9 Discussion of Model Results – Alternative Model Formulations

In this section, the results of the other scenarios discussed in Section 3.3 will be dealt with. In these scenarios, not only the values of some of the parameters are adapted, but the specification of some of the model constraints is changed as well. First, in Section 9.1, the influence of a better price information system is investigated. The influence of an improved access to credit facilities is analysed in Section 9.2. Finally, in Section 9.3, the influence of the renewal of a part of the national security cereal stock by SONAGESS is explored.

9.1 Scenario 5: More Accurate Price Expectations

In this section, I investigate the importance of making correct price expectations. In the previous chapter, it has already been shown that price expectations are important. If expectations are better, producers and traders can anticipate better on shortages or surpluses on the market. They can spread their supplies more equally over the year. As a result, prices will change gradually over the year and will not rise or fall suddenly.

In this section, I compare the base results discussed in Section 8.1 with the results of two models. First, in Section 9.1.1, I compare them with the results of the ‘perfect market model’ as discussed in Chapter 5, see (5.14). In this model, it is assumed that all producers, consumers, and traders have perfect foresight with regard to the future producer and consumer prices and the behaviour of the other market actors. In other words, it is assumed that they have access to all information they possibly need and that they know how prices are formed on the market. Secondly, in Section 9.1.2, instead of basing their price expectations on the average prices between 1996 and 1999, I consider a few cases in which the producers and traders base their expectations on other prices.

9.1.1 Perfect Market Model

In this section, I discuss the optimal market solution if all market actors have perfect foresight with regard to future market prices. Although unrealistic in itself, it is interesting to analyse such a situation because it gives an upper limit of the level of semi-welfare. Comparing the results of the perfect market model
with the results from the stochastic equilibrium model gives an idea of how much can be won if price expectations are better.\(^1\)

The perfect market model has been discussed in (5.13) in Section 5.2. The necessary variables and parameters have been defined in (5.1), (5.4), (5.5), (5.12), (6.2) and (6.3). In this model the sum of semi-welfare over all periods and all regions is maximised subject to a market equilibrium constraint for each period and each region. Because of the peculiar form of the producers’ supply behaviour, and because also transaction costs are taken into account, model (5.13) is slightly adapted. The perfect market equilibrium model can be written as the following maximisation problem in the variables \(y_{it}, x_{it}, x_{ijit}, s_{it}, \) and \(w_{it},\) see also (5.13), (6.36), (6.37), (6.38) and (6.44) in the Chapters 5 and 6:

\[
\text{Max} \left\{ \sum_{t=1}^{4} \sum_{i \in I} \sigma^{-1} \left[ \int_{0}^{y_{it}} \pi_{it}(\eta)d\eta - \alpha_{it}y_{it} + \sum_{j \neq i} \tau_{ijit}x_{ijit} - k_{it}s_{it} \right] \right. \\
\left. x_{it} + \sum_{j \neq i} x_{ijit} + \delta s_{i,t-1} = y_{it} + \sum_{j \neq i} x_{ijit} + s_{it}; \quad x_{it}^{+} \leq x_{it} \leq \delta w_{ijt}; \quad w_{it} = \delta w_{ijt} - x_{it}; \quad y_{it}, x_{ijit}, s_{it} \geq 0; \quad i, j \in I, j \neq i, t \in \{1, \ldots, 4\} \right\}
\]

The values of the parameters are estimated in Sections 7.2.3, 7.2.4, and 7.3.

In the perfect market model, all market actors have perfect foresight. This means that they can choose, for all periods simultaneously, the most efficient purchase and sales patterns, which yield the highest level of semi-welfare. Compared to the base results, the level of semi-welfare increases by 1.2% (see Table 9.1). Net revenues increase for all producers (on average by 18.8%), and utility decreases for almost all consumers (except for those in Hauts Bassins; on average it decreases by 1.1%). Traders profit the most. As expected, their net revenues are zero (see Theorem 5.1 in Section 5.2). Consumer prices increase.

