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Does agriculture possess the strong linkages necessary to drive industrialization and poverty reduction in Burkina Faso?

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Abstract

The industrial development is often considered as a way of making developing economies more resilient and improving households' livelihoods over the long run. In this paper, we have made use of a computable general equilibrium model applied to Burkina Faso and have shown that the agricultural development could allow both achieving strong growth of the manufacturing sector and increasing real households' income. In terms of industrial development, the beneficial effects of an agricultural investment are greater than those of an industrial investment. This result is explained by the strong feedback links between agriculture and industry. Our findings have interesting policy implications: industrial development in many developing countries is more hampered by the difficulties encountered by the agricultural sector than by a lack of investment in the industry. The findings therefore suggest that an even higher priority must be given to the agricultural sector by allocating the necessary resources to achieve agricultural development.

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1. Introduction

Industrialization has historically been associated with increases in real per capita incomes. In other words, industrialization seems to be the safest route to wealth. For decades, some economists working on economic growth have argued that the path to sustained growth runs through industrialization. When industry becomes the main sector of the economy, driven by technological progress, manufacturing employment increases, wages grow, real consumption increases and living standards significantly improve. In short, industry holds the key to the wealth of nations and explains why many countries strongly aspire to industrialization (O'Brien 1998).

Industrialization can be undertaken in three ways: i) as a by-product of a dynamic primary sector, ii) via an import substitution policy, and iii) via export-oriented industrialization. The first path comes from strong growth in agricultural productivity and exports, which increases households' incomes, thereby creating demand for domestic manufactured products (Murphy et al. 1989). The second option aims to restrict imports to further promote the production of domestic substitutes. This implies, first, the transition from imports of primary products towards the national production of basic consumer goods and, second, towards the national production of capital-intensive and technological goods, i.e., capital goods and intermediate consumption (Gereffi and Wyman 1990). Finally, export-oriented industrialization aims to accelerate the industrialization process by exporting manufactured products for which the national economy has a comparative advantage. It often involves a more open economy and is highly dependent on foreign markets.

The last two options have been widely used in the history of development. On the one hand, East Asian countries have opted for a strong export orientation. This option aimed to overcome certain market failures through technological learning and the strong involvement of the private sector. On the other hand, the import substitution option, with ubiquitous state interventions that are unrelated to market failures and sometimes ignore market forces in pursuit of noneconomic goals, has been widely applied in Sub-Sahara African countries. Unlike the export-oriented option, the import substitution option did not produce the expected results once the phase of import substitution had ended and when technological development and international competitiveness had become essential.

It is out of the question to argue here that the markets are functioning properly in the developing countries of Sub-Saharan Africa and that it is rather the States that are failing. Rather, the question is, given the pervasive market failures, what type of public intervention is most important. In other words, the policy issue is not whether there should be public intervention – there certainly must be – but how such interventions should be designed and implemented to promote industrial development.

Given the difficulties linked to States' intervention in industrial policy (collusion, embezzlement, corruption, etc.), another possibility could be to indirectly create industrial policy by modernizing agriculture. This policy has the advantage of not only creating significant outlets for industry (income growth for the majority of the population involved in the agricultural sector) but also reducing the production costs of industry through cheap intermediate consumption. The profitability thus created in the industrial sector would encourage the latter to invest more in technological development and innovation via research and development.

The early authors who have dealt with the issue of the role of agriculture in the process of development and industrialization (Rosenstein-Rodan 1943; Lewis 1954; Scitovsky 1954; Hirschman 1958; Jorgenson 1961; Ranis and John 1961) have seen agriculture only as a sector for providing labor and surplus to the industrial sector. Agriculture has thus been relegated to second place in policies surrounding the transformation of developing economies, and the

emphasis has been placed on a central strategy of accelerating the pace of industrialization. Hirschman (1958) even defines agriculture by its inability to present the strong intersectoral links that are essential for economic development. In particular, he considers that agriculture, unlike the manufacturing industry, lacks the possibility of directly generating new activities through linkage effects. Agriculture cannot therefore be the leading sector in the "big push" toward industrialization.

This vision of agriculture is different, however, from that of Kuznets (1968), who maintains that the condition for the success of a development strategy is that technological progress must support both industrialization and growth in agricultural productivity. For this author, if reductions in agricultural activity and employment are a basic, conventional fact of industrialization, the reductions are themselves the effects of technological progress. As a result, industrialization provides the technological basis necessary for the transformation of agriculture so that the agricultural revolution frees up human resources for the benefit of industry. Kuznets also believes that such an agricultural revolution is an indispensable basis for economic growth.

Like Kuznets, Kalecki (1960) supports the idea that the development of agriculture is essential for a successful industrialization strategy in low-income countries. He has devoted much of his work to identifying obstacles to agricultural development and has shown that institutional reforms of land tenure and credit markets can be seen as essential mechanisms for a successful agricultural development strategy. For Kalecki (1960), the basic condition for the rapid industrialization of an underdeveloped country is strong growth in agricultural production.

In the second half of the 1970s, many economists (Mellor 1976; Adelman 1984; De Janvry 1984) began to recognize the potential of agriculture to generate demand that is strong enough to stimulate the industrialization process. Adelman (1984) has thus highlighted the role of the growth of agricultural productivity through investment and technological innovation in improving the living standards of rural people in developing countries. The arguments put forward by Adelman (1984) and his supporters are that because of the productive and institutional links of agriculture with the rest of the economy, the stimulation of agriculture produces strong incentives to demand (increased demand from rural households) and supply (increased food supply without increasing prices), thereby promoting industrial expansion.

