The impact of transport- and transaction-cost reductions on food markets in developing countries: evidence for tempered expectations for Burkina Faso

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Abstract

Reductions in transport and transaction costs are expected to have a major effect on the functioning of food markets in developing countries. For many developing countries, this is a relevant issue as it may have important consequences for the food markets in urban and rural deficit areas. A partial equilibrium model is presented to analyze the effects of reduced costs on cereal price formation, inter-regional cereal trade, and farmers' and traders' storage strategies for the case of Burkina Faso. Our results show that the high expectations with regard to the direct effects of cost reductions on food prices and food availability require some nuance. First, the effects of even a huge reduction of transport costs only will be small. Secondly, an element which is often neglected is that constructing a road between two cities may have unintended negative consequences on the competitive position of farmers and traders in other regions. Finally, it is concluded that only if transport and transaction costs are reduced simultaneously, both consumers and farmers will benefit significantly.

JEL-codes: L11, O18, R41

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1 Introduction

The functioning of food markets in many developing countries is hampered by the high costs involved in market exchange. Depending on season and distance, marketing costs may determine a major part of the food prices that consumers pay in deficit areas (Bassolet, 2000). These costs result in a large price band, expressing the difference between farm prices and consumer prices. The price band explains why many subsistence farmers prefer production for home consumption and lack access to profitable market opportunities. The higher the price band, the greater the number of market imperfections and missing markets (de Janvry et al., 1991).

In the food policy debate, particularly transaction and transport costs are expected to form major barriers in the food market. It is argued that investments in infrastructure have important positive effects on development (see e.g. World Bank, 1994). Production and trade are said to improve substantially and prices to fall. At the same time, there is a debate about the effects of institutional deficiencies on the functioning of markets (World Bank, 2001). It is argued that proper market institutions promote competition and reduce transaction costs.

There is broad consensus among economists that improvements in both transport and institutional arrangements are important. Yet, not much research is published to show how food prices and food availability in the deficit and surplus regions of a country are influenced by these costs. The objective of this paper is to contribute to filling this lacuna. The macro economic effect of cost reductions is unambiguously positive. However, the question is how important the changes in the food market are in the short run, and how the effects are distributed amongst various actors, regions, and seasons. There are three main reasons why such an analysis is important:

- A regional analysis of the spatial and temporal aspects of trade is highly relevant for Burkina Faso. Regional demand and supply conditions differ enormously among the districts and marketing costs are high.[1] Furthermore, the country only has one harvest period per year, whereas supply and demand are continuous. High transport costs, especially during the rainy season, and high storage losses affect seasonal price differences considerably. An analysis in which only national and annual developments are reported, hides regional and seasonal changes that are essential for understanding the short term effects for the most vulnerable regions or groups.

[1] In Burkina Faso, some regions produce major surpluses, while others are major deficit regions, in particular in the hungry season (from July to September). Moreover, the region of the capital Ouagadougou is a permanent large deficit market.

- As many farmers in developing countries are driven by the objective of food security, the price elasticity of supply is low in the short and medium run. Some authors even report zero or negative elasticities.[2] This may reduce the effect of changes in farm prices and raises the question how food availability in deficit areas will change as a result of marketing-cost reductions.
- Transaction-cost reductions will result in a reduction of the price band in all regions of a country due to higher farm prices and lower consumer prices. Consequently, farmers and consumers in all regions benefit. Transport-cost reductions, on the other hand, influence the price differences between surplus and deficit areas. As a result, some stakeholders win, and others lose. This exemplifies that insight into the distribution of the effects among different stakeholders becomes important.

