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International Price Shocks and Technological Changes for Poverty Reduction in Burkina Faso

A General Equilibrium Approach

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International Price Shocks and Technological Changes for Poverty Reduction in Burkina Faso A General Equilibrium Approach

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Table of contents

1.	Summary.....	1
2.	Introduction	1
3.	Agricultural development, growth, poverty reduction and external factors	3
4.	The case of Burkina Faso.....	22
5.	The structure of the national economy.....	26
6.	The CGE of Burkina Faso	32
7.	Simulations of socio-economic impacts of external shocks.....	39
8.	Technological changes under “Good Agricultural Practices”	44
9.	Some policy implications	48
10.	Conclusions	49
11.	Further Reading.....	50
	Appendix A: Detailed data and tables.....	56
	Appendix B: features of the CGE model adopted.....	58
a)	The LES demand system	58
b)	Calculation of Betas	58

1. SUMMARY

After sketching the mutual links between economic growth, agriculture, technology, poverty reduction and external factors; this paper analyses the implications of recent international price shocks on welfare and growth, notably energy and agricultural products, for Burkina Faso, a less industrialised, low-income, food-deficit, net oil-importing country. The socio-economic impacts of the above-mentioned external shocks are analysed by means of a Computable General Equilibrium model (CGE). The paper also discusses the extent to which technological changes in agriculture, specifically the introduction of “Good Agricultural Practices” (GAP) towards “conservation agriculture”, could mitigate the welfare and growth losses derived by international price shocks. The results of the analysis show that oil price hikes in recent years had much greater impacts on the welfare of the poorer layers of the population than other price shifts, such as international food prices. Additionally, it is shown that the technological changes explored in this paper, in spite of their significant impacts on agricultural productivity, by no means counteract the negative welfare and growth losses brought by international price shocks. The energy dependency is a channel that systematically siphons out domestic resources, seriously hampering domestic primary capital accumulation and related endogenous-growth potential. Policy implications for poverty reduction and food security are that in Burkina Faso, there is an urgent focus on energy issues by all means, including the adoption of appropriate agricultural technologies. These findings are likely to apply to other less-industrialised energy-importing countries with similar socio-economic structure.

2. INTRODUCTION

To achieve the first Millennium Development Goal (MDG) “*Eradicate extreme poverty and hunger*”¹, many less-industrialised countries have relied so far on the formulation and implementation of the so-called “Poverty Reduction Strategies” (PRS)².

After the first wave of PRS, in the early 2000s, the focus shifted towards a more balanced, inclusive economic and social development, based on a medium-long term vision of the countries’ potential³. In this context, the prevailing development paradigm adopted for less-industrialised countries by many bi-lateral and multi-lateral development agencies, including FAO and international banks; focused on the agricultural sector as an engine of growth and poverty reduction⁴. Agricultural development is considered particularly relevant for countries

¹ See the site of the United Nations Development Group, in charge of coordinating the work of the various UN development agencies towards the achievement of the Millennium Development Goals (MDGs): <http://www.undg.org>.

² The Term “Poverty Reduction Strategy Paper” (PRSP), later on generalised as “Poverty Reduction Strategy”, first adopted by the World Bank in 1999, refers to a document “*describing a country's macroeconomic, structural and social policies and programs to promote growth and reduce poverty, as well as associated external financing needs*”. Countries are required to prepare and update PRSPs because “*PRSPs are a requirement for countries in order to receive concessional assistance from the World Bank*” (<http://go.worldbank.org/ZLBKFM2V90>).

³ World Bank (2005): 2005 Review of the PRS Approach: Balancing Accountabilities and Scaling Up Results. World Bank, Washington D.C.

⁴ Indeed, the FAO (FAO, 2003) adopted the so-called “*Twin-Track Approach*”, as the conceptual framework for its “*Anti-Hunger Programme*”. It comprises both programmes aimed at improving the direct and immediate

with a large share of agricultural employment in rural areas and the emphasis is put on: 1) direct impacts on farmers' income, especially poor smallholders, 2) indirect impacts via downstream linkages and multiplier effects: distributed income, increased consumption of local goods, etc and 3) its presumed role in slowing down urbanisation and the international migration phenomenon.

In addition, the various initiatives adopted in 2008 by many international organisations to address the so-called "soaring food prices" crisis, readdressed the focus on the agricultural sector as a "supplier" of food, on the assumption that increased agricultural output and productivity favour poor consumers due to a reduction in food prices.

For these reasons, recent agricultural policies for poverty reduction in many less-industrialised countries have as their aims: crop intensification, mechanisation of production processes, increased transformation processes and increased demand of transport services for distribution.

This is also the case for Burkina Faso, a semi-arid land-locked country with no fossil energy resources. With a poverty incidence ranging between 40 and 45% of the population, this country faces enormous difficulties in achieving the MDG 1.

Many proposed policy measures for poverty reduction in Burkina Faso within the context of the "Strategic Framework for Poverty Fighting" for 2006-2008, fall into the above-mentioned set of policies, aimed at inducing increased output and productivity. For example, selected measures focus on the distribution of "modern" agricultural inputs such as improved seeds and inorganic fertilisers.

The achievement of the first MDG however, lies in its reconciliation with other potentially conflicting objectives included in the MDG package; for example, the attainment of local and global sustainability (goal 7). In Burkina Faso for instance, intensification of imported inputs, notably pesticides used in agriculture, as well as the increasing number of dams located in the same river basins, are currently generating environmental externalities that reflect negatively on other productive sectors such as the fishing industry and presumably, health conditions⁵. In addition, substantial financial constraints associated with objective water scarcity are going to be the most limiting factors in the expansion of irrigated land and related yields' increase.

However, beyond the issues related to potential or actual conflicting development objectives, there is a fundamental problem faced by the panoply of agents involved in policy making for socio-economic development. It consists in the missed recognition of mechanisms that systematically siphon resources out of socio-economic systems, hampering the primary accumulation of capital, which is the basis of any development process. Many of these mechanisms in less industrialised countries are influenced, if not determined, by external factors, by means of direct or indirect control on domestic resources and/or by market-price mechanisms. Among them, the energy dependence in net oil-importing countries is

access of food to food-insecure people and interventions aimed at agricultural development and off-farm income generation, on the assumption that there are mutually reinforcing relationships between these components towards food insecurity and poverty reduction. FAO (2003): Anti-Hunger Programme: A twin-track approach to hunger reduction: priorities for national and international action Food and Agriculture Organization of the United Nations. Rome.

⁵ MECV (2008). Rapport sur la filière Pêche. Ministère de l'Environnement et du Cadre de Vie. Ouagadougou Burkina Faso.

particularly important. In recent years in these countries, the energy sector increasingly acted as a “drain of resources” due to dramatic increases in oil prices, as pointed out by Bellù (2007)⁶. Given its magnitude, this external shock is expected to have huge implications in terms of growth, income distribution, poverty reduction and food security. Unless these macro problems are fixed, most interventions for poverty reduction and development, including initiatives and actions of the international cooperation community, are more than likely destined to miss their objectives.

The structure of the paper is as follows: in section 3, a review of the literature concerning selected conceptual and empirical findings on the links between economic growth, agriculture, technology, poverty reduction and external factors, is provided. It constitutes the conceptual background to the analysis of the present work. The analysis of some international price shocks applied to Burkina Faso is carried out in section 4. The main socio-economic features of the country are then illustrated in section 5. Here, the country’s economic structure is analysed using selected macro-economic data, including a Social Accounting Matrix (SAM). A SAM-based Computable General Equilibrium model of the country is presented in section 6. To test the extent to which international price changes affect the socio-economic system, we have carried out some CGE simulations, which are conducted for different commodities, notably oil, fertilisers, food and cotton, which are presented in section 7. In section 8, the socio-economic impacts of introducing technological changes in the agricultural sector are analysed by means of some additional CGE-based simulations. In both sections 7 and 8, the welfare impacts of the poorer layers of the population are put at the core of the analysis. Possible policy implications are discussed in section 9 and concluding remarks are also provided.

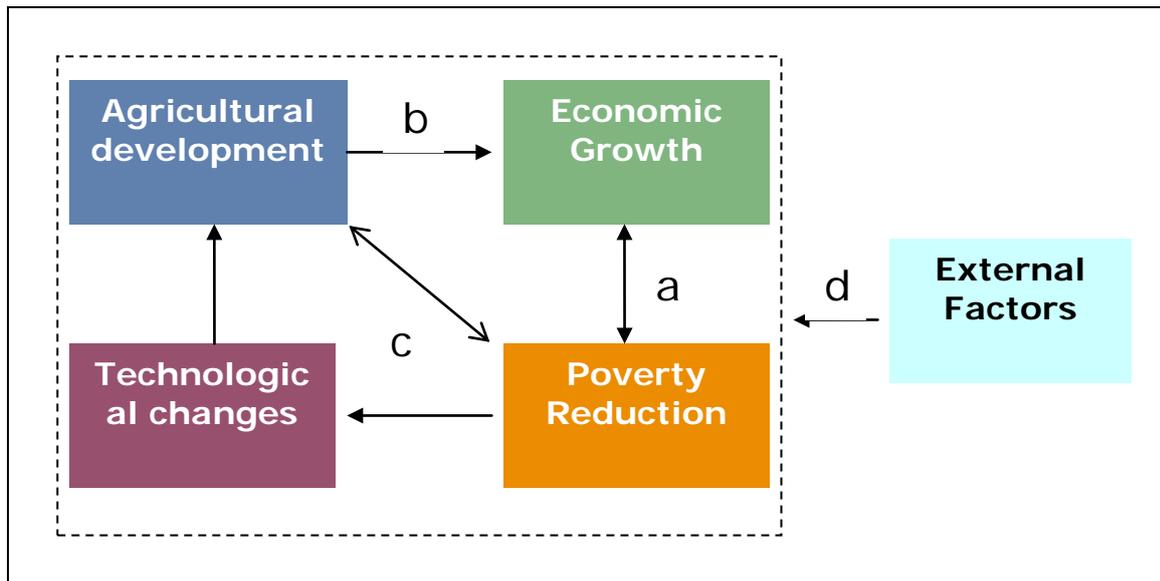
3. AGRICULTURAL DEVELOPMENT, GROWTH, POVERTY REDUCTION AND EXTERNAL FACTORS

Complex interrelationships exist among 1) the growth of an economic system, 2) the development of specific sectors, 3) the level and dynamics of poverty and inequality; 4) technology choices and technological changes in production processes, and 5) the influences of external factors on the abovementioned relationships. In many less industrialised countries, the agricultural sector is currently considered to be the core of these relationships.

In this section, this paper explores some mutual links between the different elements mentioned, notably:

- a. Economic growth versus poverty and inequality reduction;
- b. Agricultural development versus economic growth;
- c. Agricultural development and technological changes versus poverty and inequality reduction;
- d. Influence of external factors on poverty, technological changes and agricultural development (See Figure 1).

⁶ Bellù L.G., 2007. Windfall Oil Profits and Soaring Oil Bills: Some policy implications for Sustainable Development.. FAO UN. Rome [mimeo]

Figure 1: Technological changes, Agricultural development, growth and poverty

Cross-linkages among these elements are not easy to disentangle and the different strands of literature very often cross each other and overlap. Nevertheless, an attempt will be made to provide some guiding elements through recent (and less recent) findings in these areas. The review of the literature on these topics, which by no means pretends to be exhaustive, constitutes a preamble to the analysis and implications of shifts of oil and selected agricultural prices which impinge on growth and poverty. It also contains an analysis of possible technological changes in the agricultural sector which could mitigate their negative impacts.

a. Economic growth versus poverty and inequality reduction

In analysing the links between growth and inequality, Kuznets (1955)⁷ wondered whether the reverse U-shaped relationship between growth and inequality “...of the older developed countries [is] likely to be repeated in the sense that in the early phases of industrialization in the underdeveloped countries income inequalities will tend to widen before the levelling forces become strong enough first to stabilize and then reduce income inequalities”. He particularly addressed the issue of the affordability of the likely increase in inequality, as a price to be paid to achieve growth, in the context of extremely low income levels. Indeed, he underlined the need of what, almost forty years later, will be called “pro-poor growth”:

“How can either the institutional and political framework of the underdeveloped societies or the processes of economic growth and industrialization be modified to favour a sustained rise to higher levels of economic performance and yet avoid the fatally simple remedy of an authoritarian regime that would use the population as cannon-fodder in the fight for economic achievement? How to minimize the cost of transition and avoid paying the heavy price-in internal tensions, in long-run inefficiency in providing means for satisfying wants of human beings as individuals-which the inflation of political power represented by authoritarian regimes requires?”

⁷ Kuznets S., 1955. Economic Growth and Income Inequality. *The American Economic Review*, Vol. 45, No. 1. (Mar., 1955), pp. 1-28.

Almost two decades later, economists started systematically exploring the links between the growth of an economic system, essentially measured in terms of variation of GDP, and poverty reduction. Chenery and Ahluwalia (1974)⁸ pioneered these studies by proposing a model of “*redistribution with Growth*” and underlining the importance of applying redistributive processes to growth, if poverty had to be reduced.

Since then, several authors have attempted to measure, both theoretically and empirically, the extent to which poverty reduction is related to growth and/or redistribution. For example, Datt and Ravallion (1992)⁹ divide poverty changes into three components respectively as growth, inequality changes and a residual component. Kakwani (1993)¹⁰ works out the “Growth elasticity of poverty”, i.e. the percentage change in poverty for a 1 percent growth in the mean income of the society, keeping constant the income distribution (as if everyone in the society received the same proportional change of its income). Ravallion and Chen (1997)¹¹ estimate, on the basis of a sample of less industrialised countries, that the “growth elasticity of poverty” was around - 3, i.e. that 1 percent increase (decrease) in the mean income reduces (increases) the “poverty incidence” by 3 percent¹².

Bourguignon (2003), provides the mathematical link between growth elasticity of poverty reduction and the initial inequality as well as the location of the poverty line in relation to mean incomes, by assuming that incomes are log-normally distributed. Under this assumption, the complete distribution of income is known, provided information on mean income and the Gini coefficient is available. Bourguignon also identifies a direct link between a permanent redistribution of income and the elasticity of poverty reduction w.r.t. growth. Redistributing income leads to an “*acceleration*” of poverty reduction for a given rate of economic growth, thanks to an increase in the elasticity of poverty reduction to growth associated with the redistributive process.

Ravallion and Chen (2003) develop a pro-poor growth measure, based on the so called “growth incidence curve” (GIC), which is in turn based on the slopes of the Lorenz curves in two subsequent periods and the growth rate of the mean income¹³. This measure is the mean growth rate of the income for the poor and can be interpreted as the ordinary growth rate scaled up or down according to whether the distributional changes were pro-poor or not. Kakwani and Son (2003), after working out a “Poverty Equivalent Growth Rate”(PEGR) which embodies distributional concerns¹⁴, calculate the PEGR for different countries, namely,

⁸ Chenery, H., and M. Ahluwalia, 1974. *Redistribution with Growth*. Oxford: Oxford University Press.

⁹ Datt, G., and M. Ravallion (1992) Growth and Redistribution Component of changes in Poverty Measures: A Decomposition with Applications to Brazil and India in the 1980s. *Journal of Development Economics* 38, pp275-295.

¹⁰ Kawani N., 1993. Poverty and Economic Growth with Application to Cote d’Ivoire. *Review of Income and Wealth* 39, 121-139.

¹¹ Ravallion, M. and Chen S., 1997. What Can New Survey Data Tell us about Recent Changes in Distribution of Poverty? *The World Bank Economic Review* 11: 357-382.

¹² The “poverty incidence” is the proportion of people with income or expenditure below a given “poverty line”, i.e. a threshold that represents the minimum level of income or expenditure required to be considered non-poor.

¹³ Ravallion, M., Chen S., 2003. Measuring Pro-Poor Growth. *Economics Letters* 78 (2003) 93–99. This measure is based on the ordinary Lorenz curves. This implies that this measure checks for the first order dominance of the income distribution at time t with respect to the distribution at time t-1. It does not provide conclusive results on whether the growth is pro-poor or not in absence of first order dominance.

¹⁴ The PEGR is claimed to be superior to the Ravallion and Chen, 2003, estimate of pro-poor growth as PEGR respects the “monotonicity criterion”, i.e. for any increase in the index, poverty should fall (and vice-versa).

Thailand, Korea and Vietnam, and by comparing the PEGR with the actual growth rate, rank countries according to the “pro-poorness” of their growth patterns.

Son (2004)¹⁵ proposes a supposedly “*more conclusive*” pro-poor growth index than the one developed by Ravallion and Chen, as it allows us to judge whether growth is pro-poor or not in most situations, being based on Generalized Lorenz curves (GL), which consider second order dominance, rather than on ordinary Lorenz curves (L) which consider only first order dominance¹⁶. Furthermore, Son and Kakwani (2008) work out a new “PEGR” and use it to classify growth patterns of eighty countries, finding that “... *global growth processes have not generally been favourable to the poor. The global reduction in poverty would have been much greater if growth were generally positive and pro-poor*”¹⁷.

In tandem, at the beginning of the 2000s a wave of thought rose which somewhat downsized the importance of redistribution for poverty reduction. On the basis of some econometric work based on panel data of several countries, Dollar & Kraay (2002) in their most cited (and criticised) article “*Growth Is Good for the Poor*”; highlight the role of growth as being the main factor contributing to reduce poverty: “*Average incomes of the poorest fifth of a country on average rise or fall at the same rate as average incomes*”. In other words, they find a “one-to-one relationship between growth and incomes of the poor. As they point out: “*evidence does strongly suggest that economic growth and the policies and institutions that support it on average benefit the poorest in society as much as anyone else*”. Policy implications are that selected pro-poor policies may be less useful for poverty reduction than general “enabling-environment-oriented” policies because “... *private property rights, stability, and openness contemporaneously create a good environment for poor households (and everyone else) to increase their production and income*”. In addition, there is “...*little evidence that formal democratic institutions or a large degree of government spending on social services systematically affect incomes of the poor*”.

Also Kraay (2004)¹⁸ uses data from several household surveys in less industrialised countries in the eighties and nineties to show that most of the variation of poverty can be attributed to the growth of average incomes. These results have been used to support the late wave of thinking, and related policies, favourable to the withdrawal of national governments, foreign investments and further liberalisation of trade. However, around fifty years earlier Kutznetz (1955), highlighting some still very actual issues, warned that:

“Because they may have proved favourable in the past, it is dangerous to argue that completely free markets, lack of penalties implicit in progressive taxation, and the like are indispensable for the economic growth of the now underdeveloped countries. Under present conditions the results may be quite the opposite:

Kakwani N., Son, H., 2003, Pro-poor Growth: Concepts and Measurement with Country Case Studies. *The Pakistan Development Review* 42 : 4 Part I (Winter 2003) pp. 417–444

¹⁵ Son H., 2004. A Note on Pro-Poor Growth. *Economics Letters* 82 (2004) 307–314

¹⁶ For a discussion on ordinary Lorenz curves versus Generalized Lorenz curves see for example Bellù and Liberati, 2005. Bellù and Liberati, 2005: Ranking Income Distributions with Generalised Lorenz Curves. [EASYPol Module 002](#), FAO, Rome, Italy.

¹⁷ “Of 131 spells when growth rates were positive, growth was pro-poor in 55 (23.2%) cases and anti-poor in 76 (32.1%) cases. In 53 out of 106 spells of negative growth rates, the poor suffered proportionally a greater decline in their consumption compared to the non-poor”. Son H., H , Kakwani N., 2008: Global Estimates of Pro-Poor Growth. *World Development* Vol. 36, No. 6, pp. 1048–1066, 2008

¹⁸ Kraay, A., 2004. When is Growth Pro-Poor? Evidence from a Panel of Countries, *The World Bank, Policy Research Working Paper* No. 3225.

- *withdrawal of accumulated assets to relatively "safe" channels, either by flight abroad or into real estate; and*
- *the inability of governments to serve as basic agents in the kind of capital formation that is indispensable to economic growth.*

It is dangerous to argue that, because in the past foreign investment provided capital resources to spark satisfactory economic growth in some of the smaller European countries or in Europe's descendants across the seas, similar effects can be expected today if only the underdeveloped countries can be convinced of the need of a 'favourable climate'."

In this vein, among development circles it is currently commonly recognised that; *"The best way to reduce poverty is to provide people with opportunities to earn income through participation in the production process. Therefore, any strategy aimed at defeating food insecurity and poverty in the long run will have to be rooted in sustainable, broad-based economic growth and development"*¹⁹.

The qualification of the growth as "broad-based",²⁰ is of fundamental importance: only growth processes which include the large majority of individuals and households are assumed to be poverty reducing. However, it is not always clear whether this "broad-based" growth, considered "pro-poor", has to lead to a reduction of absolute poverty, as measured on the basis of some sort of "absolute" poverty line or: whether it also leads to a reduction of the relative poverty, i.e. poverty measured on the basis of some sort of income or expenditure inequality index. This issue is reported in literature as the debate on the definition of "pro-poor growth".

Lopez (2004) summarises the debate, identifying two main positions:

- The first definition of pro-poor growth focuses solely on the link between poverty and growth: growth is pro-poor if it reduces poverty, where poverty is defined on the basis of some absolute criterion²¹. This is the view supported by Ravallion (2004)²², for example.
- The second definition, as presented in Kakwani and Pernia (2000), qualifies growth as *"pro-poor only if, in the growth process, "the poor benefit proportionally more than the non-poor, i.e. growth results in a re-distribution in favour of the poor"*; explicitly admitting that there may be growth processes that cannot be characterised as "pro-poor even if they instigate a reduction of poverty incidence. This means that it is not absolute poverty which matters, but relative poverty.

The definition provided by Kakwani and Pernia, while being more difficult to meet, looks more attractive in the long term as relative income inequality has implications for non-income aspects relevant to well-being, such as the position of each individual (or household) within the society; her/his empowerment, the actual, effective role and functioning of institutions, including the way participation and democracy effectively work. Strong income inequality,

¹⁹ Kidane,W, Maetz, M., 2006. Food Security and Agricultural Development in Sub-Saharan Africa: Building a Case for More Public Support. [EASYPol Module 211](#), Policy Assistance Series 2, FAO, Rome, Italy.

²⁰ The use of the term "broad-based" firstly appeared in the World Development Report 1990: World Bank (1990), Washington D.C.

²¹ For a discussion on absolute versus relative poverty, see, e.g. Bellù L.G., Liberati P., 2005. Impacts of Policies on Poverty The Definition of Poverty. [EASYPol Module 004](#), FAO, Rome, Italy..

²² Ravallion, M.. 2004. *Pro-Poor Growth: A Primer*. Washington ,D.C.: Development Research Group, The World Bank.

may indeed lead to an erosion of the substance of any democratic institution, given the objective disparities of power of the different members of a society. Analysing poverty and informing policy processes by making use of relative rather than absolute poverty, may also help to capture “...a wider range of factors such as powerlessness, survival, personal dignity, security, self-respect ...” (Carvalho and White 1997)²³ which are usually taken into account by qualitative rather than quantitative approaches for poverty analysis.

As a concluding remark on the links between growth and poverty reduction, it is worth mentioning the findings of De Janvry and Sadoulet (1998)²⁴. After analysing the causal relationships between growth and poverty by means of econometric analysis on a panel of twelve Latin American countries between 1970 and 1994, they conclude that “*Growth only reduces urban and rural poverty if the initial levels of inequality and poverty are not too high. In the Latin American countries where this is not satisfied, growth is totally ineffective in reducing poverty/inequality*”. In other words, ‘growth’ (without any qualifier) is good for poverty (and inequality) only if we are not talking about ‘serious’ poverty (and inequality).

b. Agricultural development versus economic growth

In an economic system, some sectors more than others play the important role of “engines of growth”. It is commonly recognised that the development of the agricultural sector is particularly important in less industrialised countries to support the general economic growth for different reasons, such as:

- a) The agricultural sector is integrated down-stream as it supplies primary commodities to selected national value chains (agro-industry, textile, and more recently, bio-fuels), thus allowing national value added generation and distribution;
- b) It distributes income to people whose consumption patterns are primarily orientated towards nationally produced commodities, giving rise to multiplier effects;
- c) It produces food for the national market, contributing to food availability at national level, so reducing or zero-ing the need to import these necessary items and contributing to keep food prices acceptably low to feed the labour force in other sectors.
- d) May provide foreign currency by means of agricultural exports, allowing the import of industrial goods and including capital equipment for the industrial sector;
- e) It is a main source of a low-cost labour force, whenever the technological changes in agriculture induce the release of labour which becomes available to industry and services.
- f) Contributes to generate savings within the economic system which can finance the generation and/or consolidation of the industrial sector.