The link between agricultural development and economic growth has since been the subject of numerous studies (Mundlak 2005; Tiffin and Irz 2006; Self and Grabowski 2007; Bosworth and Collins 2008; Gollin 2010; Pauw and Thurlow 2011; Collier and Dercon 2014; Zidouemba and Gérard 2015; Zidouemba and Gerard 2018). Without going into details on the literature on this issue, we must emphasize the lack of consensus, to date, on the capacity of agriculture to represent the engine of economic development, industrialization and poverty reduction. For example, according to Himanshu et al. (2013), the nonagricultural sectors have been at the heart of the significant reduction in rural poverty in India. Collier and Dercon (2014) argue that agricultural productivity, particularly that of small family farms, is so low that a radical transformation of agriculture and a rural exodus are necessary to make agriculture an engine of economic development, which will be very costly for countries with limited resources.

In this paper, we would like to contribute to this debate for the specific case of Burkina Faso. The central question is: Does agriculture possess the strong linkages that are necessary to drive industrialization and poverty reduction in Burkina Faso? To do this, we use a computable general equilibrium (CGE) model calibrated with a social accounting matrix that represents the structure of Burkina Faso's economy. CGE models are more suited to this task than other models because of their ability to take intersectoral linkages into account (Pauw and Thurlow 2011). They are also suited for economywide impact analyses of exogenous or policy shocks (Hertel 2002). We then simulate agricultural intensification via a 10% increase in agricultural

capital. Two alternative scenarios are also simulated: a 10% increase in industrial capital, on the one hand, and a 10% increase in capital in the service sector, on the other hand. These alternative scenarios were generated to compare their efficiency in terms of industrialization and poverty reduction with the scenario of agricultural intensification.

The results show that the agricultural development enables both strong growth of the manufacturing sector and increasing real households' income. In terms of industrial development, the beneficial effects of an agricultural investment are greater than those of an industrial investment. Our study thus contributes to the economic literature by showing that the agricultural linkage pessimism developed since the early input-output studies of Chenery and Watanabe (1958) and Hirschman (1958) is factually unjustified. It therefore calls for an even higher priority to be given to the agricultural sector by allocating the necessary resources to achieve agricultural development.

The remainder of the paper is organized as follows: after describing the CGE model and data, (section 2), we analyze and discuss the simulation results (section 3) before summarizing our findings in section 4.

2. The CGE model and data

2.1. The CGE model

2.1.1. The General characteristics

The CGE model used is based on the PEP-1-t model developed by Decaluwé et al. (2010). It is a dynamic recursive model that implements the interaction between the different consumption and production behaviors while ensuring macroeconomic balances.

The firms are expected to operate in perfectly competitive markets. Thus, the representative firm maximizes the profits subject to its production technology while considering the prices of goods, services and factors as given (price-taker behavior).

Once the level of production has been determined, it is assumed that this output is sold on both domestic and foreign markets, based on a CET (constant elasticity of transformation) function that allows for imperfect substitutability between goods produced for different markets. Similarly, a standard CES (constant elasticity of substitution) function – also known as an Armington function – governs the consumption choices for products according to their origin (local or imported).

The model also integrates four categories of agents: households, government, firms and the rest of the world. Households derive their income from remunerative factors (labor, capital and agricultural land) and from net revenue transfer. Their expenditures consist of consumption spending and direct tax payments to the government. The difference between income and expenses represents households' savings. The government collects direct and indirect taxes and makes current expenditures, transfers to other institutions, and public investments. The firms receive a portion of capital income, pay dividends to households and foreign countries, pay income taxes to the government and save the rest.

The assumption of a small country with fixed international prices is adopted. The exchange rate is the numéraire of the model. The balance between supply and demand in the goods and services market is ensured by an adjustment in relative prices. The total investment is the sum of the various economic agents' savings. The current account balance, stock variation, and government spending are exogenous and evolve at the same pace as the population growth.

The following closure rules have been adopted: fixed foreign savings, fixed government savings (flexible taxation rates), and savings-driven investment.

The production function structure is represented in Figure 1. At the top level, there is a Leontief function combining added value and an intermediate consumption aggregate. The two

aggregate inputs are therefore considered to be strictly complementary, without any possibility of substitution. At the second level, the representative firm's added value consists of composite labor and composite capital, following a constant elasticity of substitution (CES) specification. At the bottom level, on the added-value side, two categories of labor (skilled, unskilled) are combined following a CES technique reflecting the imperfect substitutability between these types of labor. On the intermediate consumption side, aggregate intermediate consumption is made up of various goods and services. Intermediate inputs are therefore assumed to be perfectly complementary and are combined following a Leontief production function.

