CHAPTER III

DEMAND EQUATIONS

III 1. THE DEMAND FOR CONSUMERS' GOODS

(i) *Material.* Consumption figures are based on production, import and export figures; production sometimes also on imports and exports of raw materials. Therefore a good deal of commodity stocking is included. Demand, therefore, consists of two parts, viz. (1) actual consumer demand and (2) demand by dealers for the purpose of increasing their stocks. This latter may of course be negative.

(ii) *Theoretical.*

(1) Consumer outlay U' will primarily depend on:

(*a*) labour income L, presumably without lag or with a small lag;

(*b*) non-labour income Z, which may show a larger lag (found e.g. by COLIN CLARK for post-1919 figures [1]) and by the present author for Holland);

(*c*) the price level p of consumers' goods. This may have two different influences. First, since the consumption plans may depend on prices some time ago, they may come in with a small lag. Secondly, the actual prices will modify the planned outlay. (They may, however, leave the quantities demanded unaffected).

Other factors may be present, such as the distribution of incomes [2]); but, as a first rough approximation, the distinction between L and Z shows already that we are taking account of income distribution in a very simple way. And it may be doubted whether the material would admit of much refinement in the calculations.

Since a graphic survey showed that the lag of Z would probably be between 1 and 2 years, and that of L between 0 and 1 year, the series L, Z_{-1}, Z_{-2}, p_{-1} and p were included in the "explanation".

(2) Demand by dealers may be represented — if measured in physical units — by $w_{t+\frac{1}{2}} - w_{t-\frac{1}{2}}$ (stocks on December 31 of year t minus stocks on December 31 of year $t-1$). Now we assume that there is a tendency to vary stocks parallel to transactions:

$$w_{t+\frac{1}{2}} = \omega\, u'_t \tag{III 1, 1}$$

from which it follows: $w_{t+\frac{1}{2}} - w_{t-\frac{1}{2}} = \omega\,(u'_t - u'_{t-1})$. This relation has been tested for some commodities in order to support our hypothesis.

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1) The significance of this lag has been questioned by R. STONE.

2) Taxes were low in this period and, as a rule, only changed slowly.

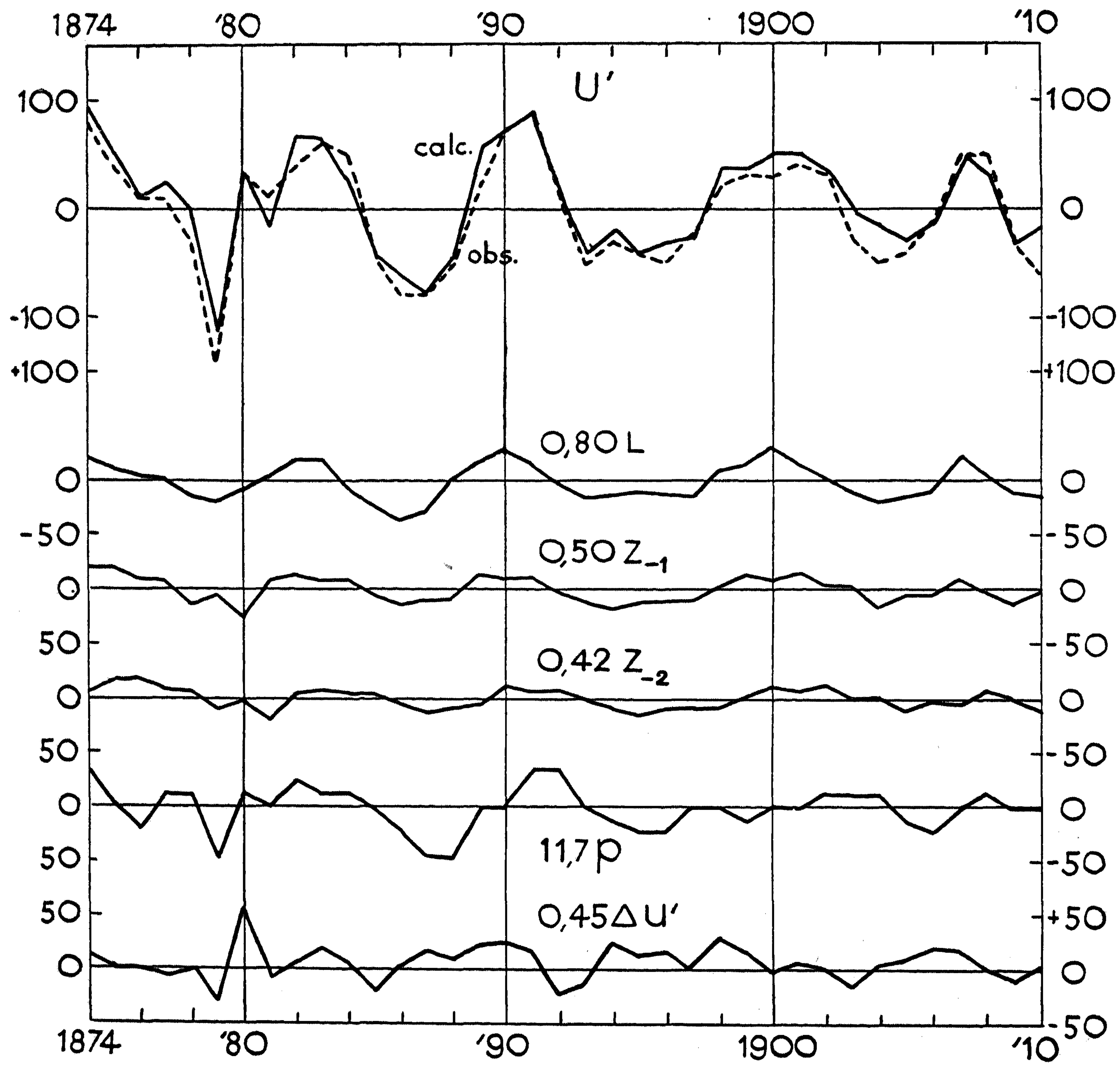
These tests will be discussed in section (v). The tendency to parallelism between stocks and transactions may be disturbed by changes in the rate of interest and in prices. Therefore m_t^s and p_t or even $p_t - p_{t-1}$ may come in. Transition from quantities to prices also brings in p_t. Summarising, the factors to be included, in addition to those enumerated above, would be:

(*d*) $u'_t - u'_{t-1}$ or $\Delta u'_t$;

(*e*) m_t^s.

The coefficient for L represents, as a first approximation, the marginal propensity to consume for workers and should therefore lie somewhat below one. It may happen, however, that it surpasses 1, since the incomes of small retail dealers may depend more closely on L than on Z.

The coefficient for p is equally bound to some limit. Since quantities consumed u' must depend negatively on prices, the "elasticity" of consumers' outlay U' with respect to prices must be below one anyhow. It would even seem probable that it would be well below one.



III 1 "Explanation" of consumption outlay.

(iii) *Statistical.*

There is a high correlation between L and Z_{-1}. Hence, an exact determination of the regression coefficients of these variables is impossible.

TABLE III 10

Consumption outlay, U'

Calculations with provisional series U' and p, shown for comparison with table III 1

Nr.	Period ↓	Regression coefficients obtained for									
	Variable →	L	L_{-1}	Z	Z_{-1}	Z_{-2}	p	p_{-1}	$\Delta u'$	m^S	R
	Stand, dev.→	19	21	22	23	23	1.8	2.0	38	0.7	
1	2	3	4	5	6	7	8	9	10	11	12
1	1874–1910	1.70				0.64					0.821
2	1874–1910	1.19				0.36	12.2				0.891
2A	1874–1910	1.19			0.01	0.36	12.0			1.9	0.893
2B	1874–1910	1.18				0.41	13.3	–1.9			0.90
2C	1874–1910	1.20	0.30		–0.06	0.22	11.5				
3	1874–1910	0.83				0.57	13.7		0.44		0.939
4	1874–1910	0.83				0.54	13.3	1.2	0.46		0.94
5	1874–1910	0.88				0.56	13.8		0.44	–2.5	0.939
6	1874–1910	0.13			0.66	0.51	14.4		0.56		0.951
8	1874–1910	0.56	0.72			0.25	11.8		0.51		0.950
9	1874–1910	1.24	$L_{-\frac{1}{2}}$			0.29	11.8		0.48	1.3	0.950
10	1874–1910	1.08	$L_{-\frac{1}{4}}$			0.42	12.6	0.3	0.45		0.95
	Ditto, excl.										
3A	1879–1881	0.67				0.56	12.1		0.55		0.936
7	1874–1910	0.29			0.74		15.9		0.49		0.929
	Ditto, excl.										
7A	1879–1881	0.41			0.74		14.4		0.34		0.925

TABLE III 1.

Consumption outlay, U', final figures

Nr.	Period ↓	Regression coefficients for							
	Variable →	L[1])	Z_{-1}	Z_{-2}	p	p_{-1}	$\Delta u'$	m^S	R[1])
	Stand. dev. →	19.4	22.9	23.0	1.73	1.92	39.5	0.66	
1	2	3	4	5	6	7	8	9	10
1	1874–1910	*1.00*	0.37	0.40	11.4		0.42		0.905
2	1874–1910	*0.90*	0.44	0.41	11.5		0.44		0.915
3	1874–1910	*0.80*	0.50	0.42	11.7		0.45		0.922
4	1874–1910	*0.70*	0.56	0.43	11.8		0.47		0.925
3A	1874–1910	*0.80*	0.46 [2])	0.46 [2])	11.5	0.0	0.46		0.921
3B	1874–1910	*0.80*	0.48 [2])	0.48 [2])	11.4		0.47	1.63	0.935

[1]) The regression coefficients for L have been chosen *a priori* and the correlations calculated after reduction of U' by the L-term; the correlation coefficients relate to this correlation.

[2]) Regression coefficients for Z_{-1} and Z_{-2} taken equal to each other, with a view to simplicity of calculation.

This became evident in various calculations made with provisional series (for U' and p) which are given in table III 10, and from which some conclusions may be drawn later.

The coefficient for L has therefore been chosen on *a priori* grounds and the others determined in the usual way. In order to be able afterwards to study the consequences of possible errors in this *a priori* choice, various values have been tried. The results are given in table III 1. Some features are characteristic of both tables, viz.

(*a*) the coefficients for p and for $\Delta u'$ are very stable and

(*b*) those for p_{-1} and m^s are—if account is taken of the standard deviations of these variables—very small.

Inclusion of p and $\Delta u'$ seems to be significant and inclusion of p_{-1} and m^s superfluous.

There is some evidence from other quarters that the marginal propensity to consume for workers is close upon 0.8. This is true—owing to budget statistics—for Dutch, as well as for American workers [1]). Therefore case 3 of table III 1 has been chosen to start with:

$$\text{(III 1)} \qquad U' = 0.80\,L + 0.50\,Z_{-1} + 0.42\,Z_{-2} + 11.7\,p + 0.45\,\Delta u'$$

This equation admits of the following interpretation. Non-labour incomes show a lagged influence, the lag being about one year and a half.

