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SECTORAL COINTEGRATION AND THE ROLE OF AGRICULTURE IN THE ECONOMY OF CYPRUS DURING 1960-1998: A VECTOR AUTO REGRESSION APPROACH

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SUMMARY

Agriculture has been considered for a long period the backbone of Cyprus economy. The agricultural sector has recently lost its leading position in the economy to the secondary and tertiary sectors of industrial production, trade and services (mainly tourism). In order to examine the existence of long-term relationships between sectors and to study the diminishing role of agriculture to the Cyprus economy, a Vector Auto Regression model was considered (VAR). The main outcome of this study is that agriculture has a positive impact on the other sectors of the economy, but its development is rather independent.

ΠΕΡΙΛΗΨΗ

Η γεωργία εθεωρείτο για μεγάλη περίοδο ως η ραχοκοκαλιά της κυπριακής οικονομίας. Τα τελευταία χρόνια έχασε την ηγετική της θέση στην οικονομία από τους δευτερογενείς και τριτογενείς τομείς της βιομηχανίας και των υπηρεσιών (κυρίως του τουρισμού). Με στόχο να εξετάσει τη μακροχρόνια σχέση μεταξύ των τομέων και τον μειούμενο ρόλο της γεωργίας στην κυπριακή οικονομία αναπτύχθηκε ένα Vector Auto Regression (VAR) μοντέλο. Βρέθηκε ότι, σε βραχυπρόθεσμο και μεσοπρόθεσμο ορίζοντα τόσο η βιομηχανία όσο και οι υπηρεσίες δεν είναι σε θέση να ερμηνεύσουν την συμπεριφορά της γεωργίας. Στον μακροπρόθεσμο ωστόσο ορίζοντα, η επίδρασή τους είναι ιδιαίτερα σημαντική στην ανάπτυξη της γεωργίας. Βρέθηκε επίσης ότι η γεωργία επηρεάζει θετικά τους άλλους τομείς της Κυπριακής οικονομίας. Συμπεραίνεται ότι η γεωργία δεν μπορεί να απομονωθεί από τους υπόλοιπους τομείς της οικονομίας και ότι θα πρέπει να της αποδίδεται η ανάλογη βαρύτητα στον προγραμματισμό του

INTRODUCTION

In the relevant economics and development literature there is a large number of models, which assume and investigate possible interactions among agriculture, industry and services sectors. Agriculture is considered, in general, to make a positive contribution to the industrial activity of an economy (Hwa, 1989), in developing relationships that are reflected both on the side of demand, as well as on the side of supply (labor force and raw material for industrial production, machinery and fertilizers for the agricultural production). In parallel, opposite aspects have been proposed which refer to possible reverse effects, that is, in the direction from industry to agriculture (increase in industry wages encourages further development in the demand of agricultural output). Regarding the services sector there is also relevant literature (Blades *et al*., 1974; Gemmel, 1982; Bhagwati, 1984), referring to possible effects of services (intermediate and final usage) both on agriculture, as well as on industry, through the functions of distribution and retail trade.

Conclusively, the development of one of the three sectors under examination could affect positively or negatively the other sectors. Of course, negative effects are more possible in the short run when resources are specific and mobility is limited. In the long-term horizon these limitations become rather lax, with most probably positive effects.

In the light of the objectives mentioned above, the aim of the present research is not to investigate particular developing factors for Cypriot economy sectors, through a relevant econometric model, but the determination of the historical behaviour among sectors under examination.

General view of the agricultural sector and identification of data sources

In the five-year period 1986-90 agricul-

ture's contribution to Gross Domestic Product was circa 7% and the gainfully employed population in agriculture accounted for about 13% of the total. During the following five-year period (1991-1995) it showed a further decline; contribution to Gross Domestic Product dropped to 5.8%, while the gainfully employed population fell to 10.8%. The Agricultural Output at current market prices increased from £198 million in 1985 to £346 million in 1995. Crop production represented about 53% and livestock production about 36%. The most important crops were potatoes, vines and citrus, which were also major export commodities, and cereals. The value of raw agricultural exports in the same period averaged £50 million and accounted for about 22.6% of the total domestic exports. In 2000, the contribution of the five broad sectors of Cyprus to the total Gross Value Added was as follows: agriculture 4.0%, constructions 5.5%, industry 14.9%, services 75.6% and transportation 11.4% (Anonymous, 1994; 2000). Table 1 presents the contribution of the five broad sectors of Cyprus economy to the Gross Value Added.