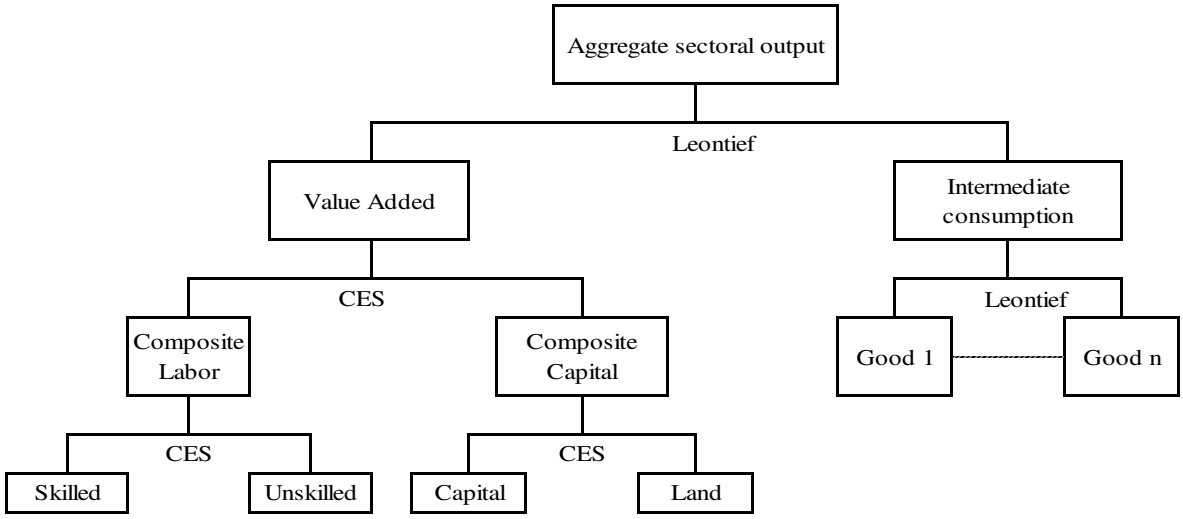

Figure 1. The structure of the production function

2.1.2. A capital market characterized by partial mobility

In the standard version of the model, capital is assumed to be sector-specific. We relax this hypothesis in favor of partial mobility in which three aggregate sectors are distinguished: agriculture, industry, and services. Their mobility is partial in the sense that agricultural capital can be used alternatively for subsistence or cash-crop agriculture, for example. However, agricultural capital cannot migrate to nonagricultural sectors. Similarly, industrial capital can migrate between industrial subsectors but not to agriculture or to services. This modeling implies a rate of return on capital that is defined by the aggregate sectors of the economy and not by individual sectors. The closure of the capital market is modified accordingly. The conditions of capital market equilibrium now arise at the macrosectoral level:

in the agricultural sector: $\sum_{j1} KS_{k,j1,t} = \sum_{j} KD_{k,j1,t}$
in the industry sector: $\sum_{j2} KS_{k,j2,t} = \sum_{j} KD_{k,j2,t}$
in the services sector: $\sum_{j3} KS_{k,j3,t} = \sum_{j} KD_{k,j3,t}$

where *KS* and *KD* represent the supply and demand of capital, respectively, and j_1, j_2 and j_3 are the subsets of agriculture, industry and services, respectively. These three equations determine the wage rates $R_{k,agsec,t}$ at the macrosectoral level

2.2. The data

2.2.1. The Social Accounting Matrix (SAM)

The social accounting matrix on which we have based the analyses was developed in 2015 by the World Bank in collaboration with the National Institute of Statistics and Demography

(INSD). It reflects Burkina Faso's 2012 economic situation. This matrix includes 17 sectors of activity producing 17 goods and services with the possibility for a sector to produce more than one product and for one good to be produced by several activities.

Four production factors are identified: unskilled labor, skilled labor, land (used only in agriculture), and capital. The matrix includes nine household categories distinguished according to the main occupation of the head of the household: public employees, formal private sector employees, informal private sector employees, cash-crop farmers, subsistence farmers, breeders, fishers, self-employed, nonagricultural employers and the unemployed.

Table 1 shows the structure of the Burkinabe economy in 2012 according to the social accounting matrix. Subsistence agriculture is the main contributor to added value, accounting for nearly 16 % of the total. This sector is followed by public administration with 14.83 %, livestock and hunting with 11.26 %, mining with 10.80 % and trade with 10.02 %. Other industries, such as cash crops, construction, transport and communications, health and social services, each represents approximately 4 to 5 %. Burkina Faso's main imports are industrial products, including metal products, transport equipment, and radio, television and communications equipment, among others. Almost 70 % of the value of imports is made up of industrial products. Combined with the products from agroindustries, the share of imports of industrial products amounts to more than 90 %.

With regard to exports, mining products, particularly gold, represent by far Burkina Faso's main source of export revenue (60.89 %). Textiles, clothing and leatherwork are in second place, with 12.33 % of export earnings. The country depends mainly on imports to the sectors of "other industries" and to a lesser extent on "financial activities" and the agroindustry, as shown by the import shares on domestic absorption. Almost all of the production of the mining sectors is exported (94.15 %). The textile, clothing and leatherworking sector exports nearly 60 % of its production.

Table 2 shows the shares of added value and intermediate consumption in the production costs of the production sectors. While agriculture is intensive in added value (mainly linked to the intensive use of land and family labor), the industrial sectors – except for the mining sector – are rather intensive in intermediate consumption. The services use relatively equal shares of added value and intermediate consumption. The breakdown of aggregate intermediate consumption (table 3) shows that the industrial sectors, particularly the textile and food processing industries, use a very large share of agricultural products for intermediate consumption. Similarly, in all agricultural sectors, agricultural products represent more than 80% of intermediate consumption. While the products of the food processing industries are mainly used in final households' consumption (81.62%), textile products are mainly used in intermediate consumption (64.84%) (Table 4). Table 5 is a breakdown of the "intermediate consumption" column of Table 4. It can be seen that the agricultural products used for intermediate consumption are mainly demanded by the industrial sectors. This short overview of the intersectoral links suggests a priori that agriculture and industry in Burkina Faso have strong links that can indirectly stimulate industry through support for agriculture. Indeed, the structure of the sectoral production implies that any policy that would lead to a decrease in the prices of production factors will be more beneficial to the agricultural sectors, while a decrease in the prices of intermediate consumption would benefit more the industrial sectors. Lower agricultural prices will not only benefit the industrial sectors but will also help to significantly reduce the production costs of the agricultural sectors. Thus, it is expected that a greater supply of capital in the agricultural sectors will benefit both the agricultural sectors (a decrease in the price of capital leading to an increase in the demand for agricultural capital) and the industrial sectors (a decrease in agricultural prices leading to a decrease in the costs of production).

