Does it pay to stabilise the price of vegetables?: An empirical evaluation of agricultural price policies

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Summary

This paper evaluates the preference for stable vegetable prices in Israel by analysing two different approaches. The first determines the consumer's willingness-to-pay measure to achieve price stabilisation in terms of the concavity-convexity properties of the indirect utility function. By examining the demand function parameters, the risk premium to avoid price instability is assessed as a function of the price elasticity of demand, the share of the budget spent on the product, the coefficient of relative risk aversion, the income elasticity of demand and the coefficient of variation of the vegetable price. The second method is a classical simulation model of market demand and supply functions where price stabilisation policies are implemented and measured in a cost-benefit framework. In general, sensible risk averse consumers prefer unstable vegetable prices, although the economy benefits from the price stabilisation of most vegetables, when income transfers are allowed between consumers, producers and wholesalers.

1. Introduction

The purpose of this paper is to evaluate the welfare implications of price stabilisation policies brought about by the Vegetable Marketing Board in Israel. Since fresh fruit and vegetables account for a large share (27%) of the household budget spent on food, any policy affecting the price behaviour of these commodities considerably influences the consumer's welfare. Stabilising fresh food prices in

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Israel usually comes within the domain of Marketing Boards which are designed to insure a steady supply of food to consumers by means of supporting the income to producers. The activities of the Israeli Vegetable Marketing Board follow these lines too in that the Board was established by the government to regulate the production and the domestic sale of fresh vegetables, and was assigned legal powers over producers and wholesalers in order to control the marketing of produce to consumers.

The policy of the Board involves the implementation of instruments such as price support to producers, production quotas on cultivated areas, and the removal of excess supply. In theory, these policies were designed to account for the welfare interests of both producers and consumers as well as the costs borne by the government in carrying out these policies. However, it appears that, in practice, the Board acts mainly in order to promote the interests of the producers, whereas the consumers remain silent, and do not contribute to the formulation of policies. In this paper, I determine quantitatively the benefits and cost of price stabilisation policies to the consumer's welfare. For that purpose, two approaches are utilised. The first investigates directly the demand function parameters, and determines on the basis of these parameters whether or not consumers prefer unstable vegetable prices to prices stabilised at their arithmetic mean. This method evaluates the consumer's willingness-to-pay in order to achieve price stability in terms of his indirect utility function. The proposed measure assesses the *price-risk premium* consumers are prepared to pay in order to avoid or incur price instability. The second approach is by means of the classical consumer's surplus and cost-benefit analysis. A market equilibrium model of supply and demand has been designed to account for the marketing channels, the intermediaries' impact, the governmental constraints, and the policy effects of the Marketing Board. Simulation experiments with the model are used to compute the welfare costs and benefits of price stabilisation policies.

The first method is quite attractive because of its simplicity. The consumer's risk premium is computed from parameters which are estimated mainly from the demand functions such as price elasticities, income elasticities, and budget shares. Furthermore, it permits the selective evaluation of price stabilisation policies. Hence, if for example consumers prefer price instability but producers are better off with stable prices, the specific stabilisation policy can be implemented and evaluated from the producer's viewpoint. The second approach is the conventional one, but it demands an econometric market model that cannot cope with policies differentiating between the consumer's or the producer's preference for price stability. Furthermore, the model must specify quantitatively the behavioural relationships of all agents in the markets and their interactions. These requirements demand that the policy-maker invests huge resources and time in the investigation when, for all qualitative purposes, the first approach is satisfactory.

The plan of the paper is as follows: In the next section, I present the reasons why consumers prefer stable prices. Section 3 tests the preference for price stabilisation. In Section 4, the market model of all the vegetables is presented and price policies are determined.

2. Consumer's preference for price stability

In a recent paper, Turnovsky, Shalit and Schmitz (1980) evaluated the benefits to consumers from price stabilisation policies, in terms of the convexity-concavity properties of the consumer's indirect utility function. The reasons why consumers prefer or do not prefer price stabilisation were shown to depend on the income elasticity of demand, the price elasticity of demand, the share of the budget spent on the commodity, and the coefficient of relative risk aversion. For empirical purposes, I will develop these factors in order to obtain a risk-premium that consumers would be prepared to pay in order to obtain stable prices.