In this paper, a model is presented to estimate the effects of transport- and transaction-cost reductions on the cereal market in Burkina Faso.[3] The model is based on the multi-period, spatial price equilibrium model developed by Samuelson (1952) and later extended by Takayama and Judge (1971). These models are frequently applied (see e.g. van den Bergh et al., 1996; Bivings, 1997; Arndt et al., 2001). The approach is a useful tool to show the effects on individual groups and regions, that remain hidden in more general analyses. Innovative features in the model are the explicit attention paid to 1) farmers' seasonal selling strategies as a function of past, current and future prices, 2) seasonal price developments, and 3) traders' transport and storage behavior and costs. Still few studies have been performed in which both spatial and temporal aspects of trade are considered. Unlike our approach, most studies analyzing temporal aspects of trade consider seperable supply function which depend on current prices only. For many developing countries, however, the temporal aspects of food

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[2] Most Burkinabé farmers are subsistence farmers; generally, they sell a small part of their cereal harvest and store the remainder for own consumption. Some farmers may be obliged to sell early in the harvest season (October-December) when prices are low, and to buy later when prices are high (July-September).
[3] In this study, the main cereals millet, sorghum, and maize are considered.

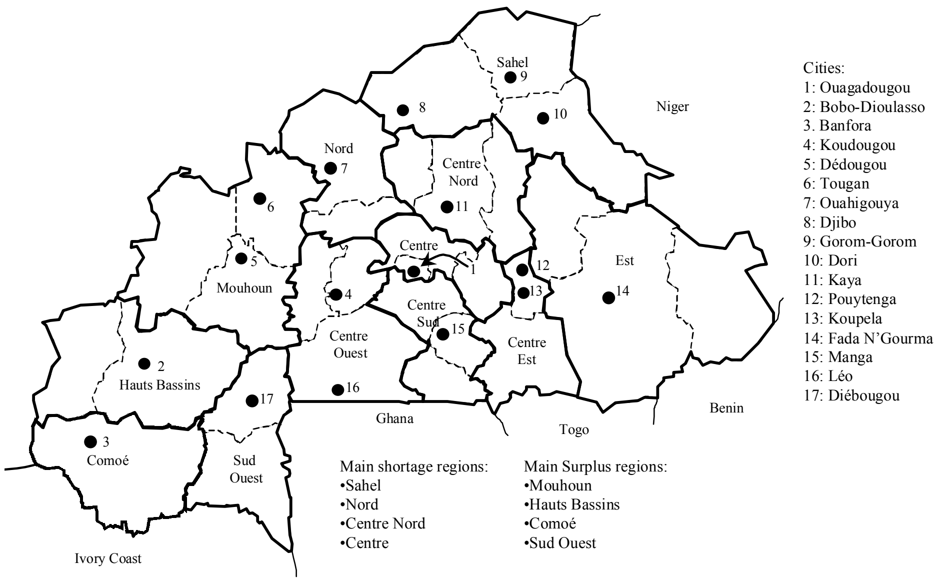

Figure 1: Map of Burkina Faso, the main cities, and the 12 agricultural regions

trade within the year are important. Furthermore, trader behavior is usually not considered in comparable studies. Their behavior is, however, seriously affected by institutional deficiencies. These deficiencies refer to a lack of market information, an underdeveloped infrastructure, non-transparent market rules, and inaccessible capital markets (Bassolet, 2000). Market exchange under these conditions leads to high transport, storage, and transaction costs (Hodgson, 1993). For Burkina Faso, estimates show that transport costs are 5-20%, storage costs 6-9%, and transaction costs 5-14% of the consumer price (see Bassolet, 2000; Sirpé 2000, and price data obtained from the Société Nationale de Gestion du Stock de Sécurité, SONAGESS). Although these estimates are only indicative of the costs involved, it is clear that marketing costs have an important effect on prices in the food market. To understand market changes, it is deemed necessary to consider marketing costs and trader behavior as well.

In the sections 2 and 3, the multi-period, spatial equilibrium model and the parameter estimates are briefly discussed. In Section 4, the results of the model are compared for different scenarios of reductions in transport and transaction costs. Finally, some conclusions and policy recommendations are formulated in Section 5.

