Tariff or quota protection – a case study of the Norwegian apple market

IVAR GAASLAND and ERLING VÅRDAL*

Foundation for Research in Economics and Business Administration, Breiviken 2, N-5035 Bergen-Sandviken, Norway and *Department of Economics, University of Bergen, Fosswinckels gate 6, N-5007 Bergen, Norway

Tariffs and quotas are alternative trade instruments. In most cases it has been shown that the use of tariffs results in a higher national welfare than the use of quotas. Most of the research in this field has been purely theoretical. This paper aims to give an empirical contribution. Referring to the Norwegian apple market, we analyse the effects of tariffs and quotas. A tariff system is estimated to be slightly more efficient than a quota system (+ 2%). However, the distributional effects are substantial. Wholesalers and importers are main gainers in a quota system, while consumers and farmers are losers.

I. INTRODUCTION

There exists a rich literature on the equivalence of tariffs and quotas as alternative trade instruments. Bhagwati (1965) wrote the seminal paper, while Anderson (1988) offers a modern treatment of the issue. An important insight from this research is that the market structure matters in determining whether tariffs and quotas have equivalent welfare effects. In most cases, it has been shown that the use of quotas results in a higher national welfare loss than the use of tariffs. Most of the research in this field has been purely theoretical. This paper aims to give an empirical contribution. With reference to the Norwegian apple market, we analyse the welfare and distributional effects of tariffs and quotas by means of a numerical model.

During the last 50 years Norway’s import restrictions on apples have varied seasonally. Occasionally the authorities have adjusted the exact framing of these restrictions. The empirical results presented in this paper are based on data from 1989–90. Import of apples was then regulated as follows: during the Norwegian season, from August to December, import was restricted by quotas (1000 tons).¹ Import was free from December to May, but prior to the Norwegian season, from May to August, import was again licenced (7000 tons).

As the inefficiency of the quota system depends on the market structure, it is important to focus on the competition. We argue that the farmers, retailers and importers have no market power. However, the wholesale market is dominated by a small number of firms, and there is hardly any import competition during the Norwegian season. Our hypothesis is that the wholesalers have some degree of market power during this period. In Section III, we offer a test for this hypothesis.

A numerical model, presented in Section II, describes the supply and demand conditions in the Norwegian apple market. Restrictions on import (tariffs or quotas) and different degrees of competition, described by conjectural variations, are specified. The wholesalers’ conjectural variations are calibrated to accord with the degree of market power reported in our test. Lastly, we use the model to estimate the welfare and distributional effects of tariffs and quotas, assuming the same import volume under both regimes. The results from the simulations are presented in Section IV.

¹ In 1988 a GATT panel concluded that Norway’s quantitative restrictions on apples were inconsistent with Article XI (GATT, 1986), which prohibits the use of quotas. In order to maintain the quantitative import restrictions within the GATT-rules Norway accepted the following major concessions: (i) the yearly production of dessert apples was to be limited to 7500 tons, and (ii) an import quota of 1000 tons was offered in the Norwegian season from August to December. The first concession was a move to fulfil an exemption from Article XI stated in Article XI:2 (GATT, 1986): ‘Import restrictions may be applied on any agricultural or fishery product imported in any form necessary to the enforcement of governmental measures that operate to: restrict the production or marketing of the like domestic product or of a domestic product that is a close substitute; etc.’
II. A SIMPLE MODEL

Model structure

In this section, a model of the Norwegian apple market is presented. The model describes, in a simplified way, supply and demand conditions at the wholesale level. It is reasonable to assume that the retailers are price takers, and we therefore omit this end of the market from the model.

Two types of wholesalers are modelled. The first type buys apples exclusively from Norwegian farmers. In the absence of sufficient foreign competition, these wholesalers are assumed to compete in quantities. Quantity competition is partly justified by the existence of capacity constraints. The total supply is to some extent determined by decisions made in earlier years, particularly by the number of trees planted. The farmers’ supply is, furthermore, divided among the wholesalers by means of agreements about delivery. The yearly capacity constraint of each wholesaler is thus to some extent known. The wholesalers can, however, sell below the capacity, for example by transferring dessert apples to the processing industry.