\(^1\) Note that one characteristic of a perfect market is that all market actors have perfect foresight, see Section 1.2.
on average by 1.8%. Increases are highest in the shortage regions Centre, Sahel, Nord, and Centre Nord (+2.6%, +3.0%, +2.6%, +3.1%). As a result the levels of consumer utility decrease the most in these regions. The modest changes in prices and semi-welfare compared to the values in the base model, show that the price expectations in the base model were rather good. In the perfect market situation, seasonal price changes are smoother than in the base situation. The price increase between the first and last period is almost the same, but the price changes between the different periods are in the perfect market situation more equal than in the base scenario. In the base scenario, consumer prices in the periods 2, 3, and 4 were on average 2.8, 7.2, and 10.4 FCFA/kg higher than the prices in the periods 1, 2, and 3, respectively. In the perfect market situation, these differences are 5.8, 7.7, and 7.4 FCFA/kg. If price expectations are better,
producers and traders can better spread their supplies, which results in a smoother price development and less drastic changes in the last period.

The total supplied quantity slightly decreases (-1.3%) because of lower supplies in the region Comoé. If producers have perfect foresight, prices change in such a way that it is profitable for more producers to supply their largest quantities in the last period. On the other hand, the producers in the largest surplus zones (Hauts Bassins and Mouhoun) spread their supplies more equally over the year. As a result, no cereals are transported from Mouhoun or Sud Ouest to Hauts Bassins and transport flows from Hauts Bassins to Centre almost disappear. The total transport flow falls by 20% (see Table 9.1). The net flow, however, only decreases by 1.6%. In the perfect market model, the imports disappear from almost all regions that exported as well as imported cereals in the base scenario. Also the quantities stored by the traders almost disappear. They only store 270 tonnes in the region Comoé in period 2 (they stored 16,970 tonnes in the base model). It can be concluded that due to perfect foresight, producers choose strategies which do better reflect the demand levels in their region. Likewise, traders choose strategies in which they trade almost the same quantity, but in which considerably less transport and storage costs have to be made. As a consequence, the surpluses or shortages in the regions, which have to be exported or imported by the traders, are smaller than in the base scenario. This gain of efficiency has important consequences for the workload of the transport companies.

9.1.2 Price Expectations Based on Other Prices

As has already been discussed in some of the scenarios in the previous chapter, the optimal strategies of the producers, consumers, and traders depend on their price expectations. Depending on the specific expectations, prices are higher or lower than in the base scenario, leading to a deterioration or improvement of the situation for the producers, consumers, and traders. In this section, I take a closer look at the influence of the price expectations.

If price expectations are not based on the average prices in Table 2.1, but on the optimal prices determined in the base model, the level of semi-welfare increases. Compared to the level of semi-welfare in the base model, it increases by 0.5%. Producer net revenues increase, consumer utility decreases, trader net revenues improve, and average prices increase. In this scenario,
hardly any cereals are stored by the traders, and the quantities transported decreases considerably. Although the effect on prices may be small, the more gradual supply of cereals and the fall in the quantities transported and stored leads to a considerable gain of efficiency.

Next, as has already been observed in Chapter 8, optimal market prices do depend to a large extent on the level of the price expectations. For a situation in which future price expectations are lower than in the base model, less is stored by the producers and traders, and more is sold in the first periods. Optimal consumer and producer prices decrease in the first three periods, and the prices in the last period increase because of the resulting scarcity of cereals. The picture is the reverse for a situation with higher price expectations. In those cases, the producers and traders do not consider well enough the effect of the scarcity or abundance of cereals on the prices in the last period.

It is not possible to say that having better price expectations is beneficial for all market actors. The changes in producer and consumer prices are beneficial for some and detrimental for other market actors. A price decrease results in a higher level of consumer utility and a lower level of producer net revenues. Opposite effects follow from a price increase. If the ability to make better price expectations does also lead to lower transaction costs, the result may be an increase of the producer and a decrease of the consumer prices. In that case the situation improves for all market actors.