2 Multi-period, spatial equilibrium model

The multi-period, spatial equilibrium model set up in this section consists of a semi-welfare function that is optimized subject to the equilibrium condition that for each market and for each period, the quantity of cereals that enters a market has to be equal to the quantity that leaves that market. In fact, the equilibrium model combines the models describing the optimal behavior of each of the individual market actors. It determines the optimal market strategies of the various actors as well as equilibrium market prices. Burkina Faso is divided into twelve regions (see Figure 1).[4] In each region, only one market is considered. Furthermore, a year is divided into four periods of three months each. The planning year starts in the post-harvest season (October) and ends with the lean season (July to October). Call I the set of twelve regions in Burkina Faso and T the set of four periods. Note that a closed economy is considered. Before discussing the multi-period, spatial equilibrium model, first the models for the individual market actors are discussed.

In the standard Takayama and Judge spatial equilibrium model, supply functions are used in which the producer's optimal supply behavior only depends on current market prices. This does not, however, well reflect the situation in developing countries. For example, in Burkina Faso, immediately after the harvest, most farmers first safeguard a part of their harvested cereals that is needed for feeding the own family members. The remainder is sold gradually over the year, depending on price developments and money needs (Reardon et al.,

[4] In order to take the different local market conditions properly into account and to improve the policy relevance of the analysis, the number of regions corresponds to the twelve administrative regions that constitute the country.

1988; Pieroni, 1990). Furthermore, almost all producers sell and purchase cereals during all months. Instead of deriving a supply function for each period, an optimization model is set up to determine the optimal distribution of the producer's cereal supply over a year. For this model, the following assumptions are made. First, for each region one aggregate producer is considered. Secondly, each producer sells in one year at most a given portion of the available harvest. Define w_{i0} as the fixed maximum annual supply for the producer in region i. Thirdly, it is assumed that each producer has to sell in each period at least a minimum quantity x_{it}^{-} to cover urgent cash needs. Fourthly, the costs for producing and supplying a quantity of cereals x_{it} is assumed to be a linear function: $c_{it}(x_{it}) = c_{it}x_{it}$ with $c_{it} > 0$ a constant. Fifthly, for the producers, the market price they receive for their sales, p_{it}, is exogenous. This price is called the producer price, which differs from the consumer price, π_{it}, which is the price consumers pay when purchasing cereals. Introduce the variables x_{it}, the supply in region i and in period t, and the parameters $0 \leq 1\text{-}\delta \leq 1$, the storage losses, and $0 \leq \sigma \leq 1$, the discount rate. The question is how the producer in region i can best spread his annual supplies over the four periods in order to generate maximum net revenues. This supply problem is formulated as follows.

$$\underset{x_{i1},\ldots,x_{i4}}{Max} \sum_{t=1}^{4} \sigma^{t-1}\left(p_{it} - c_{it}\right)x_{it} \quad s.t. \quad x_{i1} + \frac{x_{i2}}{\delta} + \frac{x_{i3}}{\delta^2} + \frac{x_{i4}}{\delta^3} \leq w_{i0}, \quad x_{it} \geq x_{it}^{-},\, t \in T \tag{1}$$

From this model, it follows that the producers sell as much as possible in the period in which they can obtain the highest possible returns. In the other periods, they sell the minimally required quantity x_{it}^{-}. Although this simple characterization of cereal trade is totally different from approaches usually adopted in comparable studies, it corresponds better to the observed supply behavior of Burkinabé subsistence farmers.

For the cereal consumers, one aggregate consumer is considered for each region. Their cereal demand in period t is represented by a demand function, $y_{it}(\pi_{it})$, which is a function of consumer price π_{it}. The consumer's problem of optimizing utility subject to their income constraint is as follows.

$$\underset{y_{i1},y_{i2},y_{i3},y_{i4}}{Max} \sum_{t=1}^{4} \sigma^{t-1} \left(\int_0^{y_{it}} \pi_{it}(\eta)d\eta - \pi_{it}(y_{it})y_{it} \right) \quad s.t. \quad y_{it} \geq 0,\, t \in T \tag{2}$$