Part of it may be attributed to the fact that for most employers and dividend and interest earners income is only fixed or distributed once a year; secondly, exact profits are often only known after the accounts have been closed, an event taking place, on the average, more than half a year after the profits have been earned. Moreover, it may be that our series Z somewhat precedes the true income series (cf. section I 2, table I F). And finally there may very well exist a psychological lag in the spending of these incomes.

The coefficients would point to a marginal propensity to consume of 0.92, if Z represents non-labour incomes exactly. There is a strong reason to suppose, however, that real fluctuations are about three times as large as those in Z [2]). If that should be true, the marginal propensity to consume would be $(0.92/3) = 0.31$, which seems reasonable: it should be lower than that for workers. This condition would be no longer fulfilled if case 4 (table III 1) had been taken; it would, if cases 1 or 2 had been chosen.

The rather high coefficient for p points to a very inelastic demand for consumer' goods; if this demand were perfectly inelastic, consumption outlay would be proportional to cost of living and the coefficient for p would have to be about 15.1 (being the average value for $\bar{u}'/\bar{p}$ (table I H)). Since 11.7 is 78 % of 15.1, this points to an elasticity of 0.22 for the demand for consumers' goods (and services).

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1) Cf. Business Cycles in the United States, p. 37.

2) Cf. Chapter VI, section 3.

The coefficient for $\Delta u'$ is about what we found it to be for several particular commodities.

An interesting theoretical question arises if the significance of the coefficients, especially that for $u' - u'_{-1}$ is to be judged. Since u' is highly correlated with U' (which is almost exactly equal to $1.00\ u' + 15.3\ p$), there may be the danger of "spurious correlation" [1]). It appears, however, that in the cases where a complete significance calculation was carried out, no important error was found to exist in the regression coefficient for $u' - u'_{-1}$. Moreover, a test with actual figures on stocks was possible in some cases (of section v), showing a satisfactory agreement between theoretical and actual figures.

(iv) *Comparison with other countries.* A comprehensive study of the numerical value of the marginal propensity to consume was made by R. and W. M. STONE [2]), from which we take the following figures:

Budget Method.	
Germany, 1926/27, all incomes . . .	0.73
U.S.A., 1929. Non-farm families . . .	0.67
Farm families	0.50
All incomes	0.67
Historical Method.	
Germany 1925—32	0.72
,, 1932—36	0.42
Great Britain 1929—35	0.52
Holland 1923—33	0.47
Poland 1928—36	0.71
Sweden 1896—1916	0.80
,, 1923—30	0.60
U.S.A. 1920—35	0.75
,, 1919—35	0.70

To these results we may add our own result for the U.S.A., 1919—1932, where separate figures were given for workers (0.95), non-workers static income (0.77) and capital gains (0.28). The possibility exists, however, that the second figure is too high [3]).

(v) *Results with regard to separate commodities.*

(*a*) The formulae have been tested for (1) sugar, (2) coffee, (3) tea,

[1]) A theoretical treatment of this question will be found in: J. TINBERGEN, "An Acceleration principle for Commodity Stock Holding and a Short Cycle Resulting from It", Studies in Mathematical Economics and Econometrics, In Memory of HENRY SCHULTZ, Chicago 1942.

[2]) R. and W. M. STONE, "The Marginal Propensity to Consume and the Multiplier, A Statistical Investigation". The Review of Economic Studies, VI (1938/39), p. 1.

[3]) Cf. Business Cycles in the U.S.A., p. 37 and 171 and also J. J. POLAK, Fluctuations in United States Consumption, 1919—1932, The Review of Economic Statistics, XXI (1939), p. 1.

(4) spirits and (5) cotton manufactures. In order to simplify matters, only total wages L (with a free lag) were used as an income series (Z was therefore left out) and p_{-1} was left out entirely, whereas the price of the product considered was introduced as a new variable. Special attention was paid to (A) the lag between income and comsumption, (B) the influence of $\Delta u'$, (C) that of the rate of interest m^s. As a by-product (D) the elasticity of demand was determined for the commodities considered. Particulars about the material used are to be found in table III 1, 50.

TABLE III 1 50

Data used in investigation on consumption of separate commodities

Commodity	Consumption represented by:	Price represented by:	
Sugar . . .	Quantity retained for home consumption, S.A. [2]		Statist [3]
Coffee . . .	Ditto	Import price	S.A.
Tea	Ditto	Import price	S.A.
Spirits . . .	Ditto	Import price	S.A.
Cotton man.	Consumption of raw cotton in lbs, minus cotton used in exports [1]	Import price, raw cotton	S.A.

[1] Cotton used in exports, in lbs = 0.20 (exports of piece goods in yards + + estimated exports of other cotton goods) + 1.50 (exports of yarn and thread in lbs), whereas "estimated exports of other cotton goods" = exports of piece goods in yards $\times$ $\dfrac{\text{exports of other manufactures, exc. thread, in mln £}}{\text{exports of piece goods, in mln £}}$

[2] S.A. = Statistical Abstract of the United Kingdom.

[3] Average of British West-Indian refining and German beet, 88 p.c., f.o.b.

(*b*) The results obtained for these commodities are given in table III1,51

TABLE III 1 51

	Lag [1]	Coeff. Δu [2]	Coeff. m^s	Elasticity
Sugar	0.5	0.52	0 pos. 2 neg.	0.06
Coffee.	1.9	0.38	—	0.08
Tea.	2.1	0.43	—	0.00
Spirits.	0.4	0.27	1 pos.	0.16
Cotton	0.5	0.47	4 pos. 2 neg.	1.5

[1] Average of cases with free lags.

[2] Median.

The following conclusions may be drawn from this table:

A. The lag between workers' income and consumption appears to be half a year for sugar, spirits [1] and cotton manufactures and even two

[1] Cf. also Augustus D. WEBB, The Consumption of Alcoholic Liquors in the United Kingdom, Journal of the Royal Statistical Society, LXXVI, 1912—13, p. 207.

years for coffee and tea. Since workers' income is already lagging about one year behind profits, this seems to be a clear indication of a considerable lag and a confirmation of our findings for consumers' outlay as a whole.

B. The influence of $\Delta u'$ is found to exist in all cases studied and the coefficients are spread fairly regularly around our figure 0.44. Some direct evidence on the validity of the hypothesis will be given below (*c*).

C. The influence of the rate of interest appears to be feeble throughout: the number of cases, where a positive influence was found about equals the number of cases where the reverse proved to be true.

D. Elasticities of demand are remarkably low, except for cotton goods. These figures cannot be compared directly, however, with the figure found in our general formula, since apart from the price of each separate article there is, in some cases, a clear influence of the general price level, which may represent goods either competing with or completing the one considered. The price term in the general consumption formula stands for both price levels.

(*c*) Test of hypothesis made on stocking.

In some cases a test could be made on the validity of the hypothesis of stocking included in equation (III 1). Some particulars may be given here.

1— *Sugar*. For sugar stock estimates are available [1]). Graph III 15 shows the actual changes in these stocks as compared with the residuals:

$$u' - 0.018 \ (L + L_{-1}) + 0.040 \ p$$

and with the terms:

$$0.52 \ (u' - u'_{-1}) - 0.041 \ m^s.$$

For the beginning of the period the agreement is very good. For the years 1889/93 and 1905/08 it is less good, however.

2— *Raw Cotton*. For raw cotton, consumption by mills and imports are both known. Graph III 15 shows the actual additions to stocks and those calculated on the hypothesis that they are proportional to the rate of increase in imports. Since, on the basis of our hypothesis, consumption would be equal to

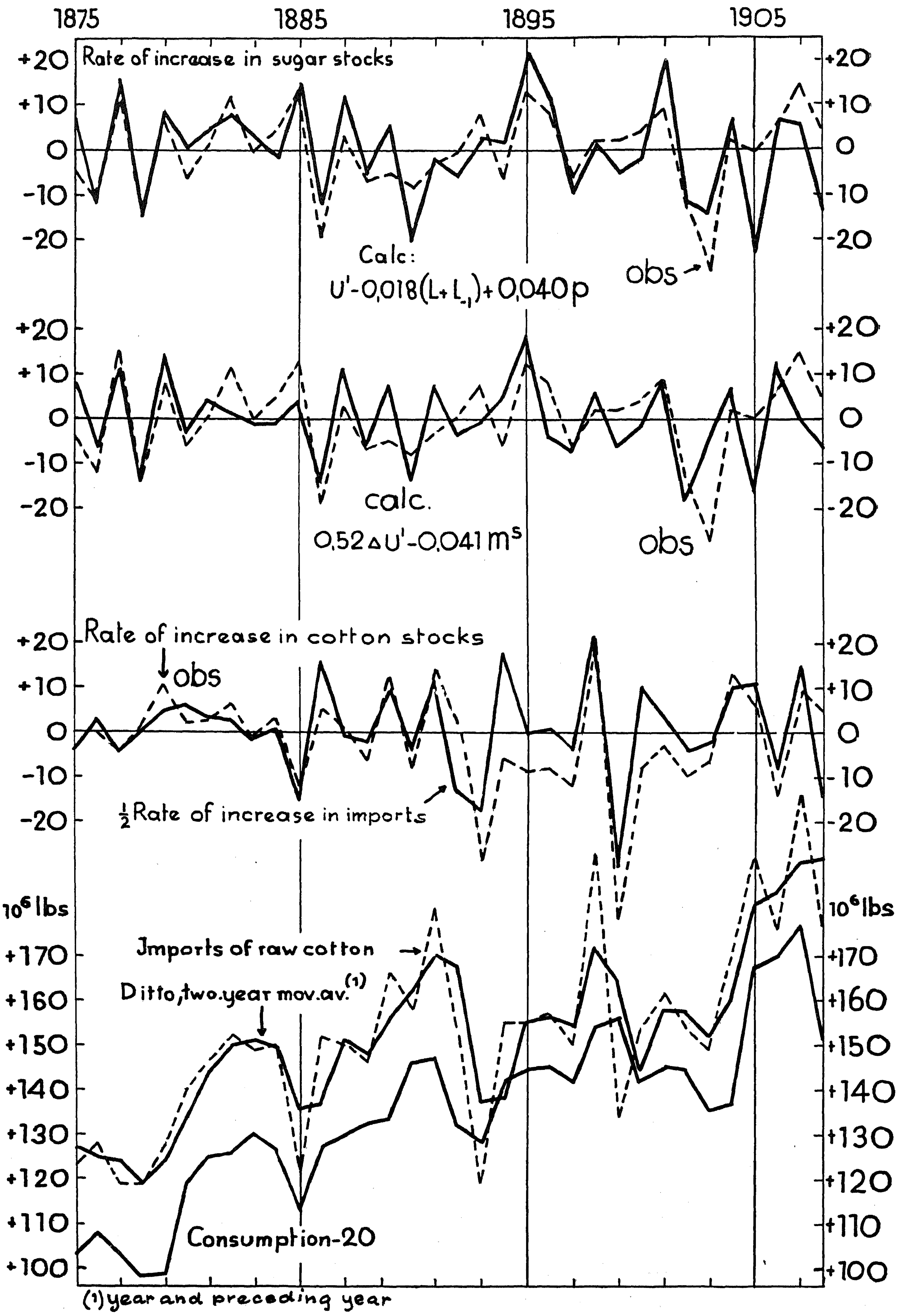
$$x - a \ (x - x_{-1})$$

where imports are x and a is a coefficient < 1, it would be a two years' moving average,

$$(1 - a) \ x + a x_{-1}$$

with weights $1 - a$ and a respectively, of imports. The comparison

[1]) The Economist, "Commercial History and Review" of each year, given, as a rule, at the end of February.