Data

According to the economic theory the Gross Domestic Product (GDP) of a country is the total income produced from different sectors of the economy in a given time period, usually one year. In the case of this study instead of the GDP the term Gross Value Added (GVA) is used. The GVA is derived from the GDP minus three components: a) the Value Added Tax, b) import duties and c) the imputed bank service charge.

The data range includes the contribution of agriculture, industry and services to the GVA of the Cyprus economy from 39 yearly variables, from 1960 to 1998 (Appendix Table 1). Figure 1, shows the time series for the five variables of interest. The main sources of information are the Economic Report and the Historical Data on the Economy of Cyprus (Department of Statistics and Research, Cyprus). Instead of the real indices, logarithms of relevant series are used (lag for agriculture, li for industry and ls for services). In the context of the econometric analysis one element that should have been investigated was the presence of structural breaks in the data set because of the 1974 Turkish invasion. For the specific test, the methodologies of Perron (1989) and Zivot-Andrews (1992) were utilized. It was ascertained that the existence of a possible structural break did not alter the statistical characteristics of the series under examination; therefore, they should be used in the econometric analysis as non stationary.

Empirical analysis

Integration Analysis. It is well known that the results of an econometric analysis, in the case of non stationary data series, are spurious because the classical t and F tests have been proved inappropriate for this case (Fuller, 1976). Consequently, the first step is to test series stationarity and determine the order of integration of examined variables. The relevant terms for stationarity of a stochastic process, as well as the test methods for the level of integration are fully described in the publication Macroeconomic environment and the agricultural sector in Greece: a multivariate empirical approach (Tambakis, 1999). All variables were tested for stationarity utilizing the Augmented Dickey-Fuller (ADF) test. Using Ordinary Least Squares

Table 1. Contribution of the major sectors of Cyprus economy to the total Gross Value Added

Sector	1970	%	1980	%	1990	%	1998	%
Agriculture	85.9	16.8	72.9	10.0	93.2	6.9	96.6	5.3
Construction	52.8	10.3	102.5	14.0	104.4	7.8	100.2	5.5
Industry	99.1	19.3	153.3	20.9	241.1	18.0	273.9	14.9
Services	230.9	45.1	342.9	46.8	765.7	57.0	1152.9	62.9
Transportation	43.8	8.5	60.5	8.3	138.6	10.3	209.7	11.4
Gross Value Added	512.5	100.0	732.1	100.0	1343.0	100.0	1833.3	100.0

Source: Economic report, Department of Statistics and Research, Nicosia.