In the single commodity price stabilisation problem, the consumer is assumed to adjust the consumption level of the commodity instantaneously in order to maximise the expected value of his indirect utility function. Thus, when prices are unstable, $EV(p,I)$ is maximised where E is the expectation factor, V is the indirect utility, p is the vector of commodity prices, and I income. Since $V(p,I)$ represents the optimal utility from which a consumer benefits when facing commodity prices p and income I, one can evaluate the desirability of price stabilisation at the mean by comparing the expected value of the indirect utility function $EV(p,I)$ with $V(\bar{p},I)$, where $\bar{p}$ is the vector of prices stabilised at their mean. The reason why the consumer prefers the price of commodity i to be stabilised at its mean is simply:

$$s_i\,(\eta_i - r) - e_i < 0, \tag{1}$$

where s_i is the share of the budget spent on commodity i, η_i the income elasticity of demand, r the Arrow-Pratt relative degree of risk aversion, and e_i the price elasticity with respect to price.

Condition (1) is obtained by differentiating $V(p,I)$ twice and applying Jensen's inequality for concave functions such as

$$EV(p,I) \leq V(\bar{p},I) \quad \text{if } \frac{\partial^2 V}{\partial {p_i}^2} \leq 0 \text{ for some } i.$$

The Arrow-Pratt relative degree of risk aversion is a measure of income risk. In terms of the indirect utility function, it is the income elasticity of the marginal utility of income, i.e.:

$$r = -\left(\frac{\partial^2 V}{\partial I^2} \cdot I\right) / \left(\frac{\partial V}{\partial I}\right).$$

For a normal good, it is usually the case that $e_i < 0$ and $\eta_i > 0$. Hence, what determines the preference for price stability is the relative size of the degree of income risk aversion. As risk aversion increases, the consumer gains from price stabilisation. Hence, contrary to the Waugh proposition (Waugh, 1944), one can establish the parameter values at which price stability is preferred to price instability. For different purposes, one evaluates the degree of risk aversion that will force a consumer to switch from preferring a state of price instability to that of stable prices. In addition, the risk-premium that consumers would rather pay to move from a state of unstable prices to a state of price stability and vice-versa is calculated using Pratt's (1971) formula derivation as follows:

$$t_i = -\frac{1}{2}\frac{\sigma_i^2}{\bar{p}_i}\,[s_i(\eta_i - r) - e_i]\,, \tag{2}$$

where σ_i^2 is the variance of the price p_i, $\bar{p}_i$ its mean, and t_i the premium for each unit of the commodity.

If consumers prefer stable prices, the risk-premium is positive and t_i is a value added to the price to have it stabilised. This willingness-to-pay measure of price stabilisation welfare is more appropriate than the consumer's surplus approach since it takes in account the individual's attitude toward price risk. The method not only considers a single price policy change but also the subjective adjustment costs as expressed by the curvature of the utility function (measure of risk aversion) and the range of the price relative variation as expressed by the coefficient of variation, $(\sigma_i^2/\bar{p}_i)$. I will use this method to analyse empirically the preference for vegetable price stability in Israel.

3. Testing the preference for vegetable price stabilisation

The market for vegetables in Israel is characterised by short-run demand functions with high price elasticities and long-run supplies with very low price elasticities. The demand for tomatoes in Israel was analysed by Melnick and Shalit (1982) who devised an estimation model to account for the existing spread between the producer and the consumer price. The difference was explained by the presence of intermediaries who exerted monopolistic and monopsonistic power on the two sides of the market. I used the same framework for estimating the demand function for vegetables. The main feature of the model is that the quantity sold to the consumers is determined by the intermediaries' profit-maximising behaviour. Since these middlemen use the deterministic parameters of the demand equations to supply the quantities to the market, it is assumed that those quantities are not affected by the stochastic disturbance of the demand function. Therefore a simple regression model of the consumer price on the quantity consumed, and all the other variables, provides consistent estimators simply by using ordinary-least-squares (OLS). The estimation results are presented in Table 1 for the eight major types of vegetable consumed in Israel. The inverse demand equation was estimated as:

$$Pc_t^i = a_0^i + a_1^i Qc_t^i + a_2^i I_t + a_3^i Pa_t^i + a_4^i Pc_{t-1}^i + \sum_{j=1}^{12} d_j^i(J_{jt}) \qquad i=1, \ldots, 8 \tag{3}$$

where Pc_t^i = consumer price, Qc_t^i = consumed quantity, I_t = income, Pa_t^i = price index of all other vegetables, J_{it} is a set of dummy variables representing the monthly effect, and i is the index of the vegetable. The demand function parameters are $a_0^i, a_1^i, a_2^i, a_3^i, a_4^i$, and d_j^i for $j = 1, \ldots, 12$.