To conclude this section, the analyses show that although the effect of correct future price expectations on welfare and prices is small, it is important indeed. Wrong expectations result in higher transport and storage expenses and lower levels of semi-welfare. Furthermore, if price expectations are better, seasonal price increases will be smoother. It will also prevent large shortages and avert sky high prices during the lean season. Having good price expectations is not beneficial for all market actors. Better price expectations lead to more efficiency, but the decrease in transported quantities results in less work for the transport companies. Although correct price expectations are important, it is difficult to say which information is essential to make good expectations. With the equilibrium models, it is not possible to analyse which information is needed and how this information has to be interpreted to make better
expectations. Additional research is necessary to analyse how producers and traders form expectations and which information they need.

9.2 Scenario 6: Credit Market Accessibility

Several recent studies have concluded that an important problem on the cereal market in Burkina Faso is related to capital problems (AHT, 1999; Danagro, 1999; Bassolet, 2000; Sirpé, 2000). Most traders finance their business with their own funds. Some borrow from family members or relatives or obtain informal credit against usury interest rates. Only a few can obtain a credit from official credit banks. Most traders can not fulfil the strict demands imposed by the lending agencies (see Sections 1.1 and 2.3). In this section, I analyse the importance of having access to credit facilities. If more traders can borrow money from a bank, the quantity traded may increase. Furthermore, trade can become more efficient if traders having a comparative advantage over others can trade larger quantities.

For this purpose, the equilibrium model will be extended. I consider a situation with three traders, each of whom may have different trade costs or a different trade network. A capital constraint will be added to the model which relates the amount of cereals traded in each period to the available capital. For this analysis, I use the perfect market model discussed in the previous section. If I would extend the stochastic equilibrium model, the number of variables would grow explosively. With three traders, the number of variables in the models for the different periods would almost triple, and solving the model would take more than 20 times the time needed to solve the base model. Using the perfect market model will not lead to different conclusions. If the stochastic model would be extended, the results would be a little more pronounced.

Before discussing the model results, I first discuss the changes made in the equilibrium model. Introduce three different types of traders, and define the set of traders $H = \{h_1, h_2, h_3\}$. Introduce the following variables for $h \in H$, $i,j \in I$, $i \neq j$, and $t \in \{1,2,3,4\}$, see (5.4).

\[ r_{ih} \quad \text{quantity of cereals sold by trader } h \text{ in region } i \text{ in period } t \text{ (in kg)} \]
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\( q_{ith} \) quantity of cereals purchased by trader \( h \) in region \( i \) in period \( t \) (in kg)

\( q_{ijth} \) quantity of cereals transported by trader \( h \) from region \( i \) to region \( j \) in period \( t \) (in kg)

\( v_{ith} \) quantity of cereals stored by trader \( h \) in region \( i \) in period \( t \) (in kg)

\( \text{cap}_{ih} \) the amount of capital available to trader \( h \) after he purchased, transported, and stored the cereals in period \( t \) (in FCFA)

\( \text{cap0}_h \) the amount of capital borrowed by trader \( h \) at the beginning of period 1 (in FCFA).

Adapt the parameters representing the traders’ costs, see (5.5).

\( \alpha_{ith} \) transaction costs for trader \( h \) in region \( i \) in period \( t \) (in FCFA/kg)

\( \tau_{ijth} \) costs to transport one unit from region \( i \) to region \( j \) during period \( t \) by trader \( h \) (in FCFA/kg)

\( k_{ih} \) storage costs during period \( t \) in region \( i \) by trader \( h \) (in FCFA/kg)

\( cm_h \) the maximum amount of capital trader \( h \) can borrow from the bank (in FCFA)

\( r \) interest rate for borrowing money from a bank (3.5% per period. see Section 7.4).