Table 1. The structure of the national economy in 2012

	Production		Value added		Imports		Exports		M/Q	X/XS
	Millions of CFA francs	%	Millions of CFA francs	%	Millions of CFA francs	%	Millions of CFA francs	%		
Subsistence agriculture	861 561	10.15	749 867	15.79	20 686	0.98	40 747	2.80	2.31	4.73
Cash-crop agriculture	298 103	3.51	239 850	5.05	4 006	0.19	55 570	3.82	1.59	18.64
Livestock and hunting	671 908	7.91	534 516	11.26	209	0.01	19 457	1.34	0.03	2.90
Forestry and logging	202 601	2.39	188 326	3.97	6	0.00	247	0.02	0.00	0.12
Fishing	12 176	0.14	11 775	0.25	37	0.00			0.17	
Mining activities	941 255	11.09	512 677	10.80	4 222	0.20	886 195	60.89	14.52	94.15
Food processing industries	832 351	9.80	166 962	3.52	217 419	10.26	12 881	0.89	17.11	1.55
Textiles, clothing, leather	312 820	3.68	90 158	1.90	37 559	1.77	179 417	12.33	21.46	57.35
Other industries	297 176	3.50	73 132	1.54	1 476 884	69.72	45 278	3.11	60.16	15.24
Electricity, gas and water	140 914	1.66	35 717	0.75	26 692	1.26			14.88	
Construction	641 512	7.56	240 845	5.07	35 125	1.66	31 476	2.16	4.54	4.91
Trade	744 843	8.77	475 746	10.02						
Accommodation, catering	146 674	1.73	15 705	0.33						
Transport communications	471 874	5.56	205 949	4.34	81 017	3.82	70 191	4.82	16.20	14.87
Financial activities	139 364	1.64	77 936	1.64	68 431	3.23	57 613	3.96	38.41	41.34
Public administration	959 997	11.31	704 027	14.83	24 978	1.18	6 602	0.45	2.56	0.69
Education	248 180	2.92	171 894	3.62						
Health and social work	567 341	6.68	252 998	5.33	121 091	5.72	49 640	3.41	18.53	8.75
Total	8 490 650	100	4 748 078	100	2 118 362	100	1 455 314	100	20.14	17.14

M/Q is the share of imports in domestic absorption; X/XS is the share of exports in sectoral production.

Moreover, given that the products of the food processing industries are mainly used for final households' consumption and that textile products are mainly used for intermediate consumption, any improvement in households' incomes as well as any growth in sectors requiring industrial products for intermediate consumption is likely to increase production in industrial sectors and thereby strengthen an industrialization process driven by agriculture. One of the advantages of the CGE model is that it can account for all these intersectoral links and consider these links during a shock that affects a particular sector. It is then possible to identify the channels through which this shock spreads throughout the economy and determine the net effects, i.e., the effects after taking into account these feedback links.

Table 2. Shares of added value and intermediate consumption in the costs of sectoral production

Sectors of activities	Spending on factors of production	spending on intermediate consumption
Subsistence agriculture	87.06	12.94
Cash-crop agriculture	80.48	19.52
Livestock and hunting	88.80	11.20
Fishing	93.45	6.55
Mining activities	**61.31**	**38.69**
Food processing industries	**22.30**	**77.70**
Textiles	**31.21**	**68.79**
Other industries	**27.31**	**72.69**
Electricity, gas and water	24.77	75.23
Construction	41.83	58.17
Trade	72.78	27.22
Accommodation, catering	10.98	89.02
Transport, communications	48.54	51.46
Financial activities	60.78	39.22
Public administration	78.28	21.72
Education, health	69.51	30.49
Other services	48.99	51.01

Source: social accounting matrix

Table 3. Shares of products used as sectoral intermediate consumption

Sectors of activities	Agricultural products	Industrial products	Services	Total
Subsistence agriculture	62.99	37.01	0.00	100
Cash-crop agriculture	79.05	20.95	0.00	100
Livestock and hunting	91.50	8.50	0.00	100
Fishing	91.92	8.06	0.01	100
Mining activities	**0.00**	**99.98**	**0.02**	**100**
Food processing industries	**70.36**	**29.64**	**0.00**	**100**
Textiles	**66.43**	**33.57**	**0.01**	**100**
Other industries	**20.63**	**79.34**	**0.03**	**100**
Electricity, gas and water	0.00	99.96	0.04	100
Construction	10.68	89.31	0.01	100
Trade	0.00	99.91	0.09	100
Accommodation, catering	42.01	57.99	0.00	100
Transport, communications	0.00	99.95	0.05	100
Financial activities	0.00	98.04	1.96	100
Public administration	0.00	99.91	0.09	100
Education, health	0.00	99.87	0.13	100
Other services	0.18	99.76	0.05	100

Source: social accounting matrix

Table 4. Distribution of goods and services by type of demand

Goods and services	Private consumption	Public expenditures	Intermediate demand	Investment Demand	Total
Subsistence agriculture	75.43		24.57		100
Cash-crop agriculture	11.55		88.45		100
Livestock and hunting	48.89		36.32	14.79	100
Fishing	26.45		73.55		100
Mining activities	**2.66**		**97.34**		**100**
Food processing industries	**81.62**		**18.38**		**100**
Textiles	**35.16**		**64.84**		**100**
Other industries	**24.31**		**46.10**	**29.59**	**100**
Electricity, gas and water	24.55		75.45		100
Construction	0.46		2.43	97.11	100
Accommodation, catering	75.86		24.14		100
Transport, communications	22.10		77.90		100
Financial activities	33.96		66.04		100
Public administration	1.88	98.12			100
Education, health	17.58	79.64	2.78		100
Other services	28.59	4.05	53.12	14.24	100