These arguments are based on findings of a conspicuous mass of studies on agricultural development and growth, carried out in the last sixty years²⁵.

²³ Carvalho, S., White H., 1997. Combining the Quantitative and Qualitative Approach to Poverty Measurement and Analysis. The Practice and the Potential. *World Bank Technical Paper 366*.

²⁴ De Janvry, A. Sadoulet, E., 1998. Growth, Poverty, and Inequality in Latin America: A Causal Analysis, 1970-1994. *Department of Agricultural and Resource Economics Working Paper no.784*. Berkeley, University of California USA.

²⁵ For a comprehensive treatment of the theory of the growth of the agricultural sector within the context of a growing economy see e.g. : Mundlak, Y., 2000. *Agriculture and Economic Growth Theory and Measurement*. Harvard University Press, USA.

Just after the Second World War, the wisdom of ‘agriculture’ (broadly intended as a set of traditional, subsistence and rural activities) as an ancillary sector functional to the development of the more ‘modern’ industrial sector, started consolidating.

The Nobel Prize winner Arthur Lewis, in the fifties pioneered the exploration of the industrialisation process of a dualistic economic system, characterised by two sectors: “*subsistence*” sector and “*capitalistic*” sector, with “*unlimited*” supply of labour, flowing from the first to the second:

“ In many economies an unlimited supply of labour is available at a subsistence wage.....The main sources from which workers come, as economic development proceeds, are subsistence agriculture, casual labour, petty trade, domestic service, wives and daughters in the household, and the increase of population....In such an economy employment expands in a capitalist sector as capital formation occurs.... Capital formation and technical progress result not in raising wages, but in raising the share of profits in the national income.As the capitalist sector expands, profits grow relatively, and an increasing proportion of national income is re-invested.... The capitalist sector cannot expand in these ways indefinitely, since capital accumulation can proceed faster than population can grow. When the surplus is exhausted, wages begin to rise above the subsistence level.... The country is still, however, surrounded by other countries which have surplus labour. Accordingly as soon as its wages begin to rise, mass immigration and the export of capital operate to check the rise. ... The importation of foreign capital does not raise real wages in countries which have surplus labour, unless the capital results in increased productivity in the commodities which they produce for their own consumption.Practically all the benefit of increasing efficiency in export industries goes to the foreign consumer; whereas raising efficiency in subsistence food production would automatically make commercial produce dearer” (Arthur Lewis - 1954)²⁶ „

The existence of this “reserve army”, concentrated in rural areas (generically referred to as “agriculture” by many authors) kept inspiring in the sixties the traditional view of the link between agriculture and growth, according to which a “developing” economy is a “dual” system where a “dynamic” industrial sector is associated with a more “traditional” agricultural sector. However, very often, the “traditional sector” was not seen only as a “reservoir” of labour, but more generally as a source of “surpluses” (variously defined as for example, savings, excess labour force, inputs, food etc), to be extracted and put at the service of the “modern” (industrial, urban) sector. Technology and productivity enhancements in the “agricultural” sector allow for the generating of “surpluses” that feed the evolution of the industrial sector. For example Kutznets (1964)²⁷, in describing the role of agriculture and related policies in such a “dual” system, highlights that it is important to identify ways for extracting the agricultural “surplus” to finance industrial capital formation without hampering the growth pattern of the agricultural sector itself.

Fei and Ranis (1964)²⁸ proposed a dual-economy model where the economic system goes through subsequent phases of development determined by productivity changes in agriculture:

²⁶ Lewis, W. A., 1954. Economic Development with Unlimited Supplies of Labour, The Manchester School, Vol. 22, pp. 139–191.

²⁷ Kutznets, S., 1964. Economic Growth and the Contribution of Agriculture: Notes for Measurement In C. Eicher and L. Witts: *Agriculture in Economic Development*. New York. McGraw-Hill, USA.

a) in the absence of any technological change in agriculture, labour is in excess supply and its marginal productivity is zero; in this phase labour may be supplied to the industrial sector without any loss of agricultural output. b) technological changes in agriculture improve the marginal productivity of labour so that it becomes positive but less than the real wage. In this case labour flows to the industrial sector with some loss of agricultural output.

Jorgenson (1967)²⁹, adopting an analytical framework similar to that of Fei and Ranis, added emphasis to the role of the agricultural surplus as a generator of savings, which in turn allowed capital accumulation and consequent expansion of the economic system. By comparing the “classical” approach to the development of a dual economy and the “neoclassical” one, he first highlights that: “*the chief difference between these two approaches to the development of a dual economy is in conditions governing the supply of labour to the industrial sector. In the classical approach to the theory[...] labour is available in unlimited amounts at a fixed real wage. In the neo-classical approach labour is never available to the industrial sector without sacrificing agricultural output*”. In spite of these differences regarding the supply of labour, according to Jorgenson, both theories converge on the fact that: “*the central fact of economic development is capital accumulation (including knowledge and skills with capital)*”. However: “*... Disguised unemployment is neither necessary nor sufficient to generate a sustained rise in the share of saving. Ultimately, a sustained increase in the saving share depends on a positive and growing agricultural surplus and not on the presence or absence of disguised unemployment*”.

Dixit (1970)³⁰, as a follow-up to the work of Jorgenson, puts forward the idea that in a dual/labour-surplus economy, technical progress as well as capital accumulation in ‘agriculture’ could allow this labour to become productive. This implies that the level of employment at which the marginal product of labour becomes zero (assuming diminishing productivity of labour) could be moved forward to a point where all the agricultural labour force is productively absorbed. Therefore, technical progress and capital accumulation in agriculture could prevent the decline of agricultural employment and its transfer to the industrial sector. This consideration gives a ‘new dignity’ to the ‘agricultural’ sector, not perceived any more as completely ancillary to the rest of the economic system, rather as a sector whose development, by means of technical progress and capital accumulation, can contribute to productive job creation and overall well-being.

‘New dignity’ to the agricultural sector, intended as ‘rural space’, was also provided by the work of Harris and Todaro (1970)³¹. In a different conceptual context, characterised by unemployment in the ‘modern’ sector, they developed a dualistic labour market model on the basis of which some paradigms of the relationships between the agricultural and the industrial sectors needed to be revisited. Productivity improvements in the agricultural sector (considered there as the rural space) were no longer seen as devices allowing the release of

²⁸ Fei, J. C. H., and Ranis, G., 1964. *Development of the Labour Surplus Economy*, Homewood: Irwin,

²⁹ Jorgenson D., W., 1967. Surplus Agricultural Labour and the Development of a Dual Economy *Oxford Economic Papers*.1967; 19: 288-312

³⁰ Dixit, A., 1970. Growth Patterns in a Dual Economy ', *Oxford Economic Papers*, 22 (2) July 1970, pp. 229-33.

³¹ Harris, J. R., and Todaro, 1970. M . P., Migration, Unemployment and Development: A Two-Sector Analysis, *The American Economic Review*, 60 (1), Mar. 1970, pp. 126-42.

labour from agriculture towards the industrial sector, but rather as devices to keep labour in rural areas, thus reducing unemployment in industrial (urban) ones. According to this model, the rural areas release labour up to a point where the expectations regarding the wage differentials between rural and urban areas are offset by the probability of falling unemployment in the urban areas. Therefore, a direct policy implication is that promoting the development of activities in rural areas could reduce the wage differentials between rural and urban areas and, by way of consequence, unemployment in the industrial (urban) sector.

Morrison and Thorbecke (1990)³² provide a rigorous definition of the “agricultural surplus” and a methodology to measure it. They make use of a Social Accounting Matrix framework, where all the accounts (activities/commodities, factors, institutions and Rest of the World) are separated into agriculture and non-agriculture³³. The net domestic flows of goods and factors from agriculture to non-agriculture are computed, to get the “domestic agricultural surplus”. Also, the “foreign agricultural surplus”, as the difference between exports and imports of agriculture, is calculated. The sum of domestic and foreign surplus constitutes the total surplus. Adopting this definition allows for a measuring of the contributions of agriculture to growth. In addition, it allows an assessment of the impacts of policies favouring technological changes in agriculture.

Chow (1993)³⁴, with reference to China, highlights that the development strategy from the beginning of the fifties to the end of the eighties was characterised by capital accumulation at the expense of consumption, essentially by peasants, and promotion of industry at the expense of agriculture. This strategy, which led to investing a large share of national output, especially into heavy industry, generated significant growth rates (around 6% annum) over almost forty years. In the absence of substantial technological changes in agriculture, this has apparently been an industry-led long-term growth, with prices of agricultural goods growing much faster than the industrial ones, essentially to absorb excess demand for agriculture and excess supply for industry. Apparently, the Chinese case confirms the paradigm that wants “agriculture” as a supplier of “surplus” to the industrial sector. In the absence of significant technological changes in agriculture, this transfer had to occur at the expense of consumption in rural areas. The peculiar institutional settings of China, i.e. autocratic and centrally planned, might have favoured inter-sectoral surplus transfers even if not supported by increased agricultural surplus generation. However, the long term rise of the relative prices of agricultural goods has partially reduced the net transfers from the agricultural sector towards the industrial one.

As inter-sectoral transfers of surplus occur both via physical flows of commodities and services, but also via changes in relative prices of agricultural goods and services w.r.t. industrial ones, to assess the role of agriculture in supporting the expansion of industry it is important to capture both components. Winters et al (1997)³⁵ call them “visible” and “invisible” surpluses. They revisited the SAM approach followed by Morrison and Thorbecke, where construction was based on fixed prices, and adopted a SAM-based CGE

³² Morrison C., E. Thorbecke, 1990. The Concept of Agricultural Surplus. *World Development* 18 (8) 1081-1095

³³ Indeed, the separation adopted, specifically for households, reflects more the geographic location : “urban” and “rural”.

³⁴ Gregory C. Chow, 1993. Capital Formation and Economic Growth in China. *The Quarterly Journal of Economics*, Vol. 108, No. 3 (Aug., 1993), pp. 809-842

³⁵ Winters, P., De Janvry A., Sadoulet E., Stamoulis K, 1996. The Role Of Agriculture In Economic Development: Visible And Invisible Surplus Transfers Department of Resource *Economics Working Paper n 143*.

approach with flexible prices. Starting with an “archetype” SAM for a “typical” African country developed by Sadoulet et al (1992)³⁶, they built up a two-sector model and used it to calculate the change in the “visible” and “invisible” agricultural surplus generated by a 10% increase of total factor productivity. They found that, in the base case, the agricultural surplus is small, representing around 0.4 % of the GDP, as in the archetype SAM for Africa (and in reality as well); the level of interaction between agriculture and non-agriculture is weak. The 10% increase of agricultural productivity gives rise to a change in the surplus transfer of around 1% of GDP. The relevant finding however is that the “invisible” transfer (via changes in relative prices) exceeds by far (around four times) the “visible” one.

More recently, in the line traced by Johnston and Mellor (1961)³⁷, Anriquez and Stamoulis (2007) revisited the role of agriculture as an engine of growth providing new evidence to the importance of “backward” and “forward” linkages of the sector. They calculate for a sample of 26 low-middle income countries, backward and forward linkage indexes³⁸ and emphasise that, in earlier stages of development, agriculture plays an important developmental role thanks to its backward linkages. This opposes the historical wisdom (see e.g. Hirschman, 1958) that denied agricultural development the role of ‘engine of growth’ due to its weak backward linkages with the rest of the economy³⁹.

Even if it is difficult to infer any conclusive judgement, given the quantity and complexity of the literature on the links between agriculture and growth, the feeling is that most of it moves within the ‘growth paradigm’ traced by Rostow (1960)⁴⁰ where a somehow ‘deterministic’ growth path in five “stages” was traced. It was essentially based on the history of western countries, from, “*the traditional society*” to “*the age of mass-consumption*”, through “*the pre-conditions to take off*”, “*the take off*” and “*the drive to maturity*”.

Whether the abovementioned “*five stages*” of growth are still the appropriate key to interpret the present and future evolution of currently less industrialised countries is an open question. But, taking for granted the “*five stages*”, technological changes in agriculture (or some surrogate shortcut, as in the case of China), can be seen as “*pre-condition to take off*”, which allows the sector to increasingly generate surplus that feeds the industrial sector.

³⁶ Sadoulet E., Subramanian S. and De Janvry A. 1992. *Adjusting to a Food Price increase in the context of Stabilization Policies : An Analysis Using Archetype Financial CGE for Developing Countries*. Report prepared for the World Bank.

³⁷ Anriquez, G., Stamoulis, K. 2007. Rural Development and Poverty Reduction: Is Agriculture Still a Key? e-JADE, FAO- Rome.

Johnston B,F and Mellor J,W. 1961 : The Role of Agriculture in Economic Development, *American Economic Review* 51(4): 566-593, 1961

³⁸ In an Input-Output (I-O) context, as in the one adopted by the authors, “*backward linkages*” are the relationships of a sector with the other sectors via its input requirements; “*forward linkages*” instead refer to relationships of a sector with the others by means of the absorption of the sector’s outputs downstream. The authors work out backward and forward linkages of the agricultural sector as first-round multipliers, i.e. “attenuated” Leontief multipliers which rule out second to nth-round effects, on the assumption that these further effects may not be realised due to frictions in the economic system or structural changes occurring during the adjustment process. In addition, these effects are weighted with the relative importance within the economy of the sectors providing the input or adsorbing the output. For more details on these indicators, see Anriquez et al, 2003: Anriquez G, Foster, W, Valdéz A., 2003: *Agricultural Growth Linkages and the Sector’s Role as Buffer*. Roles of Agriculture Project. FAO. Rome. Italy.

³⁹ Hirschman, A., O., 1958: *The Strategy of Economic Development*, Yale University Press, New Haven, Connecticut.

⁴⁰ Rostow W.,W., 1960. *The Stages of Economic Growth*. A Non-Communist Manifesto. First Edition. Cambridge University Press.

However, an additional open question is, under which conditions can this surplus be retained by national economies in order to feed their development process in a globalised environment; characterised by strong interdependencies, but also by deep asymmetries (know-how, technology, market power etc) and strong global constraints (one for all, the concerns for climate change)?

A further question, still open, is whether these technological changes able to generate additional surplus, have to be exogenous, as suggested by Rostow and other supporters of “*technology transfers*”, or have to be endogenous, i.e. based on domestic investment on knowledge, as suggested e.g. by Romer (1986)⁴¹ and other “endogenous growth” supporters.

c. Agricultural development and technological changes versus Poverty reduction

The direct link between agricultural development and economic growth discussed above is still of actual concern, as many less industrialised countries produce large shares of their GDP in the agricultural sector. However, in the last decade, in the mainstream of the debate on pro-poor growth, the focus shifted somewhat from the direct linkages between agricultural development and growth, to the role of agricultural development for poverty reduction. From the announcement of the Millennium Development Goals onward, the main question addressed by the ‘development community’ has been how to promote sustainable, “broad-based” economic growth and development in less industrialised countries to achieve poverty reduction. An ancillary question has been to what extent agricultural development is the good - or even the best - tool to fight poverty. In other words, is agriculture really the most promising sector for the achievement of poverty reduction (and, possibly, eradication)?

To answer this question, several economists were engaged in exploring links between agricultural development and poverty reduction, mainly using SAM-based multiplier approaches⁴², CGE models and econometric analysis on international panel data.

In order to explain the differences in income inequality across countries, Bourguignon and Morrison (1998)⁴³ carried out some econometric estimates using a sample of 38 less industrialized countries between 1970 and 1985. They found that the dualism between agriculture and the rest of the economy still explains most of the income inequality, concluding that “*in many countries increasing the level of productivity in traditional agriculture may have become the most efficient way of reducing inequality and poverty*”.

Mellors (2001), with reference to Pakistan, states that: “*The poor in rural areas are heavily concentrated in the rural non-farm sector. They produce non-tradable goods and services. That is, local demand is essential to their growth. It is rising agricultural incomes that*

⁴¹ Romer P., M., 1986. Increasing Returns and Long-Run Growth Author(s). *The Journal of Political Economy*, Vol. 94, No. 5 (Oct., 1986), pp. 1002-1037

⁴² Multiplier analysis has been developed by Pyatt, G and J I Round, 1979. Accounting and Fixed Price Multipliers in a SAM Framework. *Economic Journal*, 89 (356): 850-873. An application of a detailed multiplier analysis can be found in: Khan, H.A. (1999). Sectoral Growth and Poverty Alleviation: A Multiplier Decomposition Technique Applied to South Africa. *World Development*.

⁴³ Bourguignon, F., Morrison, C., 1998. Inequality and Development: The Role of Dualism. *Journal of Development Economics* 57:2, 33-57.

provide that growth in local demand. Thus, agriculture's massive impact on poverty is indirect, working through expenditures on the rural non-farm sector". Analogous findings, mutatis mutandis, are reported by Ryan & Miller (2003) who carry out a CGE-based analysis, for Chile⁴⁴.

Thirtle et al (2003)⁴⁵, after analysing data on 59 countries by means of an econometric model adopted to keep in account the causal chain between agricultural R&D, agricultural productivity growth, GDP per capita, inequality and poverty reduction; find that agricultural productivity growth has a substantial impact on poverty reduction, whereas productivity growth in industry and services does not.

Timmer (1997, 2002, 2003)⁴⁶ highlights that the impact of agricultural growth on poverty depends upon the way the poor are connected to growth (the so called "elasticity of connection" of poverty to growth) and by a country's income distribution. "With highly unequal distributions of income, caused to a substantial extent by highly unequal land ownership, agricultural growth actually seems to exacerbate poverty. By contrast, when a country's income distribution is relatively equal, agricultural growth stimulates the rest of the economy at the same time that it strengthens the connection of the poor to that more rapid growth" (Timmer 2003).

Aghion and Armendariz (2004), reporting the results of Datt and Ravallion (1998) and Todaro and Smith (2003), with reference to India, highlighted the technological changes in agriculture (notably the so called Green Revolution), which played a fundamental role in poverty reduction.⁴⁷

Byerlee et al. (2005), in summarising the findings of twelve country case studies on "how to operationalize pro-poor growth", suggest that agriculture impacts on poverty reduction also by means of generation of direct income, in particular from exports. According to them, macro economic and agricultural reforms in the nineties led to a substantial reduction of poverty among crop producers in selected countries such as Vietnam, Uganda, Ghana,

⁴⁴ Raúl O'Ryan, Sebastián Miller, 2003. *The Role of Agriculture in Poverty Alleviation, Income Distribution and Economic Development: A CGE Analysis for Chile*. Roles of Agriculture (ROA) project FAO-UN Rome.

⁴⁵ Thirtle C., Lin L. & Piesse, J, 2003. The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America. *World Development, Elsevier, vol. 31(12)*, pages 1959-1975, December.

⁴⁶ Timmer, C.P. 1997. *How Well Do the Poor Connect to the Growth Process?* Cambridge, Mass., USA, Harvard Institute for International Development

Timmer, C.P., 2002. Agriculture and Economic Development. In: Gardner, B. and Rausser, G.(Eds.), *Handbook of Agricultural Economics*. Elsevier Science, Amsterdam, North Holland.

Timmer, C.P., 2003. *Agriculture and Pro-Poor Growth. The Pro-Poor Economic Growth Research Studies*. Boston Institute for Developing Economies.

⁴⁷ Aghion P., Armendáriz B., 2004. Report the findings of Todaro and Smith, 2003. After the green revolution of the late 1960s and early 1970s, agricultural production started increasing at an annual rate of 3%. This was largely due to improvements in agricultural technologies and irrigation systems...". Datt and Ravallion, 1998, who, combining data from 24 household sample surveys spanning 35 years with other sources, found that "higher farm productivity brought both absolute and relative gains to poor rural households". See:

Aghion P., Armendáriz B., 2004. *A New Growth Approach to Poverty Alleviation*. Mimeo Harvard University.

Todaro, M, and Smith, S., 2003. *Economic Development*, Essex, Pearson Education Limited..

Datt G., Ravallion M., 1988. Farm Productivity and Rural Poverty in India, FCND *Discussion Paper No. 42* International Food Policy Research Institute. Washington, D.C.

Zambia and Burkina Faso, because “*devaluation, removal of export taxes and ... the closing of para-statal marketing boards have substantially improved the incentives for traditional export crops such as coffee and cotton. ... Not surprisingly, farmers producing export crops experienced the fastest pace of poverty reduction*”⁴⁸. However, they have to admit the fragility of this channel for poverty reduction, due specifically to international price shocks and their limited geographical impact: “*...poverty levels in Ugandan coffee areas declined by 50 percent between 1992 and 1999 (although they rose again with the collapse of coffee prices in recent years)... The effects on pro-poor growth have often been narrowly confined to areas with suitable agro-climatic conditions and/or access to infrastructure*”.

Others (e.g. FAO 2009) highlight how poverty is positively affected by agricultural development, specifically by productivity shifts due to investment in infrastructure and R&D, leading to the consequent reduction in prices of staple food consumed by the poor⁴⁹.

The conventional wisdom on the role of agriculture for poverty reduction is well summarised by Byerlee et al. (2005): “*mass of evidence [is] already available on the central role of increasing agricultural productivity on pro-poor growth, especially in the early stages of development, and especially if productivity growth is transmitted to lower food prices. ... Given widespread household food insecurity, the major challenge in Africa is how to stimulate broad-based productivity growth in food staples and sustain overall productivity gains over decades, if the Asian record of poverty reduction is to be repeated*”.

However, based on the analysis of Latin-American countries, De Janvry and Sadoulet (2000)⁵⁰ highlight that there is no ‘one fits all’ strategy to reduce poverty, particularly rural poverty, as the rural poor are highly diversified. “*Heterogeneous access to assets, heterogeneous exposure to market failures and to institutional gaps and heterogeneous access to public goods induce income earning strategies that are highly diverse across households*”. This in particular, implies that off-farm activities, including migration, generating complementary income to the agricultural income, is important for many households, and indeed, for some of them, constitutes a valid exit strategy from poverty⁵¹.

d. Influence of external factors on growth, poverty, technological changes and agricultural development

The question why for some countries it looks extremely difficult “*to get a seat on the development bus*”, i.e. get out of persistent poverty, extreme inequality, latent or explicit lasting conflicts, diffused food and health insecurity etc, has been puzzling economists (and

⁴⁸ Byerlee et al., 2005. Agriculture, Rural Development, and Pro-Poor Growth. Country Experiences in the Post-Reform Era. Pp.20-21. *Agriculture and Rural Development Discussion Paper 21*, The World Bank Washington D.C., USA.

⁴⁹ FAO 2009: *The State of Food and Insecurity (SOFI) 2009*. FAO Rome, Italy.

⁵⁰ De Janvry A., Sadoulet E., 2000. Rural Poverty in Latin America: Determinants and Exit Paths, *Food Policy*, 25, 389-409

⁵¹ On the links between agriculture and poverty reduction in a longer term perspective see also Hazell, P. , 1999. *Agricultural Growth, Poverty Alleviation, and Environmental Sustainability: Having it All*, IFPRI, Washington D.C. and Hazell, P. and Haggeblade, S., 1993. Farm/Non-Farm Growth Linkages and the Welfare of the Poor. In: Lipton, M. and van de Gaag, J. (Eds.), *Including the Poor*. The World Bank, Washington, D.C.

non-economists as well) for many decades. Development (or “non-development”) processes do not happen in a “vacuum” but are affected by and intrinsically linked to the environment in which they occur. Therefore, it is wise to wonder how, why and to what extent external factors, and related external shocks, intended as sudden, significant and persistent variations of one or more of these factors; affect the development (or under-development) dynamics of selected countries or groups of countries. An associated question is why some economies are more resilient than others to external shocks thus remaining more stably on their growth path.

