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# AN ECONOMETRIC MODEL OF AUSTRALIA, 1948–61*

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> "The preparation of essentially descriptive accounts of immigration into particular countries, together with indications of the supposed effects produced by this immigration, entails little difficulty. Much difficulty, however, besets attempts to isolate and evaluate with precision specific effects, economic and otherwise, produced in countries of immigration by foreign-born individuals who came there to make their homes."[1]

## I. Introduction

Unlike the majority of aggregate econometric models, the model presented in this paper was not designed for the purpose of forecasting. Instead, its main function is to serve as a means of analysing the cyclical effects of immigration on the Australian postwar economy. In particular, the paper will be mainly concerned with the question of the degree of stability of the Australian economic system under the impact of immigration.

In pursuing our task we shall adopt a basic model based on the hypothesis that the influx of immigrants causes shifts in the relationships of the system and that these shifts are directly related to the number of incoming immigrants. It will be assumed, however, that immigration leaves the coefficients attached to the explanatory variables unchanged. This

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1 J. J. Spengler, "Effects Produced in Receiving Countries by Pre-1939 Immigration", in Brinley Thomas (ed.), *Economics of International Migration* (London: Macmillan, 1958), p. 17.

implies that the immigration flow is introduced into the structural relationships as an additional variable. If each of the relationships in the system is of linear form, its mathematical specification will be given by

$$y = a_0 + a_1 X_1 + a_2 X_2 + \ldots a_k X_k + a_{k+1} M + u,$$

where

$y$ = endogenous variable to be explained.
$X_1, \ldots, X_k$ = endogenous and exogenous explanatory variables postulated by economic theory (excluding immigration or total population).
$M$ = influx of immigrants.
$u$ = random disturbance.

We shall assume that during the period under investigation the flow of immigrants has been determined exogenously—an assumption which is at least in part supported by evidence.[2] The introduction of immigration as an explicit variable in the structural equations enables us to examine the cyclical effects of immigration on the path of the endogenous variables through time. If we find that the coefficients attached to $M$ are likely to be close to zero, then we conclude that immigrants have been smoothly incorporated in the system without giving it a stimulus in either direction.

## II. Construction of the Model

In constructing the model, attention had to be paid to special characteristics which distinguish the Australian economy from most other western countries. The most important of these are:

(i) The economy is strongly dependent on foreign trade, exporting mainly farm products and raw materials and importing manufactured and semi-manufactured goods.
(ii) The farm sector accounts for an important part of gross national product and is typically unstable.
(iii) The economy is characterized by the existence of a large governmental sector, and it is subjected to influential governmental controls.
(iv) Minimum wage rates are periodically determined by the arbitration tribunals.

These characteristics make it necessary to pay special attention to exports and imports, to allow for the difference in the behaviour of farm and non-farm sectors, and to introduce institutional and "control" variables. In addition, there is, of course, the special consideration to be given to the factor of immigration.

[2] This is discussed by the author in his unpublished Ph.D. dissertation for Stanford University on *Australian Postwar Immigration: an Econometric Study*. The results there presented indicate that the net influx of immigrants has been unrelated to the level of economic activity in Australia.

The model which finally emerged is a result of fairly extensive experimentation with measurements, lags, various interpretations of theory and of governmental actions, etc. The basic form is Keynesian in the sense that the key macro-economic variables emphasized by Keynes are explained and measurements are, except for wage and price variables, carried out in real terms. The basic departures from Keynes are the introduction of dynamic elements, the absence of the pivotal role of the rate of interest, and the attempts to explain changes in the general price and money-wage levels. The relationships can be classified as those referring to consumption, investment, production, foreign trade, income, prices and wages; comments on some of these are given below.

The traditional approach to the construction of a consumption function is to make total consumption depend on disposable incomes of wage-earners, businessmen, and farmers, and possibly on other variables (*e.g.*, population, liquid assets, lagged consumption). This approach breaks down completely when applied to the Australian postwar data. There are two reasons for this. First, the income of farmers has been subjected to fairly violent fluctuations which have not been reflected in the consumption expenditure. It would seem that, at least for this sector, actual income is a poor explanatory variable concerning consumption and that perhaps "permanent income" would be a more appropriate concept to use.[3] However, separate data on the farm consumption do not exist and "permanent income" is notoriously difficult to measure. Secondly, incomes of wage-earners and of businessmen (including independent professional income) have been changing at much the same rate in the postwar period, so that it becomes impossible to separate their effects on consumption. This is a problem of multicollinearity which has also been encountered within the particular context of the consumption function in studies for other countries. In the Klein-Goldberger model for the United States the difficulty was resolved by incorporating results from cross-section studies into the equation relating to time series data.[4] In Australia this is impossible since no surveys of consumer expenditures of similar kind have been carried out to this date.

Previous single equation estimates of the consumption function in Australia considered consumption to be simply a function of non-farm disposable income.[5] Such a consumption function can be rationalized on the basis of the following assumptions:

[3] See M. Friedman, *A Theory of the Consumption Function* (Princeton: Princeton University Press, 1957), especially Chapter III.

[4] See L. R. Klein and A. S. Goldberger, *An Econometric Model of the United States, 1929-1952* (Amsterdam: North Holland Publishing Company, 1955), pp. 57-62.

[5] See H. W. Arndt and B. Cameron, "An Australian Consumption Function", *Economic Record*, XXXVI, 1957; and J. W. Nevile, "A Simple Econometric Model of the Australian Economy", *Australian Economic Papers*, I, 1962.

