colvk->Hurblow->Labuskif->Amzsh->Hshhld		0.0020	3.0	62.1
Aolvklc->Colvk->Hurblow->Labuskif->Aolvksh->Hshhld		0.0016	2.4	64.5
Aolvklc->Colvk->Hurblow->Labuskif->Acatsh->Hshhld		0.0013	2.0	66.5
Aolvklc->Colvk->Hurblow->Labuskif->Agrntsh->Hshhld		0.0008	1.2	67.7
Aolvklc->Colvk->Hurblow->Labuskif->Ahortsh->Hshhld		0.0007	1.1	68.8
Aolvklc->Colvk->Hurblow->Labuskif->Aogrnsh->Hshhld		0.0007	1.1	69.9
Aolvklc->Colvk->Aofdp->Cofdp->Hurbupp	0.0231	0.0100	43.2	43.2
Aolvklc->Colvk->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0006	2.4	45.6
Aolvklc->Colvk->Hurblow->Labuskif->Aolgt->Colgt->Hurbupp		0.0003	1.4	47.0

APPENDIX 3 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Aolvklc->Colvk->Hshhld->Hurbupp		0.0003	1.2	48.2
Aolvklc->Colvk->Aolgt->Colgt->Hurbupp		0.0003	1.2	49.4
Aolvklc->Colvk->Aoman->Coman->Hurbupp		0.0003	1.1	50.5
Aolvklc->Colvk->Hurblow	***0.0722***	***0.0470***	***65.1***	***65.1***
Aolvklc->Colvk->Aofdp->Cofdp->Hurblow		0.0080	11.1	76.2
Aolvklc->Colvk->Hshhld->Hurblow		0.0024	3.3	79.5
Aolvksh->Hshhld->Labuskif->Apriv->Cpriv->Hlsupp	0.0042	0.0005	11.6	11.6
Aolvksh->Hshhld->Labuskif->Aolgt->Colgt->Hlsupp		0.0003	7.7	19.3
Aolvksh->Hshhld->Capsh->Acatsh->Ccat->Hlsupp		0.0002	3.9	23.2
Aolvksh->Hshhld->Labuskif->Atdtp->Ctdtp->Hlsupp		0.0002	3.8	27.0
Aolvksh->Colvk->Hlsupp		0.0001	3.3	30.3
Aolvksh->Hshhld->Labuskif->Acatsh->Ccat->Hlsupp		0.0001	3.2	33.5
Aolvksh->Hshhld->Labuskif->Atext->Ctext->Hlsupp		0.0001	2.1	35.6
Aolvksh->Hshhld->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0001	1.7	37.3
Aolvksh->Colvk->Aofdp->Cofdp->Hlsupp		0.0001	1.5	38.8
Aolvksh->Hshhld->Hurblow->Labuskif->Aolgt->Colgt->Hlsupp		0.000	1.2	40.0

APPENDIX 3 (Continued)

Path	**Global effect**	**Total effect**	**percent of global**	**cum %**
Aolvksh->Hshhld->Capsh->Amzsh->Cmz->Hlslow	***0.0075***	***0.0007***	***9.3***	***9.3***
Aolvksh->Hshhld->Labuskif->Amzsh->Cmz->Hlslow		***0.0006***	***7.8***	***17.1***
Aolvksh->Hshhld->Landsh->Amzsh->Cmz->Hlslow		***0.0005***	***7.2***	***24.3***
Aolvksh->Colvk->Hlslow		***0.0005***	***6.5***	***30.8***
Aolvksh->Hshhld->Labuskif->Aolgt->Colgt->Hlslow		***0.0005***	***6.4***	***37.2***
Aolvksh->Hshhld->Capsh->Acatsh->Ccat->Hlslow		0.0001	1.9	39.1
Aolvksh->Hshhld->Labuskif->Acatsh->Ccat->Hlslow		0.0001	1.2	40.3
Aolvksh->Hshhld->Hurblow->Labuskif->Amzsh->Cmz->Hlslow		0.0001	1.2	41.5
Aolvksh->Hshhld	***0.0863***	***0.0859***	***99.5***	***99.5***
Aolvksh->Hshhld->Hurbupp	0.0040	0.0008	18.9	18.9
Aolvksh->Hshhld->Labuskif->Apriv->Cpriv->Hurbupp		0.0005	11.6	30.5
Aolvksh->Hshhld->Labuskif->Aolgt->Colgt->Hurbupp		0.0003	7.0	37.5
Aolvksh->Hshhld->Labuskif->Atdtp->Ctdtp->Hurbupp		0.0001	3.4	40.9
Aolvksh->Hshhld->Labuskif->Atext->Ctext->Hurbupp		0.0001	2.2	43.1
Aolvksh->Hshhld->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0001	1.7	44.8
Aolvksh->Colvk->Aofdp->Cofdp->Hurbupp		0.0001	1.7	46.5
Aolvksh->Hshhld->Hurblow->Labuskif->Aolgt->Colgt->Hurbupp		0.00	1.1	47.6