External factors influencing less industrialised economies are many and diverse and have been considered by different branches of economy, sociology and anthropology literature. All this makes it impossible to provide a comprehensive literature review. Nevertheless, an attempt will be made to focus on selected factors which more or less recently captured the attention of the development community. Among them, we can mention:

- **international trade-related factors**, such as international trade treaties (WTO membership and related clauses and conditions; bilateral trade agreements, regional groupings and associations, custom unions and free trade zones and other treaties and agreements directly influencing international trade);
- **Other international policy frameworks** (e.g.: international agreements constituting frameworks for national policies, such as MDGs, the “*Right to food*” convention, other human rights and international juridical engagements)⁵²;
- **Foreign Direct Investment (FDI)**;
- **Official Development Assistance(ODA)**;
- **International financial and monetary agreements** (Rules and regulations related to international financial transactions, borrowing, lending, monetary stability etc.)
- **Natural resource management agreements** (e.g. international watershed management and water use agreements).
- **Natural hazards** (such as floods, droughts, trans-boundary pests and diseases);

The implications, scope, short and long-term consequences of all the above-mentioned factors on national socio-economic systems are determined by: 1) the “state” of each specific country, both in the short-medium term (e.g. the potential volume of its international trade, quantity and quality of human and physical capital available, availability of natural resources) and in the long-term (e.g. geographic position, natural hazards etc.); and 2) the interactions occurring between domestic and international (foreign) actors.

Countries carry out domestic production/consumption activities and trade with their partners under the influence of the above mentioned factors. Indeed, those factors, together with a multitude of other domestic factors; such as the economic behaviour of domestic agents producers and consumers; the role played by the government; the degree of integration and homogeneity of the society; the state of infrastructures; the degree, effectiveness and enforceability of domestic legislation etc, all contribute to shape the performance of an economic system in the short, medium and long term.

⁵² On the importance of global policy frameworks for national development and national policy making processes see e.g. Cistulli (2007). Cistulli V. (2007) [*The Global Policy Environment: a Conceptual Framework*](#) . *EASYPol Module 06* 1FAO, Rome, Italy.

The links between internal and external factors in determining the performance of an economic system have been analysed from different perspectives in different periods. Following Gore (2000)⁵³ “*Before the propagation of the Washington Consensus in the 1980s, mainstream explanations of the development process [...] were conducted within a national frame of reference [...] (and) economic and social trends within countries were explained, in the mainstream on the basis of conditions within countries themselves, i.e. as a result of national factors*”. He highlights, however, that an important counter current came from the “structuralists” (particularly in Latin America), which focused on the importance of “centre-periphery” relations and the links between internal and external factors.

Structuralist economics originated within the Economic Commission for Latin America (ECLA) in the early fifties by the works of its director Raul Prebisch (1950)⁵⁴. Less industrialised countries have to rely on imports to get industrial, manufactured goods or services; such as capital equipment, domestic appliances, office equipment, cars etc. To countervail imports of manufactured goods and services they tend to specialise in one or a few export commodities, usually agricultural crops, but also other primary commodities like timber or ores. Prebisch argued that different sets of goods are produced by less industrialised countries from the industrialised ones. The weak institutions and low bargaining power in less-industrialized countries do not allow for starting up the process of accumulation of primary capital and the consequent development process. The so called “*Prebisch-Singer hypothesis*”⁵⁵, based on these considerations, argued that the degradation of terms of trade due to the different income elasticities of the two sets of goods, other things being equal, would progressively impoverish less industrialised countries to the advantage of the industrialized ones. This implies that countries should adopt a strategic behaviour towards the achievement of national objectives, using a mix of policies comprising selective openings associated with protective measures in sensitive areas (e.g. infant industry, minimum food stocks etc).

Since the 1980s, a radically different vision of the links between internal and external factors was adopted by economists adhering to the so called “Washington consensus”, as defined by Williamson (1990)⁵⁶. It was advocated and supported from the 1980s to the early 2000s in various forms and degrees by almost all bilateral and multilateral development agencies. In

⁵³ Gore, 2000. The Rise and Fall of the Washington Consensus as a Paradigm for Developing Countries. *World Development Vol 28 No 5 pp 789-804, 2000*

⁵⁴ Prebisch R. 1950. The Economic Development of Latin America and its Principal Problems. *United Nations Dept. of Economic Affairs, 1950.*

⁵⁵ For the work of Singer on trade and investment linkages and terms of trade see: Singer, 1950, and Singer, 1998.

Singer, H. W., 1950. The Distribution of Gains Between Investing and Borrowing Countries. *American Economic Review, Papers and Proceedings* 40 (2 (May), 473-485

Singer, 1998. *The Terms of Trade Fifty Years Late: Convergence and Divergence South Letter No. 30, Volume 1, 1998 The south centre* <http://www.southcentre.org>

⁵⁶ Williamson, 1990, defined a package of policy measures, specifically suitable for Latin American countries facing economic crises, comprising: 1) Fiscal discipline; 2) A redirection of public expenditure priorities towards fields offering both high economic returns and the potential to improve income distribution, such as primary health care, primary education, and infrastructure. 3) Tax reform (to lower marginal rates and broaden the tax base); 4) Interest rate liberalisation; 5) A competitive exchange rate; 6) Trade liberalisation; 7) Liberalisation of FDI inflows; 8) Privatisation. 9) Deregulation (in the sense of abolishing barriers to entry and exit). 10) Secure property rights.

Williamson, J., 1990, What Washington Means by Policy Reform, in J. Williamson, ed., *Latin American Adjustment: How Much Has Happened?*, Washington: Institute for International Economics.

particular, the prescriptions related to trade liberalisation, and liberalisation of inflows of Foreign Direct Investment (FDI), put a direct focus on the importance for an economic system to be “contaminated” by external factors. These would have to affect both capital accumulation processes (the FDI) and the sources and destination of goods and services, to be purchased or sold also on external markets.

According to this paradigm, international markets would always be available to absorb exports and provide imports at prices independent from the quantities of commodities traded. This applies in particular to “small countries”, which are typically price-takers as the volumes of commodities absorbed by or provided to foreign partners are negligible in respect of the total volumes traded on the international markets. In addition, foreign investment would complement domestic savings and would bring with it new ‘modern’ technologies, to the benefit of the less industrialised economies. Countries that adjust their domestic policies accordingly, would benefit from the new ‘globalised’ environment. Others which do not adjust would be marginalised from the ‘development’ mainstream.

Whether less industrialised countries should adhere to the ‘Washington consensus’ paradigm, somewhat revised in the later years to accommodate some social concerns, or should adopt other approaches based on ‘structuralist’ analysis, is an open question among development economists. Pingali (2006)⁵⁷ for example, attempts a nuanced answer to the question above. He browses some likely impacts of globalisation on agriculture, taking into account some relatively recent phenomena such as increased vertical integration, changing food production systems and technologies and the role of supermarkets. He adopts a (quite deterministic) tripartite classification of countries, i.e.: 1) *countries at the low end of the transformation process*; 2) *countries in the process of agricultural modernization*; 3) *countries at the high end of the transformation process*, and for each of the groups identifies some challenges and opportunities, concluding that: “*trade liberalization and global inter-connectedness poses new opportunities and challenges for developing countries...[but]... the transition will be poor to the extent that production and post harvest activities continue to be labour intensive and to the extent that there is an expansion in employment opportunities outside agriculture*”. In addition, “*trade liberalization should go hand in hand with public support for improving agriculture productivity*”.

Regarding the FDI, issues arise in relation to the institutional capacity of less-industrialised countries to retain a satisfactory share of value added and other ‘spill-over benefits’ generated by foreign-led companies. Even OECD (2002)⁵⁸, in a report prepared within the framework of the activities of the “*Committee on International Investment and Multinational Enterprises (CIME)*”, after putting a lot of emphasis on the benefits of FDI, had to admit that “*Potential drawbacks include a deterioration of the balance of payments as profits are repatriated (albeit often offset by incoming FDI), a lack of positive linkages with local communities, the potentially harmful environmental impact of FDI, especially in the extractive and heavy industries, social disruptions of accelerated commercialisation in less developed countries, and the effects on competition in national markets. Moreover, some host country authorities perceive an increasing dependence on internationally operating enterprises as representing a loss of political sovereignty*”. It is apparent that these drawbacks look even more severe in the

⁵⁷ Pingali P., 2006. *Agricultural Growth and Economic Development: A View Through the Globalization Lens*. FAO, Rome, Italy.

⁵⁸ OECD, 2002: *Foreign Direct Investment for Development: Maximizing Benefits, Minimizing Costs*. Paris, France.

absence of enforceable labour market regulations and trade unions, ability to set and maintain decent wage levels, and other civil society active components. These issues are also particularly relevant in the context of the recent wave of “land grabbing” in less industrialised countries by foreign investors and sovereign funds, on which FAO called for a ‘binding code of conduct’ (FAO, 2009)⁵⁹.

The relevance of FDI for national development should also be assessed in the light of the different strategies that foreign investors may adopt to bypass, or even violate, national legislations. Brealey and Myers, in their manual “*Principles of Corporate finance*”, widespread across Western universities for post graduate courses and MBAs, suggest some of them: “...*Multinational companies are always exposed to the criticism that they siphon funds out of countries in which they do business, and therefore, governments are tempted to limit their freedom to repatriate profits [...]. Here, once again, a little forethought can help. For example, there are often more onerous restrictions on the payments of dividends to the parent than on the payment of interest or principal on debt. So, it may be better for the parent to put up part of the funds in the form of a loan. Royalty payments and management fees are less politically sensitive than dividends, particularly if they are levied equally on all the foreign operations*”. Last but not least, “*A company can also, within limits, alter the price of goods that are bought or sold within the group and can require more or less prompt payment for such sales*”. Brealey and Myers (1991)⁶⁰.

More generally, some authors tend to de-emphasise the importance of international links for the economic performance of economic systems, attributing more importance to domestic factors. For example, Rodrik (1999)⁶¹, by means of some econometric work, analyses the dynamics of growth of several countries since 1975, trying to identify the determinants of economic performances. He emphasises, in particular, the manner in which social conflicts interact with external shock on the one hand, and the domestic institutions of conflict-management on the other. The idea is that “divided” societies, i.e. societies characterised by domestic dichotomies (ethnic, religious, social etc) insufficiently endowed with instruments for conflict management and resolution, are less resilient than others to external shocks, thus showing more erratic growth paths⁶².

Raddaz (2007)⁶³ following a more comprehensive approach going beyond the considerations of terms of trade only, found that external shocks, namely terms-of-trade variations, natural disasters and the international economic cycle⁶⁴ explain only a small fraction of performance variability of Low-Income countries. However Raddaz himself reports that Kose and Riezman

⁵⁹ FAO, 2009: From Land Grab to Win-Win. Economic and Social Perspectives. *Policy Brief 4*, June 2009
FAO, Rome, Italy.

⁶⁰ Brealey R.A. and Myers S.C, 1991. *Principles of Corporate Finance*, Fourth Edition (p. 880) Mc Graw Hill

⁶¹ Rodrik, D., 1999. Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses.
Journal of Economic Growth Volume 4, Number 4 / December, 1999

⁶² However the open question to this regard is to what extent domestic dichotomies, or at least their dramatic consequences on welfare in periods of crisis, could be considered endogenous tout court.

⁶³ Raddaz C., 2007. Are External Shocks Responsible for the Instability of Output in Low-Income Countries?
Journal of Development Economics 84 (2007) 155–187.

⁶⁴ The international cycle is measured on the basis of variations of the aggregated GDP of industrialized countries. Some counter-evidence on the importance of the international economic cycle can be found in FAO (2009), where emphasis is put on the role of remittances as a support to household incomes in rural areas.

(2001)⁶⁵, using calibrated general equilibrium small-open-economy models instead of econometric approaches, find that compared with interest rates and productivity shocks, terms-of-trade shocks can explain a large fraction (around 50%) of output fluctuations in low-income countries.

On the other hand, many authors, to a different degree, even if not always supporting the Prebisch-Singer hypothesis that was literally intended, emphasise the risks and drawbacks of commodity-dependent countries, implicitly or explicitly suggesting a more strategic approach to development, rather than a simple and blind adherence to the ‘Washington consensus’ approach.

For example, Gilbert (2006)⁶⁶ considers that; “*Relative to price of manufactured goods, primary commodity prices have exhibited a variable but steady downward trend over the past century*”. In addition he reports that Grilli and Yang (1988)⁶⁷ documented the long term decline of primary prices and shows a graph where the deflated IMF commodity index displays a 1.33% decline per annum between 1960 to 2003. After analysing price trends and volatility jointly, he concludes that “*the adverse price trend experienced by almost all the agricultural primary commodities [...] is problematic for primary producing developing countries because, with inelastic demand and elastic supply, the incidence of productivity advance is very largely on consumers, typically in developed countries. Collectively, developing countries have little incentive to undertake productivity-enhancing investments [...]. The result is that developing country farmers are forced to run fast in order to remain at the same place. Liberalization programmes, often sponsored by bilateral and multi-lateral development agencies have accelerated this process*”.

Also Cashin and Mc Dermot (2006)⁶⁸, analyse the secular trends of commodities. While refraining from any conclusive judgement about the validity of the Prebisch-Singer hypothesis, notably about the existence of any permanent downward trends in commodity prices, they conclude that, in any case, “*the long lasting variability of commodity prices is problematic, because ‘many developing countries continue to rely on a few commodities for the lion’s share of their export earnings. Therefore, a high degree of variability in commodity prices has serious consequences for commodity dependent countries. In particular, shifts in commodity prices are typically reflected in the terms of trade, real incomes and fiscal positions of commodity dependent countries*”. Small countries having, by definition, no power on the markets of the main commodities internationally traded, are assumed to be particularly vulnerable to external shocks, in particular to shocks directly affecting those markets, such as shortages or sudden price increases in import markets or decreases in export ones.

⁶⁵ Kose, M., Riezman, R., 2001. Trade Shocks and Macroeconomic Fluctuations in Africa. *Journal of Development Economics* 65, 55–80.

⁶⁶ Gilbert C. L., 2006. Trends and Volatility in Agricultural Commodity Prices. In *Agricultural Commodity markets and Trade: Analyzing Market Structure and Instability*. Edited by A Sarris and D. Hallam. FAO UN-Edward Elgar 2006.

⁶⁷ Grilli E.R. and Yang M.C., 1988: Primary Commodity Prices, Manufactured Goods Prices and the Terms of Trade of Developing Countries: What the Long Run Shows. *World Bank Economic Review* , 2, 1-47.

⁶⁸ Cashin P. and Mc Dermot C.J., 2006. Properties of International Commodity Prices: Identifying Trends, Cycles and Shocks. In *Agricultural Commodity markets and Trade: Analyzing Market Structure and Instability*. Edited by A Sarris and D. Hallam. FAO UN-Edward Elgar 2006.

The vulnerability of “small” countries is accentuated when they are “low” or “lower-middle” income countries⁶⁹. For example the World Bank (2004)⁷⁰ states that: “*Low-income countries are particularly vulnerable to natural disasters, terms-of-trade shocks and other adverse shocks*”. Among these countries, “Low-Income Food Deficit Countries” (LIFDC), as classified by FAO UN⁷¹ look even more vulnerable. These countries are considered particularly sensitive on food security grounds as their capacity to access food is directly dependent upon many factors such as: a) prices of food commodities on the international markets; b) prices of main export commodities on the international markets; c) macro-economic stability, including equilibrium of the balance of trade; d) efficiency of logistic facilities (transport, storage, distribution facilities etc); e) flexibility/resilience of domestic food sector to absorb or adapt to external shocks.

Flexibility and resilience of the domestic food sector and medium-long term equilibrium of the trade balance, are more difficult to achieve by those LIFDC which rely on imports for a significant part of their energy needs; particularly in situations where soaring oil bills due to increased oil and gas prices impose additional burden on the trade balance, domestic production costs and household budgets.

For LIFDC net energy importers, external shocks on main import-export markets may lead to a significant and sudden worsening of the terms of trade with significant consequences in terms of macro-economic stability and welfare of the population.

The international community has recently attributed great importance to external shocks as factors affecting the welfare of populations, due to “soaring food prices” in 2007-2008. This crisis was assumed to heavily affect poverty and food security in LIFDC⁷².

Much less emphasis, at least in terms of its impacts on development perspectives and welfare of LIFDC, was put on the soaring prices of energy (oil in particular) from 2003 to 2008. However, while net oil exporting countries experienced huge windfall profits in respect of the 2003 base price, as reported by Bellù (2007), net importing countries had to afford additional oil bills, ranging between 1 % of their GDP in 2006 for most OECD countries up to almost

⁶⁹ As classified by the World Bank (Atlas methodology), i.e. countries with a per capita Gross National Income (GNP) less than \$ 3,595 (classification 2008, based on 2006 data). See:

<http://siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls>

⁷⁰ World Bank, 2004: *Global Monitoring Report. Policies and Actions for Achieving the Millennium Development Goals and Related Outcomes*. World Bank, Washington, D.C.

⁷¹ FAO UN classifies as “*Low-Income Food Deficit Countries (LIFDC)*” those countries: a) classified by the World Bank as “International Development Agency (IDA) eligible and 20 years IBRD loans” (Operational Lending Category II, i.e. per capita GNI less than 1,735 US\$. Classification 2008 based on 2006 data); b) net (i.e. gross imports less gross exports) food trade position of a country averaged over the preceding three years. Trade volumes for a broad basket of basic foodstuffs (cereals, roots and tubers, pulses, oilseeds and oils other than tree crop oils, meat and dairy products) are converted and aggregated by the calorie content of individual commodities; c) Self-exclusion criterion (countries that meet the above two criteria but request to be excluded from the LIFDC category). See <http://www.fao.org/countryprofiles/lifdc.asp>

⁷² The FAO UN, in partnership with other organisations, launched in December 2007 the “Initiative for Soaring Food Prices” (ISFP), aimed at reducing food insecurity generated in LIFDC by increasing food prices. See (FAO, 2008), Initiative for Soaring Food Prices: programme document, May 2008 FAO, Rome. <http://www.fao.org/isfp/isfp-home/en/> The ISFP sustained, among other things, the “Emergency Rice Initiative” in 11 countries in West Africa: Benin, Burkina Faso, Cameroon, Côte d’Ivoire, Liberia, Mali, Mauritania, Nigeria, Senegal, Sierra Leone and Togo, aimed at “significantly increase their rice production as of 2008 and 2009,” (see Africa Rice Center (WARDA) www.warda.org)

5% for selected LIFDC⁷³. More than likely, these additional energy bills generated persistent macro-economic instability, decreased overall welfare of the population, increased poverty and hampered their long term development perspectives.

A closer view of a specific country case helps to better understand the joint impacts of these external shocks on growth, income distribution and poverty. In the next sections we explore the case of Burkina Faso, a LIFDC which has been recently considered by the international community as being among the “priority” countries for intervention to contrast negative food security consequences of soaring food prices.

4. THE CASE OF BURKINA FASO

Burkina Faso is a small, low-income food deficit country, a net importer of energy⁷⁴. In addition, given its dimensions, Burkina Faso can be considered as a price taker on all the international markets in which it operates. This implies that this country is particularly vulnerable to external shocks.

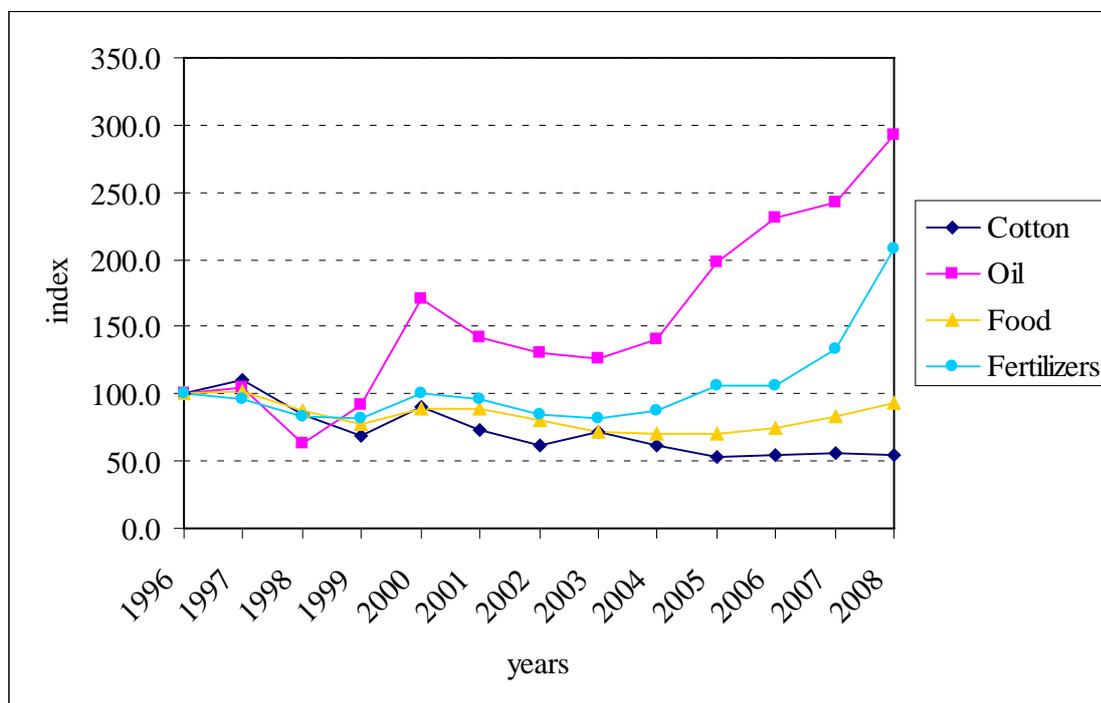
To see to what extent price shocks on international markets affected Burkina Faso, the prices faced by the country of the main import-export commodities have been analysed. The price indexes in the last twelve years of cotton (for exports) and food, energy and fertilisers for imports are reported in Figure 2. These indexes are based on international prices converted in local currency using annual average exchange rates and deflated with domestic GDP deflator (base year 2000). Given the impossibility of getting a complete time series of import and export prices for Burkina Faso, international nominal FOB prices in US dollars for fertilisers, cotton and oil were used as a starting point. The fertiliser price index is country specific, i.e. it was calculated on the basis of the prices of different types of fertilisers weighted with actual imports, derived from Customs data for 2005. Cotton, food and oil indexes are based on international composite prices⁷⁵.

⁷³ Bellù, 2007, reports that windfall profits in 2006 for example amounted to almost 16 % of GDP for Cameroon, 22% for Nigeria, 25% for Angola, 28% for Chad, up to almost 50% for Equatorial Guinea.

⁷⁴ Burkina Faso is also classified among the Least Developed Countries (LDC) by the UN and a “low-income” country also according to the classification of the World Bank.

⁷⁵ Adjustments of FOB prices with international freight costs to better reflect CIF prices were attempted on the basis of custom data 2005, reporting CIF prices 25% above FOB prices on average. These adjustments do not substantially change the overall picture and are not reported here.

Figure 2: Constant FOB price indexes for selected import and export commodities



Sources: Author’s calculations based on: Cotton index: “Cotlook A index”, Cotton Outlook (http://www.cotlook.com/information/cotlook_indices.php); Oil index: Composite Crude oil weighted by export volume. US Energy Information Administration <http://tonto.eia.doe.gov/dnav/pet/hist/wtotworldw.htm>; Food and fertilisers Indexes: FAO food price index and FAO (AGPC) indexes for various fertiliser types, UN Food and Agriculture Organization – Rome; GDP deflator and nominal average exchange rate FCFA/US\$: IMF World Outlook Database, <http://www.imf.org/external/pubs/ft/weo/2008/02/weodata/weoseigr.aspx>

In spite of the fact that Burkina Faso was unanimously considered by the international community as a country particularly affected by the food crisis in 2008, having to benefit from immediate international support, there is insubstantial evidence of long term increases of food import prices and domestic prices of main staple food (cereals). The aggregated food import price index, based on the FAO food composite index shows an upward trend only from 2005 onward, which, in any case, always remains below the 1996 level.

However, the weights of the different food commodities in that index may not necessarily reflect the appropriate weights for Burkina Faso. Therefore, in order to better assess the food price changes faced by Burkina Faso, a further investigation of the actual domestic market prices was necessary. A domestic price index of staple food (the four main cereals: millet, sorghum, maize and rice), was built for both urban and rural populations using as weights the shares of actual households’ expenditure, based on the most recent “household living standards survey”, as reported in table 1.

Table 1: Consumption shares (quantities) of staple cereals by household location

	Household		Average (LSMS)	Average (FBS-FAO)
	Urban	Rural		
Rice	30.1%	7.5%	11.0%	6.7%
Millet	12.8%	38.3%	34.3%	32.4%
Sorghum	13.7%	38.6%	34.8%	39.6%
Maize	43.4%	15.6%	19.9%	21.3%
Total	100.0%	100.0%	100.0%	100.0%

Source: “Enquête sur les conditions de vie des ménages-2003” Institut National de la Statistique et Démographie (INSD)- Ouagadougou. Average weights (FBS-FAO) based on Food Balance Sheets (FBS), FAOSTAT, Food and Agriculture Organization of United Nations, Rome.