(i) The consumption of non-farm income earners (*i.e.*, of wage-earners and of businessmen) depends on their respective disposable incomes.
(ii) The ratio of disposable income of wage-earners to that of businessmen is constant for all periods under observation (or, alternatively, the two groups of income receivers have the same marginal propensity to consume).
(iii) Farmers tend to adapt their consumption to the level of consumption in the non-farm sector.

These assumptions have been accepted as a basis for the consumption function in our model; the function has been extended to include immigration in accordance with our general hypothesis.

The above consumption function was designed to exclude expenditure on motor-cars and motor-cycles since this was regarded as sufficiently distinctive to warrant a separate relationship. The distinctiveness is perhaps most significantly borne out by the fact that governmental measures to regulate aggregate demand have at times singled out the demand for motor-cars as one of the factors requiring special attention. The main regulator was the rate of sales tax which, accordingly, can be taken as one of the factors explaining changes in effective demand for automobiles. Other than sales tax, additional explanatory variables suggested by demand theory would be income, price of automobiles relative to other prices, total stock of cars, and perhaps availability and terms of instalment buying. The income variable is taken to be the disposable income in the non-farm household sector as in the case of other consumption. The relative price has not been considered as an explanatory variable because of lack of statistical information. In any case, the main variations in car prices are likely to have been due to changes in the rate of sales tax which is considered separately. The effect of the total stock of cars in existence has been excluded because of its high correlation with non-farm disposable income.[6] Instalment buying facilities have been disregarded on the assumption that their influence is sufficiently reflected in the income variable, which is included.

The investment in private dwelling in Australia since World War II has been made mainly by private households for the purpose of owner-occupation. Commercial investment in the construction of private dwellings has been carried out primarily for the purpose of resale rather than rental. This has been true with respect to both family houses and apartment buildings, which have been sold in sections of so-called "home units".[7] The

[6] The number of registered motor-cars in Australia on December 31, 1947 was 568,312, compared to 2,148,436 on June 30, 1961. See *Quarterly Summary of Australian Statistics*, December 1947, p. 69 and March 1962, p. 59.

[7] Exceptions to this could be found in holiday resort areas where some dwelling construction for renting purposes has taken place. Also, in some cases failure to sell the "home units" at a stipulated price resulted in their conversion into rented apartments.

low rate of investment in rental housing in the postwar period has been due to a combination of factors. The most important cause probably has been the regulation of rents which was introduced during the war and has persisted, to some extent, until the present.[8] Additional explanations could be found in the preference for home-ownership which lowers the demand for rental accommodation, and perhaps in the existence of more profitable investment outlets elsewhere.

The chief characteristic of the postwar housing situation in Australia had been a chronic shortage of existing dwellings compared to the number of households.[9] This shortage has prevailed all through the period of observation; it resulted mainly from the cessation of building activity during the war and the high rate of household formation after the war. The current demand for new housing has undoubtedly been affected by the unsatisfied demands of the past since the current rate of dwelling construction exceeded the rate of new household formation in almost every year of the postwar period. But the current demand for housing is only potentially determined by the existence of a shortage; the effective demand is influenced by the traditional demand variables such as income, price, and financial assets. The existence of a shortage affects the allocation of consumers' expenditure between various commodities (for instance, by postponing expenditure on durable goods until the demand for housing has been satisfied), but the demand does not become effective until the income, asset and price situation makes it possible. In addition, institutional factors such as the existence of rent control and availability of credit could be considered as being relevant. The main traditional demand determinant, income, will again be represented by personal disposable income in the non-farm sector. The level of financial assets was thought to be reasonably well measured by the aggregate level of savings banks deposits, especially since there appeared to be a close association between savings banks and various building societies.[10] However, a preliminary examination of data revealed a very low negative value of partial correlation between the investment in private housing and the level of total deposits in savings banks; consequently the variable representing accumulated savings in banks was omitted.[11] A price variable was not included because of the lack of

8 See, for example, P. H. Karmel and M. Brunt, *The Structure of the Australian Economy* (Melbourne: Cheshire, 1962), p. 21.

9 See, for example, A. R. Hall and M. R. Hill, "Housing Demand in Australia, 1949-74", *Economic Record*, XXXVI, 1960; "Prospects for Housing", Rural Bank of New South Wales: *Trends*, Vol. 4 (March 1959).

10 See M. R. Hill, *Housing Finance in Australia, 1945-56* (Melbourne: Melbourne University Press, 1959), pp. 81-83.

11 The partial correlation referred to the investment in housing and the level of savings banks deposits at the beginning of each period; the variables held constant were the previous year's disposable income, the relative price of building materials, the "dummy variable" representing rent control, and the previous year's influx of migrants. All money values were deflated.

information on prices of houses. The availability of credit is likely to have played a role in the fluctuations of effective demand for housing, but a direct measurement of contraction and expansion of credit is virtually impossible. The funds for housing finance came from a variety of sources, ranging from small building societies to government-subsidized schemes for war veterans and their relatives. No single measure can adequately represent the credit policy of these institutions.[12] We shall assume as before that changes in the availability of credit have been closely connected with changes in the level of income and thus may be represented by the income variable.

Our variables explaining changes in private investment in dwellings are then taken to be disposable income, extent of the housing shortage, and level of immigration. Because of the nature of the investment expenditure, all variables have been lagged by one year. Further, the variable representing personal disposable income has been confined to the non-farm sector as in the consumption relationships. It is to be noted that migrants, by adding to the number of families, are expected to influence the demand for housing through the "housing shortage" variable. In addition, they may also shift the level of demand at a given level of income and at a given state of housing shortage.