The second type of wholesalers is the importers. The importers are assumed to be price takers. Two reasons justify this assumption: First, Norwegian and foreign apples are assumed to be perfect substitutes, and second, there are no major barriers to entry in this part of the market.

Market demand is assumed to be linear, and the indirect demand function can be written as:

$$P = \alpha - \beta x$$

where $\alpha$ and $\beta$ are parameters, $P$ is the market price (wholesale level), and $x$ is the market supply. The market supply, $x$, is the sum of the Norwegian supply, $x_N$, and the import from the world market, $x_W$.

At the farm level, the marginal cost is assumed to be a linear and increasing function of the Norwegian supply:

$$MC_N^F = \gamma + \delta x_N$$

$\gamma$ and $\delta$ are parameters, and $MC_N^F$ is the marginal cost. The increasing function reflects regional variations in production costs, mainly due to differences in climatic and topographic conditions.

The production of apples typically takes place at numerous small and independent farms. For this reason, it is assumed that the farmers are price takers. The wholesalers’ buying price is, in other words, equal to the farmers’ marginal costs deducted for a subsidy per unit, denoted by $S^f$, that the farmers receive. Furthermore, it is assumed that the wholesalers have constant marginal costs in other inputs and marketing, $MC^M$. $S^M$ denotes the subsidy (per unit) to the wholesalers.

As a small country, Norway cannot influence the import price. Therefore, import takes place at a given world market price inclusive of transport costs, $P_W$. It is assumed that the importers have the same marketing costs as the wholesalers, $MC^M$.

Both wholesalers and importers maximize profit. Quota protection results in first-order conditions (3) and (4):

**Wholesalers (competing in quantities):**

$$\left\{ \frac{\partial P}{\partial x_j} + \frac{\partial P}{\partial x_i} \frac{\partial x_i}{\partial x_j} \right\} x_j + P + S^f + S^M - MC_N^F - MC^M \geq 0$$

$$i, j = 1, 2$$

(3)

**Importers (price takers):**

$$(P - P_W - MC^M)x_w \geq 0$$

(4)

where

$$x_w \leq QUOTA$$

(5)

$x_j$ in Equation 3 is wholesaler $j$’s output, while the term $\partial x_i/\partial x_j$ represents the conjectural variation (CV), i.e. the assumed response of wholesaler $i$ to wholesaler $j$’s output. The value of the CV represents a single structural parameter reflecting the degree of competition as well as the behaviour of the wholesalers. Under perfect competition, Nash–Cournot and monopoly the CVs are $-1, 0$ and $1$ respectively. In the model there are two wholesalers, and for simplicity we assume that the CVs are the same for both. Expression 4 indicates that the importers are price takers. The quota will, therefore, be fully utilized when the domestic price exceeds the import costs.

In a tariff system the import costs will form a ceiling above which the domestic price cannot rise. The wholesalers are in this way forced to pursue cost pricing when import occurs. The first-order conditions in a tariff system can thus be written:

**Wholesalers (price takers):**

$$(P + S^f + S^M - MC_N^F - MC^M)x_j \geq 0 \quad j = 1, 2$$

(6)

**Importers (price takers):**

$$(P - P_W - MC^M - t)x_w \geq 0$$

(7)

where $t$ is a tariff per unit.

Equations 1–5 describe the quota arrangement which Norway applied in our base period 1989. To predict the consequences of changing the trade system to tariffs, Equations 1, 2 and 6, 7 must be used.

The model permits the calculation of economic variables like price, domestic production, import and economic surplus. The economic surplus is divided into its elements, i.e. farmers’, wholesalers’, importers’ and consumers’ surplus.
Model data

A numerical solution of the model requires knowledge of the model parameters. A crucial parameter is the conjectural variation. In Section III, we discuss how this parameter is determined. The other parameters of the model are given in Table 1, based on Gaasland and Vårdal (1990, 1991). The Norwegian season (from the middle of September to the middle of December) in 1989 is chosen as the base period. In this period there was no import, and the apples on the market were therefore exclusively Norwegian.

