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The effectiveness of the world coffee agreement: a simulation study using a quarterly model of the world coffee market

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5.1 INTRODUCTION

In this chapter we present the results of a simulation analysis of a quarterly model for the world coffee market. The model has been developed by Palm and Vogelvang (1986). More details of this study can be found in Vogelvang (1988). In the model, producing and importing countries are assumed to maximize the expected utility of the present value of profits over a two-period time horizon by buying or selling on the spot market and by holding inventories, and by hedging or speculating on the futures market. Expectations are assumed to be rational, i.e. they are equal to the conditional expectation given the model and information up to the current period. The spot and futures markets clear at each time period. The model has been estimated for the period 1971–82, a period in which the quota system of the International Coffee Agreement (ICA) has almost never been effective.

The aim of the chapter is twofold. First, we give some insight into the behaviour of the model over the period of estimation. Second, and more importantly, we analyse the impact of a substantial increase in production on prices, disappearance and inventory formation and of several policy measures aimed at reducing an imbalance between demand and supply on the coffee market by decreasing production. These measures are analysed under the assumption (a) that there is no ICA and (b) that an international quota system has been agreed upon which becomes effective as soon as the spot market price drops below a certain level. Attention is also paid to the
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impact of the distribution of initial inventories over exporting and importing countries.

We show that it is possible to solve a medium-size model for an international commodity market assuming rational behaviour of the agents (countries) under uncertainty. The simulation results are of importance for the discussions about price stabilization through international agreements aimed at restricting trade by a quota system. Our findings lead to the conclusion that the current situation on the international coffee market, which is characterized by an excess of production compared with total world consumption, requires a substantial reduction in production in the coming years to bring supply and demand more into balance.

The chapter is organized as follows. The structure of the model is briefly outlined in section 5.2. The solution of the model under rational expectations is described in section 5.3. In section 5.4 the export quota system is discussed together with its consequences for the solution of the model. Section 5.5 contains some simulation results for the sample period. In section 5.6 the model implications of several policy measures aimed at reducing production are presented. Finally, concluding remarks are made in section 5.7.

5.2 THE MAIN FEATURES OF THE MODEL

The model is a short-term quarterly model in which the production is assumed to be predetermined. A quarterly model allows account to be taken of developments which take place within the year, e.g. the quarterly quota distribution. The model of the world coffee market has been elaborated along the lines of recent developments in the theoretical literature (e.g. Newbery and Stiglitz, 1981). A schematic summary of the theoretical model is given in Table 5.1. More details can be found in Palm and Vogelvang (1986). The list of variables is as follows:

\begin{align*}
  \mathbf{z}_a & \quad \text{wholesale inventories} \\
  \mathbf{z}_r & \quad \text{retail inventories} \\
  \mathbf{q} & \quad \text{production} \\
  \mathbf{e} & \quad \text{consumption} \\
  \mathbf{e}_n & \quad \text{exports} \\
  \mathbf{d}_n & \quad \text{spot price} \\
  \mathbf{d}_m & \quad \text{disappearance} \\
  \mathbf{d}_m & \quad \text{futures price} \\
  \mathbf{d}_m & \quad \text{imports} \\
  \mathbf{d}_m & \quad \text{retail price} \\
  \mathbf{k}_n & \quad \text{unit processing costs} \\
  \mathbf{k}_n & \quad \text{consumer price index} \\
  \mathbf{n}_n & \quad \text{population} \\
  \mathbf{n}_n & \quad \text{real disposable income} \\
  \mathbf{b}_i & \quad \text{discount factor} \\
  \mathbf{b}_i & \quad \mathbf{\gamma}_i \mathbf{\delta}_i \\
  \mathbf{\gamma}_i & \quad \text{coefficient of constant absolute risk aversion} \\
  \mathbf{\gamma}_i & \quad \text{position on the futures market} \\
  \mathbf{\gamma}_i & \quad \text{parameters of the cost function for inventories}
\end{align*}
The main features of the model

\[ a_i, \beta_i \] constant parameters
\[ \text{var}_i \] variance conditional on information available at period t