When we come to the consideration of private investment in fixed business capital, we encounter a number of different theories. The results of exploratory work in Australia suggest that an acceleration theory of the type proposed by Hicks could apply to investment in stocks, but that it is much less relevant to investment in fixed capital.[13] J. W. Nevile accepted the argument of A. Smithies and others that investment in fixed capital is mainly influenced by profits, both through the availability of funds and through expectations of profitability.[14] Accordingly, Nevile proposed and estimated a relationship in which fixed investment (including housing) was a linear function of lagged profits (measured by company income) and of changes in the level of profits. Nevile's estimation of the parameters was based on deflated values for the years 1949-50 to 1959-60 and a simple least squares method was used. The coefficients of both explanatory variables were found to be highly significant and the relationship was accepted as satisfactory. A different type of investment relationship was proposed by Duesenberry and used by Klein and Goldberger in their model of the United States.[15] According to Duesenberry, business investment depends on

[12] For a detailed description, see M. R. Hill, *op. cit.*

[13] See D. J. Smyth, "The Inventory and Fixed Capital Accelerators", *Economic Record*, XXXVI, 1960, pp. 414-418; also J. W. Nevile, *op. cit.*

[14] Nevile, *op. cit.*, p. 83; A. Smithies, "Economic Fluctuations and Growth", *Econometrica*, XXV, 1957, pp. 10-14.

[15] J. S. Duesenberry, *Business Cycles and Economic Growth* (New York: McGraw-Hill Book Company, Inc., 1958), pp. 192-198; L. R. Klein and A. S. Goldberger, *op. cit.*, pp. 10-13. But note that Klein and Goldberger considered only total gross private investment, *i.e.*, combined investment in housing, fixed business capital, and stocks.

lagged income and on capital stock at the beginning of the period. In the Klein-Goldberger model, total investment is made to depend on lagged income, initial stock of capital, and initial level of liquid assets held by enterprises. The last two variables were found to be not significant in influencing investment. A preliminary test of the two theories led to the rejection of the "profit" theory and an investment function of Duesenberry type was adopted. However, the stock of capital was omitted since it was found to be highly correlated with income.

The final element of total investment, investment in stocks, depends on the current production plans of firms. The change in the level of stocks is likely to be a result of two types of adjustment:

(i) adjustment to allow for expected changes in total demand for output, and
(ii) adjustment to correct for deviations of the actual from the expected demand in the past.

We shall hypothesize that the first type of adjustment is proportionate to the preceding change in income, and that the second type of adjustment is related to last year's ratio of stocks to output.[16] The relationship is confined to investment in non-farm stocks; investment in farm stocks is greatly affected by supply conditions and by fluctuations in export demand and, therefore, regarded as an exogenous variable.

The underlying purpose of introducing a production function into an econometric model is to establish a relationship between income and employment. Since in our case capital and labour appeared to be highly correlated, we have postulated a simple dependence of employment on income. This type of a production function, which implies either a fixed combination or homogeneity of first degree and constant relative prices of factors, appeared also in the Dutch model and in the U.S. model constructed by the Research Seminar in Quantitative Economics at the University of Michigan.[17] Our production or employment function contains no variable specifically related to immigration; its purpose is to serve as a means of determining the demand for labour and the effect of immigration has to be traced through the effect on income.

In setting up the import demand function I have considered the distribution of imports by "economic" classes.[18] On the basis of this it was possible to conclude that, in view of the likely lags in production and distribution, only a small proportion of imports represented current

[16] The second type of adjustment is related to the ratio rather than to the absolute difference between the actual and the "optimal" level of stocks mainly to avoid multicollinearity since the level of stocks and of output are highly correlated.

[17] The Dutch model is presented in L. R. Klein, *An Introduction to Econometrics* (Englewood Cliffs: Prentice-Hall, 1962), pp. 222-229; for the description of the University of Michigan model of the United States see D. B. Suits, "Forecasting with an Econometric Model", *American Economic Review*, LII, 1962.

[18] Published in the *Monthly Review of Business Statistics* (Commonwealth Bureau of Census and Statistics, Canberra).

consumption. Thus we may expect that the demand for imports would be for the most part governed by factors similar to those that determine the demand for inventories and for fixed capital equipment. A modification, however, may arise from the difference between domestic and foreign prices and to the existence of governmental control. The relation between prices of imports and prices of domestic goods is traditionally considered as one of the demand-determining factors, but its importance in the postwar Australian setting is likely to have been only slight for the following reasons:

(i) A number of imported goods were produced locally only in small quantities or not at all.[19]
(ii) The existence of import controls for most of the period considerably reduced the sphere of competition of imported goods with the local products.[20]
(iii) There has been very little change in the ratio of import prices to the wholesale prices of goods that are principally home produced, at least since 1952-53.[21]

On the other hand, the existence of import licensing controls, which have been used with varying degrees of severity during most of the postwar period, was undoubtedly a factor of major significance in imposing limits on the effective demand for imports. Consequently, the problem of setting up a relationship to describe the demand for imports turns into the problem of specifying the relevant factors of investment demand and of devising a measure of the strength of direct import controls. Since the different types of investment through imports cannot be separated, we need an explanatory factor which would, to some extent, relate to all of them. We shall place the burden of explanation, at least as an hypothesis, on the simple acceleration principle. The measurement of the strength of direct import controls constituted a major problem. In general, the government varied its policy in accordance with the balance of payments situation.[22] However, the actual balance of payments turned out to be a poor indicator of the qualitative changes in import controls outlined above, probably because decisions were taken at a time when only some informa-

19 Of the total imports of merchandise, about 50 per cent, on the average, have been free of duty. *Year Book of the Commonwealth of Australia*, 1960, p. 496. Since "the Australian Customs Tariff has been developed in conformity with the policy of protecting economic and efficient Australian industries" (*ibid.*, p. 469), the above dichotomy of imports is a reasonable measure of the degree to which imports compete with local products.