Source: social accounting matrix

Table 5. Shares of intermediate consumption by aggregate sector

Goods and services	Agricultural sector	Industrial sector	Services sectors	Total
Subsistence agriculture	47.70	42.83	9.47	100
Cash-crop agriculture	23.75	76.25		100
Livestock and hunting		89.68	10.32	100
Fishing	22.29	56.04	21.67	100
Mining activities	**6.36**	**25.99**	**67.64**	**100**
Food processing industries	**1.67**	**68.67**	**29.66**	**100**
Textiles		**80.26**	**19.74**	**100**
Other industries	**4.86**	**30.31**	**64.83**	**100**
Electricity, gas and water	0.05	32.50	67.45	100
Construction	0.08	22.74	77.18	100
Accommodation, catering			100.00	100
Transport, communications	0.01	21.43	78.56	100
Financial activities		24.22	75.78	100
Education, health	1.60		98.40	100
Other services	0.08	36.07	63.85	100

Source: social accounting matrix

2.2.2. The elasticity parameters

The range of (free) parameters used in the model come from the literature (Annabi et al. 2006). The values of the main parameters are given in appendix 3. We have also performed sensitivity tests to check the robustness of the modeling results regarding elasticities (section 3.3).

3. Empirical results

3.1. Impacts of capital supply in the agricultural sector

The first tested scenario consists of increasing the stock of capital in the agricultural sector by 10%. Due to the possible mobility of capital between the agricultural subsectors, the model

endogenously allocates the additional capital to the agricultural subsectors according to its rentability. Such subsectoral allocation of capital leads to an equalization of the rental rate of capital at the aggregate sector level.

The direct effect of the capital increase in agriculture is to decrease the rental rate of capital in this sector. Thus, the price of agricultural capital decreases by 13.61% (Table 6), which has the effect of increasing the demand for capital in all the agricultural subsectors (Table 7). The increase in the demand for capital is more significant in cash-crop agriculture (+17.55%) and in subsistence agriculture (+11.07%). The sharp fall in the price of agricultural capital makes this production factor relatively cheaper than labor, whose price only decreases by 0.96%. This results in substituting capital for labor in agriculture. As seen in table 8, the demand for labor has fallen sharply (-18.90%). Given the intersectoral labor mobility, the labor freed up is deployed in the nonagricultural sectors. Industry, for example, has recorded an increase in labor demand of 7.36%, which has come mainly from the textile (+18.25%) and food processing industry (+15.13%) subsectors. Services, meanwhile, have experienced a smaller increase in labor demand (+1.31%), mainly in the catering (+4.65%) and trade (+4.33%) subsectors. These changes in demand for factors of production are consistent with basic economic theory: agricultural intensification leads to a decline in the population operating in the agricultural sector to the benefit of industry and services.

The increase in the demand for labor in the nonagricultural subsectors leads to a relative scarcity of capital, which explains the rise in the rental rate of capital in industry (+2.70%) and in services (+0.89%) (table 6).

Agricultural intensification leads to an increase in agricultural production (+8.22%), driven mainly by cash-crop agriculture (+13.78%), subsistence agriculture (+7.69%) and the livestock sector (+7.45%) (table 9). There are also positive effects on nonagricultural production, which increased by 4.12% and 0.41% for industry and services, respectively. In industry, the subsectors whose production increases sharply are textiles (+14.10%) and food processing industries (+6.98%), while in the service sector, the catering (+3.97%) and trading (+1.36%) subsectors are the largest beneficiaries. Several factors combined explain the increase in production in some nonagricultural sectors. On the one hand, as we have mentioned above, agricultural intensification leads to a reallocation of the workforce for the benefit of these sectors. On the other hand, the increase in agricultural production is beneficial to these nonagricultural subsectors due to an increase in intermediate consumption and their more affordable costs due to the decrease in agricultural prices (Table 10). Indeed, the consumer price index for agricultural goods has fallen by 11.36%, against a fall of 2.49% and 1.02% for industrial goods and services, respectively. Overall, the consumer price index has fallen by 5.15%. This drop in living costs leads to a significant increase in the purchasing power of households and allows an increase in households' real consumption regardless of socioprofessional categories (Table 11).

International trade is also strongly impacted by the agricultural capital increase. The growth in agricultural production and the resulting fall in domestic prices leads to a sharp increase in agricultural exports (+19.76%) (Table 12) – relative export prices become more attractive for producers – and a drop in imports of agricultural products (-13.24%) (Table 13) through a substitution effect for local products (+7.47%) (Table 14) – relative import prices become less attractive to consumers. On the export side, the cash-crop agriculture (+21.20%) and livestock (+19.44%) sectors have recorded the largest increases in exports, while on the import side, the declines were relatively equivalent between agricultural products. It is interesting to note that although the supply of capital concerns only the agricultural sectors, there is an increase in exports of textile products (+11.50%) and food processing products (+10.21%), as this was the case for production in these sectors. The increase in agricultural production therefore induces very significant ripple effects in these sectors.

The strong growth in agricultural and nonagricultural production, exports, private consumption and the drop in imports lead, at the macroeconomic level, to an increase in real GDP of 3.03%. This increase, as one would expect, is mainly driven by agriculture, whose real GDP increases by 8.10%, followed by those of industry (3.43%) and services (0.46%) (table 15).