These results are used to calculate the price and the income elasticities at the mean, and the share of the vegetable budget spent on a specific vegetable, i.e.:

$$s_i = \bar{P}c_i \, \bar{Q}c_i \, / \sum_{j=1}^{8} \bar{P}c_j \, \bar{Q}c_j.$$

Armed with the computed parameters, we obtain the coefficient of relative risk aversion for which $s_i(\eta_i - r) - e_i > 0$ and the tax premium for which $r = 1$. The choice for that specific value of the relative risk aversion is suggested by Arrow (1971) for a bounded utility function. However, any other value of r can be used, if obtained from individual behaviour experiments under uncertainty. The measurements for r and t are reported in Table 2.

First, we remark that the use of time-series data presents serious problems that affect the estimation of the income elasticity. This is especially important when we analyse the vegetables the consumption per capita of which has decreased over time, and, during the same period, the income per capita has increased. That is the reason why we obtain negative income elasticities for tomatoes, cucumbers and peppers which are the vegetables forming the classical Israeli salad. On the other hand, the consumption of potatoes over time has increased, a fact that can be assigned to the rise in the standard of living since 1967. The validity of the estimates for the price elasticities can be questioned since those were obtained from the inverse demand function. Hence, the elasticities presented in Table 2 must be considered as upper-bound estimates, since the correlation coefficient between Qc and Pc must be included in the transformation.

The results of Table 2 show that, in general, consumers prefer price instability to mean price stabilisation, since the tax premium is always negative for a unitary relative degree of risk aversion. For tomatoes, which on average take up the largest share of the budget spent on vegetables, the coefficient of risk aversion at which consumers switch their preferences is close to 7. However, if the price elasticity and the income elasticity of the tomato demand function are corrected to 1.00 and to 0.68 respectively according to the 0.60 coefficient of correlation between Qc and Pc, it appears that consumers prefer price stability when their

Table 1. *The demand for vegetables in Israel; inverse demand function estimates. 168 monthly observations (January 1966 – December 1980)*[1]

Vegetable	Constant a_0	Qc a_1	I a_2	Pa a_3	Pc_{t-1} a_4	Monthly effect[2] d_j 1	2	3	4	5	6	7	8	9	10	11	12	R^2	σ_{Pc}	$\overline{Pc}$
Tomatoes	3.81	-1.34	-.001	.87	.332			.8	1.4		.2							.74	1.85	4.29
	(3.8)	-(7.6)	(2.9)	(5.9)	(7.4)															
Cucumbers	13.43	-3.61	-.005	.39	.14	1.9	1.7	1.3		.9	.9				.7		.6	.86	2.88	5.86
	(10.9)	-(10.5)	-(9.8)	(2.4)	(2.6)															
Carrots	.29	-1.02	.0006	.18	.596			-.2	-.3				.6	1.3	.2	-.11		.78	.92	3.16
	(.8)	-(4.1)	(2.8)	(3.7)	(10.4)															
Potatoes	.31	-.03	.0009	.01	.38						-.14	-.17	.8	.09	-.04	-.03		.69	.33	2.53
	(1.8)	-(.8)	(7.0)	(.6)	(6.4)															
Onions	.50	-.19	.00008	.04	.75													.63	.72	2.60
	(1.5)	-(2.5)	(.4)	(.8)	(13.0)															
Eggplants	2.25	-5.08	-.0003	.50	.48	.4	1.0	1.1		-.5		.7	.4		.3			.93	2.31	4.16
	(3.6)	-(8.1)	-(.9)	(5.1)	(8.9)															
Peppers	3.78	-1.78	-.002	1.01	.19	1.0	2.0	2.7	1.4	1.0	.4	.4	.3					.75	2.81	5.46
	(3.5)	-(3.4)	-(4.1)	(5.4)	(3.6)															
Zucchini	3.78	-8.96	.00005	.39	.39	.47	.24	-.9	-.6					.4	.2			.85	1.60	4.79
	(7.2)	-(14.7)	(.2)	(4.6)	(7.5)															

1 t – values of the parameters appear in parentheses.