To describe the optimal strategies of the traders, an aggregated trader is considered. The trader purchases in a region i in a period t an amount q_{it} from the producers, sells an amount r_{it} to the consumers, transports an amount x_{ijt} to region j, and has in store an amount s_{it}. Transporting one unit from region i to j costs τ_{ijt} and storing one unit for one period costs κ_{it}. Furthermore, also transaction costs, α_{it}, are considered. These costs have to be made for each unit of cereals sold. It is assumed that the traders maximize their net revenues.

$$\begin{aligned} &\underset{\substack{r_{it},q_{it},x_{ijt},s_{it} \\ \text{for all } i,j \in I, t \in T}}{Max} \sum_{t=1}^{4} \sum_{i \in I} \sigma^{t-1} \left((\pi_{it} - \alpha_{it}) r_{it} - p_{it} q_{it} - \sum_{\substack{j \in I \\ j \neq i}} \tau_{ijt} x_{ijt} - \kappa_{it} s_{it} \right) \\ &s.t. \;\; q_{it} + \sum_{\substack{j \in I \\ j \neq i}} x_{jit} + \delta s_{i,t-1} = r_{it} + \sum_{\substack{j \in I \\ j \neq i}} x_{ijt} + s_{it}, \quad r_{it}, q_{it}, x_{ijt}, s_{it} \geq 0, \;\; i \in I, t \in T \end{aligned} \tag{3}$$

The constraints of model (3) indicate that traders cannot sell more than they purchase.

The multi-period, spatial equilibrium model combines the optimization problem of the consumers, the producers, and the trader. Two extra constraints are introduced. First, producer supply has to be equal to trader purchases, $x_{it} = q_{it}$. Secondly, trader sales have to be equal to consumer demand, $r_{it} = y_{it}$. The models (1), (2), and (3) are combined in the following maximization model.

$$\begin{aligned} &\underset{\substack{x_{it},y_{it},x_{ijt},s_{it} \\ \text{for all } i,j \in I, t \in T}}{Max} \sum_{t=1}^{4} \sum_{i \in I} \sigma^{t-1} \left(\int_0^{y_{it}} \pi_{it}(\eta)d\eta - \alpha_{it} y_{it} - c_{it} x_{it} - \sum_{\substack{j \in I \\ j \neq i}} \tau_{ijt} x_{ijt} - \kappa_{it} s_{it} \right) \\ &s.t. \;\; x_{it} + \sum_{\substack{j \in I \\ j \neq i}} x_{jit} + \delta s_{i,t-1} = y_{it} + \sum_{\substack{j \in I \\ j \neq i}} x_{ijt} + s_{it}, \quad x_{it} \geq x_{it}^{-}, \\ &\qquad x_{i1} + \frac{x_{i2}}{\delta} + \frac{x_{i3}}{\delta^2} + \frac{x_{i4}}{\delta^3} \leq w_{i0}, \quad x_{it}, y_{it}, x_{ijt}, s_{it} \geq 0, \;\; i \in I, t \in T \end{aligned} \tag{4}$$

In this equilibrium model, prices are endogenous. By making use of the Lagrangian and Kuhn-Tucker conditions, it is possible to prove that optimal equilibrium producer prices p_{it} are equal to the Lagrange multipliers of the equilibrium constraints in model (4). It can be proved that, if cereals are traded, the differences between the consumer and producer prices are equal to the marketing costs (transport, storage, and transaction costs). Else the difference is smaller. In other words, $\pi_{it} = p_{it} + \alpha_{it}$ if supply and demand are positive in region i and period t; $\pi_{jt} = p_{it} + \tau_{ijt} + \alpha_{jt}$ if in period t goods purchased in region i are sold in region j; and $\pi_{i,t+1} = p_{it} + \kappa_{it} + \alpha_{it+1}$ if in a region i goods purchased in period t are sold in period t+1.