The decision problem for each trader \( h \in H \) is comparable to the trader decision problem discussed in Section 5.1. A difference is that an equilibrium constraint is not only imposed for each period and each region but also for each trader. This gives the following equilibrium constraints for \( h \in H \), \( i \in I \), and \( t \in \{1,2,3,4\} \), see (5.7),

\[
q_{ih} + \sum_{j \neq i} \sum_{j \neq i} q_{ijth} + \tau_{ijth} + \delta v_{i,t-1,h} = r_{ih} + \sum_{j \neq i} q_{ijth} + v_{ih}
\]  

(9.2)

In the equilibrium model, the total purchases of the traders can not exceed the supplies from the producers, and the total sales from the traders can not exceed
the quantities demanded by the consumers. In equilibrium they have to be equal. For \( i \in I \) and \( t \in \{1,2,3,4\} \),

\[
\sum_{h \in H} q_{ih} = x_{it} \quad (9.3)
\]

\[
\sum_{h \in H} r_{ih} = y_{it} \quad (9.4)
\]

I assume that all traders have to borrow from the bank the money they need for their business. For simplicity, it is assumed that they only borrow in the beginning of the year. They borrow an amount \( \text{cap}0_h \). I assume that the traders of type \( h \) can not borrow more than \( cm_h \), \( h \in H \).

\[
\text{cap}0_h \leq cm_h \quad (9.5)
\]

Furthermore, it is assumed that the traders only sell after all purchases have taken place. In each period, I evaluate the capital stock after the traders have made their expenses for purchases, transport, and storage, but before they earned the money from sales to the consumers. If I would evaluate the capital stock at the end of the period, without defining explicitly the timing of purchases and sales, it would be possible that the trader purchases cereals using the revenues from the sales. So, the amount of capital in stock after trader \( h \) purchased, stored, and transported cereals in a period \( t \) is equal to the amount of capital available at the beginning of period \( t \), minus the total costs for purchases, storage, and transport in period \( t \). At the beginning of period 1, trader \( h \) has a capital availability of \( \text{cap}0_h \). The amount of capital available at the beginning of period \( t \) is equal to the amount in stock after all expenses have been made in period \( t-1 \), \( \text{cap}_{t-1,h} \), plus the total revenues from sales in period \( t-1 \).

\[
\text{cap}_{1h} = \text{cap}0_h - \sum_{j \in J} p_{ij} q_{ijh} + k_{1h} v_{1ih} + \sum_{j \in J, j \neq i} \tau_{ijh} q_{ijh} \quad (9.6)
\]
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\[ cap_{th} = (1 + r) \left( cap_{t-1, h} + \sum_{i \in I} \pi_{i, t-1, t-1, h} - \sum_{j \in I} \left[ p_{it} q_{ih} + k_{i, th} v_{ith} + \sum_{i' \in I} \tau_{i, j, i', i' th} q_{ijth} \right] \right), \]

for \( t = 2,3,4, h \in H \). Using the Kuhn-Tucker conditions of this model, it can be shown that if I would define prices \( p_{it} \) and \( \pi_{i} \) in (9.6) as variables, the optimal equilibrium results would not reflect well the optimal strategies of the producers, consumers, and traders. For that reason I define them as parameters and assign them the average observed market prices, \( \bar{\pi}_{i} \) and \( \bar{p}_{it} \), given in Table 2.1. A sensitivity analysis shows that the results of the model do not differ much if I adopt other values for these parameters.

Due to the changes in the parameters and variables, the perfect market equilibrium model in which different types of traders are distinguished can be written as the following maximisation problem in the variables \( y_{it}, x_{it}, q_{ith}, r_{ith}, q_{ijth}, v_{ith}, cap_{0h}, cap_{th}, w_{it} \) for \( i \in I, h \in H, \) and \( t \in \{1,2,3,4\} \).