At the microeconomic level we assume that market participants (individual countries in the empirical model) have access to the spot and futures markets and that they have a utility function with constant absolute risk aversion. They are assumed to take a position on these markets in such a way that the expected utility of the present value of profits for the present and next period is maximized. In this way we derive the optimal position for inventory holders at the wholesale and retail level. For price-taking inventory holders the price of storage equation 5.1 (e.g. Working, 1949) results from the two-period optimization model relating the size of inventories to the spread, i.e. to the difference between the futures and the spot price. Large producers are assumed to be price setters facing a downward-sloping demand curve, \( P_s = \phi_{10} - \phi_{11} \exp \left( \right) \) where the coefficient \( \phi_{10} \) and \( \phi_{11} \) possibly depend on the situation on the coffee market at time 1, but they are not controlled by the producer. They are able to influence the price level by varying the inventory level. For a price-setting producer, the maximization of the expected utility of the present value of profits over two periods leads to a relationship between inventories and the difference between the expected next-period spot price and the futures price, while the inventories of the other inventory holders also have an influence on his position. At the retail level, too, a price of storage equation results from arbitrage between the present and the next period. The retail inventories are related to the difference between the expected and the current retail price (5.2).

Disappearance (5.3) is equal to consumption and the change in retail inventories. Consumption per capita (5.4) is assumed to depend on the relative price of coffee with respect to the consumer price index and on per capita income. A semilogarithmic specification was chosen in order to force the income elasticity to decrease when consumption increases.

Exports by producers (5.5) are by definition equal to production minus disappearance minus the variation in wholesale inventories. For non-producing importing countries the same definition applies (5.6) with production zero.

The retail price is related to the spot market price through a cost function (5.7) where the unit costs \( k_p \) of roasting coffee are assumed to be proportional to the general price level, \( \eta_i \) denotes the profit margin (constant) and \( \beta_i(L) \) is a polynomial in the lag operator \( L \) such that \( \beta_i(1) = 1 \).

Spot and futures prices adjust to clear the spot and futures markets at each period (see Equations 5.8 and 5.9), and expectations are assumed to be rational.

The following countries have been included in the model. On the production side, it concerns Brazil and Colombia (who are price setters) and
Table 5.1 A summary of the theoretical model

<table>
<thead>
<tr>
<th>Country $i$</th>
<th>Production $q_i$</th>
<th>Consumption $c_{i,a}$</th>
<th>Disappearance $d_{i,a}$</th>
<th>Inventory $z_{i,a}$</th>
<th>Export $x_{i,a}$</th>
<th>Retail price $p'_{i,a}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producer (exporting country)</strong></td>
<td></td>
<td></td>
<td></td>
<td>Wholesale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predetermined</td>
<td></td>
<td></td>
<td></td>
<td>$z_{i,a} = \max \left{ \frac{p_i - p_r - b_i}{2c_i}, z_{i,a} \right}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predetermined Disappearance:</td>
<td></td>
<td></td>
<td></td>
<td>$d_{i,a} = c_{i,a} + \nabla z'_{i,a}$</td>
<td>$x_{i,a} = q_{i,a} - d_{i,a}$</td>
<td></td>
</tr>
<tr>
<td>(5.3)</td>
<td>(see below for a price setter)</td>
<td>Retail</td>
<td>$z_{i,a}'$ predetermined</td>
<td></td>
<td>$x_{i,a} = -\nabla z_{i,a}$</td>
<td></td>
</tr>
</tbody>
</table>

| **Importing country $q_i = 0$ | Consumption $c_{i,a} = \alpha_0 h_{i,a}$ | Wholesale | $z_{i,a} = \max \left\{ \frac{p_i - p_r - b_i}{2c_i}, z_{i,a}' \right\}$ | Import $x_{i,a} = -\text{imp}_{i,a}$ | $p'_{i,a} = (1 + \eta_i)$ |                   |
|                           | $\alpha_3 \left( \frac{n_{i,a} p_{i,a}'}{c p_a} \right)$ |                         | $x_{i,a} = -\nabla z_{i,a}$ | $x_{i,a} = -\text{imp}_{i,a}$ | $p'_{i,a} = (1 + \eta_i)$ |                   |
|                           | $\alpha_2 n_{i,a} \ln \left( \frac{y_{i,a}}{n_{i,a}} \right)$ | Retail | $z_{i,a}' = \max \left\{ \delta_i E_i p_{i,a+1} - p_i' - b_i \right.$ |                   |                   |                   |
|                           | $\alpha_2 n_{i,a} \ln \left( \frac{y_{i,a}}{n_{i,a}} \right)$ |                         | $2c_i + \gamma_i \text{var} (p_{i,a+1}) \right\}$ |                   |                   |                   |
| Disappearance | $d_{i,a} = c_{i,a} + \nabla z'_{i,a}$ |                      | $x_{i,a} = -\nabla z_{i,a}$ | $x_{i,a} = -\text{imp}_{i,a}$ | $p'_{i,a} = (1 + \eta_i)$ |                   |