APPENDIX 3 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Aolvksh->Hshhld->Hurblow	***0.0113***	***0.0065***	***57.9***	***57.9***
Aolvksh->Hshhld->Capsh->Amzsh->Cmz->Hurblow		0.0004	3.6	61.5
Aolvksh->Hshhld->Labuskif->Aolgt->Colgt->Hurblow		0.0004	3.4	64.9
Aolvksh->Hshhld->Labuskif->Amzsh->Cmz->Hurblow		0.0003	2.9	67.8
Aolvksh->Colvk->Hurblow		0.0003	2.8	70.6
Aolvksh->Hshhld->Landsh->Amzsh->Cmz->Hurblow		0.0003	2.7	73.3
Aolvksh->Hshhld->Labuskif->Apriv->Cpriv->Hurblow		0.0002	1.6	74.9

APPENDIX 5: PATH DECOMPOSITION RESULTS FOR VALUE ADDITION COST SHOCKS

Path	Global effect	Total effect	percent of global	cum %
Agrmil->Cgrmil->Hlsupp	0.0358	0.0260	72.6	72.6
Agrmil->Cgrmil->Aofdp->Cofdp->Hlsupp		0.0006	1.6	74.2
Agrmil->Cgrmil->Hurblow->Labuskif->Apriv->Cpriv->Hlsupp		0.0006	1.6	75.8
Agrmil->Cgrmil->Hurbupp->Labsk->Apriv->Cpriv->Hlsupp		0.0005	1.3	77.1
Agrmil->Cgrmil->Hurblow->Labuskif->Aolgt->Colgt->Hlsupp		0.0004	1.1	78.2
Agrmil->Cgrmil->Hlslow	***0.0923***	***0.0724***	***78.4***	***78.4***
Agrmil->Cgrmil->Hshhld	***0.0499***	***0.0259***	***51.9***	***51.9***
Agrmil->Cgrmil->Hurblow->Labuskif->Amzsh->Hshhld		0.0020	4.0	55.9
Agrmil->Cgrmil->Hurblow->Labuskif->Aolvksh->Hshhld		0.0016	3.2	59.1
Agrmil->Cgrmil->Hurblow->Labuskif->Acatsh->Hshhld		0.0013	2.6	61.7
Agrmil->Cgrmil->Hurblow->Labuskif->Agrntsh->Hshhld		0.0008	1.5	63.2
Agrmil->Cgrmil->Hurblow->Labuskif->Ahortsh->Hshhld		0.0007	1.4	64.6
Agrmil->Cgrmil->Hurblow->Labuskif->Aogrnsh->Hshhld		0.0007	1.4	66.0
Agrmil->Cgrmil->Hurblow->Labuskif->Aforsh->Hshhld		0.0006	1.3	67.3
Agrmil->Cgrmil->Hurbupp	0.0231	0.0119	51.7	51.7
Agrmil->Cgrmil->Aofdp->Cofdp->Hurbupp		0.0006	2.6	54.3