The demand parameters, \(a\) and \(\beta\), follow from the demand elasticity and the observed price and quantity combination in the base period.\(^2\) The farmers’ marginal cost curve is linearized to go through marginal cost and quantity combinations in different production regions in the base period, and the parameters \(\gamma\) and \(\delta\) follow from this method.\(^3\) The marketing costs, \(MC^M\), is based on the accounts of 30 Norwegian wholesalers.\(^4\) Finally, the import price, \(P_w\), is based on information from importers.

III. MARKET STRUCTURE

As we shall further emphasize in Section IV, the efficiency and distributional effects of different import systems depend on the market structure. Previously, we argued that it is reasonable to assume that the farmers, importers and retailers are all price takers. However, the wholesale market is dominated by a few number of firms.\(^5\) In addition, there is hardly any import competition in the Norwegian season. This indicates that there might be a potential for imperfect competition. In this section we shall, therefore, focus on the competition at the wholesale level.

Profit-margin examination

It is probable that the competition among the wholesalers is more fierce in the free import period compared to the restricted period. There are no major barriers to entry in the former period. In the second period, the supply is restricted to Norwegian apples or licensed import. The wholesalers try, in addition, to control the supply from the Norwegian farmers by means of agreements or contracts.

We have examined the profit-margin at the wholesale level under different import restrictions (Gaasland and Vårdal, 1990). The profit-margin is defined as the difference between the wholesalers’ buying and selling price. The selling price is based on information collected on a daily basis from 11 retailers in Bergen and three retailers in Oslo.\(^6\) The buying price is based on official statistics. The prices are adjusted for various subsidies and levies. The research lasted from week number 34 in 1989 till week number 10 in 1990, a total of 28 weeks. In the first four weeks, import was licensed, followed by 13 weeks with a total import ban. In the last 11 weeks, there were no import restrictions.

Figure 1 gives the weekly results of the research. The prices in the figure are calculated as a weighted average, where the relative size of the retailers is used as weights. Figure 1a presents the selling and buying prices in Bergen. It

---

\(^2\) In the base period 5.68 million kilogrammes Norwegian apples were sold, and the average selling price from the wholesalers was about 8.70 NOK per kilogramme. The demand elasticity is assumed to be \(-1\). There are only a few studies of the price elasticity of apples, and the relevant studies are old. The estimate we have used is taken from Budseth (1973).

\(^3\) The production of apples takes place for the most part in two different productive regions. About 60% of the total quantity is produced in Western Norway, while the remainder is produced in the Eastern Norway. The marginal cost is calculated to be about 8.23 and 7.46 NOK per kilogramme in the Western and Eastern Norway respectively.

\(^4\) The estimate of the marketing costs, \(MC^M\), is taken from Gaasland and Vårdal (1991). Their computation of these costs was based on an examination of the financial statements of 30 Norwegian wholesalers. The wholesalers’ product line was fruit and vegetables. The examination covered the period 1985–88 and included the three biggest firms. However, most of the wholesalers were rather small. In addition to data on operating expenses, information about the quantity sold was also used. As a simplification, it was assumed that the costs of marketing were the same for all products and that the costs were related to the weight. On average the following cost components were estimated: labour costs 0.56 NOK per kilogramme; transport costs 0.10 NOK per kilogramme; other variable costs (insurance, packing, classifying) 0.35 NOK per kilogramme and fixed costs 0.10 NOK per kilogramme. The total costs per kilo was then 1.11 NOK. Despite moderate inflation in the years 1985–1988 (7.5%), the size of the various cost components was stable over the period. Since the rate of inflation for 1989 was small (4.6%), 1.11 NOK may also be a reasonable guestimate for \(MC^M\) for the base period 1989.

\(^5\) In the fruit and vegetable sector, three firms (Gartnerhallen, BAMA and NKL) have a total market share of nearly 70%. There are, however, many small wholesalers serving local markets.