20 "While Australian imports have been running at the rate of some 15 per cent of gross national product, they have been largely non-competitive with Australian production . . ." (P. H. Karmel and M. Brunt, *op. cit.*, p. 87.)

21 See *Statistical Bulletin—Economic Supplement* (Reserve Bank of Australia, November 1961), p. 12.

22 See *History of Australia's Import Licensing Measures* (Canberra: Department of Trade, 1959); and G. Moffatt, "The Australian Import Licensing System: 1952-1960", *Australian Economic Papers*, I, 1962.

tion about the flow of trade and capital was available. Further, the balance was obviously affected by the import controls currently and previously in force. Thus, a favourable balance was, by itself, not necessarily a sufficient reason for relaxing the controlling measures. After considerable experimentation, it was found that the government policy in any given year tended to be guided by the level of exports in the preceding year. This seems reasonable also on *a priori* grounds, since the figures on exports are readily available, widely publicized, and have the role of one of the main barometers of the health of the economy. It is likely that governmental decisions with respect to imports were largely influenced by the size of the export income.

On the basis of our argument, the demand for imports will be made to depend on lagged change in income, lagged exports, and immigration. All value variables are to be deflated by the same index of general price level, partly as a matter of principle[23] and partly as a means of retaining the influence of the changes in the terms of trade in the model. The latter are relevant from the point of view of the balance of payments. Deflating imports and exports by the general price index preserves the relative value relationships. An essentially similar procedure was adopted by Klein and Goldberger in the import demand equation of the U.S. model.

According to the modern theory of inflation, prices can be subjected to the pressure of cost-push or demand-pull, or both. The cost-push element has its main basis in the cost of labour. Its operation is likely to be particularly important in Australia, where minimum wage rates are determined periodically by the arbitration system. Any changes in the basic wage automatically and immediately result in a general wage adjustment,[24] and there is little doubt about the close connection between prices and costs. P. H. Karmel, for example, writes: "In fact, it seems that prices are fairly firmly attached to costs, and the effect of excess demand, in the first instance, is in lengthening of order-books, queuing and shop-shortages".[25] On theoretical grounds it seems more appropriate to approximate the cost-push forces by nominal wage rates rather than by wage earnings since wage increases in excess of those determined by the Court are, at least partially, secured at the expense of profits.[26]

[23] For a rationale of using one index to deflate all components of national income see, *e.g.*, C. F. Christ, "Aggregate Econometric Models", *American Economic Review*, XLVI, 1956, pp. 395-397.

[24] "The increase in the American minimum wage in 1956 from 75c to $1 per hour is estimated to have affected less than 10 per cent of the work force. A rise in the basic wage in Australia affects all wage earners and most salary earners." J. E. Isaac in *Wage Determination and Economic Stability* (Sydney: The Economic Society of Australia and New Zealand, Economic Papers No. 14, 1960), p. 12.

[25] *Wage Determination and Economic Stability*, p. 47.

[26] It was at first thought that import prices should also be considered as another cost-push variable. However, in the preliminary estimation the coefficient attached to the price of imports turned out to be negative and not statistically significant.

The second force influencing prices—the "pull" of demand for goods and services—is difficult to measure in a direct way. It is, however, possible to devise an indirect measure which may be adequate for the purpose. When discussing the production function earlier in this section we argued that there has been very little substitution between labour and other factors of production. If this argument is correct, then a situation of excess demand for goods and services would necessarily be associated with a situation of excess demand for labour, and excess demand for labour can be measured by the difference between the number of unfilled vacancies and the number of unemployed. Since, as suggested by Karmel, there appears to be a delay before prices begin to respond to the pressures of demand, the variable representing the excess demand (positive or negative) should be introduced with a lag.

The above discussion on the determination of prices is also illuminating in connection with the process of determination of wages. The actual wages earned are, of course, typically different from the minimum wage rates set by the arbitration tribunals. As pointed out, any change in the minimum wage rate (and in minimum awards for skill) results in a general adjustment of wages. The changes in the minimum wage rates are thus eminently relevant in explaining changes in earnings. It remains, then, to consider the determinants of the movement in wage earnings other than that accounted for by the wage legislation—the so-called "wage drift". In part, the difference results from payments for overtime work,[27] but this is likely to have been relatively unimportant compared to the extent of over-award wage payments made by employers. In times of positive excess demand for labour one would expect that the upward drift in wage earnings would simply be the result of the competition of employers for scarce labour. However, this explanation is unsatisfactory since the drift persisted, and sometimes even increased, during periods in which the number of unemployed increased and the number of unfilled vacancies declined. A more promising factor to explain the wage drift appears to be the productivity of labour. If productivity of labour increases more than is acknowledged by the Court in the form of minimum wage increases, labour is bound to exercise other pressures to participate in the gain. On the other hand, the resistance of employers to wage increases is undoubtedly weakened if the existing profits are not threatened.[28]

The remaining equations of our system require no special explanation. The variables used are listed below.

[27] The exact extent of this factor cannot be ascertained since there is no statistical information on the number of hours worked covering most of the period of this study.

[28] It is interesting to note that Klein *et al.*, in *An Econometric Model of the United Kingdom*, pp. 76-77, have also used productivity of labour rather than a demand variable to explain the "spread between wage rates and earnings".