2 d_j is the monthly effect with $d_j = 0$ if no value appears in the row, and $d_j \neq 0$ for a non-zero figure in the row. The upper figure represents the month index with January = 1 and December = 12.

Table 2. *Testing the preference for price stability*

Vegetable	Share s_i	Income elasticity η_i	Price elasticity e_i	Tax premium $t_i(r=1)$	Risk aversion r
Tomatoes	.295	-.505	-1.68	-.49	6.90
Cucumbers	.152	-2.12	-1.84	-.94	9.98
Carrots	.068	1.30	-5.08	-.51	56.89
Potatoes	.265	15.31	-31.94	-.77	121.83
Onions	.055	.94	-23.19	-2.31	405.49
Eggplants	.049	-.206	-2.10	-1.31	42.65
Peppers	.072	-4.09	-8.29	-5.73	111.05
Zucchini	.044	.03	-1.91	-.49	43.44

All figures are computed at the arithmetic mean for the variables. See Table 1 for the means of price and quantity. $\bar{I} = 1347.73$.

relative degree of risk aversion exceeds 2.70. That value is acceptable, and shows that when the budget spent on a commodity is large, risk aversion will induce consumers to prefer mean stable prices to instability. It can be stated: even when their aversion towards risk is recognised, consumers, generally, prefer price instability to mean price stabilisation.

3. The market model

A model of the vegetable market in Israel was designed to evaluate directly the welfare implications of price stabilisation policies. The model not only included a conventional representation of supply and demand relationships, but also incorporated the market activities of the intermediaries such as the wholesalers and the retailers, together with the intervention of the Marketing Board. Price responsive supply functions were not included because of poor estimation results, and the quantity supply functions were estimated as being dependent upon the time and past realisations.[1]

The model was centred around the activities of the Marketing Board which intervenes by guaranteeing a minimum price, Pm^i, to be paid to the producers whenever the market price falls below that minimum. When this situation arises, the intermediaries sell the surplus to the Marketing Board which removes it from the market.[2] Growers sell their product to accredited wholesalers who, in turn, market it to retailers and consumers. By law, the intermediaries must purchase the total quantity produced by the growers under fixed area quotas. However, the wholesalers can determine the quantity channelled to the market by deciding what is the surplus to be sold to the Marketing Board for the minimum price,

Pm^i. This decision depends upon their monopolistic-monopsonistic position in the marketing channel. The wholesalers pay the prices, Ps^i, to the growers for their produce. These prices are functions of the power exerted by the wholesalers on the farmers. In the absence of a short-run supply function, the monopsonistic middleman will pay the lowest allowable price, which is the minimum price Pm^i. On the other hand, in perfect competition, wholesalers will pay the consumer price, Pc^i_t, less the normal mark-up θ^i. If β^i is defined as the degree of monopsonistic power exerted in the market for vegetable i, the producer price for that vegetable is expressed as the pricing function:

$$Ps^i_t = \beta^i Pm^i_t + (1-\beta^i)\cdot(Pc^i_t - \theta^i), \qquad \text{for } i=1,\ldots,8, \tag{4}$$

where $\beta^i = 0$ represents perfect competition and $\beta^i = 1$ pure monopsony, Ps^i_t is the producer price, and Pc^i_t the consumer price. The surplus to be sold to the Marketing Board is simply the difference between the quantities supplied by the growers and the quantities channelled by the intermediaries to the consumers. Thus,

$$Qe^i_t = Qs^i_t - Qc^i_t \qquad \text{for } i=1,\ldots,8, \tag{5}$$

where Qs^i_t is the quantity supplied of vegetable i at time t, Qe^i_t is its surplus, and Qc^i_t is the quantity consumed.

Since the intermediaries maximise their profit subject to the producer pricing functions (4), the quantity constraints (5), and the demand functions (3), their behaviour will determine the producer prices, the consumer prices, and the quantities of surplus. Hence the resulting decision of the intermediaries' maximisation expresses the surplus to be removed from the market as a function of the quantity supplied, Qs^i_t, and the minimum price, Pm^i_t. This is essentially explained by the fact that as Qs^i_t increases, so does Qe^i_t *ceteris paribus*, and the same for Pm^i_t. Thus the surplus equation becomes

$$\left.\begin{aligned} Qe^i_t &= d^i_0 + d^i_1 Pm^i_t + d^i_2 Qs^i_t \qquad && \text{for } Qe^i_t > 0 \\ Qe^i_t &= 0 && \text{for } Qe^i_t \leq 0 \end{aligned}\right\} \tag{6}$$