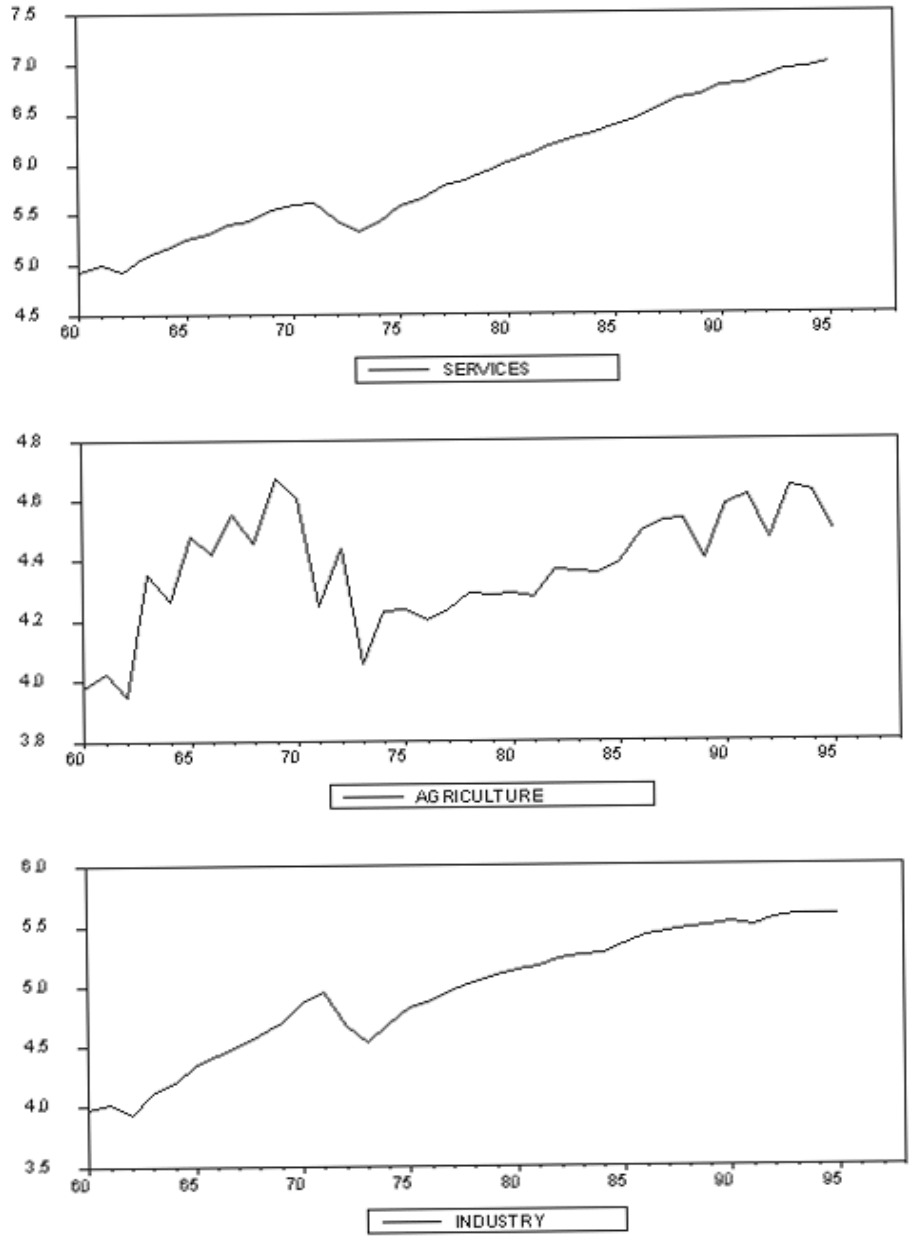

Figure 1. Real prices of sectoral indices (**Services**=Services sector; **Agriculture**=Agricultural sector; **Industry** = Industry sector).

(OLS) procedures the ADF test estimates the following equation:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

where $\Delta y_t = y_t - y_{t-1}$
and t = time trend variable

hereafter, the hypothesis $\delta=0$ with the alternative $\delta<0$ was tested. Rejection of the null hypothesis has the implication that $y_t \sim I(0)$. The upper panel of Table 2 presents the results of statistical tests for stationarity in the levels of variables. The results indicated that the null hypothesis for the existence of unit root could not be rejected at the 5% significance level. We concluded, therefore, that none of the series is stationary when the test refers to the logarithms of variables. The above tests were then applied on the first differences of logarithms and the results are pre-

Table 2. Augmented Dickey – Fuller (ADF) test for unit roots

Variable	Lag	Without trend	With trend
Lag	1	-2.6248 (-2.9422)	-2.4049 (-3.5348)
Li	1	-1.4070 (-2.9422)	-2.6867 (-3.5348)
Ls	1	-0.3689 (-2.9422)	-3.3794 (-3.5348)
dla	1	-5.0645 (-2.9446)	-5.1077 (-3.5386)
dli	1	-5.1032 (-2.9446)	-5.2794 (-3.5386)
dls	1	-5.0813 (-2.9446)	-5.007 (-3.5386)

Numbers in parentheses provide the critical values for the Dickey–Fuller statistic at 5% significance level.

sented in the lower panel of Table 2. According to these results logarithms of variables, when transformed to first differences (dla, dli, and dls), become stationary and consequently the relevant variables could be described as integrated of order one I(1).

Cointegration Analysis. Since variables are found to be integrated of the same order I(1), the existence of cointegration among variables was tested. The cointegration tests are based on maximum likelihood methods, proposed by Johansen and Juselius (1990) who used the maximum eigenvalue and the trace of the stochastic matrix criteria. The results of the relevant tests are presented in Table 3. It was noted that in the context of the application of cointegration tests, one VAR equation System has been specialized with lag, li and ls as explanatory variables and 3 periods lag length, determined utilizing the (Akaike, 1973; 1974) and (Schwarz, 1978) criteria. The likelihood tests (trace statistics) include intercept and trend in cointegrating equation and no trend in data.