*Endogenous variables:*

$A$ = expenditure of financial enterprises, deflated (£m.)
$B$ = company income, deflated (£m.)
$C$ = consumption expenditure excluding expenditure on motor-cars, deflated (£m.)
$D$ = non-farm personal disposable income, deflated (£m.)
$F$ = farm income, deflated (£m.)
$H$ = gross private investment in dwellings, deflated (£m.)
$I$ = gross private investment in fixed capital excluding dwellings, deflated (£m.)
$J$ = end-of-year excess of number of households over number of dwellings in existence (thousands)
$L$ = average number of unfilled job vacancies *less* number of unemployed applicants (thousands)
$N$ = average non-farm civilian employment (thousands)
$Q$ = imports of goods and services, deflated (£m.)
$S$ = end-of-year level of non-farm stocks, deflated (£m.)
$V$ = private consumer expenditure on motor-cars, deflated (£m.)
$X$ = non-farm personal income, deflated (£m.)
$Y$ = gross national product, deflated (£m.)
$Z$ = ratio of non-farm stocks to G.N.P.
$p$ = composite price index (1952-53 = 1,000)
$p^H$ = average value of a dwelling, deflated (thousands £)
$w^B$ = index of average weekly earnings per employed male unit in non-rural industries (1952-53 = 1,000)

*Exogenous variables:*

$E$ = exports, deflated (£m.)
$G$ = government expenditure, deflated (£m.)
$M$ = net annual immigration (thousands)
$O$ = end-of-year level of farm stocks, deflated (£m.)
$R$ = payments to overseas for government transactions and foreign travel, deflated (£m.)
$T$ = average rate of sales tax on motor-cars (per cent)
$f^N$ = net non-immigrant household formation (thousands)
$f^M$ = net influx of immigrant households (thousands)
$p^A$ = agricultural terms of trade (1952-53 = 1,000)
$t$ = time in years (1946-47 = 0)
$w^N$ = index of average minimum wage rate of adult males (1952-53 = 1,000)

In our classification of the variables we have followed the established tradition of including all governmental, external and demographic variables in the exogenous category. Agricultural terms of trade are regarded as

exogenous because of their dependence on overseas demand and on agricultural supply conditions. The minimum wage rate is determined by the arbitration system and the wage decisions are, at best, only vaguely related to the prevailing economic conditions.[29] The system contains 18 equations and identities and 19 endogenous variables; however, one of the endogenous variables—excess demand for labour, $L$—enters only with a lag.

## III. Data and Estimation

The estimates of the structural parameters of the model are based on 14 annual observations from 1947-48 to 1960-61. Most of the data were taken from *National Income and Expenditure* for various years, but some series had to be derived from secondary sources. Since, at the time of constructing and estimating the model, national income statistics were not as yet available in terms of constant prices, an adjustment for price changes and stock valuation had to be made. I have followed the procedure previously adopted by several Australian economists and formed a "composite price index" which gives the weight of two-thirds to the retail and one-third to the wholesale prices.[30] While it would have been preferable to use the "implicit price deflator" which is now available, the error of using the composite index is of minor order since the two indices are extremely highly correlated (with a correlation coefficient of 0·9897) over the period considered.[31] The data used are set out in an appendix to this paper.

In estimating the structural parameters two methods have been used. For all relationships in which the explanatory factors do not include current endogenous variables we have used the simple least squares method (SLS), since the estimates are consistent. All other relationships have been estimated by the two-stage least squares method (TSLS). The latter requires estimation of the reduced form for all explanatory current endogenous variables, which, with one exception, involved all the predetermined (*i.e.*, exogenous and lagged endogenous) variables of the system. If, in estimating the reduced form equations, we were to use all the theoretically required variables, the degrees of freedom would be reduced to an embarrassingly low number and the problem of multicollinearity would arise. Other workers have encountered the same difficulty. The problem was usually resolved by choosing a "selective set" of predetermined variables. The set was selected in such a way as to include all the predetermined variables explicitly occurring in the particular structural equations plus the most important

[29] See K. Hancock, "Wages Policy and Price Stability in Australia", *Economic Journal*, LXII, 1960; K. Hancock, "The Basic Wage and the Cost of Living", *Australian Economic Papers*, I, 1962; P. H. Karmel and M. Brunt, *op. cit.*, p. 40 and p. 133.

[30] See, for example, the articles by Smyth and Nevile referred to above.

[31] This assertion can be further confirmed by the fact that, over the period considered, the coefficients of correlation between the official national income figures in 1953-54 prices and our "deflated" figures are 0·9915 for consumption and 0·9747 for G.N.P.

among those remaining.[32] We have adopted essentially the same principle. Our set of predetermined variables consists of

$E_t$ = current exports, deflated (£m.)
$E_{t-1}$ = lagged exports, deflated (£m.)
$M_t$ = current net immigration (thousands of persons)
$M_{t-1}$ = lagged net immigration (thousands of persons)
$T_t$ = average rate of sales tax on motor-cars (per cent of selling price)
$Y_{t-1}$ = lagged G.N.P., deflated (£m.)

The estimates of the structural parameters are presented in Table I. The system can be divided into an "aggregate real sector" which is self-contained (*i.e.*, no endogenous variables are determined by reference to other sectors), and a "price and wage sector" which can be fully explained only by referring to the aggregate real sector. Thus the aggregate real sector is "dynamically complete" in the sense that we can solve iteratively for the values of the endogenous variables.[33] However, the price and wage sector, and thus the entire system, is dynamically incomplete because no explanation of $L$—the excess demand for labour—has been attempted.