The price composite indexes of main cereals for rural and urban households in the last twelve years are reported in Figure 3. Their inspection confirms that overall, cereal prices did not substantially grow in the last decade. Nevertheless, the aggregate staple food index is characterised by:

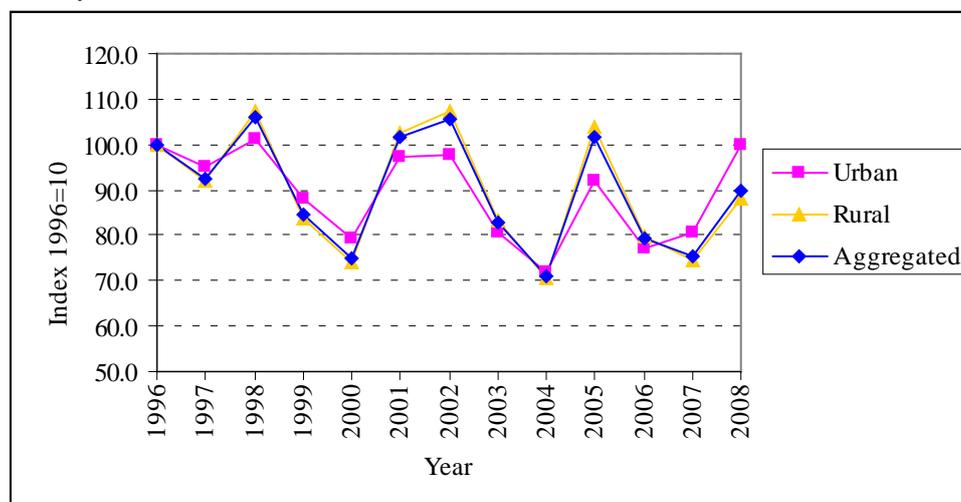
- a) Sharp oscillations, showing higher prices in some periods (1996, 1998, 2001-02, 2005) and lower prices in subsequent ones (1997, 2000, 2004, 2006).
- b) A significant increase (around 25%) from 2006 to 2008.

The absence of substantial shocks to the international food prices in real terms, i.e. at constant domestic prices until 2007, contributed to smooth domestic consumer prices of staple cereals. However on the one hand, rural households have been affected by greater price volatility than urban households, due to the higher share in consumption of domestic crops (more than 92%, comprising millet, sorghum and maize), characterised by more volatile prices (see table 1). On the other hand, since 2007, urban households experienced higher price increases instead due to the significant price increase of the imported component (30%, essentially rice).

Nevertheless, in spite of these oscillations, in 2008, *“the situation of food and nutrition of people is globally satisfactory. Even if prices are higher than those of last year, they are at a lower level than in 2005. The currently tend to stabilise, or even to drop on some markets.”* (Agrialerte, 2008)⁷⁶

⁷⁶ Translated from (Agrialerte,2008) Alerte sur la situation de la campagne agricole des régions - Burkina Faso N°023-22/07/2008 Direction Générale des Prévisions et des Statistiques Agricoles (DGPSA), Direction du Système l’Alerte Précoce (DSAP) Ouagadougou. Information System on Food Security (SISA) www.sisa.bf

Figure 3. Consumer price index for cereals in urban and rural households (prices 2000)



Source: Author’s calculations on data from the “*Direction Générale des Prévisions et Statistiques Agricoles – DGPSA*” Ouagadougou, for all prices, except: 1) price of Rice for 2007 (twelve months) and 2008 (period Jan-Mar): FAO report on Soaring food prices, May 2008. 2) Prices of millet, sorghum and white maize period Apr-Jul 2008: USAID, Famine Early Warning Systems Network (FEWSNET). West Africa Monthly bulletin of Cereal Prices, July 2008. 3) Consumer Price Index World Bank Development Indicators Database (2007 and 2008 refer to the GDP deflator). 4) Consumption weights for rural and urban households: Report on “*Enquête sur les conditions de vie des ménages-2003*” Institut National de la Statistique et Démographie (INSD)-Ouagadougou.

The relative stability of food prices strongly contrasts with the dramatic increase of real energy prices (essentially oil-based products and gas): they more than tripled since 1996. The long term growth of oil prices is associated with the more recent increase of fertiliser prices, which almost doubled in the last two years. On the other hand, the prices of cotton, the main export crop, following an almost steady long-term decline, fell in real terms by around 50%.

In order to assess the magnitude and depth of socio-economic impacts of these external shocks, it is necessary to explore the structure of the socio-economic system and the channels through which external shocks affect the economy. This will be done in two steps: 1) an analysis of selected macro-economic variables that will provide some insights into the importance of the main traded commodities; and 2) some simulations carried out with a Computable General Equilibrium model of the country that will allow assessment of the likely socio-economic impacts of these external shocks.

The following analyses will be based, among others, on the most recent Social Accounting Matrix (SAM) of Burkina Faso.⁷⁷ The SAM comprises 56 commodities, including 21 agricultural, 55 activities, five factors (agricultural labour, non agricultural labour, family labour, agricultural capital, non agricultural capital) four household groups (rural poor, rural non-poor, urban poor, urban non-poor), financial enterprises, non financial enterprises, plus

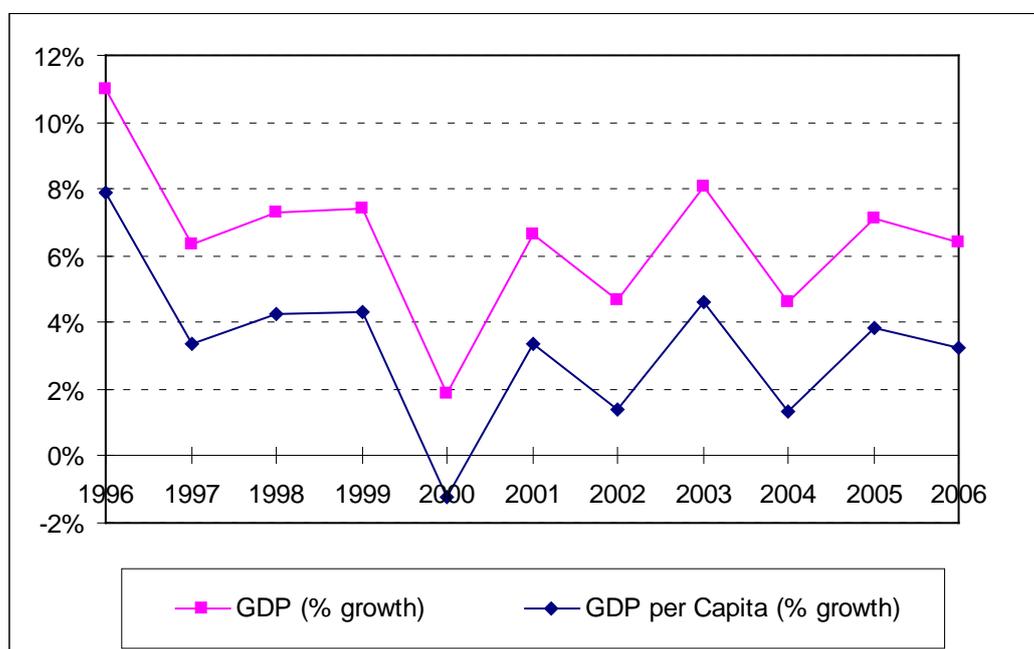
⁷⁷ Hebie, Mamadou, 2007. *Social Accounting Matrix of Burkina Faso, Year 2000*. Unpublished. Direction Générale des Statistiques et Prévisions Agricoles. Ministère de l’Agriculture, de l’Hydraulique et des Ressources Halieutiques (MAHRH). Ouagadougou. This is the only SAM available to date and was prepared in the context of a policy assistance project supported by FAO.

the government account, the Savings-Investment account and the Rest of The World (RoW). It is based on the year 2000's national accounts data, including input-output data for different sectors, and household expenditures have been calculated based on the Living Standards Survey 2003.

5. THE STRUCTURE OF THE NATIONAL ECONOMY

In the last decade, Burkina Faso has been characterised by non negligible annual GDP growth rates, ranging from 5% for GDP and 2% for GDP per capita (see Figure 1 above). The fastest growing sector was industry, (9.5% per year) followed by services (5.4%) and agriculture (less than 5%).

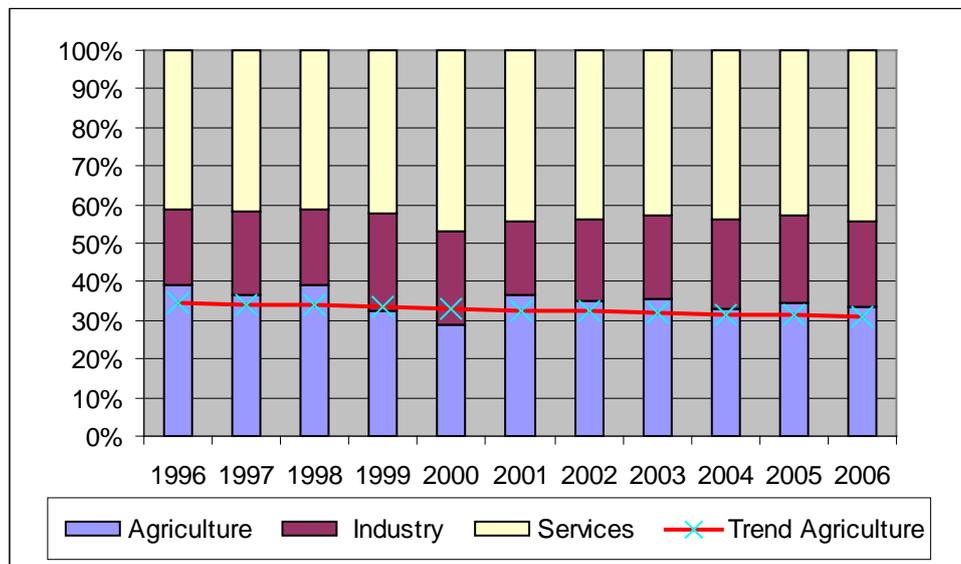
Figure 3: GDP and per capita GDP growth rates (GDP at constant FCFA)



Source: Own elaborations on: World Development Indicators, World Bank

As a consequence of this differentiated growth, Burkina Faso, as well as other countries in West Africa, is changing, little by little, its productive structure, where industry and services have more weight than agriculture.

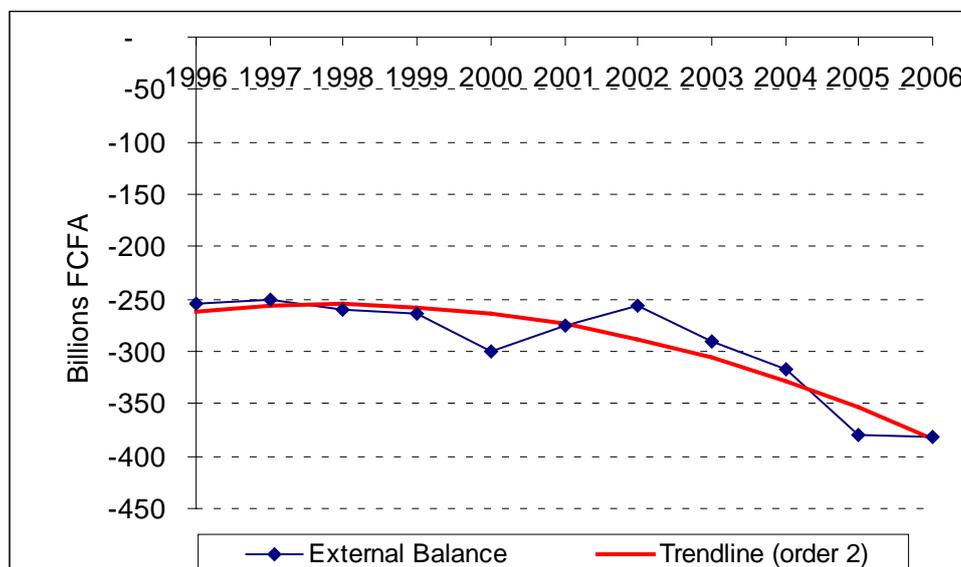
Figure 4: Value added by sector (shares of GDP, nominal).



Source: Author calculations on: World Development Indicators, World Bank.

The sustainability of growth is, however, jeopardised by external macro-economic imbalances. For example, the external balance of goods and services, which started recovering after 2000, significantly deteriorated in 2002, and a further increase of the deficit is expected for 2007.

Figure 5: External Balance of goods and services. Constant billions FCFA (year 2000)

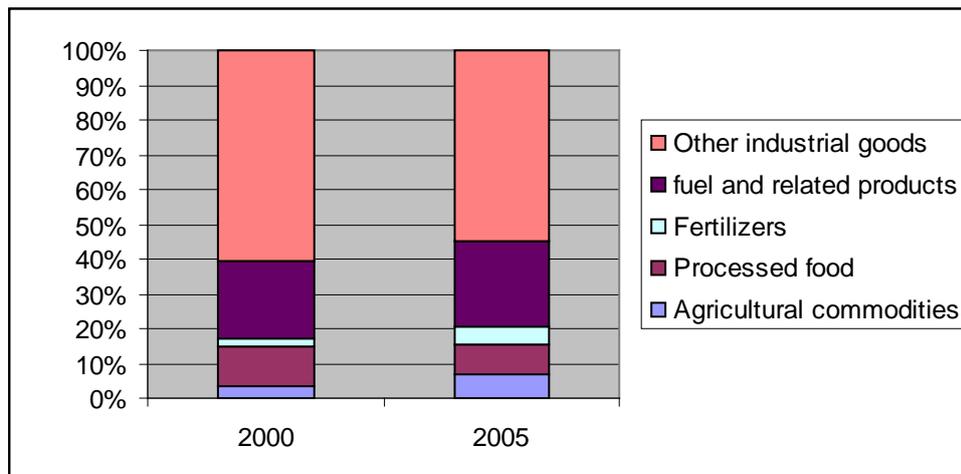


Source: Author's calculations on: World Development Indicators, World Bank (external balance in nominal FCFA) and IMF world outlook (GDP deflator at year 2000 prices).

This increased deficit is essentially due to imports growth no longer being compensated by exports.

The analysis of the structure of imports in the SAM 2000 and an inspection of custom data for 2005 reveals that the bulk of imports in the country comprises industrial goods, with a growing weight from 2000 to 2005 of chemicals; including fertilisers and pesticides, and oil-related energy products, as reported in Figure 3. Agricultural commodities and processed food items do not play a major role as they comprise around 15% of total imports. This situation looks quite stable in different years, as the only significant change between 2000 and 2005 is the increased weight of raw commodities with respect to processed food. This is essentially due to the increased imports of rice.

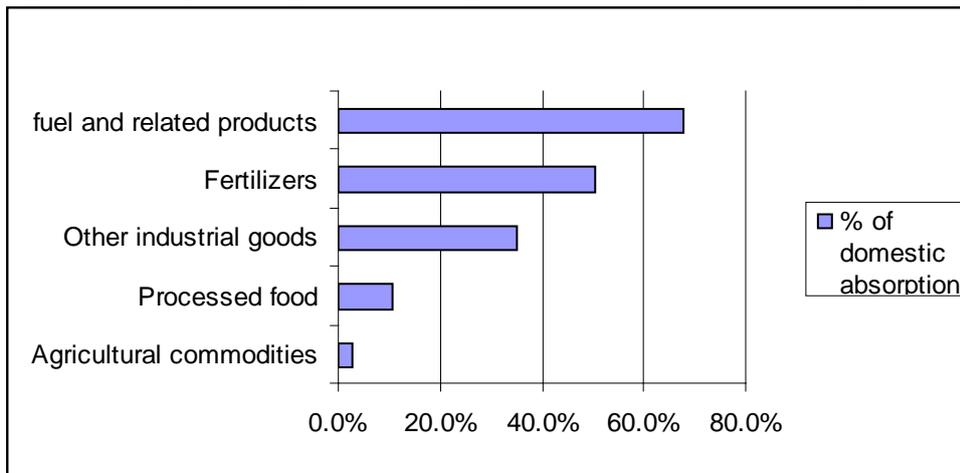
Figure 3: Imports by commodity as % of total imports (years 2000 and 2005)



Sources: Social Accounting Matrix for year 2000 and author elaborations on Customs data for year 2005.

Looking at the role of imports in respect of the domestic absorption, as reported in Figure 4, it is apparent that, overall, agricultural commodities and processed food imports are marginal related to the domestic output of the same commodities, as they represent less than 3% and 11% respectively of the total supply. In contrast, this is not the case for industrial goods, where imports cover almost 45% of the total supply. Specifically, fuel and fuel-related products are essentially totally imported (68% of the value of supply is imported, while the remaining 32% is due to domestic trade margins, taxes and distribution costs.

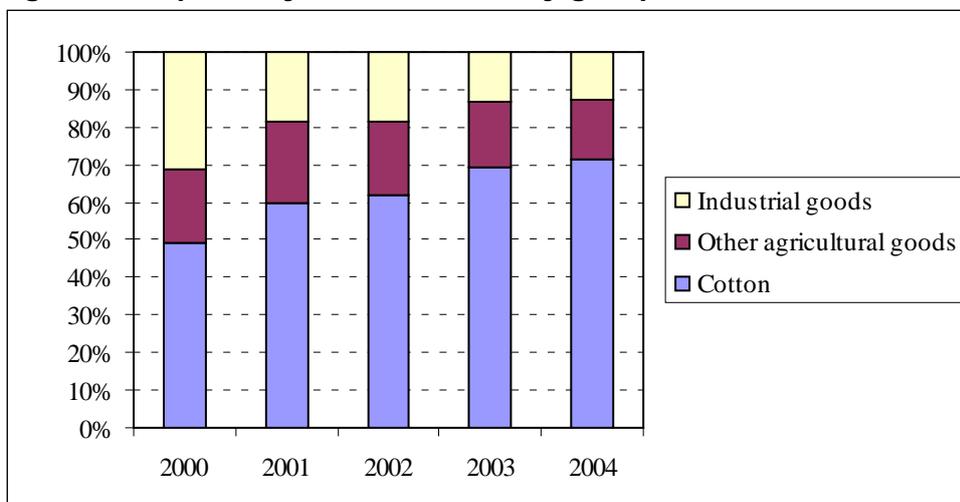
Figure 4: Imports by commodity, as % of domestic absorption, year 2000.



Source: Social Accounting Matrix, year 2000.

On the export side, Burkina Faso is almost a “single-commodity” trader. Cotton covers among 50% and 70% of export revenues in recent years, as reported in Figure 5.

Figure 5: Exports by main commodity groups.



Source: Year 2000: SAM-Burkina. Years 2001 to 2004: Author’s calculations on data from: International Trade Centre UNCTAD/WTO <http://www.intracen.org/tradstat/>

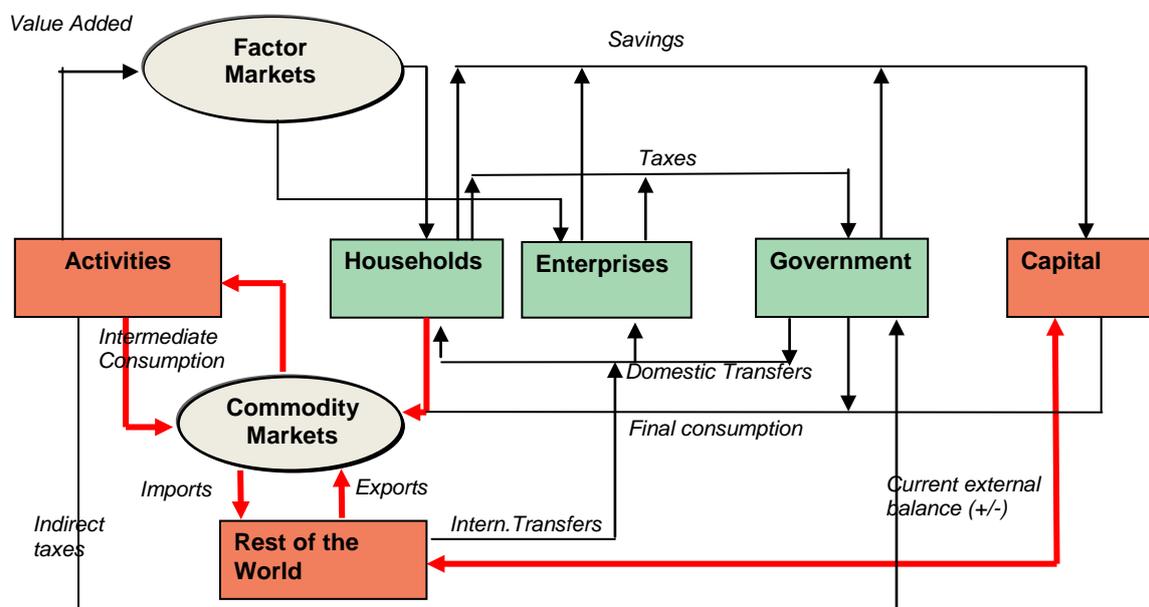
Given the overarching role of cotton in exports, the continuous fall of its real price in recent years (with the exception of 2003) represented a real loss of income to the country.

It is expected that the loss of income from cotton, in addition to the increased energy and fertiliser bills, has very likely negatively affected the growth perspectives and welfare of different social groups in a diversified way, through multiple flows of payments originated by income generation, income distribution and expenditure processes.

Figure 6 provides a schematic view of the flows of payments among the different economic entities through which external shocks are likely to affect the socio-economic system.

Upward shifts in oil prices, for example, other things being equal, lead to increased input costs for the activities utilising those imports as intermediate consumption and for households directly using oil products. This leads to increased prices of outputs produced using oil products, in particular those produced with energy intensive production processes. Increased output prices imply, other things being equal, reduced real income of institutions. In addition, increased import prices lead to a worsening of the balance of trade, particularly if import substitution by means of domestic products is difficult. Furthermore, upward price shifts will activate behavioural reactions such as substitution in consumption towards relatively cheaper goods and services; affecting in turn the output of the activities producing the different types of goods. Upward and downward shifts of activities will then affect the demand of factors and related payments to factors. This will have implications for households' incomes.

Figure 6: Main flows of payments through which external shocks affect the economic system (in red).



Source: adapted from: Round J. (2003): Social Accounting Matrices and SAM-based multiplier analysis”, chapter 14 in F. Bourguignon and L.A Pereira da Silva (Eds) The impact of economic policies on poverty and income distribution, New York, World Bank and Oxford University Press.

On these grounds, it is most likely that different socio-economic groups are affected differently, according to, for example. their geographic location (rural versus urban) or their welfare status (poor versus non-poor). To analyse the extent to which price changes on the international markets affected the different layers of the populations, and to investigate the distributional impacts of possible countervailing policy measures, it is necessary to dispose of a framework comprising the abovementioned factors and related interlinking channels. The SAM 2000 allows some considerations to be drawn about the distributional impacts of shocks and policies because in the SAM households are classified in Rural-Urban and Poor-Non poor

according to their residence and the national per capita annual poverty line⁷⁸. In the following paragraphs a short description of the household classification is provided.

The SAM 2000 bases its classification of households on the “Survey on the Living Standards of Households” run in 2003 by the INSD⁷⁹. The INSD survey allows classification of population and households as reported in table 2.

Table 2: Rural-Urban and Poor/Non-Poor Classification of Population and Households

# Population	Poor	Non poor	total	% Population	Poor	Non poor	total
Rural	4,869,012	4,446,348	9,315,360	Rural	52.3%	47.7%	100.0%
Urban	412,010	1,656,435	2,068,445	Urban	19.9%	80.1%	100.0%
total	5,281,022	6,102,783	11,383,805	total	46.4%	53.6%	100.0%

# of Households	Poor	Non poor	total	% Households	Poor	Non poor	total
Rural	612,770	794,670	1,407,441	Rural	43.5%	56.5%	100.0%
Urban	54,155	315,440	369,595	Urban	14.7%	85.3%	100.0%
total	666,925	1,110,111	1,777,035	total	37.5%	62.5%	100.0%

Source: Own calculations on INSD data from “Enquête sur les conditions de vie des Ménages» (2003) And INSD (2003): «La Pauvreté’ au 2003»

The survey data also analyses the expenditure by type of household, as reported in table 3. This analysis reveals that, overall, the urban layer of the society looks more polarized than the rural one, as the difference in the average expenditure between poor and non poor is lower in rural areas than in urban ones. In addition, although much more widespread, rural poverty is on average less significant than urban poverty, as rural poor households spend on average more than their homologues in urban areas (423,000 and 372,000 FCFA per year, respectively). On the other hand, the average expenditure of non poor is higher in urban areas than in rural ones.