3 Parameter estimation

Estimation of the parameters used in model (4) is based on a careful review of the literature on cereal trade, production, and consumption in Burkina Faso. [5] The exogenous elements in equilibrium model (4) are c_{it}, w_{i0}, $\bar{x}_{it}$, σ and δ, inverse demand function $y_{it}(\pi_{it})$, and τ_{ijt}, κ_{it}, and α_{it}. All parameters are estimated for the reference year October 2000 to September 2001. For the purpose of this paper, special emphasis is given to the transport and transaction costs. For a detailed discussion of the remaining estimates, we refer to Ruijs (2002). To estimate interregional transport costs τ_{ijt}, the costs to transport between the main cities in each region are considered (see e.g. Bassolet, 2000; Sirpé, 2000). A distinction is made between transport over busy surfaced roads, less busy surfaced roads, unpaved roads, and dirt roads, and between transport during the dry and during the rainy season. The costs per km are multiplied by the distance over each road type to determine transport costs between the various regions (see Table A1 in the appendix). Due to the difficulties to identify transaction costs,

[5] The data used and surveys consulted include among other things 1984-99 production data from the Ministry of Agriculture, census and income data from the National Statistical and Demographic Institute INSD, and surveys by e.g. Sherman et al. (1987), Szarleta (1987), Reardon et al. (1988, 1992), Pieroni (1990), Bassolet (2000), and Sirpé (2000).

commissions for services are often used as a 'lower bound' estimate (North & Wallis, 1994). Using Bassolet (2000) and Sherman et al. (1987), we estimate them as 1500 FCFA/100 kg.

Cereal demand functions are estimated as a function of cereal prices, $y_{it}(\pi_{it})$. The demand functions opted for are derived from the linear expenditure system. For this study, a difference is made between the demand function of rural and that of urban households. Define the set of household types $H = \{urban, rural\}$. Introduce the cereal demand level of a consumer, y^h_{it}, the minimally required cereal purchase level of a consumer of type h, γ^h_{it}, and the budget spent on cereal purchases, β^h_{it}. The consumer demand function is defined as: $y^h_{it} = \gamma^h_{it} + \beta^h_{it} / \pi_{it}$. The estimates of the parameters of the demand function are based on both quantitative and qualitative evidence presented in the sources discussed above.

4 Results

In this section, the model results are discussed for different scenarios of reductions in transport and transaction costs. In general, the results of the baseline model resemble the present situation relatively well. Prices reflect seasonality well (see Table 1). In the high production areas, from which cereals are transported (Mouhoun, Hauts Bassins, Comoé, Sud Ouest), prices are lower than in the low production and shortage areas (Centre, Sahel, Nord, Centre Nord). These price differences mainly result from transport costs. Transport flows are in line with flows observed in reality. Most goods are transported from the largest surplus regions to the capital in Centre and the shortage regions Sahel, Nord, and Centre Nord. Hardly any cereals are stored by the traders. This is understandable, as their storage losses and storage costs are higher than those of the farmers.

To explore how trade will react on cost changes, three scenarios are considered. Scenario 1: an overall reduction of transport costs by 25%; Scenario 2: surfacing the road

Table 1: Results of the baseline model: consumer price levels, quantities transported, and quantities stored.

Consumer price level (FCFA/kg)[1]											
→ PERIOD ↓ REGION	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Average	→ PERIOD ↓ REGION	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Average
Centre	111	117	124	132	121	**Est**	101	107	116	122	111
Centre Nord	114	120	127	135	124	**Centre Est**	106	112	121	127	116
Centre Ouest	104	110	117	124	114	**Nord**	108	114	121	129	118
Centre Sud	105	111	119	126	115	**Sud Ouest**	96	102	109	115	105
Sahel	118	125	131	142	129	**Hauts Bass.**	102	109	116	123	112
Mouhoun	99	105	112	119	109	**Comoé**	107	107	120	126	115
						Average	106	112	119	127	116

Quantity transported (in 1000 tons)								
From	**To**	**Total**	**From**	**To**	**Total**	**From**	**To**	**Total**
C.Ouest	**Centre**	7.0	**Est**	**Sahel**	3.1	**H.Bass.**	**Centre**	0.7
C.Sud	**Centre**	13.1	**Est**	**C.Est**	3.2	**H.Bass.**	**Comoe**	0.4
C.Sud	**C.Nord**	1.1	**Est**	**Centre**	5.2	**Total**		126.2
Mouton	**Centre**	35.0	**C.Est**	**Centre**	5.0			
Mouhoun	**Sahel**	9.4	**S.Ouest**	**Centre**	22.3			
Mouhoun	**Nord**	14.1	**S.Ouest**	**C.Nord**	6.6			

Quantity stored (1000 tonnes)	
Comoé	0.3

Notes: 1) The producer price is equal to the consumer price minus FCFA 15.

between Dédougou (Mouhoun) and Dori (Sahel); Scenario 3: improving institutional deficiencies, resulting in a reduction of transport and transaction costs by 25%.