From the point of view of macro-economic theory a striking feature of our system is the apparent absence of explicit monetary factors. There are two reasons for this. In the first place, some of the factors of monetary significance are extremely difficult to measure. For instance, the factor often emphasized in academic and public discussion in Australia is the government policy of credit restrictions which frequently take the form of "qualitative" directions over bank lending.[34] The extent of these restrictions cannot be measured—not even by their effect on the size of bank loans and advances, since overdraft limits may not have been reached or are in the short run inflexible.[35] A similar difficulty arises from the problem of measuring the rate of interest: there is no Bank Rate and no data on the yields of debentures or other commercial papers, and interest rates on bank overdrafts and mortgages change only very rarely.[36] The second reason for

[32] L. R. Klein and A. S. Goldberger, *op. cit.*, p. 49; L. R. Klein, *et al.*, *An Econometric Model of the United Kingdom*, p. 195.

[33] For a fuller explanation see A. S. Goldberger, *Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model* (Amsterdam: North-Holland Publishing Co., 1959), p. 7 and the subsequent analysis.

[34] P. H. Karmel, "The Australian Economy, March 1961", *Economic Record*, XXXVII, 1961, p. 9.

[35] "It is only over the last two years that statistics have been compiled of the aggregate outstanding overdraft limits of the trading banks . . . Over the two year period for which figures are available, the lowest unexercized proportion of overdraft limits was 36 per cent and the highest 44 per cent. Mostly it has been around 40 per cent . . ." Quoted from "Suitability of Overdraft Limit System", *Sydney Morning Herald*, July 18, 1962. It should be noted that the period mentioned includes the time of severe credit restrictions introduced in 1960.

[36] For a summary of interest rates, see Reserve Bank of Australia, *Statistical Bulletin—Financial Supplement* (September 1960), pp. 37-40.

## TABLE I

### *An Econometric Model of Australia, 1948-61*

(i) AGGREGATE REAL SECTOR

| | Method of Estimation | $R^2$ |
|---|---|---|
| *Consumption* | | |
| (1) Excluding motor vehicles: $C_t = 219{\cdot}0122 + \underset{(0{\cdot}0486)}{0{\cdot}9129^{**}}\ D_t - \underset{(0{\cdot}6275)}{0{\cdot}4027}\ M_t + \hat{u}_{1t}$ | TSLS | 0·9698 |
| (2) Motor vehicles: $V_t = -166{\cdot}5387 + \underset{(0{\cdot}0164)}{0{\cdot}11866^{**}}\ D_t - \underset{(0{\cdot}9535)}{2{\cdot}2804^{*}}\ T_t + \underset{(0{\cdot}1053)}{0{\cdot}1362}\ M_{t-1} + \hat{u}_{2t}$ | TSLS | 0·9105 |
| *Investment* | | |
| (3) Dwellings: $H_t = 313{\cdot}8060 + \underset{(0{\cdot}0080)}{0{\cdot}1099^{**}}\ D_{t-1} + \underset{(0{\cdot}0674)}{0{\cdot}4452^{**}}\ J_{t-1} + \underset{(0{\cdot}0898)}{0{\cdot}0170}\ M_{t-1} + \hat{u}_{3t}$ | SLS | 0·9194 |
| (4) Fixed capital excluding dwellings: $I_t = -199{\cdot}4438 + \underset{(0{\cdot}0070)}{0{\cdot}1397^{**}}\ Y_{t-1} + \underset{(0{\cdot}1397)}{0{\cdot}3869^{*}}\ M_t + \hat{u}_{4t}$ | SLS | 0·9749 |
| (5) Non-farm stocks: $S_t - S_{t-1} = 1{,}397{\cdot}0431 - \underset{(804\ 0000)}{4{,}487{\cdot}0823^{**}}\ Z_{t-1} - \underset{(0{\cdot}0667)}{0{\cdot}0204}\ (Y_{t-1} - Y_{t-2}) + \underset{(0{\cdot}2139)}{0{\cdot}1701}\ M_t + \hat{u}_{5t}$ | SLS | 0·9425 |
| *Expenditure of financial enterprises* | | |
| (6) $A_t = -1{\cdot}4407 + \underset{(0{\cdot}0006)}{0{\cdot}0117^{**}}\ (Y - F)_{t-1} + \underset{(0{\cdot}0140)}{0{\cdot}0129}\ M_t + \hat{u}_{6t}$ | SLS | 0·9675 |
| *Employment* | | |
| (7) $N_t = 1{,}737{\cdot}5573 + \underset{(0{\cdot}0146)}{0{\cdot}2356^{**}}\ (Y - F)_t + \hat{u}_{7t}$ | TSLS | 0·9558 |
| *Import demand* | | |
| (8) $Q_t = 274{\cdot}1855 + \underset{(0{\cdot}0827)}{0{\cdot}3466^{**}}\ (Y_{t-1} - Y_{t-2}) + \underset{(0{\cdot}1622)}{0{\cdot}4335^{*}}\ E_{t-1} + \underset{(0{\cdot}6323)}{1{\cdot}8842^{*}}\ M_t + \hat{u}_{8t}$ | SLS | 0·8881 |
| *Income* | | |
| (9) Company income: $B_t = -147{\cdot}6037 + \underset{(0{\cdot}0130)}{0{\cdot}1289^{**}}\ (Y - F)_t + \underset{(0{\cdot}0726)}{0{\cdot}1701^{*}}\ F_t + \underset{(0{\cdot}2505)}{0{\cdot}0441}\ M_t + \hat{u}_{9t}$ | TSLS | 0·9315 |
| (10) Farm income: $F_t = -752{\cdot}3015 + \underset{(0{\cdot}0898)}{0{\cdot}8638^{**}}\ E_t + \underset{(0{\cdot}0771)}{0{\cdot}4887^{**}}\ p^{A} + \hat{u}_{10t}$ | SLS | 0·9380 |