Table 3: Average household expenditure by type of household.

Average exp*	Poor	Non poor	total	Average exp*	Poor	Non poor	total
Rural	423	874	678	Rural	52%	108%	84%
Urban	372	1,484	1,321	Urban	46%	183%	163%
total	419	1,047	811	total	52%	129%	100%

* Thousands FCFA per household per year

* % of national average household expend. year 2000

Source: Social Accounting Matrix of Burkina Faso for year 2000.

In addition to the expenditure level, the structure of expenditure may also lead to differentiated impacts of external shocks and related policies on the different types of households.

⁷⁸ The per capita poverty line was estimated by INSD (2003) at 82 672 FCFA for 2003.

⁷⁹ INSD, 2003. *Enquête sur les conditions de vie des ménages*

Table 4. Expenditure shares by type of households

	Rural Poor	Rural non-poor	Urban Poor	Urban non-poor	Notes: SAM code
Agricultural commodities	43.9%	25.2%	30.5%	16.3%	
<i>Fruits and vegetables</i>	13.9%	6.7%	9.0%	5.3%	CAGEX,CAMAR,CAGOT
<i>Cereals</i>	17.5%	10.9%	10.5%	6.5%	CAGFO
<i>Meat and Fish</i>	12.6%	7.5%	10.9%	4.6%	CBOV,CCATF,CCHAS,CFISH
Processed food	26.4%	31.1%	26.5%	21.3%	CNAFO+CABAT
Other Primary commodities	1.8%	2.6%	3.6%	2.1%	CFORE+CMINE
Industrial goods	19.1%	20.3%	23.3%	24.6%	
<i>Fuel, related products and energy</i>	6.7%	6.6%	9.0%	8.3%	CPPTR,CENEG
<i>Other industrial goods</i>	12.5%	13.6%	14.2%	16.4%	CNAOI
Services	8.8%	20.9%	16.1%	35.7%	
<i>Transport</i>	1.4%	2.2%	1.9%	1.5%	CTRANS
<i>Other services</i>	7.4%	18.7%	14.3%	34.1%	CFINAN,CNASM,CNASNM
Total	100.0%	100.0%	100.0%	100.0%	

Source: Social Accounting Matrix of Burkina Faso for year 2000.

Looking at table 4, as expected, the percent of food expenditure on the total expenditure is higher among the poor than among the non-poor. This holds both for rural and urban layers of the population. Furthermore, the rural poor spend more on raw (unprocessed) food than the other types of households. On the other hand, the share of expenditure on industrial goods is fairly similar across the different households, ranging from the 19.1% of the rural poor to the 24.6% of the urban non-poor. This also applies to the expenditure for fuel and energy. This implies that the difference in the share of food expenditure is complemented by the differences in the expenditure on services. The share of the non-poor, in particular the urban ones, is much higher than the share of the poor (35.7% and 8.8% respectively).

The different structure of expenditure across households, associated with the different expenditure levels and likely diversified behavioural responses of the various social groups described above, should result in differentiated welfare impacts of different external shocks and related policy measures. The CGE model, described in the next section, will be used to shed some light on the cross-sectoral and inter institutional socio-economic impacts of external shocks and possible related policy measures.

6. THE CGE OF BURKINA FASO

The CGE model adopted for Burkina Faso is based on the standard IFPRI CGE (2002)⁸⁰. The SAM described above has been utilised as the base of macro-economic data for the CGE model. The SAM has been aggregated in larger groups of commodities and macro-production sectors (activities) to rule out small value cells in order to ease the convergence of the model.

In addition, the SAM was modified to highlight the expenses for agricultural chemicals (fertilisers and pesticides), because the original SAM reported only the production and use of an aggregated commodity: "other industrial goods". The payments of the agricultural sectors to the account of this aggregated commodity were assumed as payments for agricultural chemicals, thus separating these expenses from the rest of the expenses for other industrial goods. The commodities, activities and institutions comprised in the SAM are reported in table 5.

⁸⁰ Lofgren H, Lee Harris R, Robinson S. et al. 2002. *A Standard Computable General Equilibrium (CGE) Model in GAMS*. International Food Policy Research Institute, Washington D.C.

Table 5: Aggregated SAM elements for the CGE model.

#	Activities	Code	#	Commodities	Code
1	Cotton grains	ACOTN	1	Cotton grains	CCOTN
2	Cash crops	AAGEX	2	Cash crops	CAGEX
3	Vegetables	AAMAR	3	Vegetables	CAMAR
4	Food crops	AAGFO	4	Food crops	CAGFO
5	Other Agriculture	AAGOT	5	Other Agriculture	CAGOT
6	Livestock-bovine	ABOV	6	Livestock-bovine	CBOV
7	Other livestock	ACATF	7	Other livestock	CCATF
8	Hunting	ACHAS	8	Hunting	CCHAS
9	Forestry	AFORE	9	Forestry	CFORE
10	Fisheries	AFISH	10	Fisheries	CFISH
11	Mining	AMINE	11	Mining	CMINE
12	Cotton ginning	AEGRG	12	Cotton ginning	CEGRC
13	Slaughtering	AABAT	13	Slaughtering	CABAT
14	Agro-industry	ANAFO	14	Agro-industry	CNAFO
15	Other industry	ANAIO	15	Other industry	CNAIO
16	Power, water and gas	AENEG	16	Oil and oil products	CPPTR
17	Trade	ACOME	17	Fertilizers and Pesticides	CFERT
18	Transport	ATRANS	18	Power, water and gas	CENEG
19	Financial services	AFINAN	19	Trade	CCOME
20	Services to enterprises	ANASM	20	Transport	CTRANS
21	Services to households	ANASNM	21	Financial services	CFINAN
			22	Services to enterprises	CNASM
			23	Services to households	CNASNM

#	Institutions/ other accounts	Code	#	Factors	Code
1	Poor rural households	HLSLOW	1	Agricultural labour	LABAGR
2	Non-poor rural households	HLSUPP	2	Non-agricultural labour	LABNAGR
3	Poor urban households	HURBLOW	3	Family labour	MOF
4	Non-poor urban households	HURBUPP	4	Agricultural capital	CAPSH
5	Financial enterprises	ENTRF	5	Non agricultural Capital	CAPLSC
6	Non-financial Enterprises	ENTRNF			
7	Income taxes on households	YTAX			
8	Indirect taxes on activity incomes	ATAX			
9	VAT and other taxes on goods	TAR			
10	Import taxes	ITAX			
11	Export taxes	ETAX			
12	Government account	GOV			
13	Rest of the World	ROW			
14	Savings-Investment account	S-I			

The SAM was used to obtain share parameters and scale factors for almost all the demand and supply functions included in the model.

In the absence of more detailed information, we adopted a Leontief technology (fixed technical coefficients) based on SAM information, for the following levels of the “technology nest”:

- a) determination of the composite intermediate input;
- b) determination of the value-added mix.

In addition to information contained in the SAM, different sets of elasticities were used for:

- a) substitution of domestic goods versus imports (Armington-type CES function elasticities);
- b) transformation of domestic consumption goods into exports (CET function elasticities);
- c) own, cross-price and income elasticities for households. (LES demand system, with “subsistence” consumption shares. An estimate of the Frisch parameter was obtained from the literature).

- d) determination of the aggregated value added is obtained (CES function allowing for imperfect substitutability among factors).

For more details on the equations of the model regarding the demand system for final consumers the import/domestic substitution and the export/domestic transformation, see the technical appendix at the end of the paper.

Elasticities have been derived from available literature, in the absence of relevant information at country level. Given that the choice of elasticities introduced some degree of subjectivity in determining the behavioural responses of agents to shocks and policy measures; some sensitivity analysis on the most relevant parameters for the specific measures under investigation were carried out, to also take into account the very different estimates identified in literature⁸¹.

Alternative combinations of closures were also tested for the following macro-economic balances:

- **Government balance** (deficit/surplus). The government revenue (YG) has to be equal to the government expenditure (EG) plus the government savings (SG): $YG = EG + SG$. In the model, $EG = QG + Transf$, where QG is the “real” government consumption (government consumption in physical terms) and $Transf$ are the public transfers. The government expenditure is modelled as an exogenous component, as government consumption (CG) is fixed either in real terms (anchored to the base year), or as a fixed share of the nominal total absorption, and transfers from the government to other institutions are exogenous as well. The government balance adjusts by means of:
 - a. **Flexible government savings** and fixed tax rates. Government savings adjust to the new level of taxes calculated with new incomes, existing tax rates and new nominal government consumption.
 - b. **Fixed government savings** and flexible taxation, by means of fixed adjustments in the tax rates for selected institutions.
 - c. **Fixed government savings** and flexible taxation by means of proportional adjustments in the tax rates for selected institutions.⁸²
- **Rest of the World (RoW) account**. The external balance, i.e. the current account deficit/surplus, is expressed in foreign currency. Options for its equilibrium are:
 - d. **Fixed foreign savings and flexible real exchange rate**⁸³. In this case, the equilibrium in the external balance is achieved by depreciating (appreciating) the local currency, i.e. increasing (decreasing) the price of the foreign currency in real terms, to compensate for a deficit (surplus) of the trade balance which exceeds the fixed foreign savings level. Depreciation (appreciation) of the foreign currency implies that imports become more expensive (cheaper) and exports are more profitable (less profitable); entailing an adjustment of quantities imported and exported (via the Armington and CET functions).

⁸¹ To this regard see e.g. Gibson. K., 2003. Armington Elasticities for South Africa. Long and Short Run Level Estimates. *Trade and Industrial Policy Strategies Working paper 12-2003* University of Natal (South Africa).

⁸² For example, given institution A with a tax rate of 20% and institution B with a tax rate of 15%, under the closure b., a required tax change of e.g. +7% for both institutions leads to new tax rates of 27% and 22% for A and B respectively. Under the closure c. instead, a required tax change of e.g. +40%, leads to new tax rates of 28% and 21% for A and B respectively.

⁸³ Real exchange rate refers here to the price in local currency of one unit of foreign currency expressed at constant domestic prices.

- e. **Flexible foreign savings and fixed exchange rate.** Under this option the external balance is adjusted by means of flexible foreign savings and fixed exchange rate. In this case, the foreign savings adjust to compensate for imbalances in the external trade account, while the exchange rate is implicitly anchored to the numeraire of the system.
- **Savings/investment account**⁸⁴:: The Savings-investment account adjusts by means of
 - f. **Fixed capital formation (in physical terms) and flexible savings** by means of fixed adjustments of the average propensity to save for selected institutions. For example, given two institutions, A and B, with an average propensity to save 10% and 15% respectively, a required change in the savings is obtained by an additional fixed number of percentage points equal for both the institutions: say 5%, in their propensity to save, leading to 15% and 20% for A and B respectively.
 - g. **fixed capital formation (in physical terms) and flexible savings** by means of proportional adjustments of the average propensity to save for selected institutions, e.g. given the two institutions A and B above, a required change in the savings is obtained by a proportional change in the average propensities to save equally for both the institutions: say 20%, in their propensity to save, leading to 12% and 18% for A and B respectively.
 - h. **flexible capital formation and fixed savings** with fixed marginal propensity to save for non-government institutions;
 - i. **Fixed investment share of absorption and fixed government consumption share** of absorption. Absorption is expressed in value terms. This implies that quantities for investments and government consumption are flexible. The propensities to save adjust as in case a.
 - j. **Fixed shares as above.** The propensities to save adjust as in case b.

Simulations reported in the present study adopted the following macro economic closures (see Figure 6):

Government balance: flexible government savings (fixed direct tax rates), This option is likely to be better at fitting the actual situation of the country. Indeed, analysing the impact of external shocks and policy measures on tax rates, with the aim of identifying appropriate tax rates to enable the maintenance of a fixed budget deficit, would be a pure theoretical exercise, given the context of the country. Adjustments of tax rates and fiscal policies in general would actually be difficult to implement in practice, given the weak institutional structure, including the fiscal administration. In addition, by imposing flexible government saving it will allow a focus on welfare changes induced by external shocks and policy responses, not “polluted” by fiscal adjustments.

RoW account: flexible real exchange rate and fixed foreign savings (expressed in foreign currency) are chosen as the closure rules for the RoW account.⁸⁵. Therefore, real

⁸⁴ The model adopted allows for two options for the variation of the average propensity to save MPS: a) “uniform fixed points saving rate change”, through the adjustment of the parameter DMPS and b) “proportional saving rates change” through the adjustment of the parameter MPSadj, as follows:

$$MPS = mps_0 \cdot (1 + MPS_{adj}) + DMPS$$

⁸⁵ Burkina Faso belongs to the “Union Economique et Monetaire de l’Afrique de l’ Ouest” (UEMOA), which adopted the Franc CFA, a common currency anchored in nominal terms to the Euro. An alternative possible scenario for the real exchange rate could be to introduce some real appreciation, say, around 1.5% per year, to

import/export prices will be affected, in addition to shifts due to external shocks and shifts of the real exchange rate. Therefore, imbalances in the Rest of the World account generated by external shocks are absorbed by adjustments of the exchange rate and not by foreign savings⁸⁶.

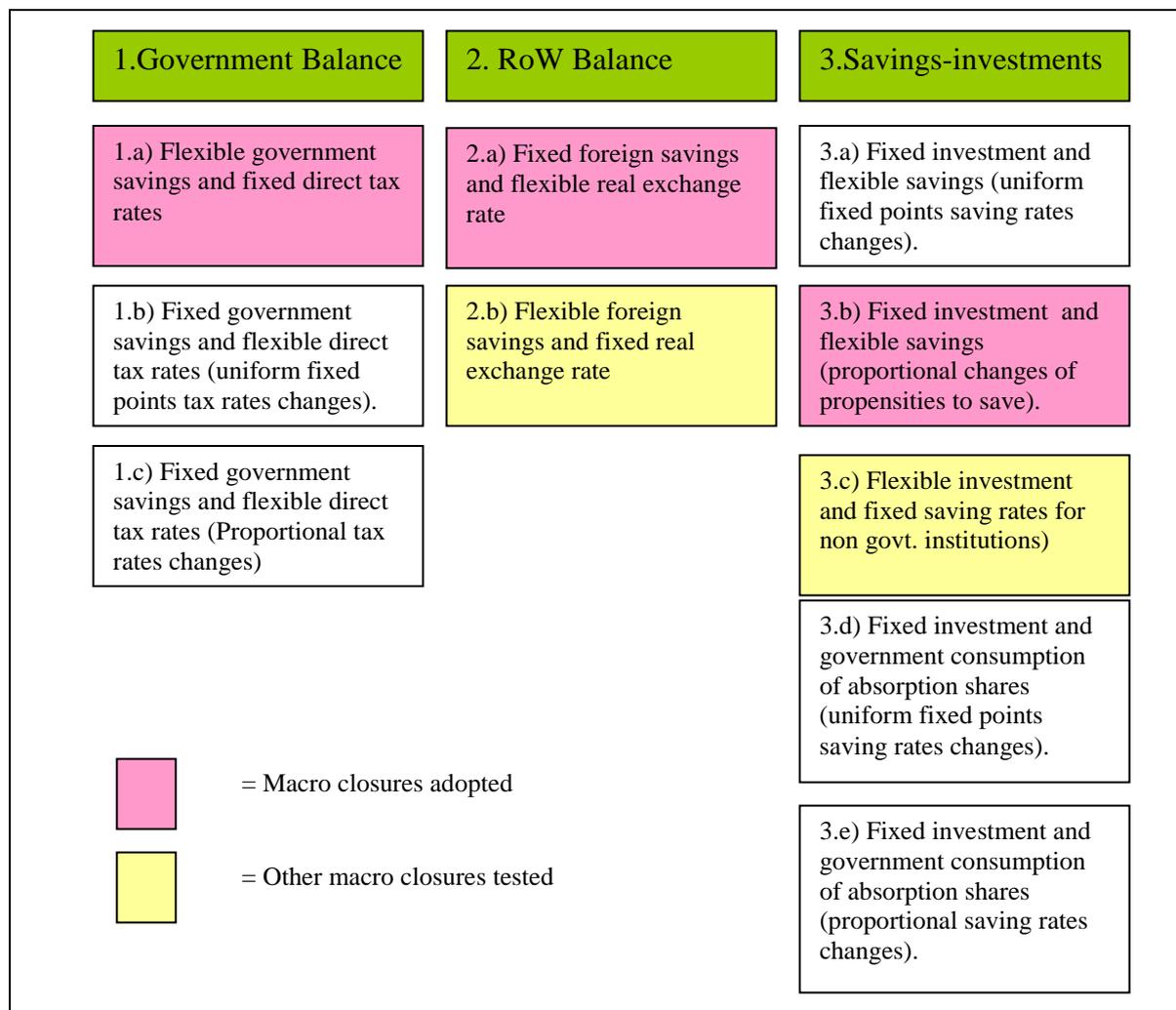
Savings-Investment (S-I) account: regarding the Saving-Investment balance, the macro-economic closure rule chosen was “investment-driven”. Investment has been kept fixed in real terms (fixed quantities). Propensities to save in households adjust to fit investment requirements. This permits looking at the pure impact on welfare of households and comparing it with the base case, after neutralising possible changes in the capital formation⁸⁷.

reflect the actual trend of this variable in recent years, as reported in Joufelkit H.D., 2005. *Evolution des taux de change effectifs réels (TCER) de la zone franc: 1993-2006*. Rapport “Jumbo”, Agence Française de Développement (AFD)-Paris.

⁸⁶ The alternative closure tested: fixed real exchange rate and flexible foreign savings, led to higher welfare impacts of external shocks, associated to increased foreign savings and increased absorption for investment, if not associated to any “investment-driven” closure.

⁸⁷ The alternative closure tested for the S-I balance was the “Savings-driven” rule (3.c in figure 7). This closure, led to larger welfare decreases for all the simulations related to external shocks as they were associated with increases in investment and savings.

Figure 7: Macro closures for CGE model.



The macro-closure adopted almost reflects the so called “Johansen closure”⁸⁸, where fixed foreign savings (closure 2.a), fixed real investment (closures 3.a or 3.b) and any of the closures for the government balance, better highlights the total negative (positive) welfare impacts of external shocks on households, as they would not be partially offset (amplified) by decreases (increases) in real investment and increases (decreases) in foreign savings, i.e. injections (drains) of resources from the S-I account or from the RoW.

To assess the welfare impacts of external shocks and policy changes we will look at the Equivalent Variation (EV) of household expenditure, by type of household, i.e.:

$$EV_h = \left(TotExp_{h,1} - SubsExp_{h,1} \right) \left(\frac{P_0}{P_1} \right) - \left(TotExp_{h,0} - SubsExp_{h,0} \right)$$

where h is the index of the type of household, 0 and 1 are respectively the indexes referring to the benchmark case and the shock/policy scenario, $TotExp_{h,1}$ and $TotExp_{h,0}$ are respectively

⁸⁸ Firstly introduced by Johansen, Leif, 1960. *A Multi-Sectoral Study of Economic Growth*. Amsterdam, North-Holland (2nd enlarged edition, 1974). An early review and discussion of alternative macro-economic closures is also found in Ratts, J (1982): “different Macroclosures of the Original Johansen Model and Their Impact on Policy Evaluation”. *Journal of Policy Modelling* 4(1) p.85-97.

the total expenditure of the household for final consumption under the shock/policy scenario and in the benchmark case, $SubsExp_{h,1}$ and $SubsExp_{h,0}$ are the “subsistence” expenditures of the household, i.e. the minimum consumption required for survival, P_1 and P_0 are price indexes built as geometric means of prices using consumption shares of the different consumption goods as powers of prices⁸⁹. Therefore, the EV is the difference between the “supernumerary” expenditure of each type of household, i.e. the expenditure in excess over the subsistence expenditure, in the policy scenario, and the supernumerary expenditure at the benchmark,; both expressed in monetary terms at the benchmark price level. In addition, the total EV is the sum of the EV across the household types. A percentage indicator EVP will also be worked out to compare the EV with the base total expenditure. Calling the “supernumerary” expenditure $SupExp_h = TotExp_h - SubsExp_h$ and dividing the EV by the total expenditure at the benchmark, the EVP results:

$$EVP_h = \frac{SupExp_{h,1} \left(\frac{P_0}{P_1} \right) - SupExp_{h,0}}{TotExp_{h,0}}$$

In our case, having opted for fixed foreign savings and flexible real investments, welfare changes of households, measured either in terms of real income changes or as Equivalent Variations (EV) will have to be analysed together with changes in the real exchange rate and with adjustments of the average propensities to save. Only in this way can we have a full picture of the socio-economic impacts of shocks and policies at micro and macro level.

To ease the direct comparison of the income changes of households with the base case, the Consumer Price Index (CPI) has been chosen as the numeraire of the system.

Factors and closures of the factor markets have been dealt with as described below:

- a) Non-agricultural labour has been assumed to be mobile across activities and fully employed. Full employment implies assuming for the simulations the same level of employment as the base case but flexible real wage rates (wages adjust across simulations).
- b) For agricultural labour and family labour the full-employment option has been relaxed, thus allowing for unemployment, retaining however the possibility to move across activities. Given the structure of the model, this implies that the real wage rate has been fixed.
- c) Both agricultural capital and non-agricultural capital have been assumed to be fully employed, but, agricultural capital has been assumed to be mobile across activities, while non-agricultural capital has been assumed to be activity-specific.

⁸⁹ The EV can be interpreted as the variation of income of the household equivalent to the shock/policy change. More specifically, it is the minimum amount that the households are ready to accept as compensation if the policy change does not occur, in case of EV positive, (also referred to as minimum Willingness To Accept - min WTA) or the maximum amount that the households would be willing to give up to avoid the shock/policy change, in case of EV negative (referred also as maximum Willingness To Pay – max WTP to avoid the change). The model adopts formulas for CV and EV reported in: Blonigen, Bruce A., Joseph E. Flynn, and Kenneth A. Reinert (1997): Sector-Focused General Equilibrium Modeling, pp. 189-230 in eds. Joseph F. Francois and Kenneth A. Reinert, Applied Methods for Trade Policy Analysis. Cambridge, MA: Cambridge University Press.

7. SIMULATIONS OF SOCIO-ECONOMIC IMPACTS OF EXTERNAL SHOCKS

On the basis of the observed changes in import-export prices in the last twelve years, the price changes reported in table 5 have been retained for simulations. Simulations of external shocks have been carried out and compared with the base case.

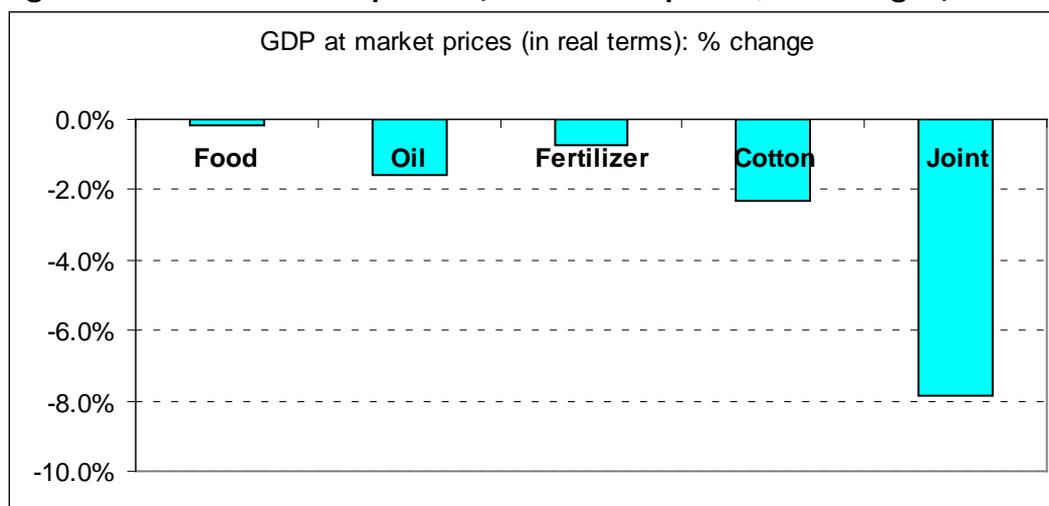
Table 5: Price changes by commodity for simulations of external shocks with the CGE model

	Food	Oil/oil products	Fertilizers	Cotton
Average index 1997-2004	85.3	118.9	90.0	80.5
Average index 2005-2008	80.5	240.8	138.7	54.4
Index 2008	93.5	292.3	208.4	54.3
% change 05-08/97-04	-5.6%	102.6%	54.2%	-32.4%
% change 08/97-04	9.6%	146.0%	131.7%	-32.6%

The focus will be put on the change registered in 2008 with respect to the average index of the periods 1997-2004.