\[
\begin{align*}
\text{Max} & \quad \sum_{i=1}^{I} \sum_{t=1}^{T} \sigma_{i-1} \left[ \int_{0}^{\gamma} \eta d\eta - c_{it} x_{it} - \sum_{h \in H} \left[ \sum_{j=1}^{J} \tau_{ijth} q_{ijth} + k_{i, th} v_{ith} + \alpha_{ith} w_{it} \right] \right] \\
& \quad q_{ith} + \sum_{j=1}^{J} q_{ijth} + \delta v_{ij, t-1, h} = r_{ith} + \sum_{j=1}^{J} q_{ijth} + v_{ith}; \quad \sum_{h \in H} q_{ith} = x_{it}; \quad \sum_{h \in H} r_{ith} = y_{it}; \\
& \quad cap_{0h} \leq c m_{h}; \quad cap_{th} = cap_{0h} - \sum_{i=1}^{I} \left[ \hat{p}_{it} q_{ith} + k_{i, th} v_{ith} + \sum_{j=1}^{J} \tau_{ijth} q_{ijth} \right], \quad (9.7) \\
& \quad cap_{th} = (1 + r) \left( cap_{t-1, h} + \sum_{i \in I} \pi_{i, t-1, t-1, h} - \sum_{j \in I} \left[ \hat{p}_{it} q_{ith} + k_{i, th} v_{ith} + \sum_{i' \in I} \tau_{i, j, i', i' th} q_{ijth} \right] \right), \\
& \quad x_{it} \leq x_{it} \leq \delta w_{i, t-1}; \quad w_{it} = \delta w_{i, j-1} - x_{it}; \quad y_{it}, q_{ith}, r_{ith}, q_{ijth}, v_{ith}, cap_{0h}, cap_{th} \geq 0, \\
& \quad i, j \in I, j \neq i, t \in \{1,\ldots,4\}, h \in H \}
\end{align*}
\]
By writing out the Kuhn-Tucker conditions of this equilibrium model, it can be verified that the optimal consumer price is equal to the optimal level of the Lagrange multiplier of (9.4). Due to the peculiar form of the producers’ supply model, the optimal producer prices do not follow directly from the model results. Like in Theorem 6.1, it can be proven that the optimal level of $x_o$ is the optimal producer supply level indeed, if the producer price is equal to the optimal value of the Lagrange multiplier of (9.3). Similar to Theorem 6.2, it can be derived that for the optimal producer and consumer prices, the results of model (9.7) reflect the optimal strategies of the traders.

To analyse the influence of credit on cereal trade, I compare the results for the situation in which $cm_h$ is restrictive with the ideal situation in which $cm_h$ is so large that capital will not be a constraint for the traders. I consider two cases for which I compare these two situations. In Case A and A’, all traders have the same unit transaction, transport, and storage costs. In Case A, capital availability is limited, whereas in case A’, capital is not constrained. In fact, case A’ is similar to the perfect market model, discussed in the previous section. In Case B and B’, the transaction costs for traders of type 1 are 25% lower, transport costs for traders of type 2 are 25% lower, and storage costs for traders of type 3 are 25% lower. In Case B, capital availability is limited, and in Case B’, capital is not constrained. The Cases A and B reflect the current market situation, in which the capital market is imperfect and capital is restrictive. The Cases A’ and B’ reflect ‘ideal’ situations, in which capital markets are functioning well.

The results show for both cases more or less the same pattern. For Case A’, prices and quantities traded are the same as for the perfect market model discussed in Section 9.1. In Case A, in which 25% less capital can be borrowed from the bank than the amount used in Case A’, welfare is only 3.6% lower than in case A’, but consumer utility is 9.8% lower and the producer revenues are even 44.2% lower. Trader revenues, however, are large. In Case A, the traders together earn 7,378 million FCFA, whereas in Case A’, their revenues are zero. In the first two periods consumer and producer prices are lower (average consumer prices are 6.2% and 6.1% less in the periods 1 and 2), but in the last two periods consumer prices are higher and producer prices lower (in the
periods 3 and 4, average consumer prices are 12.8% and 48.2% higher, and average producer prices are 6.7% and 6.9% lower). In the first two periods, capital is not constraining yet. In the last two periods, capital becomes constraining, and traders can not offer higher prices to producers to urge them to supply more. Due to the low cereal availability on the market, consumer prices rise. In these periods, for each region, the difference between producer and consumer prices is not equal to the transaction costs. This shows that the level of competition is lower if capital availability is constraining than if capital markets function well. As compared to Case A’, the lower level of producer prices and higher level of consumer prices in Case A, leads to a situation which is worse for both producers and consumers. Furthermore, in Case A, the quantities supplied and the transport flows to the shortage regions are lower (-8.4% and -10.6%, respectively). Supplies are lower, especially in the remote surplus regions for which transport costs to the shortage regions are relatively high (Comoé, Sud Ouest, Centre Sud). In these regions net producer revenues are rather low in Case A’, and they are negative in Case A. Due to the capital constraint, in these regions, traders can not offer higher prices to urge producers to supply more. In Case A, traders can not offer producer prices for which they can transport profitably to other regions, whereas in Case A’, they can. It is more efficient if traders transport from the regions nearby the shortage regions. If the capital availability was only 10% less than in Case A’, the differences with case A’ would be less pronounced, but the picture would be very similar.