(5.1) (5.5) (5.6) (5.7)
Market clearing

\[ \sum_i \exp_i = 0 \iff \sum_i (q_{it} - \text{cons}_{it} - \nabla z_{it} - \nabla z_{it}^0) = 0 \quad (5.8) \]

Spot market

\[ \sum_i f_{it} = 0 \iff \sum_i \left\{ \left[ \frac{p_i^t - \delta_i \bar{p}_{t+1}}{\gamma_i \text{var} (p_{t+1})} \right] + z_{it} + \frac{\text{cov} (p_{t+1} \mid q_{u+1}, p_{t+1})}{\text{var} (p_{t+1})} \right\} = 0 \quad (5.9) \]

Futures market

\[ z_{it} = \max \left\{ \frac{1}{2(\phi + c_i)} \left[ 2\phi_i(q_{it} + z_{it-1}) - \phi_i f_{it-1} + p_i^t - b_i - \phi_{it} + \delta \frac{\partial E_{t+1}}{\partial z_i} - \frac{\delta E_{t+1} - p_i^t - \gamma_i \text{cov} (p_{t+1} \mid q_{u+1}, p_{t+1})}{\gamma_i \text{var} (p_{t+1})} \right] ; \tilde{z}_{it} \right\} \]

*For individual countries:*
groups of countries producing respectively Unwashed Arabicas, Other Milds, Colombian Milds and Robustas. On the consumption side, the USA and the European member countries of the International Coffee Organization (ICO) have been modelled individually. The specification for the wholesale inventories had to be extended by assuming a partial adjustment scheme in which the desired level of the inventories is modelled by Equation 5.1. Also, as the market for the various sorts of coffee has been modelled, the market-clearing conditions 5.8 and 5.9 are solved for the Composite Indicator Price 1968, (CIP68) (a weighted average of the spot prices) and the futures price of the New York market. Prices of the other sorts are assumed to be related to the price of Unwashed Arabicas and the New York futures price through an error correction model with a constant term reflecting the difference in quality between the various sorts of coffee. The general conclusion was that the estimation results are in fair agreement with the theoretical model.

5.3 SOLUTION OF THE MODEL

5.3.1 Solution when the export quotas are not effective

The entire model of the coffee market as specified and estimated in Palm and Vogelvang, (1986) will be solved for the coffee price on the spot and futures markets and for the price expectations. The remaining endogenous variables will first be expressed in terms of prices and predetermined variables and will then be substituted in the market-clearing equations of the spot and futures markets. Equations 5.8 and 5.9 form the starting point from which the prices will be derived. Some assumptions have to be made to obtain operational equations to determine the price variable. These assumptions are as follows.

1. Price expectations are rational.
2. The conditional second moments of \( p_{t+1} \) are constant over time.
3. Given all available information at time \( t \), \( q_{t+1} \) and \( p_{t+1} \) are independent.
4. Each country holds inventories at the wholesale level and has access to the futures market.

The rationale of assumption 2 is simplicity. On a priori grounds this assumption is not necessarily in agreement with the rational expectations hypothesis, but without the assumption the equations would be non-linear in the variables which would complicate the solution very much; for an example of a non-linear rational expectations model see Broze et al. (1986). As the simulation results appear to be plausible, there is little reason to abandon this assumption at the present stage of the research.

With assumptions 2–4, Equation 5.9 can be written as

\[
\nu_1 p_t - \nu_2 \text{Ep}_{t+1} + Z_t + E_Q_{t+1} = 0
\]  

(5.10)
Solution of the model

with $v_1 = \Sigma_i \{1/|\gamma_i \varphi_i, (p_{i+1})|\}$ and $v_2 = \Sigma_i \{\delta_i/|\gamma_i \varphi_i, (p_{i+1})|\}$. Capital letters denote aggregated quantities, e.g. $Z_t = \Sigma_t z_n$. Equation 5.8 can be expressed as

$$Q_t + Z_{t-1} - \text{DIS}_t - Z_t = 0 \quad (5.11)$$

The variables $Q_t$ and $Z_{t-1}$ are predetermined in these equations. For the endogenous variables $Z_t$ and DIS, their components will be substituted. The world inventory $Z_t$ is the aggregate of all the inventories of individual countries and is therefore related to futures and spot prices and predetermined variables.