The results of scenario 1 clearly show that an overall reduction of transport costs hardly affects cereal prices, cereal supply, and cereal demand (see Table 2). Compared to the base results, if transport costs decrease, producer and consumer prices decrease in the destination regions (Centre, Centre Nord, Sahel, Nord), and increase in the surplus regions (Mouhoun, Sud Ouest, Hauts Bassins, Est). The price change, however, is very small. If transport costs decrease by 25% – indeed a very ambitious scenario – consumer prices in the largest shortage region (Sahel) decrease by only 2.5%. The minor price changes can be explained as follows. If the price decrease in the shortage regions were larger, traders would have to bring in more supply from Mouhoun and Est. However, producers in these regions are unable to satisfy this extra demand due to the inelasticity of cereal supply. As a result, prices in Sahel can only fall by a small percentage, and prices have to rise in Mouhoun and

Table 2: Change in cereal prices compared to the base results for the three scenarios [1]

	Scen. 1	Scen. 2	Scenario 3			Scen. 1	Scen. 2	Scenario 3	
	Cons. Price[2]	Cons. Price[2]	Prod. Price	Cons. Price		Prod. Price[2]	Cons. Price[2]	Prod. Price	Cons. Price
Centre	-1.0%	0.4%	2.2%	-1.2%	**Cen. Est**	0.0%	0.3%	3.4%	-0.3%
Cen. Nord	-1.6%	0.4%	1.3%	-1.9%	**Nord**	-0.4%	-1.5%	2.9%	-0.7%
Cen. Ouest	0.6%	0.4%	4.1%	0.3%	**Sud Ouest**	2.4%	0.5%	6.6%	2.1%
Cen. Sud	0.2%	0.4%	3.7%	0.0%	**H. Bassins**	0.8%	0.2%	4.5%	0.6%
Sahel	-2.5%	-4.4%	0.2%	-2.7%	**Comoé**	-0.1%	0.0%	0.7%	-2.7%
Mouhoun	1.7%	0.6%	5.7%	1.5%	**Average**	0.0%	-0.3%	3.3%	-0.4%
Est	1.1%	0.3%	4.9%	0.9%					

Note: 1) Averages over all four periods; 2) The change of the producer price is more or less equal to the change of the consumer price.

Est. This example shows that a large reduction in transport costs will result in only modest price changes. Consequently, also the effect on transport flows is small (+1.2%).

Secondly, if the route from Dédougou (Mouhoun) to Dori (Sahel) is asphalted, transport costs for this route decrease by as much as 30%. For the regions traversed by the newly surfaced road, prices decrease slightly in the importing regions and increase slightly in the exporting regions (see Table 2). Prices in the regions not traversed by the new road also change. Transported flows from Mouhoun to Sahel and Nord increase, while less is transported from Mouhoun to Centre. Due to higher prices in Mouhoun, prices in Centre have to rise as well. This also affects prices in the other regions. This example shows that the construction of a new road has some negative consequences for the food situation or competitive position for at least some traders, consumers, and farmers. Furthermore, less is transported to Sahel in the post-harvest season (periods 1 and 2) and more in the rainy season (period 4). Put differently: Transport becomes less critical for Sahel during the lean season.[6]

Thirdly, the effect of improvements in market institutions is considered, which result in a reduction in transaction and transport costs by 25%. The results show that, compared with the base results, the consumer prices decrease on average by 0.4% whereas the producer prices

[6] Note that a simpler model specification with only a few regions (e.g. surplus, shortage, and equilibrium regions) would not be able to capture these indirect effects in regions not traversed by the new road and changes in directions of transport flows.

increase on average by 3.3% (see Table 2). Consumer prices can hardly decrease due to the scarcity of cereals. Compared to the other scenarios in which only transport costs changed, the results are much better for consumers and for farmers. In this third scenario, all producers and the majority of consumers benefit. Furthermore, the positive effects are much larger and unintended negative effects are much smaller. This analysis illustrates that much can be gained if we succeed in arriving at lower transaction and transport costs simultaneously. Especially the decline in the price band between producer and consumer prices is important.