Equations (4) and (6) were estimated separately; the first expressing the extent of the mark-up for each vegetable, the second presenting the surplus removed from the market as a function of the intermediaries' behaviour. The results are shown in Table 3. The large β^i (monopsonistic power) is obtained for the vegetables produced mainly by small-holders, (*Moshavim* and private farmers). This is especially true for tomatoes, peppers and eggplants. On the other hand, the monopsonistic power of the intermediaries seems to be weaker for vegetables grown mainly by larger farms (*Kibbutzim* and private ranches) such as potatoes, onions and carrots. For the surplus equation, however, satisfactory results could only be obtained for tomatoes.

Table 3. *The producer pricing function and the surplus equation*

Vegetable	θ	β	R^2	Constant	Pm	Qs	R^2	D.W.
Tomatoes	1.85 (16.5)	.65 (34.8)	.74	−.67 (−7.8)	.073 (1.5)	.37 (16.4)	.62	1.67
Cucumbers	2.19 (25.0)	.36	.92	−.017 (−2.9)	−.003 (−.6)	.04 (6.9)	.26	1.69
Carrots	1.36 (30.2)	.43 (24.3)	.84	−.10 (−6.2)	.08 (5.0)	.12 (8.4)	.35	1.20
Potatoes	1.36 (33.8)	.28 (4.2)	.16	−.39 (−3.2)	−.09 (−1.6)	.24 (5.9)	.16	1.20
Onions	1.04 (17.4)	.35 (10.8)	.56	−.02 (−.8)		.16 (5.3)	.15	1.63
Eggplants	.68 (6.8)	.56 (49.6)	.90	−.025 (−1.7)		.13 (8.8)	.33	1.30
Peppers	.13 (.4)	.58 (22.5)	.62	−.01 (−1.7)	.007 (1.2)	.05 (5.3)	.16	2.11
Zucchini	1.75 (17.6)	.46 (27.4)	.85	−.01 (−3.9)		.08 (11.0)	.43	1.35

We now analyse the model synthesised by the flow chart presented in Figure 1. The policy-maker fixes the minimum prices that will prevail during the entire period to be analysed. Each month, the model simulates for each vegetable the quantity produced by the farmers, according to supply functions estimated by ARIMA methods.[3] These quantities behave cyclically over time with the addition of a normally distributed random effect.

When the supply of produce has been calculated, consumer and producer prices are calculated simultaneously according to the demand functions (3) and the intermediaries' decision rules (4). Then, if the computed producer price is lower than the minimum price, Pm^i, surplus is created according to the behavioural equations (6).

The quantities consumed are adjusted accordingly [equation (5)] and the market producer and consumer prices are determined by (3) and (4). By the end of the month, benefits and costs are computed for the four sectors involved: the consumers, the producers, the intermediaries and the government. The consumer's benefits are obtained by means of the consumer's surplus which is computed by the end of each month. The limitations of that criterion are well-