It can be seen (Table 3) that the eigenvalue criterion traces one cointegrating vector, while the trace of the stochastic matrix criterion traces two vectors. Taking into consideration the shape of cointegrating residual graphs, the second vector was rejected as not representing the long-term relationship linking the three sectors. The cointegration relationship that was accepted eventually as the most reliable, normalized for the variable lag, is presented below:

$$lag=2.8075+1.3li+1.2663ls \qquad (2)$$

Relying on the positive prepositions of the above cointegrating function it was concluded that in the long-term, agriculture is positively affected by the other sectors, a fact

Table 3. Cointegration test results

Cointegration test based on the maximum eigenvalue of the stochastic matrix

			Critical values	
Null hypothesis	Alternative hypothesis	Statistics	(95%)	(90%)
r=0	r=1	33.4392	22.002	19.766
r<=1	r=2	15.2238	15.672	13.752
r<=2	r=3	8.6265	9.243	7.525

Cointegration test based on trace of the stochastic matrix

			Critical values	
Null hypothesis	Alternative hypothesis	Statistics	(95%)	(90%)
r=0	r>=1	57.2895	34.91	32.003
r<=1	r>=2	23.8504	19.964	17.852
r<=2	r=3	8.6265	9.243	7.525

consistent with the relevant economic theory. **Error Correction Model (ECM).** An Error Correction Model (ECM) is a particular form of dynamic econometric model, and is used to estimate short-term and long-term impact of explanatory variables on the dependant variable. The long-term relationship is reflected in the cointegration function between the variables concerned. Cointegration and error correction models are formally linked through the 'Granger Representation Theorem' which notes that the validity of the latter is dependent upon the existence of the former (Hallam, 1991; Hallam and Zanoli, 1991). In the context of model specialization from a general to a specific form (general to specific modelling) the error correction model can be derived as a simple reparameterization of a general autoregressive distributed lag model (Hendry, Pagan and Sargan, 1984). Furthermore, it should be noted that the combination of a VAR equation system and the ECM, known as ECVAR model (error – correction vector autoregressions) provides the capability to trace the Granger causal effects among system endogenous variables. The relevant causality tests (Granger causality tests) provide the opportunity to verify causality effects both in short term period, by utilizing the Likelihood ratio tests based on the X^2 distribution, as well as in the long-term period, by utilizing tests based on t–statistics. Additionally, the process provides the possibility to determine the direction of causality effects among endogenous variables examined.

Table 4 provides estimation results of the ECVAR model, which has been specialized in the context of this research, as well as the necessary diagnostic tests for good specialization. The relevant tests are related to the existence of autocorrelation (SC), residual normality (NO), suitability of functional form (FF) and finally to the existence of heteroscedasticity (HE). Based on these tests it was ascertained that on a 5% significance level, indications for low specialization did not exist.

Granger Causality Tests. Table 5 presents the results of Granger causality tests. Regarding agriculture, it was ascertained that in the short-term effects from industry and services were insignificant; therefore agriculture is autonomously developed. On the contrary, based on the significance test of the EC term, it was ascertained that in the long term period, agriculture undergoes significant causality effects from the other two sectors. Regarding industry, it seems that it undergoes significant causality effects only from agriculture and only in the short term period, while services seem to be affected only in the short run period and only from industry.

The above results depict the positive

Table 4. Error Correction Model estimations

1- dla_i= -0.538dla_{i-1}-0.088dla_{i-2}+0.1062dli_{i-1}+0.8423dli_{i-2}+0.5367dls_{i-1}-0.766dls_{i-2}-0.3476EC_{i-1}
(0.174) (0.188) (0.652) (0.602) (0.66) (0.624) (0.1147)

SC:$X^2(1)$=2.859 (0.091) FF:$X^2(1)$=0.1476 (0.701)
NO:$X^2(2)$=0.433 (0.805) HE:$X^2(1)$=0.1178 (0.731)

2- dli_i=0.155dla_{i-1}+0.281dla_{i-2}+0.2497dli_{i-1}-0.923dli_{i-2}+0.0336dls_{i-1}+0.6335dls_{i-2}+0.1113EC_{i-1}
(0.1202) (0.13) (0.449) (0.416) (0.456) (0.431) (0.0791)

SC:$X^2(1)$=1.7164 (0.19) FF:$X^2(1)$=1.0586 (0.304)
NO:$X^2(2)$=6.38 (0.12) HE:$X^2(1)$=0.4304 (0.512)

3- dls_i= 0.0299dla_{i-1}+0.1982dla_{i-2}+0.0524dli_{i-1}-1.163dli_{i-2}+0.419dls_{i-1}+0.819dls_{i-2}+0.1128EC_{i-1}
(0.1114) (0.1205) (0.417) (0.385) (0.422) (0.399) (0.0733)

SC:$X^2(1)$=2.141 (0.143) FF:$X^2(1)$=0.00165 (0.968)
NO:$X^2(2)$=6.54 (0.19) HE:$X^2(1)$=0.37477 (0.540)

Note: The numbers in parentheses provide p-values of statistical test.