\(^6\) The wholesalers were not willing to reveal their selling price. A difficulty was that the wholesalers offer different kinds of bonus. First, the retailers receive a bonus on the total amount bought during a year. Second, the retailers get a special bonus on each purchase (invoice bonus). These bonuses may add up to as much as 20% and may differ between the retailers. Instead of asking the wholesalers what their selling price was, we asked the retailers for their buying price. The prices were collected by telephone on a daily basis, and were given net of bonuses. The retailers were carefully chosen. As a general rule, a retailer receives apples from only one wholesaler. The retailers were selected such that the wholesalers’ market shares in the examination were in accordance with the actual market shares. There are many types of apple, and it was important to find the appropriate type for our purpose. Granny Smith was selected as a representative foreign apple. This apple type has a high market share in Norway (25% of imported apples), and it has also a close substitute among the Norwegian apples, namely Gul Gravenstein. Gul Gravenstein is considered to be one of the most popular apples in Norway (market share: 28% of Norwegian apples). Consequently, Gul Gravenstein was chosen as the Norwegian apple.
Table 1. Model data (base period: from the middle of September to the middle of December in 1989)

<table>
<thead>
<tr>
<th>Demand parameters</th>
<th>Supply parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha = 17.39$</td>
<td>$\gamma = 6.93$</td>
</tr>
<tr>
<td>$\beta = 1.53$</td>
<td>$\delta = 0.23$</td>
</tr>
<tr>
<td>$MC^M = 1.11$</td>
<td>$S^M = 1.27$</td>
</tr>
<tr>
<td>$MC^F = 1.46$</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Profit-margin at the wholesale level (NOK per kilogramme)

<table>
<thead>
<tr>
<th>Period</th>
<th>Bergen</th>
<th>Oslo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import ban (week 38–50 (1989))</td>
<td>3.41</td>
<td>3.09</td>
</tr>
<tr>
<td>Licensed import (week 34–37 (1989))</td>
<td>1.85</td>
<td>2.45</td>
</tr>
<tr>
<td>Free import (week 51 (1989) – 9 (1990))</td>
<td>1.35</td>
<td>2.37</td>
</tr>
</tbody>
</table>

Fig. 1. Profit-margin at the wholesale level in a) Bergen and b) Oslo. Week 34–37 (1989); Licensed import. Week 38–50 (1989); Import ban. Week 51 (1989)–9 (1990); Free import. (–●–, selling price; –■–, buying price)

is seen that the profit-margin is substantially higher in the period when import is banned compared to the other periods. This result is confirmed in Table 2, which shows the average profit-margin under the different import regimes. The results from Oslo fluctuate more and therefore are less clear (Fig. 1b). In the Norwegian season there is, for example, one observation with an extremely low profit-margin, i.e. week 44. Nevertheless, on an average basis, the profit-margin in Oslo is slightly higher in the Norwegian season compared to the other periods.

The results from the research indicate, not unexpectedly, that there is more competition in the free import period compared to the period with import restrictions. This applies both to the market in Oslo and Bergen. Consequently, it supports the hypothesis that the wholesalers have some degree of market power during the Norwegian season. The research is, however, based on a small set of data, so the results should be interpreted with some care.

A conjectural variation approach

As a next step, the wholesalers’ conjectural variations are calibrated to accord with the degree of market power reported in the profit-margin research. In other words, we use the model in Section II, Equations 1–5, to estimate CVs which result in a selling price close to the observed price reported in the research. If the conjectural variations are larger than $-1$, this indicates imperfect competition.

The first column of Table 3 shows the observed price and quantity combination in the base period. Results from three different model experiments then follow. In the second column the solution of the experiment based on CVs $=-1$ is found, while the third and fourth columns give the solutions based on CVs $=-0.5$ and CVs $=1$ respectively. It is seen that conjectural variations equal to $-0.5$ give results that are close to the actual situation. This indicates that competition in the market for apples is imperfect, but more competitive than Cournot. The simulations in the following section are based on CVs $=-0.5$.