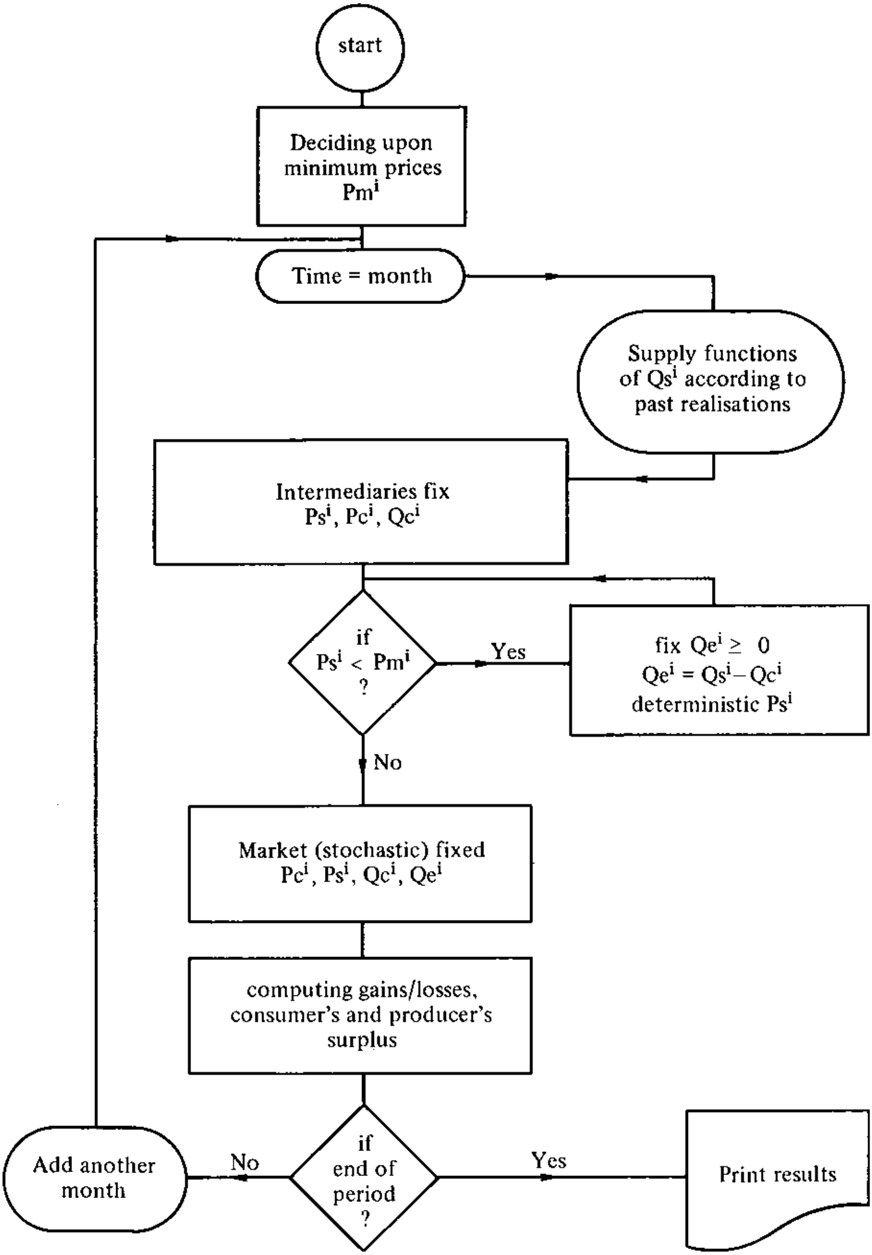

Figure 1. *Flow chart of simulation model*

known; especially in the context of price stabilisation policies. For consumer's surplus to be a valid measure of the utility changes, it is necessary that the income elasticity of the demand function equals the income elasticity of the marginal utility of income, which is the coefficient of relative risk aversion (see Turnovsky, Shalit and Schmitz, 1980). However, as shown by Willig (1976) and, furthermore, by Just, Hueth and Schmitz (1982), the error can be approximatively small. For the intermediaries, profits are calculated as the revenue generated by the sale of products, less the payments to the farmers. The government expenses and the expenses of the Marketing Board are simply the value of the surpluses evaluated at the respective minimum prices when disposal activities are effective. For the farmers, we calculate as benefits the revenue received from the sales of all eight types of vegetable.

The price stabilisation instrument used by the Marketing Board is principally the minimum-price mechanism for each vegetable guaranteeing that the producer price will not fall below that minimum, and that quantities will be withdrawn from the market for that purpose. The minimum price instrument will, of course, raise the average price to both the producer and the consumer, since low price realisations are not allowed, when the minimum price mechanism is in effect. Hence the comparison with mean-price stabilisation is inadequate, since the reference points are different. However, since it is known from the second section of the paper that consumers are reluctant to accept price stabilisation policies, we will examine the question of the welfare of society when income transfers are permitted from one sector to the other.

As the welfare of society is dependent upon the different surplus measures, the problem is how to define a number of criteria that will account for the success or the failure of the price stabilisation policies. One would expect that when the Marketing Board raises the minimum price of a vegetable, the consumer price and the producer price will become more stable, the farmer's total revenue will increase, as will the intermediaries' profit, but that the consumer's surplus will decrease. In Table 4, this process is exemplified for a *ceteris paribus* change in the minimum price of tomatoes; the first at the state of non-intervention for all other vegetables and the second at a given positive level of minimum prices. The table presents the average weekly costs and benefits for the tomato industry only. Increasing the minimum price for tomatoes reduces the coefficient of variation of both the producer and the consumer price $CV(Pc)$. The consumer's surplus ($\overline{CS}$) declines since the average consumer price is shown to increase. Unexpectedly, the average intermediaries' profit ($\overline{TI}$) resulting from sales of tomatoes declines, but the average producer revenue from tomatoes ($\overline{TR}$) increases. In general, we obtain no sensible change in the total average surplus ($\overline{TS}$) which is expressed as $\overline{CS} + \overline{TR} + \overline{TI} - \overline{TG}$, but merely an exchange between the average government and Marketing Board expenses ($\overline{TG}$), intermediaries profit ($\overline{TI}$), and the producer revenue ($\overline{TR}$). However, by increasing all *other* minimum prices, the average total surplus ($\overline{TS}$) extracted from the tomato market increases. This can be explained by the fact that as the average consumer