All the four exogenous shocks considered have negative effects on GDP, as reported in Figure 7⁹⁰.

Figure 7: GDP at market prices (at constant prices, % changes)



Source: CGE model results

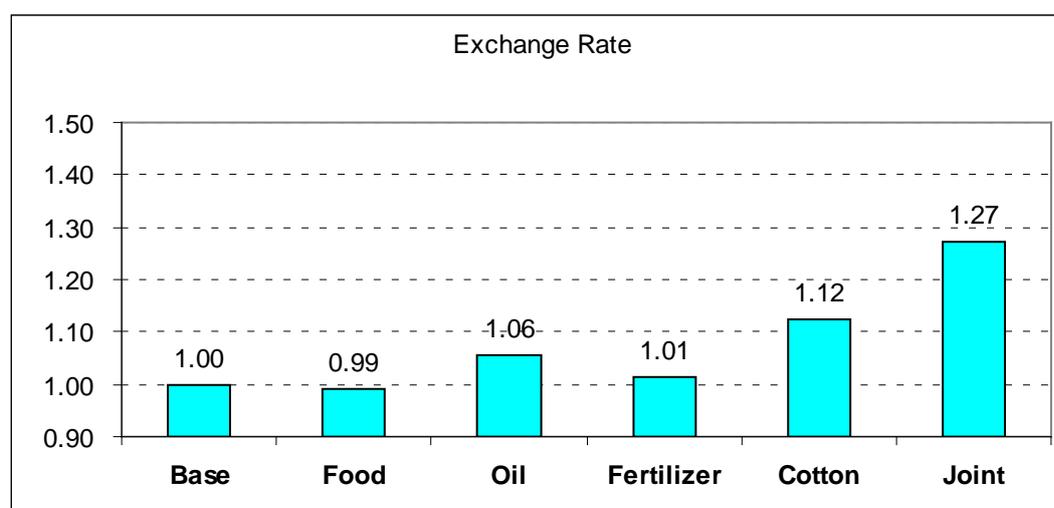
⁹⁰. GDP data reported here are in “real” terms, i.e. new quantities calculated in different scenarios are evaluated at “base” prices. Data in tabular format are reported in the appendix.

Table 6: Macro-economic impacts of external price shocks (at constant prices)

		Base	Food	Oil	Fertilizer	Cotton	Joint
		<i>Million FCFA</i>	<i>% variation w.r.t.the base</i>				
a=b+c+d	Total Absorbption	2,119,964	-0.4%	-6.6%	-1.6%	-2.3%	-12.9%
b	Private consumption	1,441,816	-0.6%	-9.8%	-2.4%	-3.4%	-19.0%
c	Investment	279,655	0.0%	0.0%	0.0%	0.0%	0.0%
d	Government cons.	398,493	0.0%	0.0%	0.0%	0.0%	0.0%
e	Exports	149,849	-1.5%	32.3%	3.9%	-29.7%	-11.4%
f	Imports	458,157	-1.7%	-13.8%	-3.2%	-11.0%	-32.7%
g=a+e-f	GDP at market prices	1,811,656	-0.2%	-1.6%	-0.8%	-2.3%	-7.8%

However, while the food shock has marginal impacts (around - 0.2 % of GDP) and fertiliser shows a moderate impact (-0.8%), the price shocks on oil and cotton have significant impacts (around 2% each). When considered jointly, four price shocks show a very strong impact on GDP, of almost 8%. For the “Joint” scenario, table 6 (rows b, e and f) show that private consumption falls more proportionally than GDP, at around 20%, due to a significant contraction of imports. It also happens to exports.

Shifts in prices of imports and exports change the quantities of internationally traded commodities compared to domestically produced substitutes, impacting on the balance of trade. Given the chosen macro-economic closure for the Rest-Of-the-World account, for all the four external shocks the balance of trade is adjusted by means of a devaluation of the Real Exchange Rate (RER); expressed as the amount of local currency at constant base consumer prices required to buy one unit of foreign currency. As reported in Figure 8, significant devaluation of local currency has to occur due to oil price increase (6%) and cotton price decrease (12%) in order to avoid the degradation of the balance of payments, without increasing external debt. The joint impact of external shocks on the local currency amounts to a devaluation of 27%.

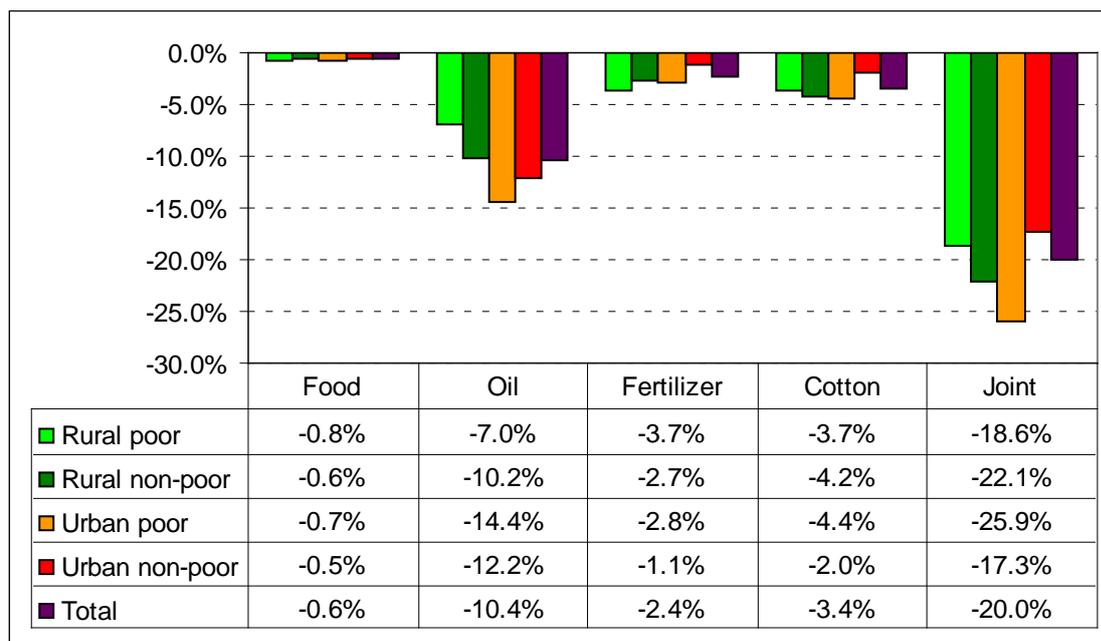
Figure 8: Local currency devaluation (Real Exchange Rate: local currency at constant base consumer prices per unit of foreign currency)

Source: CGE model results

In order to highlight the distributional effects of the external shocks, an analysis of the Equivalent Variation of expenditure for different household groups was carried out and reported in Figure 8⁹¹.

As expected, all the shocks have negative welfare impacts on all the household groups. However, note that the impacts of the different shocks do not only differ in magnitude, but also on distributional grounds.

Figure 8: Impacts of price shocks on welfare (EV) of different household groups.



Source: CGE model results

While the shift in the international price of food items affects household welfare only marginally, oil price increases has a very strong impact on the welfare of all household categories (-10.4%) with negative impacts ranging from 7% to more than 14% respectively for rural and urban poor. This diversification in the magnitude of welfare impacts across the households depends on:

1. **Factor income variations:** the different income sources of the different household groups. As reported in table 7, the bulk of non-agricultural wages falls more than agricultural wages and remuneration of family work (15.8%, 0.73% and 2.88%, respectively) thus affecting more significantly the urban segment of the population⁹². Analogously, rents of non-agricultural capital also shrink more than rents of agricultural capital;
2. **Domestic price changes and expenditure allocation.** Under the simulation with international oil price shift, the domestic price of energy products increases by around 116%. (see table A2 in appendix). In addition, table 4 shows different expenditure shares across household groups on energy (oil) intensive items: urban poor allocate

⁹¹ Detailed tables are reported in appendix.

⁹² Note that the factor income is the product of the quantity of each factor absorbed times the specific factor wage.

more expenditure on energy products and transport than rural poor (9% and 1.9% against 6.7% and 1.4% respectively).

Table 7: Factor income by type of factor (FCFA for the base, and %change)

	Base	Food	Oil	Fertilizer	Cotton	Joint
Agricultural labour	14,355	-0.39%	0.73%	-3.00%	-11.95%	-24.80%
Non-agricultural labour	308,282	-0.89%	-15.83%	-3.20%	-6.93%	-32.41%
Family labour	301,027	-0.31%	-2.88%	-3.49%	-8.63%	-23.50%
Agricultural capital	169,155	-0.55%	-8.98%	-2.00%	-1.27%	-16.59%
Non-agricultural capital	877,322	-0.78%	-20.04%	-4.19%	-6.89%	-37.61%

Source: CGE model results

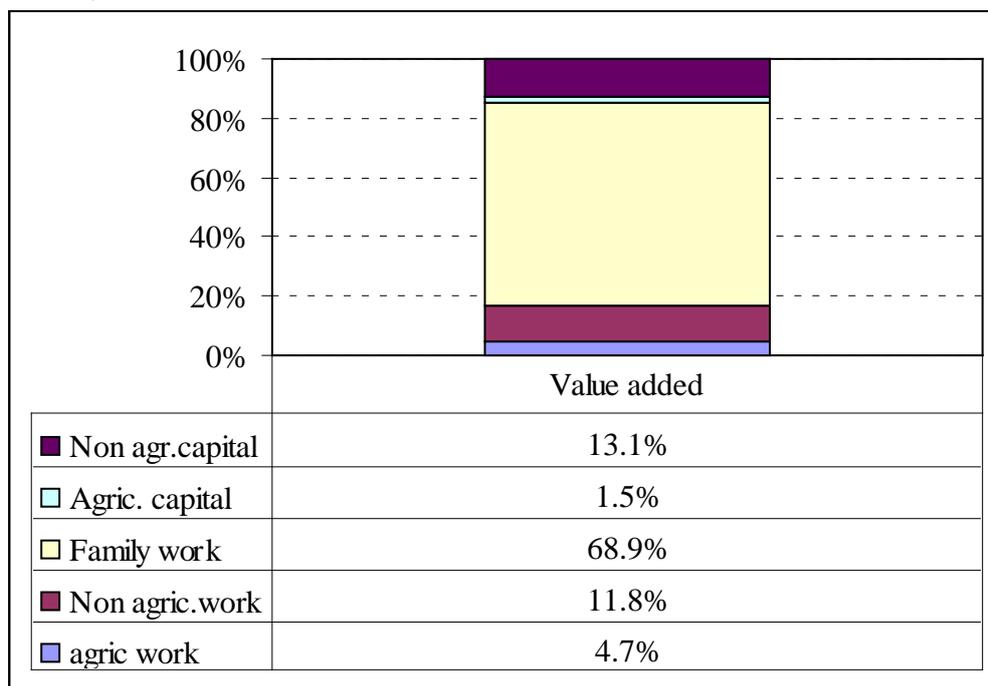
Regarding the shock on fertiliser's price, the magnitude of its impacts on welfare is lower than that of oil, affecting overall household expenditure by -2.4%. Nevertheless, it is not negligible, as it ranges from 1.1% for urban non-poor households to 3.7% for rural poor ones, shown to be particularly adverse to this layer of the population. Again, this can be explained by:

1. **Factor income variations:** the inspection of factor income variations highlights a negative impact (-3.5%) on family labour, by far the most used factor in agriculture.
2. **Domestic price changes and expenditure allocation:** the analysis of domestic price changes highlights that domestic prices of agricultural goods, and in particular, food crops and vegetables are more affected than other goods, with price increases ranging between 6.5% and 11% (see table A2). In addition, as reported in table 4, the expenditure of rural (and urban) poor concentrates on these items (44% and 30% respectively) proportionally more than the expenditure of rural and urban non-poor (25% and 16% respectively). That is why welfare impacts of the fertiliser's price increase are stronger on the poor layers of the population.

The welfare impact of the shock on cotton export price is stronger in magnitude than the shock on fertilisers (-3.4% overall). This affects in particular rural people and urban poor people. This impact can be explained considering the sharp reduction in the activity levels in the cotton value chain. Both primary production and ginning, other things being equal, shrink at around 70% (see table A4 in appendix). As shown in Figure 9, the cotton value chain makes wide use of family labour (more than 67% of the value added is allocated to remunerate this factor) and to a lesser extent of non agricultural capital⁹³. It is mainly through these factor channels that the reduction in the cotton value chain output affects welfare.

⁹³ The larger impact on urban poor could be due to the fact that more than 50% of their income is represented by the remuneration of non-agricultural capital services (micro-enterprise, self employed income).

Figure 9: Value added repartition in the cotton value chain (% of total value added)



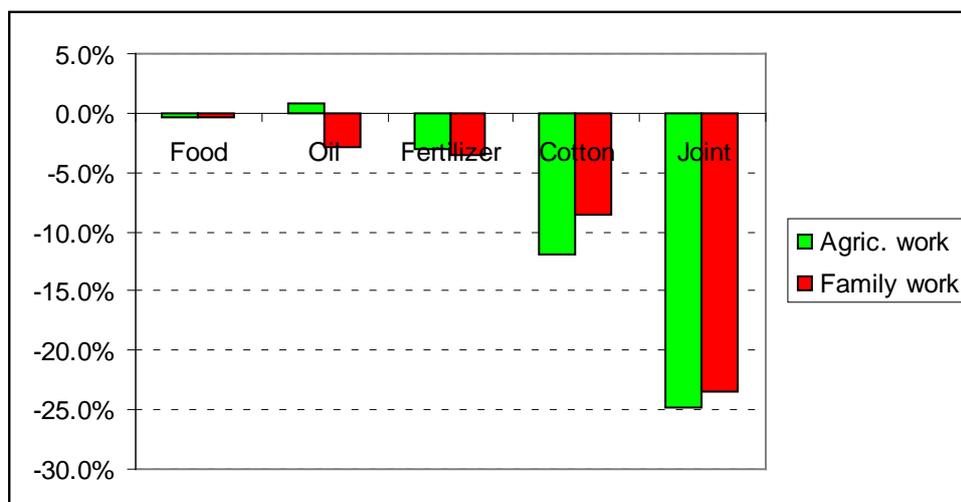
Source: SAM year 2000 Burkina Faso

The joint welfare effects of the different international price shocks amount to -20%, affecting in particular urban poor (-25.9%) and rural segments (-22.1% rural non-poor and 18.6% rural poor population). The rural poor households are shown to be, to some extent, more resilient to external shocks than urban poor ones, probably due to their lower degree of integration with the economic system, in particular through the energy sector, and the possibility of adjusting their income sources by shifting their cropping patterns to some extent.

Beyond price, income and expenditure impacts, all directly affecting the welfare of households, it is important to look at the way international price shocks affect factor uses. Figure 10 reports shifts in the use of agricultural (wage) work and family work⁹⁴. Note that all the price shocks have negative impacts on employment, particularly strong for fertiliser and cotton price shocks. The joint effect amounts to a loss of around 25% of job units for these factors, generating significant further unemployment in a context already characterised by few job opportunities.

⁹⁴ Note that agricultural (wage) work and family labour are the only factors assumed to be flexible, i.e. showing unemployment at the base case. The assumptions of full employment of non-agricultural work, agricultural and non agricultural capital imply no changes in the use of these factors.

Figure 10: Factor use (% changes) under different international price shocks scenarios.



Source: CGE model results

The analysis of international price shocks reported above highlights the importance of decoupling income generating activities, specifically of the poorer layers of the population, from international price fluctuations, in particular energy and fertilisers. This implies, among other things, the adoption of policy measures favouring less energy intensive technologies and the exploitation of comparative advantages in domestic energy and fertiliser production.

8. TECHNOLOGICAL CHANGES UNDER “GOOD AGRICULTURAL PRACTICES”

Since 2005, the Food and Agricultural Organization of United Nations (FAO UN), in collaboration with the “Institut de l’Environnement et de Recherches Agricoles (INERA)” (Institute for the Environment and the Agricultural Research) and the Ministry of Agriculture and Water Resources; support the “Union Nationale des Producteurs de Coton du Burkina Faso (UNPC-B)” (National Union of Cotton producers of Burkina Faso) in the promotion of the so-called “Good Agricultural Practices” (GAP) for the integrated Cotton-Cereals-Livestock production systems. This support comprises the identification and extension of appropriate production techniques, also by means of field experiments involving local farmers. In general terms, GAP aim at increasing yields by means of increased organic fertilisation, reduced use of chemicals (reduction of chemical fertilisers and elimination of pesticides) and increased use of agricultural labour⁹⁵. Figure 11 reports average yields per hectare for maize and cotton induced by GAP technologies with respect to “ordinary” agricultural practices, calculated on the basis of the experimental data reported in FAO

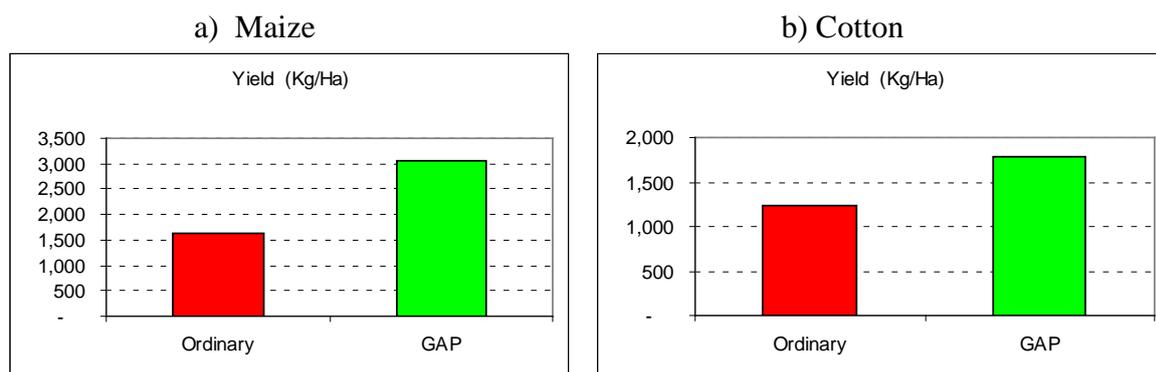
⁹⁵ For more details on conservation agriculture see e.g. Garcia-Torres, L., Benites, J., Martinez-Vilela, A. and Holgado-Cabrera, A. 2003. (Eds.) *Conservation Agriculture: Environment, Farmers Experiences, Innovations, Socio-Economy, Policy*. Kluwer Academic Publishers, The Netherlands.

For a review of the experiences and the potential of organic agriculture for poverty reduction see: Setboonsarng S. 2006. *Organic Agriculture, Poverty Reduction, and the Millennium Development Goals* August 2006, Asian Development Bank Institute (ADBI).

(2008)⁹⁶. Figure 12 reports the different cost and value-added structure for maize and cotton under the two different agricultural practices as percent of the value of output.

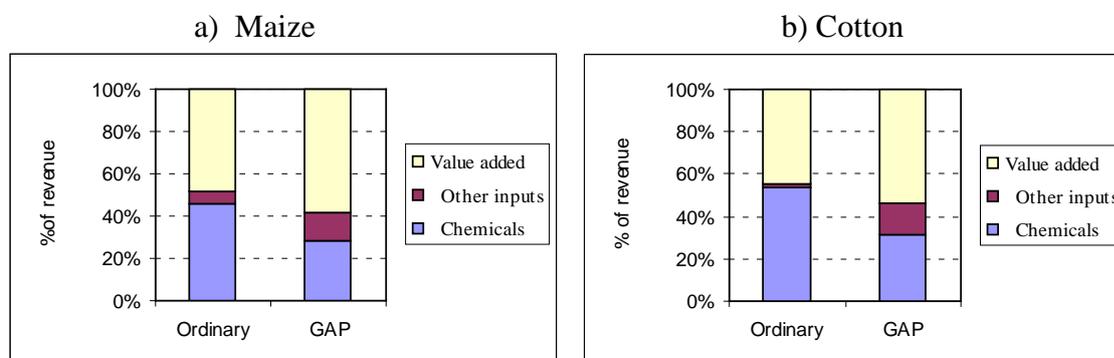
It is apparent that, on the basis of the experimental results, GAPs lead to: a) a less input-intensive agriculture, making reduced use, in particular, of imported inputs; b) greater demand of factors per unit of output; and c) reduced land use, other things being equal, thanks to increased yields per hectare⁹⁷.

Figure 11: Yields for Maize and Cotton With “ordinary” and GAP technologies.



Source: Author’s calculations on data reported in FAO, 2008.

Figure 12: Input costs and value added for Maize and Cotton with “ordinary” and GAP technologies



Source: Author’s calculations on data reported in FAO, 2008.

Given the importance of cotton as export commodity and fertilisers as imported inputs in Burkina Faso as discussed in section 5, it is interesting to see to what extent the adoption of GAP technologies on a large scale could constitute a response to external shocks or, at least, could contribute to mitigate the negative impacts analysed in section 7.

⁹⁶ FAO, 2008. *Formation participative sur les bonnes pratiques agricoles dans les systèmes de production coton-céréales-élevage*. Rapport final de la campagne 2007-2008 FAO-AGPP, Rome ; UNCPB –INERA, Burkina Faso; March 2008. Unpublished.

⁹⁷ Detailed data on GAP based on FAO, 2008. are reported in the appendix.

The following simulations have been carried out using a CGE model in order to analyse the macro-economic and welfare impacts of a country-wide adoption of GAP practices for cotton, maize and other crops:

1. reduced use of chemicals (fertilisers and pesticides) (- 20% of chemicals per unit of aggregate intermediate input);
2. reduction (-20%) of the aggregate intermediate input per unit of output;
3. increased factor requirements (+20%) per unit of output;
4. joint effects of the three technological changes above; and
5. adoption of GAP practices in the context of international prices shifts.

Table 8 summarises the changes simulated with the CGE model, with respect to the base case assumed to reflect the “ordinary” technology⁹⁸.

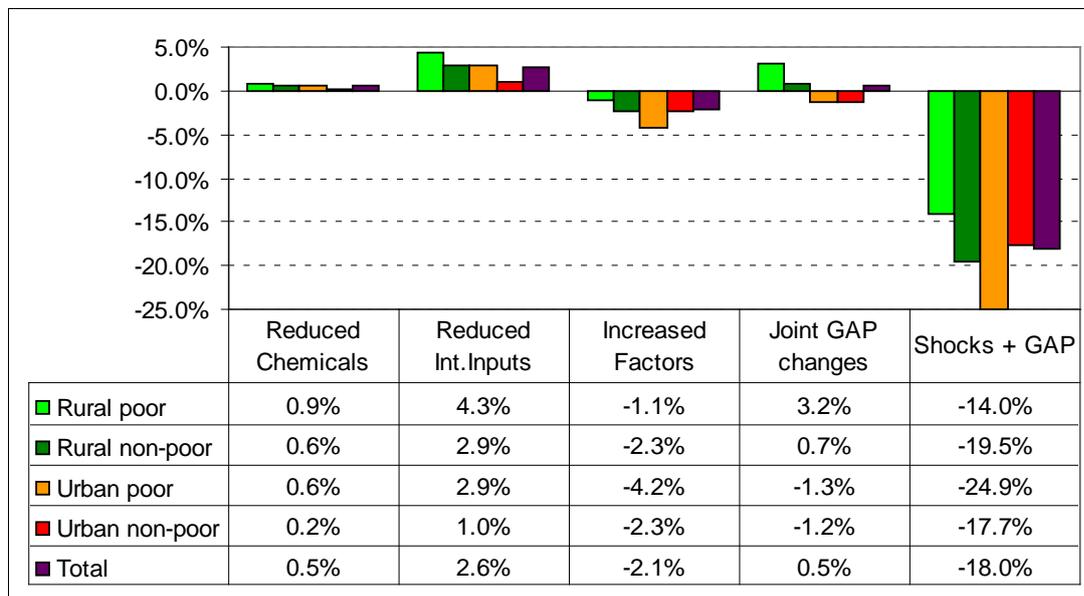
Table 8: Simulations of technological changes for GAP

	Chemicals per unit of aggreg.input	Aggregated input per unit of output	Aggregated factor per unit of output
	(1)	(2)	(3)
Cotton	-20%	-18%	22%
Other crops	-24%	-19%	20%

The reduction of intermediate inputs per unit of outputs (specifically, imported chemicals) has obvious positive welfare impacts on households (Figure 13, simulations 1 and 2). However, their reduction has to be read jointly with the required increase of factors per unit of output (simulation 3), as reported in simulation 4 (Joint GAP changes). The large scale adoption of GAP practices implies a slightly positive welfare impact on all the households (+0.5%). Furthermore, it shows important distributional impacts to the advantage of the rural poor (+3.2%) which more than compensate the slight losses of the urban segments of the population. Therefore, the adoption of GAP practices is likely to imply important positive improvements of poverty and food security.