Comparing Case A, in which the capital market is imperfect, with Case A’, in which the capital market functions perfectly, shows that a larger availability of credit may lead to higher supply and consumption levels, more market transactions, more transport activities, and fairer producer and consumer prices.

For the Cases B and B’, the results show the same pattern. Compared to Case B’, in Case B in which credit is constraining, consumer prices are higher whereas producer prices are lower in the periods 3 and 4. As a result, cereal supplies and transports to the shortage regions are lower. Furthermore, in Case B’, in which capital is not constraining, each trader makes the transactions for which he has the lowest costs. As a result traders of type 1 transact the cereals which are purchased and sold immediately in the same region and transport the cereals over the short distances (for these routes these traders make the lowest costs, which include transaction and transport costs). Traders of type 2 transport
the goods over long distances. For these routes, they make lower transport and transaction costs than the other traders. Traders of type 3 do nothing. Their storage costs are lower than those of the other traders, but since their transaction costs are higher than those of traders of type 1 they do not have a comparative advantage for storage. For Case B, traders of type 1 can only do a part of the activities they would do in the situation without a capital constraint. As a consequence, traders of type 1 do not transport or store. They only do intra-regional trade. Traders of type 2 take upon themselves all transports. Traders of type 3 do the remaining transactions which can not be financed by the other traders. These changes result in a loss of efficiency. If more capital is available, the traders who have a comparative advantage for a certain activity will perform this activity, because they can offer or demand the best prices. The others will be priced out of the market. For example, in Case B' the difference between consumer and producer prices is 11.25 FCFA per kg, which is equal to the transaction costs of the traders of type 1. Since the transaction costs for the other traders are equal to 15 FCFA per kg, they will not do any intra-regional trade. In Case B, the difference between the consumer and producer price in the regions in which only traders of type 1 operate, is a little less than 15 FCFA/kg for the periods 1 and 2. This difference is equal to 15 FCFA/kg in the other regions. Because of the capital constraint, the traders of type 1 do not have to fear the entry of new traders of type 1. Therefore, they can demand consumer prices for which the difference with the producer price exceeds the transaction costs. On the other hand, they will not ask a price which is more than 15 FCFA/kg higher than the producers price. In that case, the other traders would also start intra-regional trade, in that way affecting the net revenues of the traders of type 1. So, in this case, traders can abuse their market power to ask too high prices.

To conclude this section, a number of interesting conclusions can be drawn from the above analyses. First, if more credit can be obtained from official credit organisations, more cereals will be supplied, consumed, transacted, and transported. Especially the remote regions will profit from this. More will be transported to the shortage regions, and producers in the remote surplus regions can compete with producers from the other regions. Secondly, an improved accessibility of credit may lead to higher producer and lower consumer prices.
In that case, the traders’ purchase level or the producer price they offer will be less restricted by their capital availability. Furthermore, they will not have the possibility to ask consumer prices which exceed the producer prices with more than their trade costs. A higher capital availability will be positive for the level of competition and will prevent the abuse of market power. Thirdly, if credit is more easily accessible, traders having a comparative advantage will be able to trade larger quantities, leading to fairer cereal prices and more efficient trade.

Note that an important problem on the capital market is the amount of capital that can be borrowed at reasonable interest rates. Many traders can obtain credit from informal money lenders, but they have to pay usury interest rates. This has the same negative effects on the market as discussed above: consumer prices are too high, producer prices are too low, and competition is seriously hindered.