TABLE I—*continued*

| *Income* | Method of Estimation | $R^2$ |
|---|---|---|
| (11) Non-farm personal disposable income: $D_t = 43{\cdot}4236 + 0{\cdot}9313^{**}\ X_t + \hat{u}_{11\,t}$ (0·0319) | TSLS | 0·9862 |
| (12) Non-farm personal income: $X_t = 712{\cdot}0987 + 0{\cdot}6191^{**}\ (Y-F)_t + \hat{u}_{12\,t}$ (0·0184) | TSLS | 0·9895 |
| (13) Gross national product: $Y_t = A_t + C_t + E_t + G_t + H_t + I_t + (O_t - O_{t-1}) - Q_t - R_t + (S_t - S_{t-1}) + V_t$ | | |
| *Other relations* | | |
| (16) Housing shortage: $J_t = J_{t-1} + f_t^N + f_t^M - (H/p^H)_t$ | | |
| (17) Average value of a dwelling: $p_t^H = 1{\cdot}9948 + 0{\cdot}0878^{**}\ t + \hat{u}_{17\,t}$ (0·0253) | SLS | 0·7621 |
| (18) Ratio of non-farm stocks to GNP: $Z_t = S_t/Y_t$ | | |
| (ii) PRICES AND WAGES | | |
| (14) Prices: $p_t = 31{\cdot}4013 + 0{\cdot}9174^{**}\ w_t^N + 0{\cdot}4582^{*}\ L_{t-1} + 0{\cdot}1542\ M_t + \hat{u}_{14\,t}$ (0·0342) (0·1947) (0·1987) | SLS | 0·9945 |
| (15) Wages: $w_t^H = 455{\cdot}3844 + 0{\cdot}9822^{**}\ w^N + 340{\cdot}7600^{**}\ (Y-F)_t/N_t + 0{\cdot}1196\ M_t + \hat{u}_{15\,t}$ (0·0319) (41·9000) (0·0910) | TSLS | 0·9988 |

*Notes:*

(i) Standard errors of coefficients are shown in parentheses.

(ii) Asterisks represent levels of significance; a single asterisk means "significant at the five per cent level" and a double asteris "significant at the one per cent level" (not applicable to regression constants for which standard errors have not been comp

(iii) $R^2$ has been calculated by the conventional formula for the coefficient of determination; in the case of equations estimate TSLS method the calculation was based on the second-stage least squares regression.

(iv) The last column shows the Durbin-Watson statistic to test the null hypothesis of independence of disturbances against the al hypothesis that successive disturbances are positively correlated. Here ‡ means "do not reject the null hypothesis at five level", ‡‡ means "do not reject the null hypothesis at one per cent level", i stands for "inconclusive test", and § means "r null hypothesis in favour of the alternative hypothesis of positive correlation"

neglecting the monetary factors is the fact that those monetary variables which it was possible to measure (the quantity of money, bank loans and advances, bank deposits, yield of government bonds, etc.) manifestly failed to improve any of the relationships in which their relevance might possibly be expected.[37] It appeared that monetary factors had no influence on the course of the endogenous variables in our model and that adequate explanations could be offered with reference to the "real" variables alone.

It is interesting to note that the same conclusion concerning the lack of importance of monetary factors was reached in the econometric study of the United States economy.

> "Although the initial formulation of the model by Klein and Goldberger allowed for numerous interdependencies between real variables and money variables, the estimated model shows few important plausible connections between them. . . . It may be that the dichotomization of the KG model simply reflects the situation in the real world. That is, the influence of the monetary phenomena upon income, output and employment is minimal."[38]

In the U.S. model, monetary factors appear only because liquid assets are presented as an explanatory variable in the consumption and investment equations. In each case their coefficient is not statistically significant,[39] which gives the impression that the authors were making a concession to their "money-minded" professional colleagues. Similar situations can be found in the British quarterly model where the bridge into the monetary sphere is, apart from the variables relating to international reserves, provided by the appearance of the rate of interest in the equation determining the production of capital goods. The authors state: "We have tried hard to forge this link empirically, without success, but on the basis of *a priori* analysis this is where the link might logically come".[40] Here again the estimated coefficient attached to the rate of interest is not significantly different from zero. It should be emphasized, however, that in the case of our model the absence of monetary factors may just be the result of difficulties of measurement or of over-simplified aggregation. At any rate, monetary factors may have affected the price level indirectly through the excess demand for labour which remains unexplained. Since the latter appears in the system only with a lag, the effect of monetary variables would also necessarily be lagged.[41]

[37] In the preliminary experiments monetary variables were introduced, without success, in the equations on business investment in fixed capital, housing investment, and price determination.

[38] A. S. Goldberger, *op. cit.*, p. 133.

[39] Except for the coefficient attached to liquid assets in the consumption function of the revised version of the model.

[40] L. R. Klein, *et al.*, *An Econometric Model of the United Kingdom*, p. 55.

[41] Some monetary factors are built into our model implicitly, since money values of imports and exports have been deflated by the same general price index. This implies that monetary effects of changes in overseas terms of trade are allowed to play their part in the system.