III 15 Changes in sugar stocks — actual and calculated.
Changes in raw cotton stocks — actual and calculated.

between consumption and this moving average of imports, which constitutes a more rigorous test, shows satisfactory results.

3— *Timber.* As has been stated already (section II 6) it was found that employment in the building industry shows a better correlation with a two-year moving average of imports of timber than with imports themselves. This might point to the same type of relation existing here.

III 2. EXPORTS OF CONSUMERS' GOODS [1]

(i) *Composition of exports of consumers' goods.* In British exports, three categories of consumers' goods are of primordial importance, viz. cotton goods, woollen and worsted goods and coal. In 1907 their value was, in mln £: 110, 37 and 42 respectively, the next large items being linen and jute goods (16) and leather goods (6), all others being less than 6 mln.

(ii) *Theoretical.* The following explanatory variables have been included:

(*a*) World trade T^w as an indicator of total demand (in value units) exerted by all countries on foreign markets. A better variable would undoubtedly have been some world income estimate, but it is an impossible task to calculate such an estimate.

(*b*) The price level of British export goods (consumer goods), p^e.

(*c*) An estimated index of "price disparity", being the difference between a British index and a "world index" of prices for the chief type of export goods considered (in this case cotton goods) and written as $p^e - p^w$. Particulars about the construction of the world index are to be found in section I 2.

(*d*) capital exports K^e, since they may facilitate the export of consumers' goods to non-capitalistic areas.

There may be some doubt as to whether the variables p^e and $p^e - p^w$ ought to be included both or whether only $p^e - p^w$ should be included. The latter alternative would mean that, for a given level of total world trade T^w, only a decrease or an increase of p^e *relatively* to p^w will influence exports.

A number of attempts have also been made by including still further variables, supposed to explain stocking of goods at oversea ports, as e.g. the rate of increase in prices, the rate of increase in exports themselves (in analogy with the previous section) and the short-term rate of interest.

(iii) *Statistical.*

Table III 2 summarises the results found.

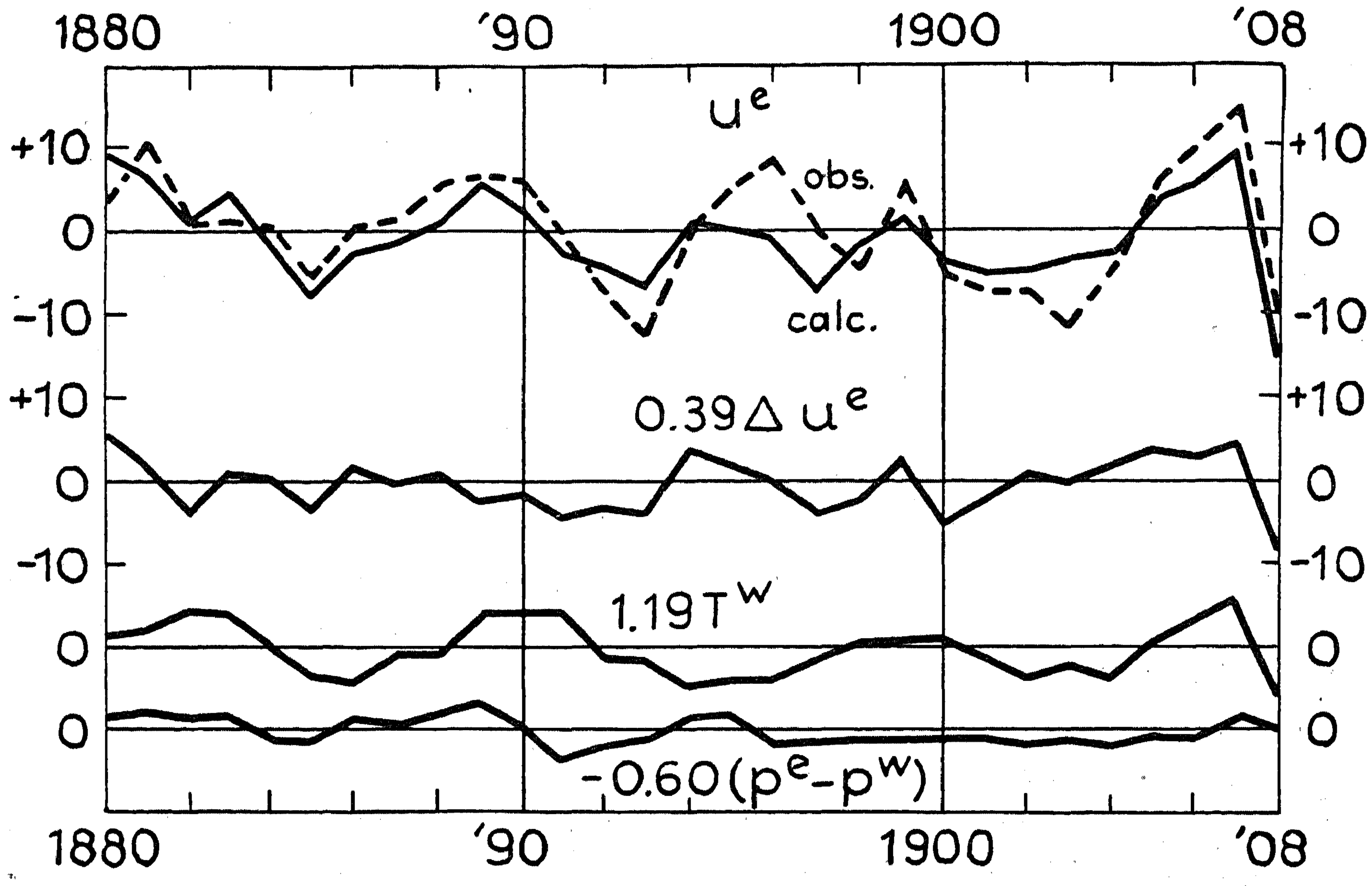
Not one of the results is quite satisfactory, which becomes particularly clear when the historical graphs are drawn. Nowhere is the sudden upturn

[1]) I am indebted to Mr ALB. ROMBOUTS for the investigations used in this part of the report, as well as for those used in section III 5.

in exports in 1895/96 satisfactorily explained. From reports on the economic situation in those years one gets the impression that fluctuations in the national income of India could possibly explain this upturn. Hence the discrepancy may be due to the lack of accurate statistics on this matter, which forces us to use the series T^w as an indicator of world income: evidently only a rough approximation. Some theoretical calculations [1]) suggested that the influence we found for the rate of increase in exports themselves is only due to spurious correlation. The influence of m^s, added in some cases, also seemed uncertain, since the inclusion of this variable does not increase the correlation coefficient to any appreciable extent; and the same is true of the rate of increase in prices. This is why the last three variables have been left out of consideration.

As to the question whether only $p^e - p^w$ or also p^e should be included, the table gives no clear answer. Of course there is an increase in correlation, if p^e is also included, but it is only moderate. For the sake of simplicity the formula without p^e has been taken:

(III 2) $$u^e = -0.7\ (p^e - p^w) + 0.94\ T^w + 0.18\ K^e$$



III 2. "Explanation" of exports of consumers' goods. (Eq. 7; eq. 1 and 2, chosen in text, give a better fit except for the period 1892—1902, discussed above).

Some of the calculations of the following chapters have, however, also been made with the alternative formula including a p^e-term:

(III 2′) $$u^e = -0.6\ p^e - 0.6\ (p^e - p^w) + 1.3\ T^w + 0.17\ K^e$$

1) For the details of these calculations, the reader may be referred to my paper on "An Acceleration Principle for Stock Holding", Essays in Honour of HENRY SCHULTZ.

TABLE III 2

"Explanation" of consumers' goods exports.

Nr.	Period	Regression coefficients for:							
	Variable	p^e	p^e–p^w	T^w	K^e	p^e	Δu^e	m^s	R
	Stand. dev.	2.85	2.49	2.74	15.7	3.64	8.6	0.66	
1	6	3	4	5	6	7	8	9	10
1	1880–1908	–0.63	–0.57	1.34	0.17				0.789
2	1880–1908		–0.74	0.94	0.18				0.762
3	1880–1908	–0.76		1.44	0.21				0.770
4	1880–1908			1.03	0.22				0.730
5	1880–1908	–0.61	–0.86	1.71					0.710
6	1880–1908	–0.75	–0.89	1.66		0.34			0.725
7	1880–1908	–0.06	–0.60	1.19			0.39		0.807
8	1880–1908	–0.54	–0.81	2.18				–2.6	0.720

Before comparing the results just found with those found on other occasions for other countries, we must introduce some new terms. In the above equation, where u^e is explained by, *inter alia*, $p^e - p^w$, we shall simply speak of the *elasticity of demand* when calculating the elasticity with respect to p^e, which, in this case, is the same (apart from the algebraic sign) as the elasticity with respect to p^w.

In other investigations the variable to be explained is not the absolute quantity u^e, but the ratio of u^e to some competing quantity, e.g. the exports of a competing country, or of all competing countries, or home production. If this competing quantity is indicated by u^w, then a relation $H = (\overline{\overline{u}}^e/\overline{\overline{u}}^w) = f\,(\overline{\overline{p}}^e/\overline{\overline{p}}^w) = f(P)$ is established.

The corresponding elasticity

$$e_H = (dH/dP) \cdot (P/H)$$

will be called *elasticity of substitution* 1). If, instead of H, the percentage ratio between $\overline{\overline{u}}^e$ and $\overline{\overline{u}}^e + \overline{\overline{u}}^w$ or Q is taken to be a function

$$Q = g(P),$$

the corresponding elasticity

$$e_Q = (dQ/dP) \cdot (P/Q)$$

is called *elasticity of competition*. The following relations between these two elasticities exist:

$$e_Q = (1/1 + H)\, e_H \quad \text{and} \quad e_H = (100/100–Q)\; e_Q.$$

Hence, for $\overline{\overline{u}}^e$ small in comparison to $\overline{\overline{u}}^w$: $e_Q = e_H$.

1) Cf. DERKSEN and ROMBOUTS, The Influence of Prices on Exports, De Nederlandsche Conjunctuur, Special Memoranda No. 1, p. 47.

For a small ratio of $\bar{\bar{u}}^e$ to $\bar{\bar{u}}^w$ it is, in addition, easy to prove that e_Q as well as e_H are about equal to the elasticity of u^e with respect to p^e. In this case $\bar{\bar{u}}^e + \bar{\bar{u}}^w$ will not be much affected by a change in p^e; it may be taken as approximately constant. There is, then, no difference between the elasticity of u^e with respect to a change in p^e and that of H or Q with respect to such a change.