Table 5. Granger causality tests

Dependent variable	Lagged variable	LR test	-t test
dla	dli	2.6048 (0.272)	
	dls	2.0157 (0.365)	
	EC		3.0303 (0.005)
Dependent variable	Lagged variable	LR test	-t test
dli	dla	5.4289 (0.066)	
	dls	3.1023 (0.212)	
	EC		1.4066 (0.171)
Dependent variable	Lagged variable	LR test	-t test
dls	dla	3.8015 (0.149)	
	dli	10.0852 (0.006)	
	EC		0.56114 (0.579)

Numbers in parentheses are p-values of statistical tests.

impact of agriculture to the other examined sectors (directly on industry and indirectly on services) in the short-term period. Furthermore, a feedback towards agriculture was ascertained, which was traced in the long-term period through the long-term equilibrium mechanism.

The Granger Causality tests indicated that agriculture constitutes an integral part of the Cyprus economy. The effects of agriculture on industry can be explained by the direct dependence of the processing industry, which utilizes agricultural products as raw material, and by the dependence of agriculture on input manufacture and supply chains (fertilizers, pesticides, machinery, equipment and other agricultural utilities). The impact of agriculture on services is related on the one hand to the supply of the tourist industry with agricultural products, and on the other hand to the approximate wholesale and retail trade activities.

Variance Decomposition Analysis. Sims (1980) proposed the use of variance decomposition mainly for economic policy evaluation since it provides a means for forecasting, beyond the utilized time sample, of the effects of an external break; in say a policy instrument to a policy objective. This part presents the results from the application of the variance decomposition method. This technique includes the appropriate transformation of the model, the determination of an orthogonal innovation vector (residuals), which will be estimated by the data and, finally, the determination of the dynamics of each innovation. This technique renders possible the estimation of the variance forecast error of an endogenous variable in the t+1 period, which is attributed to innovations of another endogenous variable. The relevant analysis describes the effect of a one standard deviation shock to the residuals.

The percentage of variance in the forecast error for variables in question, which could be attributed to each one of variables included in the relevant equation, in different time horizons are presented in Tables 6 to 8. In particular, the results of three time horizons are provided (k=1, 5 and 10). A short-term horizon is considered the period of one year, a medium-term horizon the period of five years, and a long-term horizon the period of 10 years.

According to Table 6, in the short-term period, neither industry nor services, with percentages 10.523 and 4.439 respectively, are in position to explain the behaviour of agriculture. In the medium-term horizon, percentages increase significantly (18.543 and 17.079, respectively), though not to such an extend to become determinative factors for the configuration of the development behaviour of agriculture, which was expected based on international literature (Hwa, 1989). Finally, in the long-term period, the percentages explain why the variance of agricultural

Table 6. Forecast Variance Decomposition for variable dla (agriculture)

Forecast horizon	Error variance (%) due to innovations in		
	dla	dli	dls
1	85.037	10.523	4.439
5	64.360	18.543	17.097
10	36.108	32.189	31.702

Table 7. Forecast Variance Decomposition for variable dli (industry)

Forecast horizon	Error variance (%) due to innovations in		
	dla	dli	dls
1	37.812	47.889	14.297
5	50.340	26.649	23.009
10	62.279	25.926	21.792

Table 8. Forecast Variance Decomposition for variable dls (services)

Forecast horizon	Error variance (%) due to innovations in		
	dla	dli	dls
1	23.736	25.619	50.643
5	26.461	24.112	49.424
10	34.993	18.773	47.233

output are so high (32.189 for industry and 31.702 for services) and it is, therefore, concluded that their long-term impact is significant in the development of agriculture.

Regarding industry results (Table 7), in the short-term horizon, the basic explanatory factor of this sector behaviour constitutes agriculture (47.889). In the medium-term horizon, both agriculture and services, with percentages 26.649 and 23.009, respectively, seem to exercise significantly lower impact, compared to the impact of agriculture in the short-run; however, it is surely rated remarkable. Finally, similar conclusions are derived for the long-term horizon, where the percentages from agriculture and services attributing the variance of industry are modulated to 25.926 and 21.792, respectively.