APPENDIX 4 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Agrmil->Cgrmil->Hurblow->Labuskif->Apriv->Cpriv->Hurbupp		0.0006	2.4	56.7
Agrmil->Cgrmil->Hurblow->Labuskif->Aolgt->Colgt->Hurbupp		0.0003	1.4	58.1
Agrmil->Cgrmil->Hurblow	***0.0624***	***0.0472***	***75.7***	***75.7***
Agrmil->Cgrmil->Hshhld->Hurblow		0.0019	3.1	78.8
Aofdp->Cofdp->Hlsupp	0.2635	0.1844	70.0	70.0
Aofdp->Cofdp->Hurbupp->Labsk->Apriv->Cpriv->Hlsupp		0.0071	2.7	72.7
Aofdp->Cofdp->Aolvklc->Colvk->Hlsupp		0.0056	2.1	74.8
Aofdp->Cofdp->Acatlc->Ccat->Hlsupp		0.0037	1.4	76.2
Aofdp->Cofdp->Hurbupp->Labsk->Aolgt->Colgt->Hlsupp		0.0036	1.4	77.6
Aofdp->Cofdp->Hurbupp->Labsk->Atdtp->Ctdtp->Hlsupp		0.0029	1.1	78.7
Aofdp->Cofdp->Hlslow	***0.2903***	***0.1110***	***38.2***	***38.2***
Aofdp->Cofdp->Aolvklc->Colvk->Hlslow		0.0215	7.4	45.6
Aofdp->Cofdp->Hurbupp->Labsk->Aolgt->Colgt->Hlslow		0.0057	2.0	47.6
Aofdp->Cofdp->Hlsupp->Caplsc->Amzlc->Cmz->Hlslow		0.0051	1.8	49.4
Aofdp->Cofdp->Acatlc->Ccat->->Hlslow		0.0035	1.2	50.6
Aofdp->Cofdp->Hurbupp->Labsk->Apub->Cpub->Hlslow		0.0034	1.2	51.8
Aofdp->Cofdp->Hshhld	***0.2987***	***0.1303***	***43.6***	***43.6***

APPENDIX 4 (Continued)

Path	Global effect	Total effect	percent of global	cum %
Aofdp->Cofdp->Aolvklc->Colvk->Hshhld		0.0093	3.1	46.7
Aofdp->Cofdp->Hurblow->Labuskif->Amzsh->Hshhld		0.0064	2.1	48.8
Aofdp->Cofdp->Agrntsh->Hshhld		0.0058	2.0	50.8
Aofdp->Cofdp->Hurbupp->Labsk->Apub->Cpub->Hshhld		0.0056	1.9	52.7
Aofdp->Cofdp->Hurblow->Labuskif->Aolvksh->Hshhld		0.0051	1.7	54.4
Aofdp->Cofdp->Hurbupp->Labsk->Aolgt->Colgt->Hshhld		0.0045	1.5	55.9
Aofdp->Cofdp->Hurblow->Labuskif->Acatsh->Hshhld		0.0042	1.4	57.3
Aofdp->Cofdp->Ahortsh->Hshhld		0.0033	1.1	58.4
Aofdp->Cofdp->Acatlc->Ccat->Hshhld		0.0031	1.0	59.4
Aofdp->Cofdp->Hurbupp	0.2396	0.1900	79.3	79.3
Aofdp->Cofdp->Hurblow	***0.2879***	***0.1531***	***53.2***	***53.2***
Aofdp->Cofdp->Aolvklc->Colvk->Hurblow		0.0136	4.7	57.9
Aofdp->Cofdp->Hshhld->Hurblow		0.0097	3.4	61.3
Aofdp->Cofdp->Hurbupp->Labsk->Aolgt->Colgt->Hurblow		0.0048	1.6	62.9
Aofdp->Cofdp->Hurbupp->Labsk->Apriv->Cpriv->Hurblow		0.0030	1.0	63.9
Aofdp->Cofdp->Hlsupp->Caplsc->Amzlc->Cmz->Hurblow		0.0029	1.0	64.9