From equation (III 2) we may now calculate the elasticity to be:

$$0.7\ (\bar{p}^e/\bar{p}^w) = 0.7\ (90/180) = 0.35$$

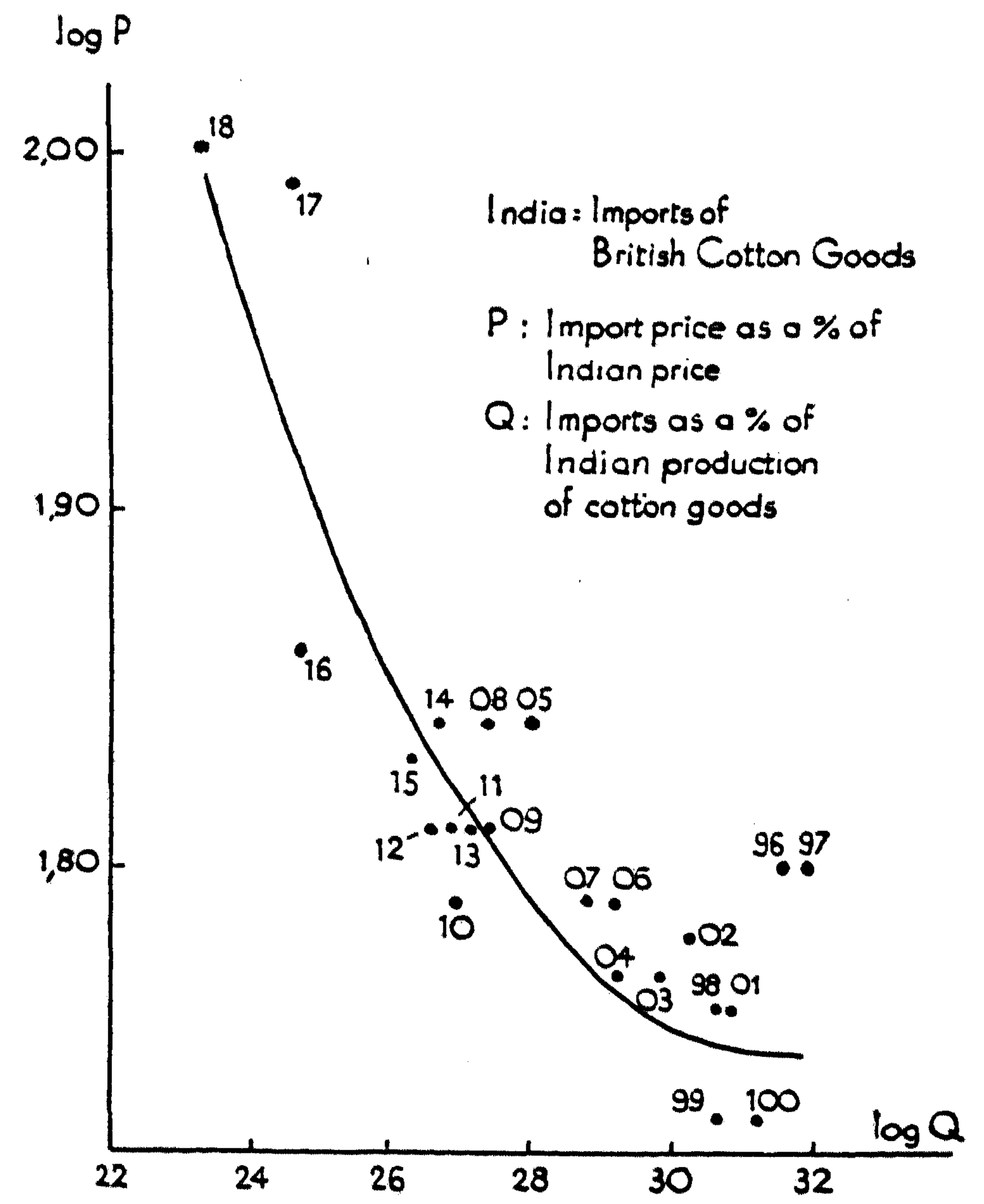
or, in the case of (III 2′)

$$1.2\ (\bar{p}^e/\bar{p}^w) = (1.2/2) = 0.6$$

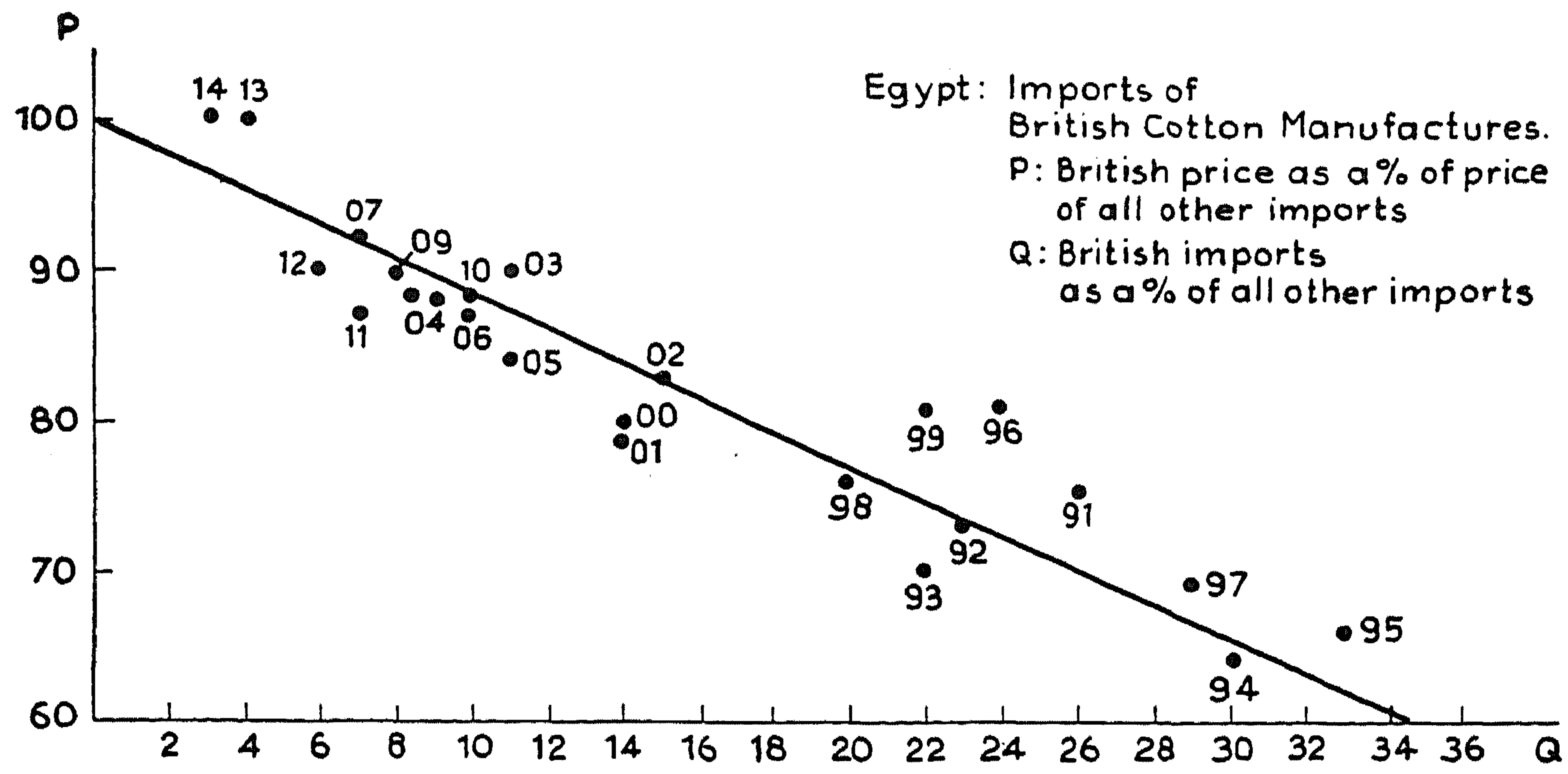
which is remarkably low. This may reflect the rather monopolistic position of Great Britain in world trade in the period studied. It would mean that price reductions would not help her to get a higher value of exports, since volume would increase at only 0.35 (or 0,6) $\times$ the percentage of the price reduction.

(iv) *Comparison with other countries.* The figure just found is considerably lower than those found for the elasticity of substitution for Dutch exports as a whole and some separate Dutch products [1]). For Dutch exports as a whole a figure of 1.5 to 2.5 was found. Since, however, the share of England in world exports is about 5 times as large as that of Holland, there seems to be a good deal of agreement between the two figures.

(v) *Comparison with elasticity of competition for exports to India and*



[1]) Cf. DERKSEN and ROMBOUTS, loc. cit.



III 2 5 1/2. Competition in cotton goods on foreign markets.

Egypt. Graphs III 25_1 and III 25_2 illustrate the high correlation between price ratios and quantity ratios concerning imports of British cotton goods in India and Egypt. The exact meaning of the variables is indicated in the legend. The elasticities of competition for these two cases turn out to be 0.9 and 4, respectively. The high figure for Egypt must be attributed to the severe competition on this market; moreover, British imports are only a small part of total imports. The Indian figure is correspondingly lower: here British imports are almost the only imports. The figure relates to the period 1896—1918; if the war figures are excluded, a figure of 0.6 is obtained. This already approaches the figure found for the elasticity of exports as a whole. In these exports as a whole other markets and other goods (coal) play a rôle, for which the elasticity of demand may be still lower than 0.6.

III 3. IMPORTS OF FINISHED CONSUMERS' GOODS

(i) *Theoretical.* Imports of finished consumers' goods consist chiefly of the following commodities, the value of which in 1907 has been indicated below (in mlns of £):

Butter and margarine	24	Tea	11
Sugar	19	Mutton	9
Bacon and ham	18	Eggs	7
Beef	11		

The quantities imported chiefly depend, as all demand does, on incomes and prices. This is especially true of commodities which do not (e.g. tea) or hardly (sugar) compete with home products. As far as competition with home products exists (bacon and ham, beef, mutton), the ratio between home prices and import prices will largely determine the ratio between demand for home produce and imported goods [1]). In only one

[1]) Cf. DERKSEN and ROMBOUTS, loc. cit.

case the situation may be different. If home produce and imports are identical goods, prices will be identical and the ratio is one. Imports may depend, in such cases, on the quantities supplied. For crop products these may be subject to accidental fluctuations.

Instead of considering imports in absolute figures, we may therefore study relative imports, i.e. imports in comparison to consumption of home produce. The ratio $(\bar{\bar{u}}'/\bar{\bar{u}}^i)$ of consumption of home produce $\bar{\bar{u}}''$ to imports of finished goods may be approximated by the expression $u' - 9.2\ u^i$, as far as the deviations from average are considered. This is obtained by neglecting products of deviations [1]).

In consequence of the foregoing, the following explanatory variables were introduced in an explanation of imports u^i of consumers' goods ready for use:

(*a*) total consumption u', of which it must be hoped that the regression coefficient will be $1/9.2 = 0.11$;

(*b*) a price index p^i composed of the import prices of beef, ham and bacon, mutton, eggs, butter and sugar (tea has been left out since the demand for tea does not, as far as can be ascertained, depend on its price (cf. iii, below);

(*c*) a price index p' of home prices of the same goods, except eggs and sugar. The price of eggs could not be obtained and both products were chiefly imported;

(*d*) total wages L, as an index of incomes.

A crop index was not introduced, since home crops do not seem to have competed with the products under review.