3.2. Impacts of capital supply in the industry and service sectors

Scenario 2, which simulates a 10% increase in the supply of capital in industry, leads to a decrease in the rental rate of industrial capital (-7.85%), leading to an increase in the demand for capital in industrial sectors, especially in the mining sector (+11.88%). This result is a fall in the demand for labor in industry (- 8.97%) by the substitution effect. These adjustments of factor demand lead to an increase in industrial production of 5.04%, mainly driven by the mining sector (+9.24%). The growth of industrial production is unfortunately not strong enough to induce a drop in the consumer price index, which has even increased by 0.86%. The industrial price index has slightly risen, by 0.07%, compared with an increase of 2.14% for the agricultural price index and 0.77% for the services price index. This increase in the price index explains why the growth in real consumption in all household categories is very marginal (Table 11). Table 12 shows that with the exception of industrial products, exports of other products decline, while imports of most products increase due to higher domestic prices. The impact on real GDP is small compared to that in the first scenario since the real GDP increases by only 1.48%, mainly driven by the industrial sector, whose real GDP increases by 6.74%. It should also be emphasized that investment in agriculture leads to stronger growth in the industrial sectors (except the mining sector) than in investment in industry. Indeed, while the production of the agroindustry and the textile subsectors increase by 6.98% and 14.10%, respectively, in the first scenario, these increases are only 3.97% and 3.50% in the second scenario. This means that the development of these industrial sectors could be better provided by agricultural development than by policies directly targeting these sectors.

The third scenario, i.e., investment in the services sector (10% increase in the supply of capital for services), provides higher positive effects than investment in industry but lower positive effects than investment in agriculture. Indeed, the real GDP in this scenario increases by 2.06%, mainly driven by the services sector (+5.26%). Real households' consumption increases but less so than in the scenario of investment in agriculture. Investment in services leads to much lower growth in industry production (+1.12%) than investment in agriculture (+4.12%), highlighting the fact that industrialization comes less from the services sector than from agriculture.

Table 6. The effects on the prices of production factors (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Capital			
Agriculture	-13.61	2.36	0.48
Industry	2.70	-7.85	0.95
Services	0.89	1.78	-10.36
Labor	-0.96	0.24	-1.24

Source: CGE model simulations

Table 7. The effects on the sectoral capital demand (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Subsistence agriculture	11.07	-0.73	-0.39
Cash-crop agriculture	17.55	0.98	-2.07
Livestock and hunting	7.45	0.23	0.56
Fishing	5.19	0.80	2.04
Mining activities	-3.19	11.88	0.10
Food processing industries	4.39	6.17	0.06
Textiles	13.34	6.19	-4.00
Other industries	-3.00	8.80	4.65
Electricity, gas and water	0.37	-0.62	17.25
Construction	-1.11	-0.44	10.72
Trade	1.16	0.69	4.57
Accommodation, catering	0.84	-4.14	28.40
Transport, communications	-0.21	-0.11	12.83
Financial activities	-0.89	-2.06	22.84
Education, health	-0.98	-4.24	29.15
Other services	-1.39	-0.48	16.03

Source: CGE model simulations

Table 8. The effects on the sectoral labor demand (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	**-18.90**	**4.47**	**3.62**
Subsistence agriculture	-20.68	4.28	4.07
Cash-crop agriculture	-13.95	4.96	2.30
Livestock and hunting	-21.02	4.06	5.02
Fishing	-19.41	5.43	5.34
Industry	**7.36**	**-8.97**	**5.43**
Mining activities	1.51	-6.03	5.14
Food processing industries	15.13	-13.23	5.46
Textiles	18.25	-10.66	0.92
Other industries	5.37	-10.14	10.06
Services	**1.31**	**2.34**	**-6.18**
Electricity, gas and water	1.97	3.13	-6.25
Construction	2.11	2.86	-11.47
Trade	4.33	5.77	-20.43
Accommodation, catering	4.65	1.37	-4.34
Transport, communications	1.92	3.43	-9.71
Financial activities	1.02	1.74	-2.81
Public administration	-0.29	-0.12	2.73
Education, health	-0.16	0.18	1.27
Other services	1.52	4.58	-11.41

Source: CGE model simulations

Table 9. The effects on the sectoral productions (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	**8.22**	**0.28**	**0.19**
Subsistence agriculture	7.69	-0.22	0.06
Cash-crop agriculture	13.78	1.44	-1.57
Livestock and hunting	7.45	0.23	0.56
Fishing	5.05	0.83	2.06
Industry	**4.12**	**5.04**	**1.12**
Mining activities	-2.53	9.24	0.81
Food processing industries	6.98	1.25	1.37
Textiles	14.10	3.50	-3.25
Other industries	2.94	3.97	5.98
Services	**0.41**	**0.65**	**5.34**
Electricity, gas and water	1.25	1.43	4.05
Construction	-0.43	0.26	5.81
Trade	1.36	1.01	2.90
Accommodation, catering	3.97	0.38	1.17
Transport, communications	0.32	0.77	6.97
Financial activities	-0.10	-0.48	11.80
Public administration	-0.14	-0.06	1.31
Education, health	-0.18	0.07	1.90
Other services	-0.57	0.93	7.95

Source: CGE model simulations

Table 10. The effects on consumer prices (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture (index)	**-11.36**	**2.14**	**-0.60**
Subsistence agriculture	-11.19	2.05	-0.40
Cash-crop agriculture	-12.20	2.44	-0.19
Livestock and hunting	-11.51	2.27	-1.00
Fishing	-12.01	2.24	-0.61
Industry (index)	**-2.49**	**0.07**	**-1.93**
Mining activities	1.17	-1.55	-4.22
Food processing industries	-4.04	0.04	-1.95
Textiles	-3.29	-0.32	-2.01
Other industries	0.04	0.12	-1.81
Services (index)	**-1.02**	**0.77**	**-4.00**
Electricity, gas and water	0.11	0.37	-2.82
Construction	-0.38	0.81	-4.88
Trade	0.88	1.65	-9.76
Accommodation, catering	-5.97	0.86	-1.78
Transport, communications	0.26	0.90	-5.23
Financial activities	0.19	0.70	-3.67
Public administration	0.15	0.08	-1.27
Education, health	0.31	0.13	-2.06
Other services	0.40	0.88	-5.46
All (consumer price index)	**-5.15**	**0.86**	**-1.83**