IV. TARIFF VERSUS QUOTA PROTECTION – SIMULATIONS OF EFFICIENCY AND DISTRIBUTIONAL EFFECTS

In this section, we first review some of the findings of the literature on the equivalence of tariffs and quotas when

---

7 The profit-margin for tomatoes was also examined, where the same conclusion was reached.
Table 3. Competition at the wholesale level

<table>
<thead>
<tr>
<th></th>
<th>The actual situation</th>
<th>Perfect competition (CVs = -1)</th>
<th>CVs = - 0.5</th>
<th>Monopoly (CVs = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price (NOK per kg)</td>
<td>8.70</td>
<td>6.89</td>
<td>8.76</td>
<td>11.77</td>
</tr>
<tr>
<td>Quantity (mill. kg)</td>
<td>5.68</td>
<td>6.86</td>
<td>5.64</td>
<td>3.67</td>
</tr>
<tr>
<td>Norwegian</td>
<td>5.68</td>
<td>6.86</td>
<td>5.64</td>
<td>3.67</td>
</tr>
<tr>
<td>Import</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Firms engage in quantity-setting behaviour. Then we present the results from our own study.

Bhagwati (1965) argues, in his classic article, that a tariff and a quota system is equivalent if the universal assumption of competition, i.e. competitive domestic production, supply of imports and holding of quotas, is fulfilled. The equivalence is defined such that a tariff would lead to a level of imports which, if alternatively set as a quota, would generate the same implicit tariff. He argued that a departure from the universal assumption of competition generally destroys this equivalence. Shibata (1968), and later other writers, adopt a slightly different definition of equivalence. According to this definition, a tariff is equivalent to a quota if, permitting the same import volume, the domestic output and prices are identical under the alternative trade policies. Because this definition focuses on the prevailing domestic output and price, it is more appropriate if the main interest is to measure the protective effects of tariffs and quotas.

Based on Shibata’s definition, the introduction of any imperfectly competitive element will not necessarily destroy the equivalence relationship. Shibata (1968) shows, for example, that the equivalence of tariffs and quotas does not break down with the introduction of a monopoly element into the foreign supply condition when perfect competition exists in domestic production and among quota holders. More recently, Fung (1989) shows that tariffs and quotas are also equivalent if the home firm and the foreign firm are Cournot producers. Hwang and Mai (1988) have, however, demonstrated that this equivalence holds only in the Cournot case. If the competition is less (more) competitive than Cournot, then the domestic price is lower (higher) under quotas than under tariffs.

The research clearly demonstrates that market structure matters in determining whether tariffs and quotas are equivalent. Our study is based on the assumed market structure of the Norwegian apple market. As emphasized in the previous section, there seems to be imperfect competition in the domestic market at the wholesale level. We assume that this market power can be described by a conjectural variation equal to $-0.5$. The supply of imports and the holding of quotas are, however, assumed to be competitive.

In what follows, we use the model to compare the efficiency and distributional effects of a tariff and a quota system within this market structure. The base period, characterized by an import ban, is used as a point of departure. For the sake of simplicity, we ignore the subsidies. Except for these subsidies, our first model experiment is based on the same assumptions as that reported in Table 3 (CVs = -0.5). The results from this experiment, which we will call the base solution, are presented in column 1 in Table 4.

As a next step, we permit import on a level with the minimum import quota allowed by Norway (from 1990) in connection with the GATT dispute; i.e. 1000 tons. First, we set a tariff rate which generates this import level. We then set the same import level as a quota. The results from these two simulations are presented in columns 2 and 3, Table 4.

Irrespective of definition, it is evident that the equivalence relationship is destroyed. The implicit tariff in the quota system exceeds the explicit rate in the tariff system. The price also is highest and the Norwegian production is lowest in the quota system. Figure 2 illustrates this result. The domestic demand and supply curves are $D$ and $MC_N$ respectively. The foreign supply curve is $P_w$. A tariff per unit is introduced, and this results in a domestic price $P^T_N = P_w + t$ and domestic consumption $C^T$. The total supply consists of $X^T_N$ units of Norwegian production and $X^T_W$ units of imports. Alternatively, if we set the same import volume as a quota, the domestic wholesalers face a residual demand function $D^Q_R$. Since the wholesalers have market power, their marginal revenues from selling Norwegian apples, $MR^Q_N$, are lower than the price. The wholesalers maximize profit by setting $MR^Q_N = MC_N$. Compared to the tariff system, it is seen that this result in a lower Norwegian production, $X^Q_N$, and so a higher domestic price, $P^Q_N$.