(ii) *Statistical.*

The regression equation obtained is:

$$u^i = 0.10\ u' - 0.54\ p^i + 0.48\ p'$$

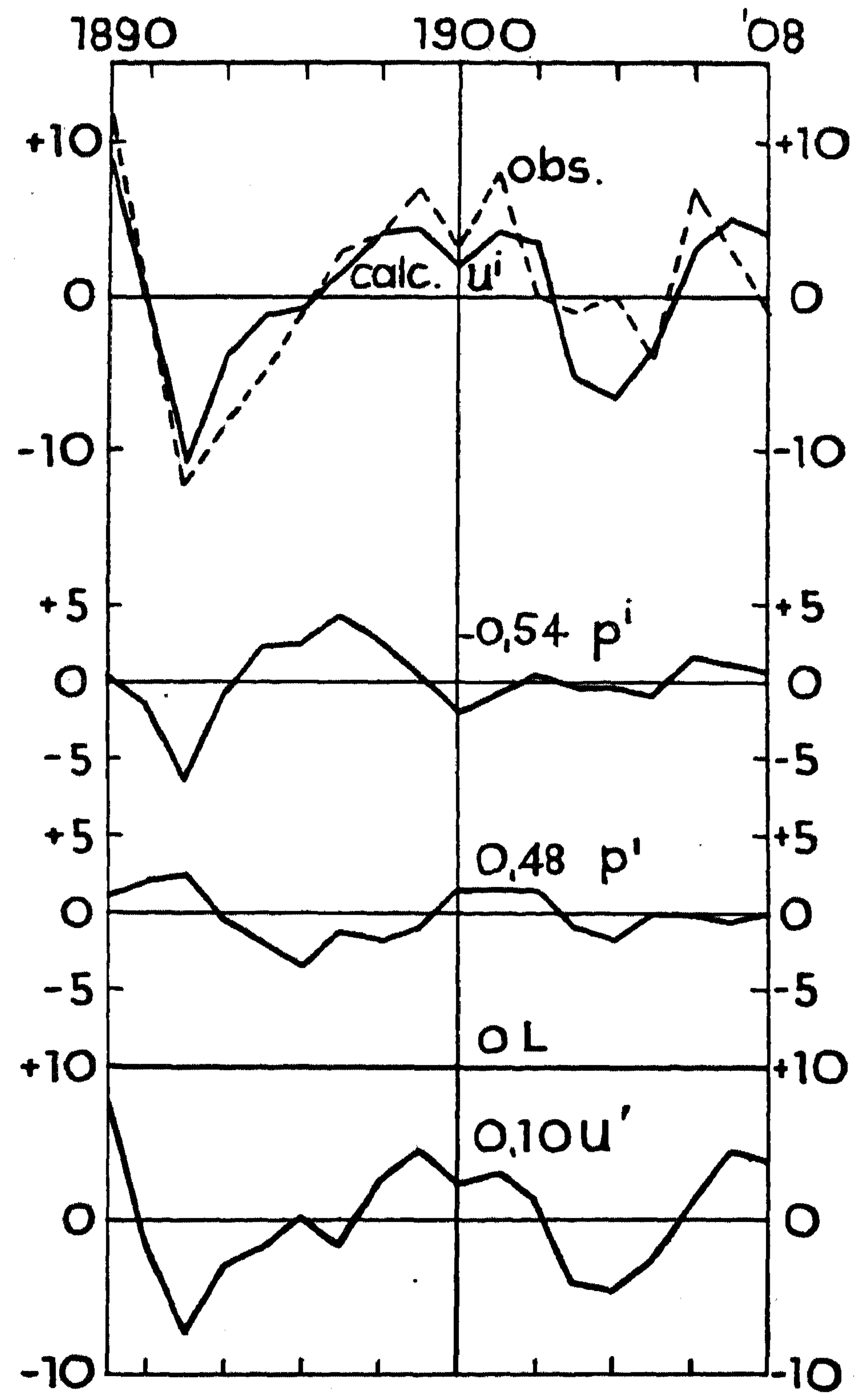
showing a correlation coefficient of 0.834. The regression coefficient for L is zero; the one for u' is quite near to the expected value. The elasticities with respect to the prices p^i and p', respectively, are $0.54 \times (100/217) = 0.25$ and 0.22.

Using a different price index p' (where eggs and sugar prices have been included and taken equal to import prices), we obtain a simular result with elasticities 0.48 and 0.34, but a somewhat lower coefficient for u' which is therefore less in accordance with theoretical expectations.

[1]) The calculation runs:

$$\frac{\bar{\bar{u}}''}{\bar{\bar{u}}^i} = \frac{\bar{u}'' + u''}{\bar{u}^i + u^i} = \frac{(\bar{u}'' + u'')\ (\bar{u}^i - u^i)}{\bar{u}^{i2} - u^{i2}} = \text{const.} + \frac{-\bar{u}''u^i + \bar{u}^i u''}{\bar{u}^{i2}},$$ by neglection of second order terms; further $u'' = u' - 1.63\ u^i$, since u^i must be brought on a retail basis when deducted from u'. The figure 1.63 is based upon figures by Flux in the General Report of the 1907 Census.

Omitting, in the last calculation, the explanatory variable u', we get elasticities of 0.74 and 0.46 and a considerable term with L, now taking the place of the term with u'. The correlation coefficients are about the same in all three cases.



III 3. "Explanation" of imports of consumers' goods.

(iii) *Investigations for separate commodities.*

In order to test the result obtained, imports of the separate commodities were investigated in the same way. Since, however, the total consumption of these separate commodities is not known, it was not possible to include that series. The results obtained are summarised in the following table:

Commodity and period	Corr. coeff.	Elasticities	
Bacon and ham, 1871—1910	0.834	0.72	0.52
Beef, 1891—1910 [2])	0.774	0.86	0.00[1])
Sugar, 1875—1908 (consumption) . . .	0.716	0.09	—
Butter, 1890—1910	0.525	0.56	0.00[1])
Mutton	0.441	0.35	0.00[1])

[1]) Home price, when included, gets coefficient with wrong sign and has therefore been dropped as an explanatory variable.

[2]) Income series Z_{-1} also included.

The results for butter and mutton are very unsatisfactory, perhaps because home production fluctuations cannot be neglected.

The low elasticities found seem to be in accordance with the character of necessities of these imports.

(iv) *Results for Holland.* For Holland similar calculations have been made [1]) for imports of all consumers' goods, as well as for investment goods and separate commodities. The elasticity of substitution found was higher throughout, averaging about one, which is in agreement with the different character of Dutch imports: less food, more finished clothing and luxuries.

III 4. THE DEMAND FOR INVESTMENT GOODS [2])

(i) *Theoretical.* The volume of investment goods delivered on the home market is assumed to be determined by the demand exerted by entrepreneurs. It consists of two big items, of which the raw materials are metals (chiefly iron) and timber respectively, the latter being one of the raw materials for the building industry. For the former the consumption of iron and steel has been used, for the latter the imports of timber. In virtue of the great fluctuations in imports and of the big stocks usually held, the average of the last two years has, in each year, been taken to represent consumption (cf. section III 1).

The theory of demand for investment goods used has been taken from the League of Nations publication on this subject [3]). Since for the U.S. of America, according to this publication, a considerable influence of share yield on investment activity was found to exist, this variable has also been included in some alternatives. It could not, however, be measured directly, since no dividend percentage figures exist. Therefore, share prices (n) and profits (Z) have been taken instead of share yield [4]). As profits had already been included, only share prices n had to be added. Moreover, short and long term interest rates, m^s and m^L, have both been included.

On the other hand, rents as an incentive to building have not been included; reliable figures do not seem to be available, whereas in official publications a very smooth development has often been assumed to exist. Building costs, as a further factor influencing building, have not been included separately, as their fluctuations do not seem to have been important (cf. section IV 4).

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1) J. TINBERGEN, An Econometric Approach to Business Cycle Problems, Paris 1937.

2) Cf., however, the study by Mr PESMAZOGLU, mentioned in the Preface.

3) A Method and its Application to Investment Activity, Geneva 1938.

4) The parallelism between profits and dividends is found to be striking in the case of Germany (cf. O. DONNER, Die Kursbildung am Aktienmarkt, Vierteljahrshefte zur Konj.-Forschung, Sonderheft 36, 1934) and of the United Kingdom since 1907 (Economist figures).

Thus, the factors included in the final form of the relation are:

Z non-labour income, representing profit expectations as well as financial resources of enterprises;
q price of investment goods;
m^s short-term interest rate;
m^L long-term interest rate;
n prices of shares, representing (*a*) the ease with which capital may be raised and (*b*) the state of confidence.

A lag of one year was applied, as was found to be the case in the L.o.N. publication quoted.

(ii) *Factors rejected.* In agreement with the last mentioned publication the following factors have not been included:

(*a*) profit margin (in contradistinction to total profits);
(*b*) production of investment goods some seven to eleven years ago;
(*c*) rate of increase in production of consumers' goods.

The rejection of the last two factors means the rejection, motivated in that publication, of the echo principle and the acceleration principle respectively for the explanation of short term fluctuations in general investment activity.