The inventories can be eliminated now because $Z_t$ is expressed as a linear function of $p_n, p'_i$ and $Ep_{t+1}$ and an aggregate of predetermined variables originating from the inventory equations. Define $S_t$ to be the sum of the above-mentioned aggregated predetermined variables and the expected production. Then Equation 5.10 can be written as

$$a_0 + a_1 p'_i + a_2 Ep_{t+1} + a_3 p_t + a_4 S_t = u_{t1} \quad (5.12)$$

The disturbance term $u_{t1}$ represents the aggregate of disturbances of the original model. Equation 5.1 expressed in terms of the CLIP68 for simplicity rather than in terms of prices of the various types of coffee has been substituted for $Z_t$ in 5.10 to obtain 5.12. The disturbance term is assumed to be normally independently distributed. After substitution of 5.7 for $p'_i$ and the expected value of 5.7 for $Ep'_{t+1}$ in cons$_d$ (5.4) and $\zeta''_d$ (5.2), the total disappearance DIS$_t$ is expressed as a linear function of $p_n, Ep_t$ and $Ep_{t+1}$ and a number of aggregate predetermined variables from the disappearance and retail price equations, in addition to lagged values of the price variable. Let $H_t$ be the sum of the aggregate predetermined variables in the disappearance, retail and inventory equations, plus $Q_t + Z_{t-1}$. Then Equation 5.11 can be written as

$$\beta_0 + \beta_1 p'_i + \beta_2 Ep_{t+1} + \beta_3 Ep_t + \beta_4 p_t + \beta_5 p_{t-1} + \beta_6 H_t = u_{t2} \quad (5.13)$$

The disturbance term $u_{t2}$ has been introduced for the same reason as $u_{t1}$ and is also assumed to be normally independently distributed. The price expectations are assumed to be rational, i.e.

$$Ep_{t+1} = E(p_{t+1}|\Phi_{t-1}, \text{model}) \quad Ep_t = E(p_t|\Phi_{t-1}, \text{model}) \quad (5.14)$$

where $\Phi_{t-1}$ denotes the information available at time $t - 1$, and the second moments are assumed to be constant.

The solution equations are now complete. The system in 5.12, 5.13 and 5.14 consists of four equations in the endogenous variables $p_t, p'_i, Ep_t$ and $Ep_{t+1}$.

When the parameters of Equations 5.12 and 5.13 have been estimated and expected prices have been computed using a solution method for rational expectation models, Equations 5.12 and 5.13 can be solved for $p_t$,
and \( p_1 \). The system will be solved for CIP68 and the futures price in New York. Data on expected production are available. The US Department of Agriculture obtains and publishes production estimates in its *Foreign Agriculture Circular: World Coffee Situation*.

There are various methods to determine rational price expectations (see, for example, Blanchard and Kahn, 1980). A useful treatment for linear rational expectation models can be found in Chow (1983, pp. 356–61). His solution method has been applied here. More specifically, we estimate the parameters of 5.12 and 5.13 by the method of instrumental variables using \( p_{t-1} \) and \( p_{t+1} \) as proxies for \( EP_t \) and \( EP_{t+1} \) respectively and lagged prices as instruments. Then by eliminating \( p_1 \) from 5.12 and 5.13, we obtain the reduced form equation for \( p_t \), which expresses \( p_t \) in terms of \( p_{t-1} \), \( EP_t \), \( EP_{t+1} \) and the predetermined variable \( x_t = \alpha_{4} \alpha_{1} S_t - \beta_{4} \beta_{1} H_t \). The associated final form equation for \( p_t \) is a dynamic regression model in which \( p_t \) is explained by its own lagged values and by the truly exogenous part of \( x_t \), denoted by \( x_t^* = \alpha_{4} \alpha_{1} S_t^* - \beta_{4} \beta_{1} H_t^* \), where \( S_t^* \) and \( H_t^* \) are the exogenous parts of \( S_t \) and \( H_t \) respectively. Notice that \( x_t^* \) is the only exogenous variable that varies in the simulations.