Source: CGE model simulations

Table 11. The effect on households' real consumption (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Public employees	4.89	0.01	0.50
Formal private sector employees	4.43	0.41	0.83
Informal private sector employees	3.91	0.58	0.93
Cash-crop farmers	3.17	0.74	1.02
Subsistence farmers	2.77	0.65	0.89
Breeders	3.94	0.90	1.21
Fishermen	4.25	0.70	1.06
Self-employed	3.94	0.77	1.10
Unemployed	3.00	0.54	0.80

Source: CGE model simulations

Table 12. The effects on sectoral exports (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	**19.76**	**-1.80**	**-0.48**
Subsistence agriculture	17.94	-2.14	-0.15
Cash-crop agriculture	21.20	-1.43	-0.89
Livestock and hunting	19.44	-2.17	-0.02
Fishing	18.53	-1.85	0.55
Industry	**0.10**	**7.21**	**1.28**
Mining activities	-2.36	8.44	1.43
Food processing industries	10.21	0.93	1.53
Textiles	11.50	2.59	-0.42
Other industries	0.28	3.26	5.01
Services	**-0.28**	**-0.77**	**10.80**
Construction	0.17	-0.70	8.38
Transport, communications	-0.11	-0.57	10.02
Financial activities	-0.32	-1.25	12.79
Public administration	-0.22	-0.12	2.00
Other services	-0.76	-0.54	11.12

Source: CGE model simulations

Table 13. The effects on imports (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	**-13.24**	**3.31**	**0.92**
Subsistence agriculture	-16.06	3.91	0.36
Cash-crop agriculture	-14.01	7.15	-1.71
Livestock and hunting	-16.34	4.47	1.05
Fishing	-18.83	5.07	2.74
Industry	**-0.82**	**1.72**	**1.31**
Mining activities	1.48	-3.36	6.12
Food processing industries	-4.19	0.79	-0.23
Textiles	-3.11	0.27	0.40
Other industries	-0.28	1.85	1.80
Services	**0.65**	**3.10**	**-5.30**
Electricity, gas and water	1.52	2.32	-2.70
Construction	-1.60	3.37	-5.71
Transport, communications	1.05	3.20	-6.40
Financial activities	0.76	2.68	-2.97
Public administration	0.16	0.11	-1.28
Other services	0.42	3.88	-6.71

Source: CGE model simulations

Table 14. Domestic demand for commodities produced locally

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	**7.47**	**0.41**	**0.26**
Subsistence agriculture	7.17	-0.13	0.07
Cash-crop agriculture	12.05	2.09	-1.73
Livestock and hunting	7.09	0.29	0.57
Fishing	5.02	0.83	2.06
Industry	**3.16**	**1.80**	**3.21**
Mining activities	-0.69	3.24	5.14
Food processing industries	6.81	1.26	1.42
Textiles	7.78	2.32	0.19
Other industries	1.17	3.87	5.32
Services	**0.77**	**0.78**	**3.31**
Electricity, gas and water	1.24	1.42	4.12
Construction	-0.81	1.63	4.78
Trade	2.77	1.47	1.60
Accommodation, catering	3.88	0.38	1.24
Transport, communications	0.42	1.01	6.43
Financial activities	0.06	0.07	11.10
Public administration	-0.14	-0.07	1.34
Education, health	-0.18	0.07	1.90
Other services	-0.56	1.66	6.98

Source: CGE model simulations

Table 15. The effects on macro-sectoral GDPs and global real GDP (%)

	Agriculture (S1)	Industry (S2)	Services (S3)
Agriculture	8.10	0.27	0.24
Industry	3.43	6.74	0.88
Mining activities	-2.53	9.24	0.81
Manufacture	**7.37**	**2.50**	**1.00**
Services	0.46	0.75	5.26
Real GDP	3.03	1.48	2.06

Source: CGE model simulations

3.3. Sensitivity tests

Some behavioral parameters used for the implementation of the model stemmed from other sources. For this reason, it may not be reasonable to consider these values well fit Burkina Faso's reality. Sensitivity tests are necessary to check the robustness of our findings. We performed sensitivity tests on the elasticities of international trade, incomes, and production function. We present the impacts on macrosectoral GDPs, real GDP (Appendix 1), and sectoral productions (Appendix 2) when dividing these elasticities by 2 and then multiplying them by 2, respectively. As it is highlighted, the conclusion that the agricultural sector is a powerful engine of industrialization is maintained. Indeed, the GDP and the production of the manufacturing sector are higher when the investment is made in the agricultural sector. The growth of the manufacturing GDP is between 5.77% and 9.12% in scenario 1 while it only ranges from 2.07% to 2.77% in scenario 2 and much weaker in scenario 3 (between +0.88% and +1.00%). The same observation holds true for manufacturing production presented in Appendix 2.

4. Conclusion, policy implications, and outlook

In this paper, we have investigated the capacity of agriculture in Burkina Faso to initiate an industrialization process that would raise the living standards of the Burkinabè. A computable general equilibrium model has been used because of its ability to represent the various intersectoral and institutional links and to consider the structure of the economy in the study of a shock or a policy affecting the national economy. Simulations of agricultural intensification show effects that are positive not only for agriculture and households' living standards but also for the industrial sector in general and the manufacturing sector in particular. The positive impact – in terms of increased production and added value – of agricultural intensification on the manufacturing sector turns out to be greater than that of investment in the industrial sector. These findings clearly show that the strong links between agriculture and manufacturing can be exploited to both develop agriculture and stimulate an industrialization process in Burkina Faso.