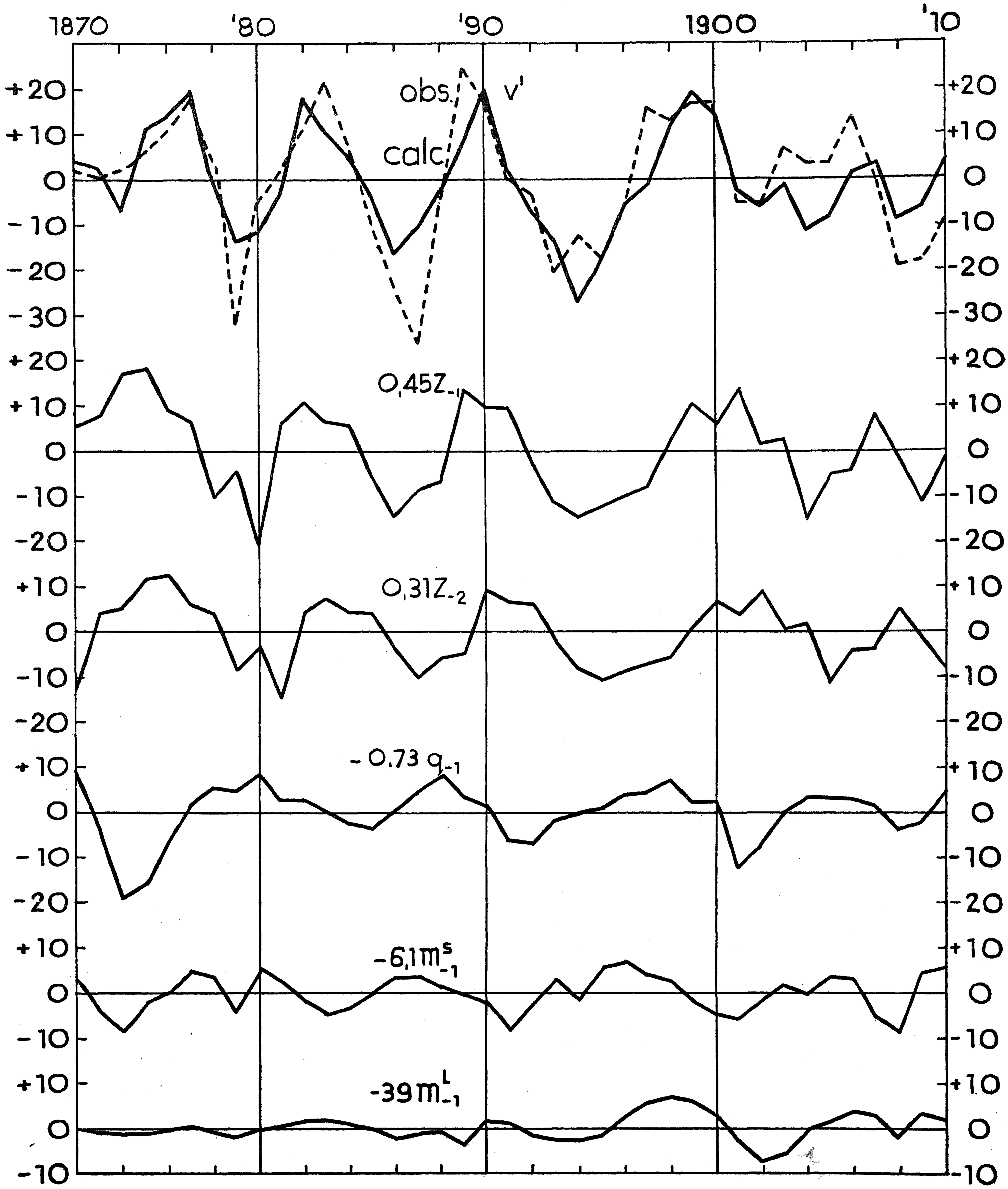
(iii) *Statistical results.* Apart from (1) the calculations relating to the total volume of investment, some further calculations were made. Some of these try to "explain" (2) the demand for iron and steel products only or employment in (3) iron founding and moulding and (4) engineering, by the same factors, others to "explain" (5) building volume (as measured by timber consumption) and (6) building employment in terms of iron consumption ($v^{I'}$), share prices n and long term interest rates (m^L). The last two calculations were made for the purpose of detecting whether share prices (as indicators of the state of confidence) or long term interest rates do especially affect building activity. The results are given in table III 4. It will be seen that the signs of the coefficients for all variables are economically significant with the exception, in cases 4 and 6, of long term interest rates. The equation chosen provisionally is 1 C, running:

$$v' = 0.62\ Z_{-1} - 0.20\ q_{-1} - 7.2\ m^s_{-1} - 46\ m^L_{-1}$$

Since there is some uncertainty as to the exact lag of non-labour income after Z, this equation was re-calculated with Z_{-1} and Z_{-2} as explanatory variables instead of Z. This gives as the best approximation:

$$\text{(III 4)} \qquad v' = 0.45\ Z_{-1} + 0.31\ Z_{-2} - 0.73\ q_{-1} - 6.1\ m^s_{-1} - 39\ m^L_{-1}$$

The coefficient for q is affected most. It corresponds with an elasticity of 0.73 (86/277) = 0.23.



III 4. "Explanation" of investment activity.

TABLE III 4
"Explanation" of investment activity

Nr.	Variable "Explained"	Period ↓ / Variable → / Stand. dev. →	Regression coefficients for Z_{-1}	q_{-1}	m^s_{-1}	m^L_{-1}	n_{-1}	R
1	2	3	4	5	6	7	8	9
1A	v'	1872—1910	0.60	−0.22	−7.1	− 44	0.06	0.765
1B	v'	,,	0.53	−0.40	−6.9		0.38	0.746
1C	v'	,,	0.62	−0.20	−7.2	− 46		0.764
2	$v^{I'}$	,,	0.27	−0.43	−3.1	− 16	0.19	0.648
3	$-b^{I'}$	,,	0.39	−0.41	−4.7	−2.4	0.36	0.716
4	$-b^{I''}$	,,	0.12	−0.11	−1.35	+1.1	0.14	0.745

(iv) *Comparison with other countries.* A first comparison is possible on the basis of the results of the L.o.N. publication mentioned above. Table III 4.1 relates to the most satisfactory case for each country drawn from this study. In considering this table it should be remembered that our present case relates to investment activity as a whole, including building and that the price index taken is no longer the pig iron price, but a price showing smaller fluctuations. This latter circumstance would in itself increase elasticity. Nevertheless the elasticity is found to be lower, which is to be attributed to the inclusion of building activity. The elasticity with respect to long term interest rates is higher than in Germany and the United States, as was found before, but also here the inclusion of building activity seems to have had a mitigating influence. The lag seems to be larger than in Germany and the United States.

TABLE III 41
International comparison of "explanations" for investment activity

Country and Period	Elasticity of demand for inv. goods with respect to: Iron price	Short term interest rate	Long term[1] interest rate	Lag in years
1	2	3	4	5
U.K. 1871—1895	− 0.33 ± 0.10	[3])	− 1.7	1
U.K. 1871—1910	− 0.31 ± 0.10	[3])	− 0.8	1
Germany 1871—1912	− 0.23 ± 0.17	about 0	− 0.2	½
U.K. 1920—1936	− 0.24 ± 0.14	[3])	− 0.2	1
United States 1919—1933 . .	− 0.25 ± 0.12	− 0.2	− 0.2 [2])	½
Present case.	− 0.23	− 0.06	− 0.41	1

[1]) Calc. on the assumption that the average level of interest is 3 %.
[2]) Share yield.
[3]) Not ascertained.
[4]) Source: A Method and its Application to Investment Activity, Geneva 1929, Table III, 10.

The coefficient for Z can better be compared with those obtained for the United States and Holland, where a similar system of units was used. The coefficient for Holland was 0.51, that for the United States 0.66; the agreement is satisfactory (Cf., however, § VI, 3).

(v) *Results for separate series and for employment figures.*

1. Applying the same procedure to iron consumption $v^{I'}$, employment in iron foundry and moulding $b^{I'}$ and employment in engineering trades $b^{I''}$ and making all series roughly comparable by giving the dependent variable the same average (viz. 93, that of the employment series) one finds the following regression coefficients:

Regression coeff. for:	Z_{-1}	q_{-1}	m^s_{-1}	m^L_{-1}	n
Total investment v' . .	0.23	— 0.09	— 2.8	— 17	0.02
Iron consumption $v^{I'}$ . .	0.18	— 0.29	— 2.1	— 11	0.13
Employment:					
Iron founders, etc. $b^{I'}$.	0.39	— 0.41	— 4.7	— 2.4	0.36
Engineering $b^{I''}$.	0.12	— 0.11	— 1.4	+ 1.1	0.14

The higher coefficient for q_{-1} in the equation for $v^{I'}$ seems natural. The low coefficients in $b^{I''}$ throughout must be attributed to the spreading of fluctuations in the engineering trade, as compared with iron founding, by the longer duration of the production process.

2. As has already been mentioned, building activity as indicated by two-year moving averages of timber imports and by unemployment figures for the building trade (i.e. carpenters and bricklayers) has been "explained" by general investment activity v' (representing construction of factories, commercial buildings, etc.) and m^L and n, in order to find whether the two latter factors have a stronger relative influence on building than on general investment activity. For m^L this appears hardly to be so: the additional influence found is very small; for n it may be the case.

3. For investment in railway rolling stock [1]) no influence of iron prices could be detected, but the influence of long term interest rates was found to be considerable.

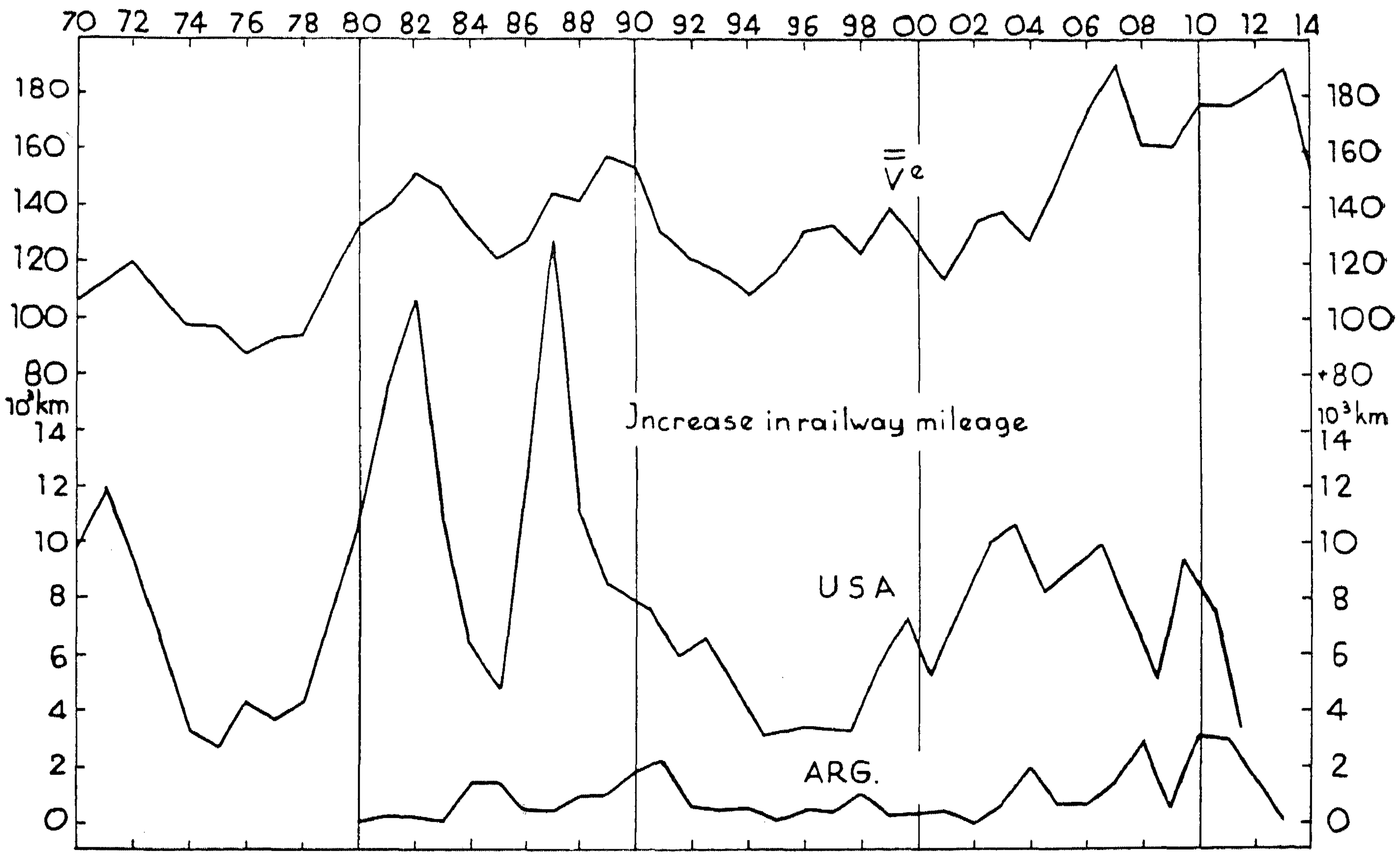
4. Investment in spinning machines may be very well explained by spinning profits, with a lag of one year. The influence of iron prices and interest rates was, however, not easily recognised.