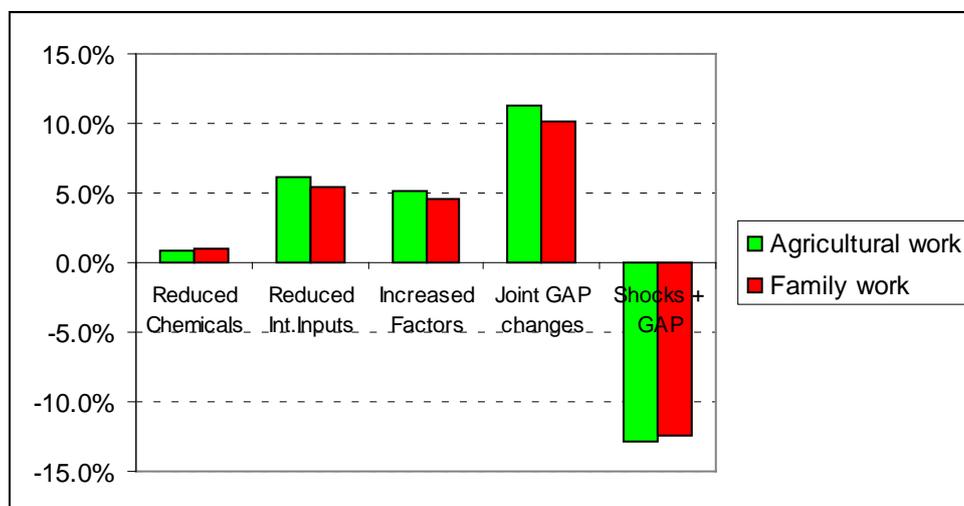
⁹⁸ For cotton and other crop activities: simulation 1 reduces the technical coefficient of chemicals per unit of aggregate input (parameter “ica” in the model), simulation 2 reduces the technical coefficient of the aggregate input per unit of output (parameter “inta” in the model) and simulation 3 increases the value of the technical coefficient of the aggregate factor per unit of output (parameter “iva” in the model). If more detailed data on GAP technologies were available, it would be possible to simulate impacts of separate changes for energy consumption, agricultural labour and capital services.

Figure 13: Burkina Faso. Households' welfare impacts (EV) of adoption of GAP practices and their mitigating impacts on price shocks. CGE simulations' results



Source: CGE model results

Figure 14: Factor use (% changes) under GAP and international price shocks scenarios



Source: CGE model results

The positive impacts of the adoption of GAP technologies are particularly important when looking at factor use. Figure 14 reports employment changes for agricultural wage work and family work. Note that under the full adoption of GAP (fourth scenario from the left), employment increases more than 10%.

This appears particularly important if considered in the context of international price shocks. Negative employment impacts of these shocks are definitely mitigated. The adoption of GAP shifts the job losses from almost -25% (Figure 10, fifth scenario) to -13% (Figure 14, fifth scenario).

9. SOME POLICY IMPLICATIONS

The analyses carried out above highlight that the country in general, and in particular the poorest layers of the population, are vulnerable to international price variations of selected commodities, both on the import and on the export side. This is essentially due to:

- a) The dependency of the country on imports of energy products (oil in particular);
- b) The need to rely on foreign markets for most of the industrial goods, including intermediate inputs, final consumption goods, investment goods and technology;
- c) The dependency on the cotton sector as the main source of foreign currency.

It is important, in this context, to identify policies and strategies that while improving the overall macro-economic framework of the country, will also improve the welfare of the poorer layers of the population. Following Bhagwati (1988)⁹⁹, there are two alternative policy designs to achieve poverty reduction: a) the “indirect route”, i.e. the use of resources to promote growth, relying on the “trickle-down” effects, and b) the direct route i.e. “*the public provision of “minimum-needs-oriented” services relevant to achieve welfare improvements of selected layers.* Bagwati however, suggests shaping the first route in such a way that it results in a “pull-up” strategy, i.e. a growth strategy biased towards generating income in the hands of the poor, in order to bring them out of poverty. This approach, which paved the way to what nowadays is named “pro-poor” growth, is probably what is needed in Burkina Faso.

Breaking the energy dependency, re-designing technologies, adapting consumption towards less import-intensive patterns and diversifying export sources are challenges that the country needs to address, in order to embrace more self-sustaining development strategies which would also be “pro-poor”.

In order to address the energy issue, the exploration of alternative energy sources is a possible way forward. This implies carrying out a thorough analysis of the various options available, considering their technical feasibility, economic viability, environmental sustainability and their geo-political strategic implications.

Among the options that may have direct and significant impacts on rural areas and/or agricultural activities, bio-energy technologies look particularly interesting for exploration. While some of them may conflict with food production, as for example those requiring high quality-irrigated land (e.g. sugarcane-based ethanol or cassava-based diesel) others, such as Jatorpha-based diesel, if properly managed, might not conflict with other crops.

In addition, decentralised solar energy production might be particularly important for the development of specific off-farm activities in rural areas. While probably requiring comparatively larger investment, this technology could be also important for direct income generation if it is associated with the extension of the electricity network, which is planned in the 2010-2015 Strategic Development Framework of the country¹⁰⁰. Once interconnected with the national electricity network, rural areas could also potentially become net sellers of energy.

⁹⁹ Baghwati, J.N. 1988. *Poverty and Public Policy*. World Development. Vol 16, n. 5 pp. 539-555.

¹⁰⁰ 2009. *Strategie de développement 2010-2015*. Ministère de l’Economie et des Finances (Draft, unpublished)

The energy issue, but more generally, the import dependency, cannot be decoupled from technological research and technological choices, particularly relevant for predominant sectors such as agriculture. As shown above, the possibility to adopt on a large scale less import-intensive technologies, such as the “Good Agricultural Practices” (GAP) may lead to some improvement in the welfare of the poorest layers of the population. This implies developing and disseminating local knowledge on most adapted production and processing techniques and favoring their adoption by economic agents. Public policies aimed at supporting appropriate technological changes, while contributing to reduce pressure on the trade balance, may also be beneficial for employment generation and diversification of income sources. This may apply in particular to the adoption of carbon-fixing technologies, such as the technologies which increase the organic content of soil. These could receive adequate remuneration within the framework of current or future carbon-fixing international schemes.

As both the diversification of energy sources and the adoption of more appropriate technologies could contribute to reduce pressure on the balance of trade, appropriate policies to promote them could also lead to a reduction of pressure on export sectors, such as cotton and allowing for free resources, such as land and water, for other sectors.

10. CONCLUSIONS

This paper analysed the socio-economic impacts of selected international price shocks faced by Burkina Faso in recent years. It highlighted in particular that household welfare is significantly affected by oil and fertiliser price increases, as well as from the decline of cotton price. Among the possible ways to mitigate or countervail negative welfare impacts of international price shocks, the adoption of less-energy/import intensive technologies could play an important role.

Possible improvements of the analytical framework, in the context of enhanced, more detailed and updated information comprises, among other things: a more precise estimation of selected parameters such as the elasticities of transformation or substitution between exports and domestic products or the Armington elasticities. Also, an enhanced modelling of selected technological relationships, including the substitutability between capital and labour, as well as a closer investigation of factor uses and factor constraints.

However, in spite of some analytical limitations, essentially due to the weak information base, the findings of this work are quite interesting for their policy implications. It emerges in particular that the issue of energy is crucial if the country wants to achieve a sustainable reduction of poverty and food insecurity. In addition, reducing the energy dependency would also allow a reduction of the country’s dependency on cotton, the main export crop, and from its international price variations.

This finding may also apply to other less industrialised net energy importing countries, with a similar socio-economic structure. A further general remark is that, to achieve sustained poverty reduction and food security in a given socio-economic system, it is of crucial importance to identify and fix the “bugs” that generate systematic and sustained drain of domestic resources, pretty much as in the energy sector in Burkina Faso, hampering local surplus accumulation and related endogenous growth potential.

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APPENDIX A: DETAILED DATA AND TABLES

Table A1 Consumer Prices (composite domestic-import prices) under different international price shock scenarios

	Base	Food	Oil	Fertilizer	Cotton	Joint
Cotton grains	1.000	-0.3%	3.3%	1.5%	1.0%	5.8%
Cash crops	1.033	2.0%	4.2%	6.1%	0.8%	16.0%
Vegetables	1.000	-0.3%	1.5%	6.5%	-1.8%	5.8%
Food crops	1.002	0.1%	0.4%	10.7%	0.7%	14.6%
Other Agriculture	1.002	0.3%	0.4%	7.9%	0.6%	11.3%
Livestock-bovine	1.001	0.0%	-5.0%	-1.2%	-2.2%	-12.4%
Other livestock	1.002	-0.3%	-6.9%	-1.4%	-2.0%	-14.8%
Hunting	1.000	-0.4%	-6.7%	-1.5%	-0.8%	-12.5%
Forestry	1.000	-0.4%	-6.6%	-1.5%	-0.7%	-12.2%
Fisheries	1.000	-0.4%	-6.6%	-1.5%	-0.7%	-12.2%
Mining	1.017	-0.9%	-6.9%	-2.2%	-3.5%	-27.7%
Cotton ginning	1.000	2.0%	-25.4%	-4.3%	137.6%	90.7%
Slaughtering	1.003	-1.1%	-21.2%	-5.3%	-7.4%	-39.9%
Agro-industry	1.057	2.4%	-7.7%	-1.3%	1.2%	-9.8%
Fertilizers and Pesticides	1.000	-0.8%	0.2%	126.5%	9.1%	166.7%
Other industry	1.110	-0.9%	2.0%	0.2%	7.3%	10.8%
Oil and oil products	1.000	-1.1%	116.1%	-0.9%	6.6%	154.5%
Power, water and gas	1.056	-1.0%	23.5%	-2.1%	-0.7%	27.2%
Trade	1.000	-0.8%	3.9%	-2.2%	-4.3%	-6.9%
Transport	1.028	-1.0%	8.5%	-1.1%	1.9%	12.1%
Financial services	1.189	-1.0%	-15.2%	-3.3%	-5.7%	-31.3%
Services to enterprises	1.023	-0.9%	-16.0%	-3.4%	-4.7%	-30.2%
Services to households	1.000	-0.9%	-9.0%	-3.0%	-5.5%	-21.7%

Source: CGE model output

Table A2. Impacts of price shocks on income of different household groups.

	Base	Food	Oil	Fertilizer	Cotton	Joint
Rural poor	271,356	-0.5%	-6.4%	-2.3%	-3.6%	-16.9%
Rural non-poor	793,400	-0.6%	-12.3%	-3.1%	-5.2%	-26.2%
Urban poor	25,357	-0.7%	-13.3%	-3.0%	-5.2%	-26.9%
Urban non-poor	657,493	-0.8%	-16.0%	-3.3%	-5.6%	-30.4%

Source: CGE output

Table A3. Yields, cost structure and value added for maize and cotton under ordinary and GAP technologies.

	Maize			Cotton		
	Current	GAP	Var %	Current	GAP	Var %
Yield (Kg/Ha)	1,617	3,047	88.5%	1,229	1,777	44.7%
Revenue	100.0	100.0	0.0%	100.0	100.0	0.0%
Interm.Cons.	51.5	41.7	-18.9%	55.8	45.9	-17.7%
<i>Chemicals</i>	45.9	28.4	-38.0%	53.8	31.7	-41.1%
<i>Other inputs</i>	5.6	13.3	138.0%	2.0	14.2	606.9%
Value added	48.5	58.3	20.1%	44.2	54.1	22.4%

Source: Author's calculations on data reported in FAO UN (2008).

Table A4 Consumer Prices (composite domestic-import prices) under different technologies and international price shock scenarios.

	Base	Reduced Chemicals	Reduced Int.Inputs	Increased Factors	Joint GAP changes	Shocks + GAP
Cotton grains	1.000	-0.2%	-7.9%	12.6%	5.0%	10.6%
Cash crops	1.033	-1.4%	-9.0%	12.2%	2.9%	14.9%
Vegetables	1.000	-1.4%	-13.1%	6.5%	-6.6%	-1.7%
Food crops	1.002	-2.6%	-5.6%	14.5%	7.7%	17.1%
Other Agriculture	1.002	-1.9%	-4.8%	15.2%	9.5%	17.2%
Livestock-bovine	1.001	0.3%	1.2%	-1.1%	0.2%	-10.5%
Other livestock	1.002	0.3%	1.2%	-1.0%	0.4%	-12.6%
Hunting	1.000	0.3%	1.6%	-0.7%	1.0%	-10.3%
Forestry	1.000	0.3%	1.6%	-0.7%	1.0%	-10.1%
Fisheries	1.000	0.3%	1.6%	-0.7%	1.0%	-10.1%
Mining	1.017	0.6%	0.0%	-6.1%	-5.5%	-29.2%
Cotton ginning	1.000	0.9%	-15.0%	38.1%	17.3%	136.8%
Slaughtering	1.003	1.2%	5.7%	-5.1%	0.8%	-36.8%
Agro-industry	1.057	0.3%	0.4%	-1.6%	-1.0%	-9.1%
Fertilizers and Pesticides	1.000	-9.7%	-9.4%	-2.8%	-12.1%	151.0%
Other industry	1.110	0.1%	-2.2%	-0.6%	-2.3%	7.7%
Oil and oil products	1.000	0.3%	2.6%	0.1%	2.7%	149.0%
Power, water and gas	1.056	0.5%	2.6%	-4.2%	-1.7%	25.0%
Trade	1.000	1.1%	-6.0%	-8.0%	-12.9%	-13.0%
Transport	1.028	0.3%	0.5%	-3.0%	-2.3%	9.7%
Financial services	1.189	0.7%	3.6%	-6.7%	-3.1%	-31.0%
Services to enterprises	1.023	0.7%	3.2%	-6.1%	-2.7%	-29.8%
Services to households	1.000	0.6%	3.7%	-7.1%	-3.7%	-22.4%

Source: CGE model output

Table A5. Activity levels under different international price shock scenarios

	Base	Food	Oil	Fertilizer	Cotton	Joint
Cotton grains	58,637	-2.5%	53.7%	6.4%	-66.1%	-57.2%
Cash crops	37,730	1.9%	-12.5%	-8.8%	3.7%	-18.0%
Vegetables	27,900	-0.2%	-7.9%	-4.0%	-1.5%	-15.5%
Food crops	147,770	0.1%	-8.7%	-5.9%	-2.2%	-18.7%
Other Agriculture	42,897	0.5%	-7.9%	-4.7%	-0.8%	-14.6%
Livestock-bovine	111,708	-0.3%	-4.1%	-0.9%	-0.1%	-8.0%
Other livestock	109,470	-0.2%	-4.6%	-1.0%	-0.7%	-9.1%
Hunting	8,025	-0.4%	-8.4%	-1.8%	-2.8%	-16.9%
Forestry	49,636	-0.3%	-5.2%	-0.6%	0.9%	-4.3%
Fisheries	8,896	-0.3%	-7.5%	-1.7%	-2.6%	-15.4%
Mining	13,640	-0.1%	13.2%	4.4%	23.0%	99.0%
Cotton ginning	76,146	-2.7%	57.3%	6.9%	-70.6%	-61.1%
Slaughtering	119,992	-0.1%	-3.3%	-0.7%	-0.8%	-10.5%
Agro-industry	257,294	0.9%	-2.9%	-1.0%	0.5%	-4.5%
Other industry	232,837	-0.1%	2.8%	1.5%	7.5%	20.2%
Power, water and gas	51,129	-0.1%	-7.8%	-0.8%	-2.6%	-13.7%
Trade	255,150	0.0%	2.6%	0.1%	-0.6%	2.9%
Transport	93,443	0.0%	-2.8%	0.6%	1.8%	-0.6%
Financial services	34,637	-0.2%	-2.7%	-0.6%	-1.0%	-8.1%
Services to enterprises	672,900	-0.1%	-2.1%	-0.3%	-0.2%	-3.9%
Services to households	413,041	0.0%	-0.3%	0.0%	0.0%	-0.5%

APPENDIX B: FEATURES OF THE CGE MODEL ADOPTED

a) The LES demand system

As final demand functions, the model uses a Linear Expenditure System (LES), based on the Stone-Geary utility function.

Demand functions for each commodity c are as follows:

$$p_i c_i = p_i \gamma_i + \beta_i \left[Y - \sum_j p_j \gamma_j \right]$$

where parameters γ_i may be thought of as representing the purchase of "subsistence quantities" of every good c , and the term in square brackets as "supernumerary" expenditures (remaining resources after having purchased subsistence quantities) to be divided among goods on the basis of a fixed proportion (parameters β_i). Note that the β_i are the marginal expenditure shares, which tell how much the expenditure share of a commodity changes, as expenditure changes (the first derivative of the expenditure on c w.r.t. Y)

Note that the major attractiveness of this system is that it is the only theoretical consistent demand function for which demand for every good is a linear function of all prices and expenditures. Unfortunately, Engel curves are linear, which is somehow not realistic.

In the model, the user provides the following data:

1. expenditure by commodity per type of household (from the SAM), to calculate expenditure shares
2. Expenditure elasticities
3. The FRISCH parameter, the so called "flexibility of money" i.e. the elasticity of the marginal utility of income wrt the income (how the marginal utility of income changes for an 1% increase of income) (See FRISCH, *Econometrica* 1959)

The model works out the betas and gammas, to be then used in the demand functions, using the links among LES parameters of the demand functions, and expenditure elasticities, expenditure shares and FRISCH parameter (for formulae about these links see e.g. Sadoulet, De Janvry 1995 p. 42).

b) Calculation of Betas

In the model the parameters beta are calculated as follows:

$$betam(C,H) = BUDSHR(C,H)*LESELAS1(C,H);$$

Note that for LES holds: $\eta_i = \frac{\beta_i}{w_i}$, i.e the expenditure elasticity of commodity C equals the ratio of the beta parameter of the demand function and the expenditure share for commodity C, as derived here below:

$$c_i = \gamma_i + \frac{\beta_i}{p_i} \left[Y - \sum_j p_j \gamma_j \right]$$

$$\eta_i = \frac{\partial c_i}{\partial Y} \frac{Y}{c_i}$$

$$\frac{\partial c_i}{\partial Y} = \frac{\beta_i}{p_i}$$

$$\eta_i = \frac{\beta_i}{p_i} \frac{Y}{c_i}$$

Nothing that $\frac{Y}{p_i c_i} = \frac{1}{w_i}$ i.e. the inverse of the expenditure share for Ci, we get:

$$\eta_i = \frac{\beta_i}{w_i}$$

This implies therefore: $\beta_i = \eta_i w_i$, which is the formula applied in the model:

Calculation of the subsistence consumptions gammas

In the model the subsistence consumption for each (marketed)commodity γ_i and for each household type H, is calculated as:

$$\begin{aligned} \text{gamma}_i(C,H) &= \text{\$BUDSHR}(C,H) \\ &= \left(\left(\text{SUM}(CP, \text{SAM}(CP,H)) + \text{SUM}(AP, \text{SAM}(AP,H)) \right) / \text{PQ0}(C) \right) \\ &\quad * \left(\text{BUDSHR}(C,H) + \text{betam}(C,H) / \text{FRISCH}(H) \right); \end{aligned}$$

- the dollar condition $\text{\$BUDSHR}(C,H)$ to be interpreted “...for all the commodities whose budget share is different from zero (the “NE 0” i.e. “not equal to 0” is omitted because it is the default)
- The sum of the two summations in the RHS: $\left(\text{SUM}(CP, \text{SAM}(CP,H)) + \text{SUM}(AP, \text{SAM}(AP,H)) \right)$ represents the total expenditure Y .
- $\text{PQ0}(C)$ is the price of commodity i , p_i (at the benchmark)
- $\text{BUDSHR}(C,H)$ is the budget share for commodity C in household H, i.e. $\frac{p_i c_i}{Y}$
- $\text{betam}(C,H)$ is the other LES parameter defined above;
- $\text{FRISCH}(H)$ is the FRISCH parameter for the household type H

- For the home consumption the same apply.

The γ parameter is directly derived by the demand function of the LES for each commodity C, i.e. and from the definition of the FRISCH parameter. On the basis of the fact that the LES is based on a pointwise separable utility function (i.e. the marginal utility of one good does not depend on the level of consumption of other goods), the FRISCH parameter in the LES is¹⁰¹:

$$\omega = -\frac{Y}{Y - \sum_j p_j \gamma_j} \Rightarrow \sum_j p_j \gamma_j = \frac{Y}{\omega} + Y$$

Substituting to the summation in the demand function:

$$p_i c_i = p_i \gamma_i + \beta_i \left[Y - \frac{Y}{\omega} + Y \right]$$

and working out the parameter γ_i gives:

$$\gamma_i = \frac{p_i c_i}{p_i} + \frac{\beta_i Y}{p_i \omega}$$

$$\gamma_i = c_i + \frac{\beta_i Y}{p_i \omega}$$

Alternatively, multiplying both numerator and denominator of the first term in the RHS by Y gives:

$$\gamma_i = \frac{p_i c_i Y}{p_i Y} + \frac{\beta_i Y}{p_i \omega} \Rightarrow \gamma_i = \frac{Y}{p_i} \left[\frac{p_i c_i}{Y} + \frac{\beta_i Y}{p_i \omega} \right] \text{ and noting that } \frac{p_i c_i}{Y} \text{ is the budget share for}$$

commodity C, w_i , we get:

$$\gamma_i = \frac{Y}{p_i} \left[w_i + \frac{\beta_i Y}{p_i \omega} \right] \text{ which is the formula used in the model.}$$

¹⁰¹ See e.g. Sadoulet, De Janvry 1995 p. 42.

Own and Cross-price elasticities of LES in the CGE model

In the model, own and cross-price elasticities are calculated on the basis of expenditure elasticities and the parameters beta and gamma of the LES demand functions worked out above.

Own-price elasticities.

The model calculates in a similar way own-price elasticities for both marketed commodities of non-marketed commodities, say, home consumption, for different types of households H. For example, the own price elasticities for the marketed commodities are calculated as follows:

$$LESELASP(H, 'MRK', C, 'MRK', C) = -LESELASI(C, H) * (PQO(C) * \text{gammam}(C, H) / (SUM(CP, SAM(CP, H)) + SUM(AP, SAM(AP, H)))) - 1/FRISCH(H);$$

Note that:

$(SUM(CP, SAM(CP, H)) + SUM(AP, SAM(AP, H)))$ corresponds to the total expenditure Y.