Table 4. *The impact of changes in the minimum price for tomatoes*

Minimum price for tomatoes	Coefficient of variation of consumer price of tomatoes	Coefficient of variation of producer price	Consumer's surplus	Producer revenue	Intermediaries profit	Marketing board expenses	Total benefits	Average consumer price of tomatoes
Pm	CV(Pc)	CV(Ps)	$\overline{CS}$	$\overline{TR}$	$\overline{TI}$	$\overline{TG}$	$\overline{TS}$	$\overline{Pc}$
(a)								
0.00	.52	.62	13472	5960	18830	0	38262	3.52
0.60	.47	.59	11867	8472	20145	334	40150	4.25
1.20	.40	.38	11048	12749	19699	748	42748	4.78
1.80	.31	.27	9931	15283	15814	1515	39513	4.68
2.40	.26	.20	8889	20263	13820	3493	39479	5.05
(b)								
0.00	.43	.60	14955	7493	24985	0	47434	4.45
0.60	.36	.44	12530	10619	23070	195	46025	4.83
1.20	.33	.32	12651	13460	21247	532	46817	4.85
1.80	.28	.22	11850	17680	19350	1155	47725	5.19
2.40	.28	.22	10077	22055	18472	2332	48273	6.00

(a) The minimum price of other vegetables is held at zero for all crops.
(b) The minimum price of other vegetables is held at the mean of past mimimum prices, i.e. 1.16 IL for cucumbers, 0.70 for carrots, 1.20 for potatoes, 0.60 for onions, 0.30 for eggplants, 0.60 for peppers and 0.40 for zucchini.

Table 5. *Changes in all vegetable minimum prices: The optimal policy*

Vegetable	Minimum price	Coefficient of variation consumer price	Coefficient of variation producer price	Consumer's surplus	Producer revenue	Intermediaries profit	Marketing board costs	Total surplus	Average consumer price	Average producer price
	Pm	CV(Pc)	CV(Ps)	$\overline{CS}$	$\overline{TR}$	$\overline{TI}$	$\overline{TG}$	$\overline{TS}$	$\bar{P}c$	$\bar{P}s$
No intervention										
Tomatoes	0.00	0.52	0.62	13472	5959	18830	0	38262	3.52	0.81
Cucumbers	0.00	0.44	0.61	6011	5547	8694	0	20253	6.15	2.72
Carrots	0.00	0.38	0.47	1247	1896	3731	0	6875	2.58	0.87
Potatoes	0.00	0.05	0.14	936	7010	12314	0	20260	2.36	0.85
Onions	0.00	0.14	0.29	158	1964	3263	0	5387	2.44	0.91
Eggplants	0.00	0.60	0.64	1750	1412	2404	0	5566	3.60	1.35
Peppers	0.00	0.38	0.40	181	2408	3407	0	5997	5.95	2.49
Zucchini	0.00	0.30	0.41	1373	1295	2651	0	5320	4.37	1.47
Optimum price stabilisation policy										
Tomatoes	1.14	0.31	0.31	12508	14373	22617	506	48993	5.15	1.92
Cucumbers	0.00	0.37	0.46	5312	8205	9039	0	22557	6.91	3.47
Carrots	0.00	0.29	0.45	1310	2396	5031	0	8737	3.19	1.07
Potatoes	1.20	0.04	0.16	195	8927	4583	4126	9580	2.56	1.25
Onions	0.00	0.11	0.22	165	2082	2463	0	4711	2.52	1.16
Eggplants	0.00	0.49	0.52	1721	2176	3141	0	7039	4.89	2.03
Peppers	0.00	0.31	0.30	222	3877	4301	0	8401	7.28	3.42
Zucchini	0.40	0.30	0.40	1490	1789	2827	1	6105	4.99	1.97

prices of other vegetables are high, the overall demand for tomatoes increases. In conclusion, raising the minimum price for tomatoes definitely increases the price stability for both the consumer and the producer, but it is a known fact that the consumer does not benefit from that stabilisation, whereas the producer does.