III 5. EXPORTS OF INVESTMENT GOODS

(i) *Theoretical.* About exports of investment goods much the same could be said as about exports of consumers' goods. There is, however, one characteristic difference. Apart from incomes, there are other resources which are of importance for the purchase of investment goods, viz. capital exported by the U.K. An explanation of the exports of investment

[1]) Cf. "A method ....", chapter V.

goods requires one further step, viz. an explanation of capital exports or — which comes to about the same — an explanation of investment activity itself abroad. In this connection it may be observed that for the first three boom periods considered in this study, viz. 1873, 1883, and 1890 the extension of railway mileage in the U.S. and (for 1890 particularly) in Argentina were of especial importance. This is illustrated by graph III 5,1. An explanation of the construction of railways in the U.S. would therefore be of great importance. This, however, would lead us too far. A few words will be said on this question in chapter VIII.



III 5, 1. Exports of investment goods and extension of railway mileage in the United States and Argentine.

Hence the variables included in the explanation of u^e are:

(*a*) capital exports K^e,

(*b*) world trade T^w,

(*c*) the price difference for investment goods between U.K. and competing countries, and

(*d*) investment goods' prices themselves.

(ii) *Statistical.* The correlation obtained is so high that no necessity for further experiments seems to exist. The corresponding formula is:

(III 5) $$v^e = 0.25\, K^e + 2.1\, T^w - 0.88\, (q - q^w) - 0.27\, q$$

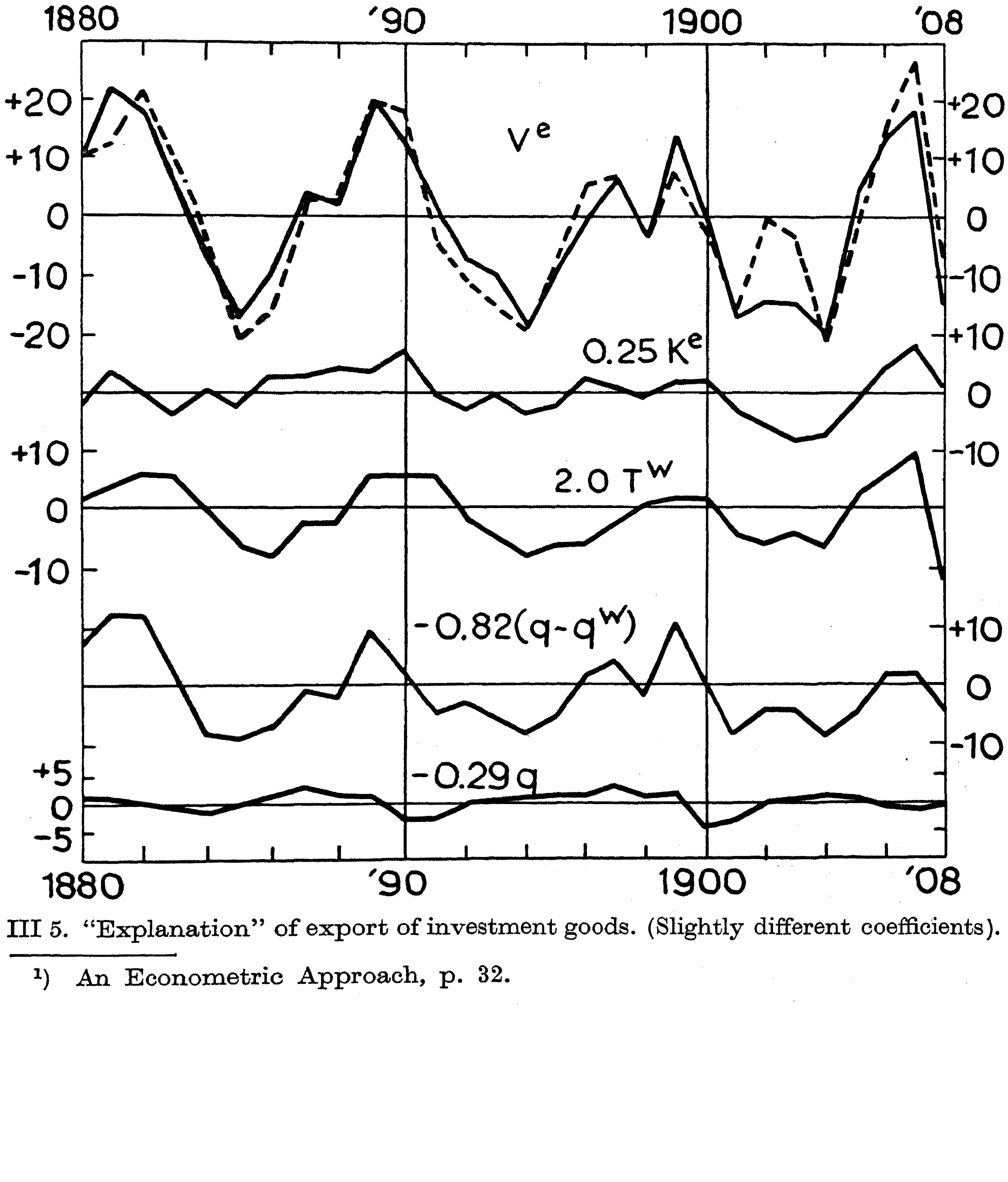
The meaning of the coefficients may be illustrated by the following remarks:

(*a*) 25 % of additional capital exports seems to have been spent on the English market.

(*b*) since v^e is 182 for 1907 and $T^w = 100$, exports of investment goods would only fluctuate slightly more than world trade. This may be understood by the fact that a large part of world trade relates to raw materials.

(*c*) For q^w constant, the elasticity of demand is equal to $-$ 1.1 $(\bar{q}/\bar{v}^e) =$ $-$ 0.70. For some separate investment goods (cf. iii, below) and for Dutch imports of investment goods [1]) much higher figures were found. This may be explained by the mass character of the separate goods under consideration and the smallness of the Dutch market in proportion to the world market. British exports of investment goods as a whole are, on the other hand, a large part of the world market, where, for the more complicated goods, Great Britain used to have almost a monopoly.

(*d*) Assuming parallelism between q and q^w, the elasticity of demand may be deduced from the last term only and equals $-$ 0.27 $(\bar{q}/\bar{v}^e) = -0.16$, being lower than the figure found in section III 4 and than the figures given in table III 4,1 for the U.K., the U.S. and Germany.



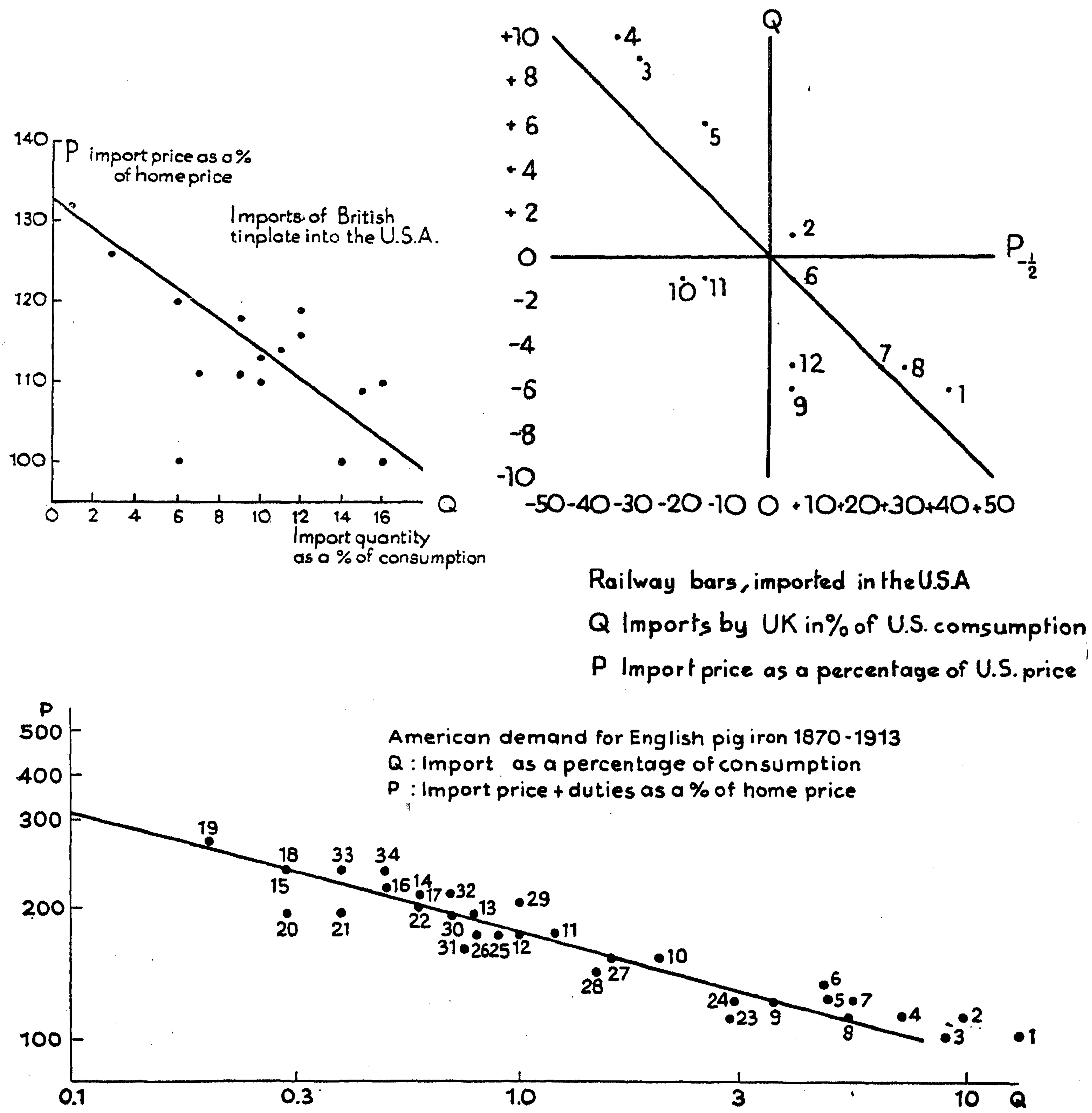
III 5. "Explanation" of export of investment goods. (Slightly different coefficients).

1) An Econometric Approach, p. 32.

(iii) *Results for some separate commodities.* As to the influence of prices, some partial investigations were made, viz. for pig iron, tin plates and railway bars exported to the United States. The elasticity of substitution (cf. § III 2) was determined from a relation:

$$\log Q = A + B \log P,$$

where A and B are constants,
Q is the ratio of British imports to U.S.A. consumption (in %), and
P is the ratio of import price, plus duties, and home price, (in %).
B will then be the "elasticity of competition" which, for small values of Q as compared to 100 is about the same as the elasticity of substitution [1]). It was in the neighbourhood of 3.75 for pig iron, 4.7 for tin plates and



III 5.3 1/3. Competition in three types of investment goods on foreign markets.

1) Cf. Derksen and Rombouts, loc. cit., p. 47.

4.4 for railway bars. Graph III 5,3 gives an impression of the correlations found.