The model makes use of the own-price elasticity formula¹⁰²:

$$\eta_{(i,i)} = -\eta_i \left[\frac{\gamma_i p_i}{y} - \frac{1}{\omega} \right]$$

In general, the LES elasticities are derived as follows. We suppose a two-good case and then generalise the result to n-good case.

$$c_1 = \gamma_1 + \frac{\beta_1}{p_1} [Y - p_1 \gamma_1 - p_2 \gamma_2]$$

$$\eta_{(1,1)} = \frac{\partial c_1}{\partial p_1} \frac{p_1}{c_1}$$

$$\frac{\partial c_1}{\partial p_1} = \frac{\beta_1}{p_1^2} [p_2 \gamma_2 - Y]$$

$$\eta_{(1,1)} = \frac{\beta_1}{p_1^2} [p_2 \gamma_2 - Y] \frac{p_1}{c_1}$$

After rearranging we get:

¹⁰² This formula is provided in K. Dervis, J. De Melo, Robinson (1982): General Equilibrium models for development policy. World Bank Research Publication. Cambridge University Press.

$$\eta_{(1,1)} = \frac{\beta_1 [p_2 \gamma_2 - Y]}{p_1 c_1} \text{ Adding and subtracting 1 :}$$

$$\eta_{(1,1)} = \frac{\beta_1 [p_2 \gamma_2 - Y]}{p_1 c_1} + 1 - 1$$

$$\eta_{(1,1)} = \frac{\beta_1 [p_2 \gamma_2 - Y] + p_1 c_1}{p_1 c_1} - 1 \text{ Recalling that, from the demand function :}$$

$$p_1 c_1 = p_1 \gamma_1 + \beta_1 (Y - p_1 \gamma_1 - p_2 \gamma_2) \text{ and substituting in the numerator :}$$

$$\eta_{(1,1)} = \frac{\beta_1 (p_2 \gamma_2 - Y) + p_1 \gamma_1 + \beta_1 (Y - p_1 \gamma_1 - p_2 \gamma_2)}{p_1 c_1} - 1. \text{ From which :}$$

$$\eta_{(1,1)} = \frac{\beta_1 p_2 \gamma_2 - \beta_1 Y + p_1 \gamma_1 + \beta_1 Y - \beta_1 p_1 \gamma_1 - \beta_1 p_2 \gamma_2}{p_1 c_1} - 1.$$

$$\eta_{(1,1)} = \frac{+ p_1 \gamma_1 - \beta_1 p_1 \gamma_1}{p_1 c_1} - 1$$

$$\eta_{(1,1)} = \frac{(1 - \beta_1) p_1 \gamma_1}{p_1 c_1} - 1.$$

Cleaning p and generalising to the n-commodity case¹⁰³:

$$\eta_{(i,i)} = \frac{\gamma_i (1 - \beta_i)}{c_i} - 1.$$

The model applies a different rearrangement of this formula, derived as follows:

$$\eta_{(i,i)} = \frac{\gamma_i (1 - \beta_i)}{c_i} - 1$$

$$\eta_{(i,i)} = \frac{\gamma_i - c_i - \gamma_i \beta_i}{c_i}$$

Recall from the demand function that:

$$\gamma_i - c_i = -\frac{\beta_i}{p_i} \left[Y - \sum_j p_j \gamma_j \right]$$

Substituting into the numerator, leads to:

¹⁰³ This is the same formula reported in Sadoulet and de Janvry (1995)

$$\eta_{(i,i)} = \frac{-\frac{\beta_i}{p_i} \left[Y - \sum_j p_j \gamma_j \right] - \gamma_i \beta_i}{c_i} \quad \text{rearranging, we get :}$$

$$\eta_{(i,i)} = \frac{-\beta_i \left[Y - \sum_j p_j \gamma_j \right]}{p_i c_i} - \frac{\gamma_i \beta_i}{c_i} \quad \text{multiplying and dividing both RHS terms by } Y :$$

$$\eta_{(i,i)} = \frac{-\beta_i \left[Y - \sum_j p_j \gamma_j \right] Y}{p_i c_i Y} - \frac{\gamma_i \beta_i Y}{c_i Y} \quad \text{and recalling that :}$$

$$\frac{-\left[Y - \sum_j p_j \gamma_j \right]}{Y} = \frac{1}{\omega} \quad \text{i.e. the inverse of the LES Frisch parameter, and substituting :}$$

$$\eta_{(i,i)} = \frac{\beta_i Y}{p_i c_i \omega} - \frac{\gamma_i \beta_i Y}{c_i Y}$$

Recall also that the partial derivative of the LES demand functions, w.r.t. the total expenditure is ¹⁰⁴:

$$\frac{\partial c_i}{\partial y} = \frac{\beta_i}{p_i} \quad \text{and substituting in the above leads to:}$$

$$\frac{\partial c_i}{\partial Y} = \frac{\beta_i}{p_i} \quad \text{and noting that } \frac{\partial c_i}{\partial Y} \frac{Y}{c_i} = \eta_i, \text{ i.e. the expenditure elasticity of } C_i,$$

$$\eta_{(i,i)} = \frac{\partial c_i}{\partial Y} \frac{Y}{c_i} \frac{1}{\omega} - \frac{\partial c_i}{\partial Y} \frac{Y}{c_i} \frac{\gamma_i p_i}{Y}$$

this implies:

$$\eta_{(i,i)} = \eta_i \frac{1}{\omega} - \eta_i \frac{\gamma_i p_i}{y}$$

$$\eta_{(i,i)} = -\eta_i \left[\frac{\gamma_i p_i}{Y} - \frac{1}{\omega} \right]$$

After rearranging:

$$\eta_{(i,i)} = -\eta_i \left[\frac{\gamma_i p_i}{Y} - \frac{1}{\omega} \right]$$

which is the formula for the own price elasticity provided in Dervis et al (1982) and used in the model.

¹⁰⁴ In the LES, the betas are the marginal budget shares, i.e. the change in the budget allocated to each commodity C_i for a change in the total expenditure. This is easily verifiable by differentiating the demand function for C_i in value form w.r.t. the total expenditure y

Cross price elasticities in LES

The model calculates cross-price elasticities in a similar way for both marketed commodities of non-marketed commodities, say, home consumption, for different types of households H. For example, the cross price elasticities for the marketed commodities with the other marketed commodities are calculated as follows¹⁰⁵:

$$\begin{aligned} &LESELASP(H, 'MRK', C, 'MRK', CP) \\ &\$((ORD(C) NE ORD(CP)) AND LESELASI(C, H) AND LESELASI(CP, H)) \\ &= -LESELASI(C, H) \\ &* PQO(CP) * gammam(CP, H) / (SUM(CPP, SAM(CPP, H)) + SUM(APP, SAM(APP, H))); \end{aligned}$$

In mathematical notation (after dropping the household index H, the formula is the following

$$\eta_{(i,j)} = \frac{-\eta_i p_j \gamma_j}{Y}$$

The formula is derived as follows:

$$c_1 = \gamma_1 + \frac{\beta_1}{p_1} [Y - p_1 \gamma_1 - p_2 \gamma_2]$$

$$\eta_{(1,2)} = \frac{\partial c_1}{\partial p_2} \frac{p_2}{c_1}$$

$$\frac{\partial c_1}{\partial p_2} = -\frac{\beta_1}{p_1} \gamma_2$$

$$\eta_{(1,2)} = -\frac{\beta_1 p_2 \gamma_2}{p_1 c_1}$$

Generalising to the n-case¹⁰⁶:

$$\eta_{(i,j)} = \frac{-\beta_i p_j \gamma_j}{c_i p_i}$$

Noting that: $\beta_i = p_i \frac{\partial c_i}{\partial Y}$ as it can be easily verified differentiating the demand function w.r.t.

Y, and substituting into the numerator:

$$\eta_{(i,j)} = \frac{\partial c_i}{\partial Y} \frac{p_j \gamma_j p_i}{c_i p_i}$$

Cleaning up Pi and multiplying both numerator and denominator by Y, we

get:

$$\eta_{(i,j)} = \frac{\partial c_i}{\partial Y} \frac{Y}{c_i} \frac{p_j \gamma_j}{Y}$$

Recalling the definition of the expenditure elasticity for commodity Ci:

¹⁰⁵ The

¹⁰⁶ The same formula is provided e.g. in Sadoulet, De Janvry (1995)

$$\eta_i = \frac{\partial c_i}{\partial Y} \frac{Y}{c_i}$$

and substituting it in to the formula above, leads to:

$$\eta_{(i,j)} = \frac{-\eta_i P_j \gamma_j}{Y} \text{ which is the formula used in the model}^{107}.$$

Armington Functions

For all the commodities C which are both imported ($Q_m > 0$) and produced domestically ($Q_d > 0$) the model utilises a Constant Elasticity of Substitution (CES) function in order to aggregate domestic production and imports to create a “minimum cost” composite commodity Q_q ¹⁰⁸. Therefore, the problem for the economy is to choose the appropriate mix of Q_m and Q_d which minimizes the cost of a given quantity Q_q , knowing that Q_q is linked to Q_m and Q_d by the CES “production” function¹⁰⁹.

$$\text{Min}_{Q_m, Q_d} P_q \overline{Q_q} = P_m Q_m + P_d Q_d$$

$$\text{s.t. } Q_q = \alpha \left[\delta Q_m^{-\rho_c} + (1 - \delta) Q_d^{-\rho_c} \right]^{\frac{1}{\rho_c}}$$

Using the method of Lagrange multipliers, the minimization problem amounts to:

$$\text{Min}_{Q_m, Q_d, \lambda} L = P_m Q_m + P_d Q_d - \lambda \left\{ \alpha \left[\delta Q_m^{-\rho} + (1 - \delta) Q_d^{-\rho} \right]^{\frac{1}{\rho}} - Q_q \right\}$$

The first order partial derivatives of the lagrangean are:

$$\frac{\partial L}{\partial Q_m} = P_m - \frac{\partial \lambda \{ \dots \}}{\partial \{ \dots \}} \frac{\partial \{ \dots \}}{\partial Q_m} = P_m - \lambda \alpha \left(-\frac{1}{\rho} \right) \left[\dots \right]^{\frac{\rho-1}{\rho}} (-\rho) \delta Q_m^{-(\rho+1)}$$

$$\frac{\partial L}{\partial Q_d} = P_d - \frac{\partial \lambda \{ \dots \}}{\partial \{ \dots \}} \frac{\partial \{ \dots \}}{\partial Q_d} = P_d - \lambda \alpha \left(-\frac{1}{\rho} \right) \left[\dots \right]^{\frac{\rho-1}{\rho}} (-\rho) (1 - \delta) Q_d^{-(\rho+1)}$$

¹⁰⁷ As also provided in Dervis et Al. (1982).

¹⁰⁸ The CES function was originally introduced by K.J. Arrow, H.B. Chenery, B.S. Minhas and R.M. Solow (1961): Capital-Labour Substitution and Economic Efficiency, Review of Economics and Statistics, August 1961 pp 225-50.

¹⁰⁹ The objective function of the minimization problem enters in the CGE model as the equation of the “absorption” for each commodity C which is both produced domestically and imported. This equation provides the total value of the composite commodity C absorbed by the economic system. Note that, dividing both sides of the equation by Q_q , the equation provides the price of the composite commodity C as the weighted sum of prices P_d and P_m , where the weights are the shares of Q_m and Q_d with respect to Q_q .

$$\frac{\partial L}{\partial \lambda} = \alpha [\dots]^{\frac{1}{\rho}} - Qq$$

The first order conditions amount to:

$$Pm - \lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho) \delta Qm^{*-(\rho+1)} = 0 \Rightarrow Pm = \lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho) \delta Qm^{*-(\rho+1)}$$

$$Pd - \lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho)(1-\delta) Qd^{*-(\rho+1)} = 0 \Rightarrow Pd = \lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho)(1-\delta) Qd^{*-(\rho+1)}$$

$$\alpha \left[\delta Qm^{*-\rho} + (1-\delta) Qd^{*-\rho} \right]^{\frac{1}{\rho}} - Qq = 0 \Rightarrow \alpha \left[\delta Qm^{*-\rho} + (1-\delta) Qd^{*-\rho} \right]^{\frac{1}{\rho}} = Qq$$

This implies that, taking the ratio of the first two first order conditions:

$$\frac{Pm}{Pd} = \frac{\lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho) \delta Qm^{*-(\rho+1)}}{\lambda \alpha \left(-\frac{1}{\rho} \right) [\dots]^{\frac{\rho-1}{\rho}} (-\rho)(1-\delta) Qd^{*-(\rho+1)}} \Rightarrow \frac{Pm}{Pd} = \frac{\delta}{(1-\delta)} \left[\frac{Qm^*}{Qd^*} \right]^{-(\rho+1)}$$

Here, the import-domestic price ratio is expressed as a function of the import-domestic demand ratio. We can then work out the import-domestic demand ratio as a function of the domestic-import price ratio:

$$\frac{(1-\delta) Pm}{\delta Pd} = \left[\frac{Qm^*}{Qd^*} \right]^{-(\rho+1)} \Rightarrow \frac{Qm^*}{Qd^*} = \left[\frac{(1-\delta) Pm}{\delta Pd} \right]^{\frac{-1}{(\rho+1)}} \Rightarrow \frac{Qm^*}{Qd^*} = \left[\frac{\delta Pd}{(1-\delta) Pm} \right]^{\frac{1}{(\rho+1)}}$$

The import-domestic demand ratio expressed as a function of the domestic-import price ratio enter, together with the CES Composite supply function (the Armington function) and the price function of the composite commodity, as expressed by the objective function of the minimisation problem, into the set of equations of the model¹¹⁰.

Note that, as the production function constraining the cost minimisation problem is a CES, the elasticity of the import-domestic demand ratio with respect to the domestic-import price ratio is constant (i.e. does not depend upon the level of the demand or price ratios). It is expressed by:

¹¹⁰ Note that, if the prices Pm and Pd are assumed exogenous as well as the quantity of composite commodity to be obtained Qq, these three equations determine the three endogenous variables Qm Qd and Pq, i.e. the optimal quantities of “inputs” Qm and Qd to obtain a given quantity of “output” Qq at the minimum cost Pq.

$$\varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} = \frac{\partial \frac{Q_m^*}{Q_d^*} \frac{P_d}{P_m}}{\partial \frac{P_d}{P_m} \frac{Q_m^*}{Q_d^*}} = \frac{1}{(\rho+1)} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{1}{(\rho+1)}} \left[\frac{P_d}{P_m} \right]^{\frac{1}{(\rho+1)-1}} \frac{P_d}{P_m} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{-1}{(\rho+1)}} \left[\frac{P_d}{P_m} \right]^{\frac{-1}{(\rho+1)}}$$

$$\frac{\partial \frac{Q_m^*}{Q_d^*} \frac{P_d}{P_m}}{\partial \frac{P_d}{P_m} \frac{Q_m^*}{Q_d^*}} = \frac{1}{(\rho+1)} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{1}{(\rho+1)}} \left[\frac{P_d}{P_m} \right]^{\frac{1}{(\rho+1)-1}} \frac{P_d}{P_m} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{-1}{(\rho+1)}} \left[\frac{P_d}{P_m} \right]^{\frac{-1}{(\rho+1)}}$$

Executing the multiplications on the RHS above, leads to:

$$\varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} = \frac{1}{(\rho+1)} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{1-1}{(\rho+1)}} \left[\frac{P_d}{P_m} \right]^{\frac{1-\rho-1+\rho+1}{(\rho+1)}} \Rightarrow$$

$$\varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} = \frac{1}{(\rho+1)} \quad (\rho+1) \neq 0 \Rightarrow \rho \neq -1$$

A positive elasticity of substitution ensures that the share of imported goods in the mix of the composite commodity increases if the price of the domestic good increases relative with respect to the price of the imported good, and vice-versa. This implies:

$$\varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} > 0 \Rightarrow \frac{1}{(\rho+1)} > 0 \Rightarrow \rho > -1$$

However, note that in the CES function ρ appears at the denominator of the exponent. This implies that:

$$\rho \neq 0 \Rightarrow \frac{1}{(\rho+1)} \neq 1 \Rightarrow \varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} \neq 1$$

i.e. the elasticity of substitution, when using a CES, cannot take the value 1, as in the case of the Cobb Douglas. It can approximate to 1 for $\rho \rightarrow 0$.

On the other hand, the elasticity of substitution cannot take the value 0 for any value of ρ . It can only approximate to 0 for $\rho \rightarrow \infty$. To summarize, when using the CES function, the links between the value of ρ and the elasticity of substitution are as follows:

$$-1 < \rho < 0 \Rightarrow 1 < \varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} < \infty$$

$$\rho > 0 \Rightarrow 0 < \varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} < 1$$

$$\rho < -1 \Rightarrow \varepsilon_{\frac{Q_m^* P_d}{Q_d^* P_m}} < 0$$

$$\rho \neq 0, \rho \neq -1$$

Calibration of the Armington functions in the model

In the model, the rho (exponent) for each commodity, which is both imported and produced domestically, is worked out from the elasticity of substitution SIGMAQ, provided in the database of specific country data:

$$\varepsilon_{\frac{Qm^* Pd}{Qd^* Pm}} = \frac{1}{(\rho + 1)} \Rightarrow \rho = \frac{1 - \varepsilon}{\varepsilon}$$

The delta (share parameter) is worked out from the tangency condition with prices and quantities at the benchmark: $\frac{Qm_0^*}{Qd_0^*} = \left[\frac{\delta Pd_0}{(1 - \delta) Pm_0} \right]^{\frac{1}{(\rho+1)}}$

After some algebraic calculations, this leads to¹¹¹:

$$\delta = \frac{\frac{Pm_0}{Pd_0} \left[\frac{Qm_0}{Qd_0} \right]^{(\rho+1)}}{1 + \frac{Pm_0}{Pd_0} \left[\frac{Qm_0}{Qd_0} \right]^{(\rho+1)}}$$

Once delta is worked out, it is replaced in the Armington production function in order to work out alpha (scale parameter).

$$Qq = \alpha \left[\delta Qm^{-\rho_c} + (1 - \delta) Qd^{-\rho_c} \right]^{\frac{1}{\rho_c}} \Rightarrow$$

$$\alpha = Qq \left[\delta Qm^{-\rho_c} + (1 - \delta) Qd^{-\rho_c} \right]^{\frac{1}{\rho_c}}$$

CET functions for Export versus Domestic Supply.

The problem of trading-off the output to be sold on the domestic market QD versus the output to be exported QE is addressed by the producer by trying to maximise his/her aggregated sales revenue on domestic and export markets. The producer faces a technical constraint expressed by means of a Constant Elasticity of Transformation (CET) function, where QD

¹¹¹ Note that in the model the numerator is called; PREDELTA. Therefore:

$$PREDELTA = \frac{Pm_0}{Pd_0} \left[\frac{Qm_0}{Qd_0} \right]^{(\rho+1)} \quad \text{therefore: } \delta = \frac{PREDELTA}{1 + PREDELTA}$$

can be transformed into QE and vice-versa but QD is not a perfect transformation of QE, in a one-to-one way. This means that a reduction of one unit of QD allows one to obtain less than or more than one unit of QE according to the relative quantity QE/QD. Broadly speaking, if QE/QD is relatively high, a reduction of a unit of QD will allow only small increases of QE. Vice-versa, if QE/QD is small, a reduction in QD will allow large increases of QE.

The maximisation problem can be set as follows:

$$\begin{aligned} \text{Max}_{Qe, Qd} \overline{PX QX} &= PeQe + PdQd \\ \text{s.t. } QX &= \alpha \left[\delta Qe^{-\rho} + (1 - \delta) Qd^{-\rho} \right]^{-\frac{1}{\rho}} \end{aligned}$$

Using the method of Lagrange multipliers, the maximisation problem amounts to:

$$\text{Max}_{Qe, Qd, \lambda} L = PeQe + PdQd - \lambda \left\{ \alpha \left[\delta Qe^{-\rho} + (1 - \delta) Qd^{-\rho} \right]^{-\frac{1}{\rho}} - QX \right\}$$

The revenue maximisation problem, which can be solved in a similar way as the Armington cost minimisation problem described in the section above, gives rise to two supply functions, one for Qe and one for Qd which are direct functions of own-prices (Pe and Pd respectively) and inverse functions of the cross-prices (Pd and Pe respectively). In an alternative, the quantity ratio¹¹² can be derived from the ratio of the two first-order conditions:

$$\frac{Qe^*}{Qd^*} = \left[\frac{\delta}{(1 - \delta)} \frac{Pd^*}{Pe^*} \right]^{\frac{1}{(\rho+1)}}$$

The elasticity of transformation can be worked out, as above as¹¹³:

$$\varepsilon_{\frac{Qe}{Qd}, \frac{Pd}{Pe}} = \frac{\partial \frac{Qe}{Qd} \frac{Pd}{Pe}}{\partial \frac{Pd}{Pe} \frac{Qe}{Qd}} = \frac{1}{(\rho+1)} \left[\frac{\delta}{(1 - \delta)} \right]^{\frac{1}{(\rho+1)}} \left[\frac{Pd}{Pe} \right]^{\frac{1}{(\rho+1)} - 1} \frac{Pd}{Pe} \left[\frac{\delta}{(1 - \delta)} \right]^{\frac{-1}{(\rho+1)}} \left[\frac{Pd}{Pe} \right]^{\frac{-1}{(\rho+1)}}$$

After some manipulations we get:

¹¹² This ratio enters in the set of equations of the model. In this model however, the CET is written with the positive power ρ , which implies that the quantity ratio is reported with the exponent $(-\rho + 1)$ or analogously,

with exponent $(\rho - 1)$ but the inversed basis, as follows: $\frac{Qe^*}{Qd^*} = \left[\frac{(1 - \delta) Pe}{\delta Pd} \right]^{\frac{1}{(\rho-1)}}$

¹¹³ From now on we drop the star signalling optimality, for simplicity of notation.

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} = \frac{1}{(\rho+1)} \left[\frac{\delta}{(1-\delta)} \right]^{\frac{1-1}{(\rho+1)}} \left[\frac{P_d}{P_e} \right]^{\frac{1-\rho-1+\rho+1}{(\rho+1)}} \Rightarrow$$

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} = \frac{1}{(\rho+1)}$$

Note that the denominator has to be different from zero, therefore:

$$(\rho+1) \neq 0 \Rightarrow \rho \neq -1$$

We assume the elasticity of transformation to be negative¹¹⁴:

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} < 0 \Rightarrow \frac{1}{(\rho+1)} < 0 \Rightarrow \rho < -1$$

Note also that ρ can also be expressed as function of the elasticity of transformation:

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} = \frac{1}{(\rho+1)} \Rightarrow (\rho+1) = \frac{1}{\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}}}, \text{ so that}^{115}:$$

$$\rho = \frac{1}{\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}}} - 1 .$$

This implies that, when using a CET, the elasticity of substitution cannot be zero:

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} \neq 0$$

Calibration of the CET parameters ρ , δ and α

The calibration of the CET parameters is analogous to the calibration of the CES. ρ is calculated from the elasticity parameter as above.

δ is worked out starting from the quantity ratio, where prices and quantities are set at the benchmark level:

¹¹⁴ Note that in the model, given the change in the sign of ρ in the CET, the elasticity results:

$$\varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} = \frac{1}{(1-\rho)} . \text{ Therefore: } \varepsilon_{\frac{Q_d, P_d}{Q_d, P_e}} < 0 \Rightarrow \frac{1}{(1-\rho)} < 0 \Rightarrow \rho > 1 .$$

¹¹⁵ Note that, for some reasons, in the model, the elasticity value (parameter *SIGMAT*) is inserted in the country database as a positive value. Therefore, ρ has to be calculated as: $\rho = \frac{1}{\text{SIGMAT}} + 1$. This ensures a positive

ρ (and always greater than 1) and, given the positive sign of the exponent ρ in the CET, leads to a negative elasticity of transformation, as desired.

$$\delta = \frac{\frac{Pe_0}{Pd_0} \left[\frac{Qe_0}{Qd_0} \right]^{(\rho+1)}}{1 + \frac{Pe_0}{Pd_0} \left[\frac{Qe_0}{Qd_0} \right]^{(\rho+1)}} \text{ or, analogously, after some manipulations:}$$

$$\delta = \frac{1}{1 + \frac{Pd_0}{Pe_0} \left[\frac{Qd_0}{Qe_0} \right]^{(\rho+1)}}$$

Note that $0 < \delta < 1$ as the denominator is always greater than 1 because it is 1 plus a positive quantity. Indeed, the price ratio is positive, the quantity ratio is positive as well and it keeps the positive sign even if powered with whatever exponent (for whatever value of rho).

Note also that the restriction of the elasticity of transformation to be negative implies that $\rho < -1$, thus $(\rho + 1) < 0$. This leads, other things equal, to $\delta \rightarrow 0$ if $\frac{Qd}{Qe} \rightarrow 0$, as this

implies that $\left[\frac{Qd}{Qe} \right]^{(\rho+1)} \rightarrow \infty$ as well as all the denominator. On the other hand $\delta \rightarrow 1$ if

$\frac{Qd}{Qe} \rightarrow \infty$. In other words, a large share of exports implies a small delta, vice-versa, a small share of exports implies a large delta.