We now analyse the change in prices in all vegetables, and try to find a general price policy that maximises the total surplus and at the same time, brings about a sensible price stabilisation. The analysis is conducted by gradually changing all the minimum prices in order to obtain a larger surplus value for all the vegetables. The results are reported in Table 5, where the non-intervention state is presented with $Pm^i = 0$ for all vegetables, together with the optimal policy of price stabilisation. The increase in total surplus is apparent in all the vegetables with the exception of potatoes and onions, the surpluses of which decline due to a loss of profit by the intermediaries. It is mainly the producers who gain, whereas consumers suffer welfare losses due mainly to the increase in the average consumer price of all vegetables. Intervention at the given minimum price is made only for tomatoes, potatoes and zucchini. However, the prices of these vegetables affect all others. In general, one notices a considerable decrease in price instability, as shown by the coefficient of variation for the consumer and the producer prices. The model has demonstrated that because of substitution effects between commodities, it is sufficient to stabilise prices in one vegetable in order to affect the price stability of the others. This feature is not due entirely to the linearity of the model, but to the fact that a large share of the budget spent on vegetables is used for the consumption of tomatoes and potatoes (55%). Hence any sensible partial price stabilisation policy that deals with the main crops will considerably affect the total market.

4. Conclusion

Two different approaches were used to determine the welfare effects of price stabilisation policies. The first method based on the Waugh-Oi model (Oi, 1961) has shown that *risk-averse* consumers prefer unstable prices to prices stabilised at their arithmetic mean. These results, that were known for risk-neutral individuals, were, however, always questioned in relation to the consumer's surplus validity under risk aversion consideration. The second method used a market equilibrium model to show that if welfare transfers are made, price stabilisation brought about by the minimum price mechanism is optimal.

The price stabilisation policy deals in general with the most important vegetables, that is, tomatoes and potatoes. However, the policy stabilises the whole market because of the substitution and complementary effects of these products. Although quantitative answers were provided for consumers' mean price stabilisation, only the market model could weight the benefits and losses of a general intervention policy system. This policy is carried out by supporting the price to the producer, which affects the benefits and costs to the consumers, the intermediaries, the producers, and the government.

APPENDIX

ARIMA estimation of supply functions

Tomatoes: $Qs_t = Qs_{t-12} + a_t + .2032a_{t-1} - .8962a_{t-12} - .1821a_{t-13}$ with $\sigma_a = 2069.031$

Cucumbers: $Qs_t = Qs_{t-12} + a_t + .3985a_{t-1} - .7669a_{t-12} - .3056a_{t-13}$ with $\sigma_a = 770$

Carrots: $Qs_t = Qs_{t-12} + a_t + .5893a_{t-1} - .9124a_{t-12} - .5377a_{t-13}$ with $\sigma_a = 448$

Potatoes: $Qs_t = Qs_{t-12} + a_t - .8665a_{t-1} + .3029a_{t-12} - .2625a_{t-13}$ with $\sigma_a = 1445.6$

Onions: $Qs_t = Qs_{t-12} + a_t - .3616a_{t-12}$ with $\sigma_a = 1264.6$

Eggplants: $Qs_t = Qs_{t-12} + a_t + .5083a_{t-1} - .5644a_{t-12} - .2669a_{t-13}$ with $\sigma_a = 279.3$

Peppers: $Qs_t = Qs_{t-12} + a_t + .2571a_{t-1} - .9121a_{t-12} - .2345a_{t-13}$ with $\sigma_a = 596.5$

Zucchini: $Qs_t = Qs_{t-12} + a_t + .4860a_{t-1} - .8599a_{t-12} - .4179a_{t-13}$ with $\sigma_a = 265.5$

where Qs_t is the total supply of vegetables, and a_t is a stochastic disturbance with standard deviation σ_a.

NOTES

1. This is different from the model by Bigman (1982) who presents a simulation analysis with risk supply responses.
2. For an economic background of the Agricultural Marketing Boards in Israel see Sadan and Melamed (1980).
3. The functions are shown in the Appendix.

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