The final form equation for \( p_t \) is approximated by an ARMAX (Auto-Regressive Moving Average with Exogenous Variables) model and is estimated by non-linear least squares after replacing the unknown coefficients in \( x_t^* \) by consistent estimates to get \( x_t^* \). The final form equation is then used to generate the values for \( EP_t \) and \( EP_{t+1} \). To compute \( EP_{t+1} \) we need the one-step-ahead forecast errors of \( x_t^* \), which are obtained from a univariate time series model fitted to the series \( x_t^* \). Finally, the values of \( EP_t \) and \( EP_{t+1} \) are substituted into 5.12 and 5.13 which are solved for \( p_t \) and \( p_1 \) (the CIP68 and the futures price in New York). Prices for the various coffee types and the futures price in London are then obtained from the error correction models mentioned above and the definition of the CIP68. These prices appear in the equations for the various coffee types and countries.

### 5.3.2 Solution when the quotas are effective

When the exports of coffee by producing countries are restricted by means of export quotas, it follows that \( exp = quota_d \) and the inventories of the producing countries are \( z_{0} = z_{d-1} + q_{d} - quota_d \). For the aggregate inventories of importing countries, we have \( Z_{i}^{T} = Z_{i-1}^{T} + QUOTA_{i} - DIS_{i} \), where \( QUOTA_{i} \) denotes aggregate imports. The clearing condition 5.11 for the spot market remains unchanged.

It is also straightforward to show that the expression for the optimal position on the futures market is not changed if the quota system is introduced. The clearing condition for the futures market is therefore given in 5.10. When we solve for the rational expectations, we have to split \( Z_{i} \) in 5.10 and 5.11 into \( Z_{i}^{l} \) and \( Z_{i}^{f} \) respectively. For \( Z_{i}^{l} \), we substitute expression
The behaviour of the model over the sample period

5.1; \( Z^*_p \) is carried along as a predetermined variable. The rational expectations solution when quotas are effective is then obtained along the same lines as explained above. Only the variables \( S_t \) and \( H_t \) have to be redefined to include \( Z^*_p \) which is now predetermined.

Before the simulation results are presented, we give a brief description of the way in which the quota system has been incorporated in the simulation study.

5.4 THE QUOTA SYSTEM MODELLED

The quota system of the ICA 1976 is based on daily developments on the coffee market (ICA, 1976). As the model is a quarterly one, the quota system has to be formulated in terms of restrictions on quarterly variables. Obviously such an approximation will be more inert than the real quota system, because only four decisions a year can be taken. Although quotas come into effect after the CIP has been below the ceiling of the price range for a period of 20 market days, the quota distribution is a quarterly matter.

The quota system has been introduced in the simulation study in the following way. Each exporting member is entitled to a basic quota, according to the provisions of the agreement. The quotas become effective in the quarter after the quarter in which the CIP76 is at or below 135 $ct per pound, with

\[
CIP76_t = \frac{1}{2} (P^{ROB}_t + P^{OM}_t)
\]

The quarterly quotas are divided into two parts, a fixed and a variable part. The initial allocation is 97.6% of the annual quota that has been agreed in ICO meetings. The fixed part is 70% of this allocation. The variable part is 30% of the total initial allocation. It is allocated to a country in the ratio of its own inventory level to the total inventory level of the relevant coffee type (ICO, 1976).

Quotas are adjusted downwards if the CIP76 falls below 120 $ct and again when this price average drops below 115 $ct. If prices rise, quotas are adjusted upwards if the CIP76 rises above the level of 135, 150 and 155 $ct respectively. Quotas must be suspended above the last-mentioned level. The size of the adjustment is also decided in ICO meetings. In the simulation experiments the quota adjustments equal 1.4 million bags, an amount decided by the International Coffee Council in the autumn of 1980.

5.5 THE BEHAVIOUR OF THE MODEL OVER THE SAMPLE PERIOD

To give the reader some insight into the performance of the model, we solved the model for the period 1977.II through 1980.I and computed
standardized root mean square forecast errors (SRMSEs)\(^1\) of the variables in the model. The largest sample period for which all variables of the model are observed is the period 1977.II to 1980.I.