The wholesalers and the importers gain the most in the quota system. While the wholesalers have no surplus in the

---

8 In both Shibata’s and Fung’s example, the equivalence breaks down if we use Bhagwati’s implicit-tariff definition. In a case involving monopolistic foreign supply, the explicit tariff rate will always be above the implicit tariff of the quota.

9 $S^T = S^M = 0$. The subsidies are the only difference between the solution in Table 3 (CV = -0.5) and this solution.
Table 4. Efficiency and distributional effects of a tariff and a quota system. (Prices and tariffs are measured in NOK per kilogramme, surpluses in million NOK and quantities in million kilogrammes)

<table>
<thead>
<tr>
<th></th>
<th>The base solution</th>
<th>Tariff system</th>
<th>Quota system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>10.71</td>
<td>9.06</td>
<td>10.27</td>
</tr>
<tr>
<td>Quantity</td>
<td>4.36</td>
<td>5.43</td>
<td>4.65</td>
</tr>
<tr>
<td>Norwegian</td>
<td>4.36</td>
<td>4.43</td>
<td>3.65</td>
</tr>
<tr>
<td>Import</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Explicit tariff</td>
<td>–</td>
<td>1.65</td>
<td>0.00</td>
</tr>
<tr>
<td>Implicit tariff</td>
<td>–</td>
<td>–</td>
<td>2.86</td>
</tr>
<tr>
<td>Farmers’ surplus</td>
<td>2.19</td>
<td>2.26</td>
<td>1.53</td>
</tr>
<tr>
<td>Wholesalers’ surplus</td>
<td>7.28</td>
<td>0.00</td>
<td>5.10</td>
</tr>
<tr>
<td>Importers’ surplus</td>
<td>0.00</td>
<td>1.66</td>
<td>2.87</td>
</tr>
<tr>
<td>Consumers’ surplus</td>
<td>14.57</td>
<td>22.67</td>
<td>16.54</td>
</tr>
<tr>
<td>Economic surplus</td>
<td>24.04</td>
<td>26.60</td>
<td>26.03</td>
</tr>
</tbody>
</table>

Fig. 2. Market equilibrium under a tariff and a quota system

Fig. 3. Economic surplus under different degrees of competition in the domestic market. An import quota of 1000 tons is assumed

However, one objection to this argument is that the farmers’ surplus depends on ownership structures. The largest wholesaler (Gartnerhallen) is, for example, owned by the farmers. Gartnerhallen’s surplus is thereby to a certain extent distributed to the members.

Obviously, the economic surplus is highest in the tariff case. However, the difference (570 000 NOK or 2%) is not substantial. This is mainly due to the fact that the market power in the domestic market is relatively weak (CV = -0.5). The loss induced by quota protection, will naturally be higher if the competition becomes less competitive. This is illustrated in Fig. 3, which compares the level of the economic surplus under different degrees of market power when quota protection is assumed. Under perfect competition (CV = -1), the economic surplus is equivalent in the quota and the tariff case. However, as the degree of market power increases (CV > -1), it is seen that the economic surplus declines. Under pure monopoly in the domestic market, the economic surplus is calculated to be 15% below the surplus in the tariff case.

V. CONCLUSION

With specific reference to the Norwegian apple market, we have analysed the welfare and distributional effects of tariffs and quotas as alternative trade instruments. In this particular market, we have argued that the competition at the wholesale level is imperfect, but more competitive than Cournot. The supply of imports and the holding of quotas are, however, assumed to be competitive. Within
this market structure, a tariff system is estimated to be slightly more efficient than a quota system (+2%). The distributional effects are more substantial. The wholesalers and the importers are the main gainers in a quota system, while the consumers, and in some cases, the farmers are the losers.

The inefficiency of quotas will naturally increase if the competition is assumed to be less competitive. Under pure monopoly in the domestic market, the welfare is, for example, calculated to be 15% below the level in the tariff case.

ACKNOWLEDGEMENTS

We are indebted to Rolf Brunstad, Ole Gjølberg, Agnar Hegrenes, Jan Haaland and Lars Sørgard for helpful comments and suggestions to an earlier draft of this paper. Financial support from the Council of Research in Norway is greatly acknowledged.

REFERENCES