In the case of services (Table 8), it is observed that in all three time horizons under examination, industry, with percentages 50.643, 49.424 and 47.233 respectively for each horizon, and agriculture, with percentages 25.619, 24.112 and 18.773, seem to explain to a significant level the development behaviour of this sector.

Summarizing, it may be concluded from that agriculture significantly affects the performance of the other sectors of the economy. On the other hand, in the medium and long-term forecasting period, agriculture seems to be affected to a lesser degree by industry and services, while in the short-term, there is no impact from the other sectors of the economy. It is noted that the results of the application of the variance decomposition method were revealed to be consistent with the results obtained through the Granger causality tests, because in both cases it was found that in the short-term the other sectors do not affect significantly agriculture, while in the long-term their impact is significant.

CONCLUSIONS

The scope of the present econometric analysis was to reveal the relation of agriculture with the examined sectors of the Cyprus economy. It was found that in the short-term, both industry and services did not explain the behaviour of agriculture. In the medium-term horizon, these sectors were not considered as determinative for the configuration of the development behaviour of agriculture. In the long-term horizon, however, their impact on the development of agriculture was certainly significant. It was also found that agriculture affected positively the other sectors of the economy, while it was affected, although to a lesser extent, positively by the other sectors of the economy. Therefore, it is concluded that agriculture could not be isolated from the other sectors of the economy and the corresponding importance should be attached to the planning of the national development frame.

The above results have significant policy implications and should be carefully interpreted by policy makers in cyprus. Agricultural policy was planned and applied rather autonomously and irrespective of developments in other sectors. this selective approach has favoured other sectors, mainly tourism and services, while agriculture became the less competitive sector in the

economy. Accession to the EU and globalization impose pressure on the sector to become more competitive. However, the key point in this process is the turnabout in the approach of policy makers concerning agricultural policy issues, and more specifically the realization that agriculture has to play a more socially oriented role instead of being nearly a producer of food. Under this framework agriculture should become a fundamental component in development planning. Cyprus should fully exploit the opportunities provided in the EU rural development framework in order to elaborate a long-term development plan for agriculture.

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Appendix Table 1. Time series data for Agriculture, Industry and Services

Year	Agriculture	Industry	Services
1960	4 250 000	2 810 000	1 113 000
1961	4 900 000	3 530 000	1 231 000
1962	5 340 000	3 690 000	1 382 000
1963	5 580 000	3 850 000	1 490 000
1964	5 170 000	3 000 000	1 374 000
1965	7 770 000	3 280 000	1 589 000
1966	7 110 000	3 700 000	1 753 000
1967	8 840 000	4 160 000	1 916 000
1968	8 340 000	4 720 000	2 032 000
1969	9 500 000	5 130 000	2 184 000
1970	8 590 000	5 280 000	2 309 000
1971	1 067 000	6 030 000	2 523 000
1972	1 003 000	6 320 000	2 693 000
1973	7 000 000	8 570 000	2 743 000
1974	8 460 000	5 470 000	2 307 000
1975	5 780 000	3 480 000	2 062 000
1976	6 880 000	5 330 000	2 253 000
1977	6 890 000	7 670 000	2 624 000
1978	6 660 000	8 850 000	2 815 000
1979	6 900 000	1 003 000	3 202 000
1980	7 290 000	1 025 000	3 429 000
1981	7 240 000	8 850 000	3 742 000
1982	7 270 000	8 640 000	4 095 000
1983	7 190 000	8 620 000	4 335 000
1984	7 860 000	8 780 000	4 779 000
1985	7 840 000	8 670 000	5 110 000
1986	7 800 000	8 700 000	5 382 000
1987	8 070 000	8 970 000	5 795 000
1988	8 950 000	9 330 000	6 312 000
1989	9 250 000	9 940 000	6 942 000
1990	9 320 000	1 044 000	7 657 000
1991	8 140 000	1 093 000	7 837 000
1992	9 770 000	1 145 000	8 697 000
1993	1 009 000	1 088 000	8 768 000
1994	8 740 000	1 076 000	9 468 000
1995	1 034 000	1 067 000	1 015 400
1996	1 018 000	1 065 000	1 042 800
1997	8 910 000	1 021 000	1 091 000
1998	9 660 000	1 002 000	1 152 900

Source: Economic Report, Department of Statistics and Research.

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