In general, our findings support the idea that Burkina Faso's agricultural sector can be a powerful lever for industrialization and the fight against poverty. Our study is the first to undertake a comparison between the three major sectors of the economy. The study by Tarp and Tarp (2004) which has highlighted the superiority of an industrialization strategy based on agricultural development rather compared three development strategies : (i) an agriculture-first strategy, (ii) an agricultural-development led industrialization (ADLI) strategy, and (iii) a primary-sector export-oriented strategy. The industry as a whole and services have therefore not been considered in their development strategies. In terms of economic policy recommendations, development policies should be oriented towards taking into account the strong agriculture-industry relationship in order to make good use of the advantages offered by such an economic structure. The recommendations can be generalized to many developing countries as a greater number of people are employed in the agricultural sector in these countries.

The results presented in this study are derived from a model assuming perfect competition in the productive and trading sectors. This can constitute a fundamental limit insofar as the absence of competition, especially in the trading sector, can jeopardize the expected gains from agricultural growth (Atkin and Donaldson 2015). Future research can therefore be directed towards modeling monopoly or oligopoly situations to analyze the implications for this study's conclusions. By the same token, the fact that the social accounting matrix used does not disaggregate the representative household according to residence (rural versus urban) or income group (poor and non-poor) does not allow to discuss the distributive effects between the rural and the urban and between the poor and the non-poor. However, as it is shown in Table 11, the increase in real consumption of all socioprofessional categories shows that both rural and urban dwellers are benefiting from an agricultural-development led industrialization (ADLI) strategy.

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Appendices

Appendix 1. The effects on macro-sectoral GDPs and real GDP (%)

	Investment in agriculture			Investment in Industry			Investment in service sectors		
	E/2	E	E*2	E/2	E	E*2	E/2	E	E*2
Agriculture	8.35	8.10	7.85	0.15	0.27	0.36	0.08	0.24	0.42
Industry	2.81	3.43	3.94	6.86	6.74	6.59	0.78	0.88	1.00
Mining activities	-1.91	-2.53	-3.28	9.28	9.24	9.26	0.68	0.81	1.07
Manufactures	**5.77**	**7.37**	**9.12**	**2.77**	**2.50**	**2.07**	**0.94**	**1.00**	**0.88**
Services	0.08	0.46	0.84	0.25	0.75	0.92	4.88	5.26	5.50
Real GDP	2.96	3.03	3.11	1.37	1.48	1.53	1.91	2.06	2.17

Source: CGE model simulations

Appendix 2. The effects on the sectoral productions (%)

	Investment in agriculture			Investment in industry			Investment in service sectors		
	E/2	E	E*2	E/2	E	E*2	E/2	E	E*2
Agriculture	**8.44**	**8.22**	**8.01**	**0.17**	**0.28**	**0.35**	**0.04**	**0.19**	**0.35**
Subsistence agriculture	8.56	7.69	6.73	-0.42	-0.22	-0.01	-0.23	0.06	0.38
Cash-crop agriculture	10.91	13.78	17.10	2.38	1.44	0.52	-0.79	-1.57	-2.47
Livestock and hunting	8.24	7.45	6.59	-0.13	0.23	0.53	0.23	0.56	0.93
Fishing	5.13	5.05	4.94	0.45	0.83	1.02	1.70	2.06	2.35
Industry	**3.54**	**4.12**	**4.70**	**5.18**	**5.04**	**4.83**	**0.98**	**1.12**	**1.20**
Mining activities	-1.91	-2.53	-3.28	9.28	9.24	9.26	0.68	0.81	1.07
Manufactures	**5.52**	**6.89**	**8.33**	**2.50**	**2.30**	**1.94**	**1.18**	**1.32**	**1.29**
Food processing industries	6.28	6.98	7.62	1.35	1.25	1.07	1.16	1.37	1.49
Textiles	10.28	14.10	18.57	4.53	3.50	2.41	-2.24	-3.25	-4.39
Other industries	-1.60	-0.96	-0.45	3.59	3.97	3.88	4.83	5.98	6.72
Services	**-0.02**	**0.41**	**0.86**	**0.24**	**0.65**	**0.80**	**5.13**	**5.34**	**5.44**
Electricity, gas, and water	0.76	1.25	1.77	1.35	1.43	1.37	3.88	4.05	4.11
Construction	-2.25	-0.43	1.65	-1.32	0.26	0.88	5.25	5.81	5.93
Trade	1.33	1.36	1.23	0.30	1.01	1.31	1.99	2.90	3.53
Accommodation, catering	4.41	3.97	3.44	0.06	0.38	0.66	0.97	1.17	1.41
Transport, communication	0.27	0.32	0.36	0.94	0.77	0.63	7.01	6.97	7.00
Financial activities	0.26	-0.10	-0.58	0.60	-0.48	-1.17	11.80	11.80	12.02
Public administration	0.08	-0.14	-0.29	0.32	-0.06	-0.18	1.53	1.31	1.01
Education, health	-0.09	-0.18	-0.09	0.41	0.07	0.04	2.58	1.90	1.34
Other services	-0.89	-0.57	-0.21	0.96	0.93	0.89	8.39	7.95	7.66

Source: CGE model simulations

Appendix 3. Values of main parameters of the model

Income elasticity		Armington elasticity	CET elasticity (Exports and Domestic sales)	Elasticity of substitution for primary factors (Added value)	Frisch Parameter
Agricultural goods	Other goods				
0.5	1.5	3.5	2	1.5	-3.5