The predetermined variables take the observed values. For each quarter the values of the endogenous variables are determined: first the prices by using the solution equations, then inventories, disappearance and retail prices of the individual countries. Quotas were not effective in the sample period.

Generally, the simulated series fit the observed data reasonably well. An analysis of the simulations over the sample period shows that for the price expectations and for the spot price realizations, the simulated turning point lags somewhat behind the historical turning points. In this respect, we emphasize that in the quarter 1977.II coffee prices reached their peak after the crop in Brazil had been destroyed during the harvest year 1976–7. The years 1976–7 were exceptional for the coffee market, with extreme world market price increases, which are not fully explained by the model. The SRMSE for world market prices is approximately 0.20. In contrast, the behavior of the simulated retail coffee prices in importing countries fairly accurately describes the observed pattern. The SRMSE for retail prices varies in the range from 0.02 to 0.10.

The disappearance variable performs very well too. Most SRMSEs are in the range from 0.10 to 0.15. This is due to the fact that SRMSE depends mainly on the retail price. The simulated level of the inventories in some importing countries is rather high compared with the observed values (e.g. 0.25 for Norway, 0.27 for the UK and 0.30 for the USA), but in most cases the simulated inventory levels are rather close to the observations (SRMSEs in the range from 0.09 to 0.20).

The simulation results for the inventories in producing countries vary in quality per country. They are quite good for Colombia, reasonable for the countries producing Robusta and Other Milds and least satisfactory for Brazil. The reason for these different outcomes is not clear. The producers of Other Milds and Robusta are aggregates of many countries, and the result confirms our assumption that these countries act in a similar way with an SRMSE of about 0.20. The model for a price-setting producer performs very well for Colombia, with an SRMSE equal to 0.07. In spite of the rather good estimation result for the inventory equation of Brazil, the simulation outcome (SRMSE = 0.31) suggests that the present specification probably needs more refinement because of specific features of the coffee trade of Brazil.

\(^1\)The SRMSE is defined as \(\text{SRMSE} = \left(\sum_{t=1}^{T} (A_t - F_t)^2 / \sum_{t=1}^{T} A_t^2\right)^{1/2}\) with \(A\) and \(F\) the actual value and simulated value respectively of a given variable.
5.6 THE IMPACT OF POLICY MEASURES AFFECTING THE VOLUME OF PRODUCTION

5.6.1 Introduction

Several hypothetical situations for the world coffee market will be analysed in this section. Simulation of these situations will give insight into the quantity and price effects of the quota system and will be informative about the market behaviour with respect to various levels of coffee production, which is exogenous in the model. For one-step-ahead simulations it does not matter whether the volume of production is exogenous or only predetermined (for instance, it could depend on lagged prices). For dynamic simulations with a conditional model, the exogeneity of production is required. In this section, production is assumed to be a policy variable that will be varied in the simulations. The distribution of inventories over producing and importing countries will also be varied. It will be interesting to analyse differences of the effects in the short run and in the long run. To examine long-term effects the quarterly simulations will have to be run for a longer period.

As a starting point we take the situation in 1979.IV. The end of the year 1979 was chosen because it is the beginning of a period with more or less normal market circumstances, although the price level is still rather high. The market had recovered from a period of heavy price changes. From 1979.IV on, the model will be simulated over a period of 16 years (64 quarters), a period long enough to investigate the long-term properties of the model. For this simulation period the exogenous variables such as deflators, population and exchange rates will be kept constant at the level of the base quarter 1979.IV. Relative coffee prices can therefore be compared with observed nominal prices in 1979.IV.

In the 1970s world production varied around 71 million bags (of 60 kg), and imports of coffee by member countries were around 56 million bags. Further, non-member countries imported about 6.5 million bags of coffee in these years. Therefore officially about 62.5 million bags of coffee were imported.

We present the results in terms of world production which includes imports by member and non-member countries and domestic use in coffee-producing countries. World production is set equal to ±0.3 of total production on behalf of the member countries, which is determined in the model.