9.3 Scenario 7: The Influence of SONAGESS on the Cereal Market

In Burkina Faso, the organisation SONAGESS has the responsibility to keep a national security stock. With this security stock, the cereal demand of the northern shortage regions can be satisfied for a few weeks in case of urgent cereal shortages. In Section 2.2.2, it has been discussed that SONAGESS renews 1/3 of the stock each year. They have a maximum capacity of 35,000 tonnes, but the last years the stock measured approximately 15,000 tonnes. This means that they supply and demand each year approximately 5,000 tonnes of cereals. In the period December – February they purchase cereals from the large cereal wholesalers and in the period July – August they sell. The cereals are stored in seven storehouses, of which one is situated in Ouagadougou, one in Ouahigouya in the region Nord, two in the region Centre Nord, and four in the region Sahel. According to Bassolet (2000), SONAGESS is an important player on the cereal market in the northern regions. In this section, I analyse whether the trade activities of SONAGESS have a disturbing effect on the cereal market in the northern regions.

For this analysis, I introduce in the model the supply and demand of SONAGESS. In period 2 (January – March), SONAGESS demands 5,000 tonnes of cereals on the market. They can purchase in all regions, and they purchase at the market price. In period 4 (July – September), they sell 5,000 tonnes of cereals in the regions Centre, Centre Nord, Sahel, and Nord.
It is expected that the influence of the sales and purchases of SONAGESS on cereal prices is modest. The 5,000 tonnes they purchase in period 2, is 5.7% of the producer supplies in period 2 in the base scenario and only 1.3% of the annual quantity supplied. The 5,000 tonnes they sell in the four shortage regions, is about 9.7% of the total amount of cereals purchased by the consumers in those regions in period 4 (it is 22% of the quantity purchased by the consumers in the three northern regions in period 4). According to the results, semi-welfare increases by 0.4%. SONAGESS purchases 1,510 tonnes in Mouhoun, 170 tonnes in Est, and 3,320 tonnes in Sud Ouest. For the prices it makes no difference in which of the four shortage regions they sell. If it is specified in the equilibrium model that everything has to be sold in Sahel, or if a part can also be sold in other regions, the differences between the model results are negligible. Prices are the same, and only the quantity transported to the shortage regions changes, if the specification of the distribution of the stock over the warehouses changes.

The purchases by SONAGESS in period 2 result in a fall of the quantity stored by the traders in the region Mouhoun by 1,500 tonnes, a fall in the quantity demanded by 770 tonnes, and an increase of the quantity supplied by the producers by 2,730 tonnes (supplies only increase in the region Centre). Furthermore, in period 2, the quantities transported by the traders from the region Sud Ouest fall by 3,200 tonnes. Because of the lower availability of cereals in period 2, prices increase. Due to the decrease of the quantity stored in period 2 in Mouhoun, less cereals are transported from Mouhoun in period 3. Average consumer prices remain the same in period 1, increase by 1.4% in period 2, by 2.06% in period 3, and by 0.65% in period 4.

If the security stock kept by SONAGESS increases to its maximum level (35,000 tonnes) and they renew each year 12,000 tonnes, the market prices hardly change compared to the case in which they renew only 5,000 tonnes. Prices in period 1 and 4 do not change, and in the periods 2 and 3 they increase a little bit. The extra purchases in period 2 by SONAGESS result in lower storage in Mouhoun, increased supply in Sud Ouest and Centre, and lower demand.
It can be concluded that the yearly renewal of a part of the national security stock by SONAGESS only has a small effect on prices and does probably hardly disturb the market. The most important effect is a fall of the quantity stored by the traders. Transport companies will not be affected if SONAGESS does not itself transport the cereals to its warehouses. In Bassolet (2000), it is argued that the supply activities of SONAGESS in the northern regions results in less competition in these regions. This may be true indeed if they supply to a small number of large wholesalers only. If they sell to a larger number of wholesalers and semi-wholesalers, this will be less a problem. Note that even without the presence of SONAGESS, the number of wholesalers active in these thinly populated areas will be small. Furthermore, it is not likely that these traders ask excessively high prices because of the low purchasing power of the population. To conclude, the positive effects of the national security stock, that is an improved level of food security, are anything but overruled by negative market disturbing effects.
Part III – Results of the Equilibrium Model