5 Conclusions

This article shows that major reductions in transport and/or transaction costs do not necessarily provoke major changes in the food market. Improvements for some regions or during some seasons may be neutralized by side-effects elsewhere. Two major conclusions can be drawn.

First, it turns out that surfacing the main routes, or bringing about a major reduction of transport costs, has a much smaller effect on the trade volume of staple crops than is often expected. As long as farmers in Burkina Faso do not succeed in escaping from their subsistence situation, there is no reason to believe that the inelasticity of cereal supply will change. They will continue supplying only a small part of their harvest. Furthermore, surfacing only some important trade routes has some unintended negative side-effects for the inhabitants of regions not traversed by the new road. A positive effect is that surfacing unpaved routes makes regions more easily accessible, especially during the rainy season – the most critical period for food availability in the shortage regions. Surfacing the roads to the shortage regions may indeed solve that problem. An unintended side-effect is, however, that consumers in shortage regions not traversed by the new road may have to face higher prices. Furthermore, producers in surplus regions not traversed by the new road may lose their competitive position to the producers benefiting from the new road. This effect is often ignored in more general models and traditional cost-benefit analyses trying to assess the desirability of road construction.

The second conclusion concerns the importance of improvements in market institutions. The effect of the reductions in transaction costs resulting from better institutions is much larger than the effects of changes in road infrastructure, as most consumers and all farmers will profit from these cost reductions simultaneously. Transaction-cost reductions lead to only minor negative side-effects. The results indicate that, although investing in road infrastructure is attractive because of its clear-cut end result, a substantial improvement of food trade is only possible if market institutions are reformed.

To conclude, the results clearly give evidence for tempered expectations of the impact of marketing cost reductions. The specific characteristics of cereal production and trade, make an improvement of food security unlikely if only one type of marketing cost is reduced. The model set up in this paper, proved to be very useful in showing the temporal and spatial impacts of market changes for the most vulnerable regions.

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Appendix:

Table A1: Estimate of the transport costs in the dry season (in FCFA/100kg bag)

Dry Season	Centre	Centre Nord	Centre Ouest	Centre Sud	Sahel	Mou-houn	Est	Centre Est	Nord	Sud Ouest	Hauts Bassins	Comoé
Centre	0	343	510	377	1097	987	788	274	634	1288	712	1544
Cen. Nord	343	0	925	720	810	1363	1134	826	966	1631	1589	1887
Cen. Ouest	510	925	0	916	1679	990	1370	1062	1130	905	1081	1594
Cen. Sud	377	720	916	0	1474	1364	891	583	886	1839	1623	1921
Sahel	1097	810	1679	982	0	1740	1554	1459	1124	2385	2343	2640
Mouhoun	987	1363	990	1364	1740	0	1775	1467	715	1968	1140	1438
Est	788	1134	1370	891	1554	1775	0	308	1421	2076	2034	2331
Cen. Est	274	826	1062	583	1459	1467	308	0	1113	1768	1726	2023
Nord	634	966	1130	886	1124	715	1421	1113	0	1922	1855	2153
Sud Ouest	1288	1631	905	1839	2385	1968	2076	1768	1922	0	828	1126
Hauts Bass	712	1589	1081	1623	2343	1140	2034	1726	1855	828	0	298
Comoé	1544	1887	1594	1921	2640	1438	2331	2023	2153	1126	298	0

Source: Based on Sherman et al. (1987), Bassolet (2000), and Sirpé (2000).