5.6.2 High production level

In a first simulation, world production will be held constant at a level of approximately 100 million bags. The distribution among producing countries is as follows (in million bags): Colombia, 13.7; Ethiopia, 4; Brazil, 27;
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Kenya and Tanzania, 2.9; Other Milds, 29.3; Robustas, 21.3. Production has been spread over the quarters according to the observed seasonal pattern in the harvest of the various producing countries. If there is no coffee agreement, the market collapses as a result of this high sustained production. Prices go to zero and inventories in producing countries increase tremendously so that interventions in the market cannot be avoided.

When there is an ICA, most variables in the model, in particular prices, fluctuate in the first simulation periods. The lower price bound is immediately reached and the quota system becomes effective. As a result of the reduction in the quantity brought to the market, prices cross the upper bound and the quota system becomes ineffective.

The alternations result from the simplified translation of the rules of the ICA into formulae in the model. Exports on a yearly basis vary between about 50 and 70 million bags and total export revenue equals on average about $9000 million. Disappearance equals approximately 10–11 million bags per quarter. Inventories in producing countries double to become 80 to 90 million bags whereas importing countries only marginally increase their inventories. In fact the simulation results are very similar to the actual situation on the coffee market in the 1960s when a high world production level had to be reduced via an international agreement. We simulated the effect of a high production level for various initial values for the coffee inventories and for the production in Brazil. In particular when we analyse an exceptional situation, i.e. when we set the production in Brazil equal to zero in the first year and 50% and 100% of its size in the preceding simulation in the second and later years respectively, we only find short-run effects. The price level is higher during the first and second year. In the long run the results are similar to those of the preceding simulation. Similarly, when we set the inventories in the importing countries equal to zero with inventories in producing countries unchanged or increased such that total inventories are left unchanged, the results only deviate in the short run from those in the first simulation.

When initial inventories in producing countries are set equal to zero, the deviation is stronger and lasts for about three years.

5.6.3 Decreasing the production level to stabilize the market

It is now natural to investigate to what extent world production has to be lowered to reach a situation in which the ICA becomes ineffective and coffee prices and trade become stable. When world production is decreased by 10% from 100 million bags to a constant level of 70 million bags after five years, the quota system becomes ineffective and prices become almost stable but slightly decreasing. A reduction by an additional 10% of production in the sixth year leads to slowly increasing prices. These findings are illustrated in Figs 5.1–5.6 where the outcome for aggregate inventories
Fig. 5.1 Inventories, producing countries.

Fig. 5.2 Inventories, importing countries.

Fig. 5.3 Exports.
Fig. 5.4 Disappearance.

Fig. 5.5 CIP 68.

Fig. 5.6 Export earnings.
in producing and importing countries, total exports, total disappearance, the CIP68 and total export earnings are plotted.

A few interesting conclusions emerge from these findings. When there is an ICA (the broken line), the price level and export earnings are higher than in the situation without an ICA (the full line), whereas exported quantities, disappearance and inventories are lower. All series quickly reach a roughly constant level when world production remains at a level of 70 million bags.

In the long run, with the ICA, exports become 43.7 million bags which are sold at a price of $1.58 per pound, yielding earnings of about $9145 million. In the case where there is no ICA, the level of exports is about 43.8 million bags in the long run, the world market price is about $1.11 per pound, yielding total export revenues of $6439 million.

These findings are similar to those of Herrmann (1988), who reports a price increase of about 30% resulting from the conclusion of an ICA (to be compared with a price increase of about 42% in our case). The difference in export earnings in his study fluctuates in the range of $1700–$1900 million, which is less than the $2706 million reported above.

Notice that the differences might be explained by the fact that he does not model the impact of uncertainty on decisions in his model and that he disaggregates his model according to countries and distinguishes between ICO member and non-member countries. In his analysis of the coffee market, the ICA roughly leads to a loss in revenue of about $2200 million for importing member countries and a gain of $140 and $1700–$1900 million for importing non-member countries and producing countries respectively.

It should be realized that there are costs involved for producing countries to earn the extra revenue from exports. As illustrated in Fig. 5.1 producing countries will temporarily increase the inventory level when there is an ICA. In the long run, however, inventories will be at a lower level compared with a non-quota regime and the extra income will more than compensate the initial costs.

Finally, we summarize the medium- and long-run impact of a reduction in coffee production on the main variables in the model. In Table 5.2 we give the elasticities for various variables when the quota system does not become effective. It shows that a reduction in coffee production is favourable for the producing countries in the long run, but certainly not for the importing countries. The former countries realize much higher export earnings in the long run. The increase in coffee price amply compensates for the decrease in disappearance.