(iv) *Comparison with other countries.* As was already mentioned, a high elasticity of substitution for this kind of commodities was also found in the case of imports in Holland, where it was found to be 4.8.

III 6. IMPORTS OF RAW MATERIALS FOR CONSUMERS' GOODS (x^i)

(i) *Theoretical.* The term raw materials is meant to include also semi-finished products — in short all articles which are not ready for retail trade. The composition of our index is illustrated by the following figures:

Imports in mln £ (1907):

Raw cotton . .	71	Leather	9	Barley	7
Wheat	37	Oxen, bulls, etc. .	8	Petroleum. . . .	6
Wool	33	Jute	8	Cotton seed . . .	5
Maize	15	Flour of wheat .	7		

Although certainly to some extent these goods will be competitive with home produce — as we suppossd finished products to be — they will chiefly be of a completing character.

Their imports may be split up into two parts, viz.

(*a*) imports consumed in the same year and

(*b*) imports used for increasing stocks.

The former part will be proportional to the volume of production of the goods made with their help, with relatively high weights to those industries showing a high import quota. Since exports of consumers' goods, especially cotton goods, belong to this class in particular, a good first approximation will be obtained if the volume of home production u and the volume of exports u^e are both introduced as explanatory variables. It does not matter that u^e is already included in u.

The latter part will be assumed — according to what was found in section III 1 — to be proportional to the rate of increase Δx^i of x^i itself.

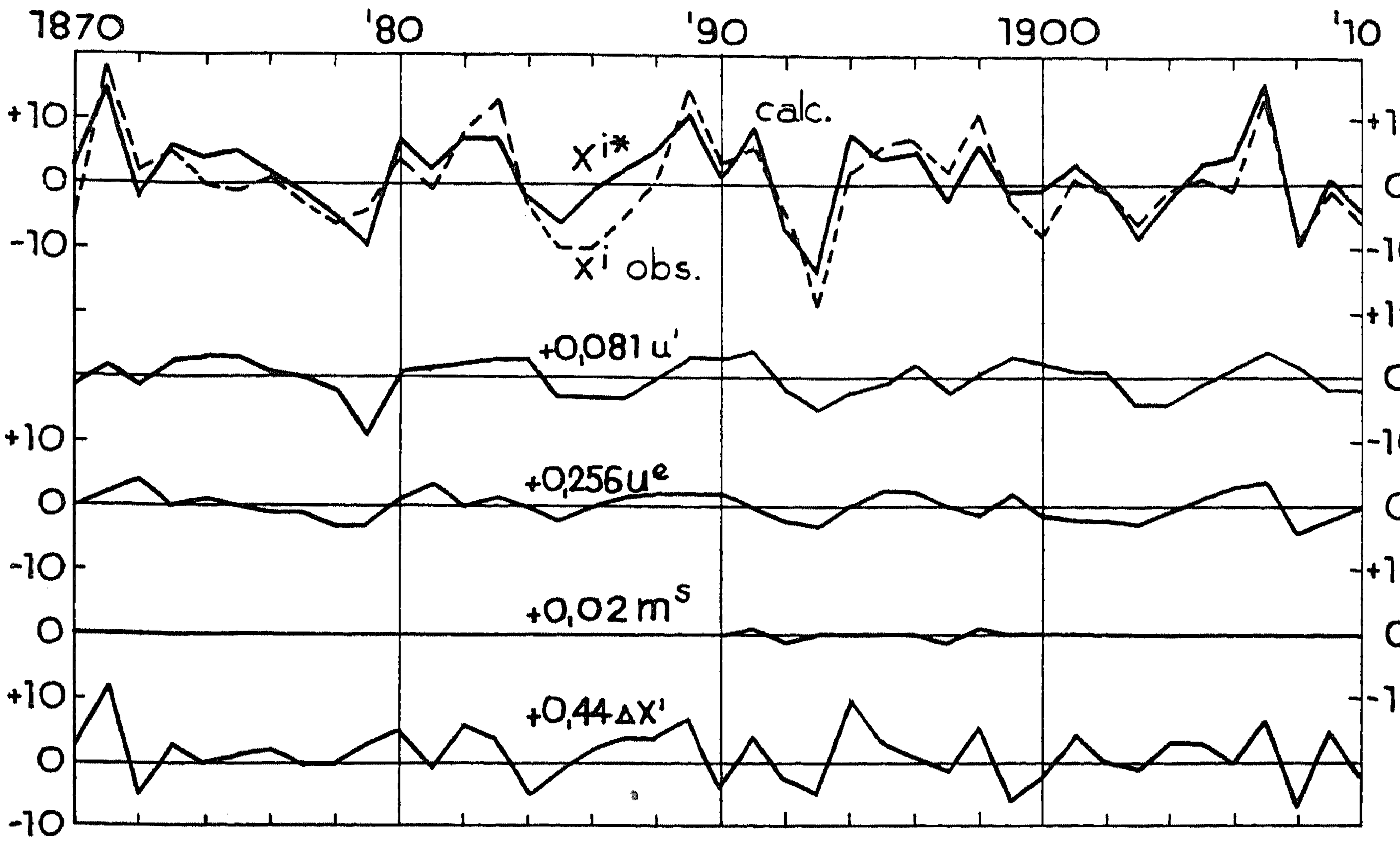
(ii) *Statistical.* The formula obtained is (cf. graph III 6):

$$\text{(III 6)} \qquad x^i = 0.081\, u + 0.256\, u^e + 0.44\, \Delta x^i$$

The coefficients of this equation may be tested in the following way. Since it is probable that raw material imports are about proportional to the volume of production, substitution of the average values of $\overline{\overline{u}}$ and $\overline{\overline{u}}^e$, i.e. $\bar{u}$ and $\bar{u}^e$, must yield the average value of $\overline{\overline{x}}^i$, i.e. $\bar{x}^i$, which is 198. The substitution yields:

$$0.081 \times 1540 + 0.256 \times 180 = 125 + 46 = 171,$$

which is not too bad. The low import quota for goods for home consumption



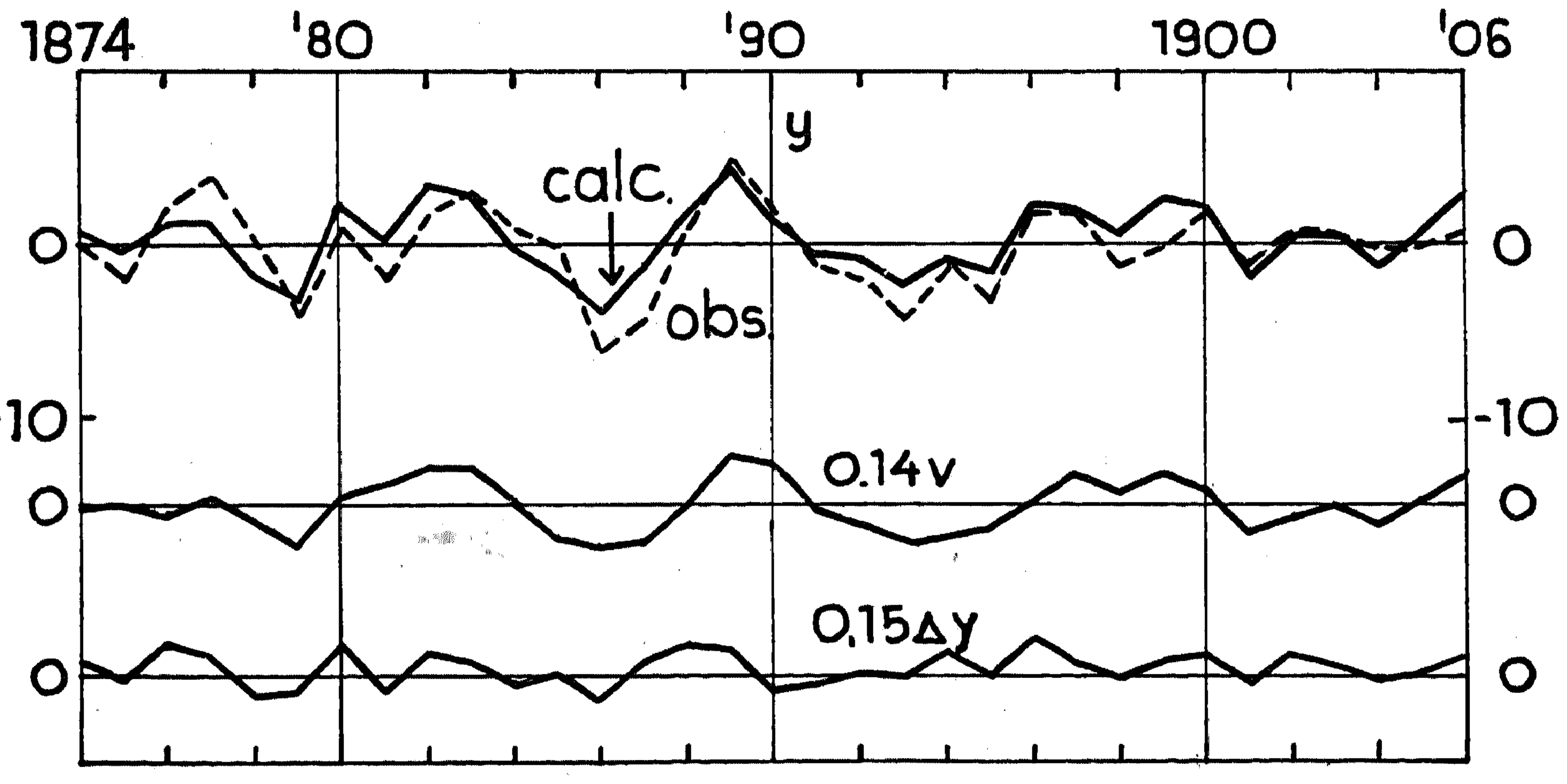
III 6. "Explanation" of imports of raw materials for consumers' goods.

(0.081) is to be attributed to the fact that all services, including retail services and housing, are in u; the much higher coefficient (0.30) for raw material prices in the equation for cost of living does not contradict this, since these raw material prices include those for home produced materials and imports of finished food.

The coefficient for export goods, being $0.081 + 0.256 = 0.34$, seems very reasonable. The coefficient 0.44 in the third term corresponds very well to the value found for cotton stocking, where separate figures are available (cf. section III 1).

III 7. IMPORTS OF RAW MATERIALS FOR INVESTMENT GOODS (y^i)

(i) *Theoretical.* The composition of this index is shown by the following chief items for 1907, in mlns of £:



III 7. "Explanation" of imports of raw materials for investment goods.

Wood and timber	25	Iron ore	7
Rubber	11	Copper ore	5
Tin	8	Iron and steel	4
Copper	7	Lead	4

The theory used is much the same as that used for III 6, but there is less reason now for distinguishing between home-consumed and exported investment goods.

(ii) *Statistical.* Since the relation found by correlation calculus, viz.:

$$y^i = 0.066\, v + 0.33\, \Delta y^i$$

shows too low a coefficient for v, this coefficient was determined a priori to be about $\bar{y}^i/\bar{v} = 0.14$, the import quota of the two types of investment goods, each of them not being far from this average. This leads to an equation:

(III 7) $$y^i = 0.14\, v + 0.15\, \Delta y^i$$