5.6.4 Low production level

When production is held constant at a level of 70 million bags, the price level is almost stable. It very slowly decreases from ±$1.65 to ±$1.50 in 50
The effectiveness of the world coffee agreement

Table 5.2 Medium- and long-run elasticities with respect to production under stable market conditions

<table>
<thead>
<tr>
<th></th>
<th>After 3 years</th>
<th>After 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIP68</td>
<td>-1.35</td>
<td>-4.59</td>
</tr>
<tr>
<td>Retail price, Netherlands</td>
<td>-0.77</td>
<td>-2.77</td>
</tr>
<tr>
<td>Retail price, USA</td>
<td>-0.88</td>
<td>-3.39</td>
</tr>
<tr>
<td>Inventories, producing countries</td>
<td>0.48</td>
<td>1.10</td>
</tr>
<tr>
<td>Inventories, importing countries</td>
<td>-0.06</td>
<td>0.52</td>
</tr>
<tr>
<td>Exports</td>
<td>0.85</td>
<td>0.82</td>
</tr>
<tr>
<td>Export earnings</td>
<td>-0.39</td>
<td>-3.39</td>
</tr>
<tr>
<td>Disappearance</td>
<td>0.22</td>
<td>0.83</td>
</tr>
</tbody>
</table>

periods and the ICA does not become effective.

After 12 years, the CIP68 becomes $1.46 and total annual exports to member countries become 44.650 million bags. Export earnings become $8730 million. For disappearance, inventories in importing countries and inventories in exporting countries, we find a yearly average of 45.950, 7 and 37 million bags respectively. The pattern of the simulations is fairly robust with respect to the size of total inventories and its distribution among producing and importing countries in the initial period. As expected, a reduction in the size of the initial inventories leads to a higher price level in the long run, whereas a redistribution of inventories from importing countries to exporting countries or vice versa holding total inventories unchanged also has a positive effect on the price level in the short and medium run. But the order of magnitude of this effect is much smaller than when the size of the total inventories is reduced. Similar conclusions are reached for disappearance (or total demand) but, as expected, with opposite sign.

5.7 CONCLUDING REMARKS

In this chapter we simulated an econometric model for the international coffee market under various circumstances. The rational price expectations were calculated by using the solution method as presented by Chow (1983) assuming that the second moments of future values of the endogenous variables are constant. We compared the simulated values for the sample period 1977.II–1980.I with the observations. With the exception of the price simulations in the years 1977–9, in which heavy fluctuations occurred in the coffee market, the performance of the model is quite satisfactory. Overall, the results appear to be plausible. The determination of turning points of the spot price and of the inventories in Brazil need further investigation. The simulations for other variables are good. The simulations
for retail prices in general and for inventories in Colombia perform very well.

The simulation experiments for various hypothetical circumstances are very instructive and allow us to draw some policy-relevant conclusions. These experiments are concerned with the effects of the ICA when coffee production is at a high level. When production remains at a high level, the coffee market will collapse whether an ICA is concluded or not. When there is an ICA, the price will settle at the lower bound agreed upon in the ICA but the increase in inventories will necessitate an intervention leading to a reduction in total production. The ICA will only be workable if it is accompanied by restraint on the supply side.

When production is decreased to a level of 70 million bags, the market becomes stable. The ICA appears to be favourable to producing countries who earn more revenues from their exports because they are smaller in quantity but sold at a higher price. The increase in revenue (we abstract from possible negative effects of the increased price variability) of exporting countries leads to a welfare transfer from importing member countries to exporting countries. Our finding is very much in line with the conclusions reached by Herrmann (1988) who used a more disaggregated but theoretically less sophisticated model to study the effects of the ICA on the coffee market. It also becomes clear that the ICA does not lead to higher coffee consumption by importing member countries.

Recently, in October 1988, after two weeks of negotiations, the ICO agreed on a maximum export level of 56 million bags for the coffee year 1988–9 to bring the world market price to between $1.20 and $1.40, as the average price had been decreased to $1.14 because of the over-supply of coffee. In 1987, it was already agreed that production should be substantially reduced in the following years. Our simulation results show that such an export quantity, together with a reduction in total coffee production to this level, may be successful in reaching a stable situation in the long run.

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REFERENCES