With respect to the main purpose of our study, the most important result revealed by the estimated relationships is the lack of significance of the migration factor in most of the equations. It appears that immigration flow had a directly significant effect only on business demand for fixed capital equipment and on the demand for imports. In other words, there is no statistical evidence that immigration caused structural shifts in any but two of the estimated relationships. Apparently the flow of immigrants has been absorbed into the Australian economy with relatively little structural change.

The relevance of immigration to business investment in fixed capital is largely in accordance with our expectations. Business investment decisions are likely to be influenced by the current level of immigration in two ways. First, immigration stimulates the expectation of a growing demand in the future. Secondly, immigration raises the limits of capital expansion imposed by the size of the available work force. The latter implies complementarity of labour and capital which, as we argued earlier, appears to have been predominating. Unfortunately, we have no ways of finding which of the two kinds of influences was the more important.

The significance of immigration in the import demand relationship is also not surprising—the influence of immigrants in this respect has often been emphasized. It arises partly through the stimulating effect of immigration on business fixed investment in general, partly through the demands of immigrants and immigration-induced government expenditure,[42] and partly through the influence of immigrants on the tastes of non-immigrants.[43] At the same time it should be noted that the coefficient attached to the migration variable in the import demand equation has a fairly large standard error, indicating a wide range of uncertainty. Its value is, however, significantly higher than the corresponding value in the investment equation. That is, the effect of immigration on the demand for imports appears to be considerably greater than its effect on the demand for fixed investment.

On the basis of our test we have to conclude that migration did not directly influence the level of prices or wages. This is a revealing result, since almost any analysis of the postwar inflation in Australia contains a reference to immigration as one of the contributory factors.[44] Of course, immigration

[42] Note also that the definition of imports in the national income statistics includes fares paid in Australia to oversea shipping companies as well as imports of immigrants' household effects. See, *e.g.*, *The Australian Balance of Payments 1928-29 to 1951-52*, p. 21.

[43] For a lengthy discussion on this topic see A. Lodewyckx, *People for Australia* (Melbourne: Cheshire, 1956), Chapter 17. W. M. Corden, analysing this problem in "The Economic Limits to Population Increase", *Economic Record*, XXXI, 1955, concluded that "irrespective of whether additional investment takes place or not, it seems reasonable to conclude that the initial impact of a population increase is to cause a balance of trade deficit" (p. 249).

[44] A representative example can be found in D. B. Copland, *Inflation and Expansion* (Melbourne: Cheshire, 1951), p. 50.

may have affected prices indirectly through the excess demand variable, but no direct structural effects are apparent. Similarly, it is often argued that immigration, by increasing the supply of labour, tends to depress wages. Our results, however, give a positive—although not significant—value of the appropriate coefficient in the wage equation. Thus, the hypothesis cannot be accepted. This conclusion is reinforced by the fact that changes in wage earnings can be almost fully explained by the minimum wage set by the court and by the productivity of labour. The indirect effect of immigration on the wage level is to be traced through the effect of immigration on the productivity of labour.

As a general description of the structure of the Australian economy, the estimated relationships seem quite plausible. The combined marginal propensity to consume of wage earners and of businessmen is less than 0·913. The demand for motor cars responds positively to increases in lagged income and negatively to increases in the rate of sales tax. When sales tax remains unchanged, about 12 per cent of each increase in disposable income is spent on cars. In the equation describing the demand for private dwellings, the estimated coefficient of the "housing shortage" variable implies that, with income unchanged, about 15-20 per cent of additional home-seeking families will purchase a dwelling in the following year.[45] In equation (5) the effect of lagged change in G.N.P. on investment in non-farm stocks is not significantly different from zero. The estimated value of the constant term and of the coefficient of $Z_{t-1}$ suggests that the desired ratio of non-farm stocks to G.N.P. —*i.e.*, the ratio which would occasion no further adjustment to inventories— has been about 0·31.[46] The estimates of the remaining structural equations are straightforward and require no special comment.

Statistically, our results seem quite satisfactory: the observed data fit the theoretical relationships quite well and autocorrelation of disturbances is unlikely to have been present in most cases. All explanatory variables appear with statistically significant coefficients, except migration and $(Y_{t-1} - Y_{t-2})$ in the equation determining investment in non-farm stocks, and the signs of the coefficients agree with prior expectations.

## IV. Dynamic Effects of Immigration and of Other Exogenous Variables

In the previous section we have confined our attention to the direct effects of immigration on the structure of the Australian economic system. Presently, we shall examine the effect of immigration and of other exogenous variables on the path of the endogenous variables through time and analyse the dynamic properties of the model. The construction and estimation of the structural relationships discussed so far have been for the purpose of testing

[45] The average "real" cost of a dwelling was about £2,500, and 445/2,500 = 0·178.
[46] *I.e.*, —(1,397·0431)/(—4,487·0823).

the significance of immigration. To simplify further analysis, we shall eliminate the migration variable from those relationships in which its apparent influence was of minor importance and obtain new estimates.[47]

The revised version of the model can be used to obtain a derived reduced form, that is, to express each current endogenous variable as a function of the predetermined (exogenous and lagged endogenous) variables of the system. The coefficients attached to the predetermined variables in the reduced form equations are called "impact multipliers". They measure the short-run effects of predetermined variables on the current values of the endogenous variables. In deriving the reduced form we make use of the following simplifications:

(i) Following the usual procedure we disregard all the structural disturbances.
(ii) Since the structural equations (15), (16) and (18) are non-linear, the exact values of the impact multipliers in the solution for $J_t$, $Z_t$ and $w^E{}_t$ cannot be determined in the conventional way. We shall, therefore, use linear approximations of these equations as suggested by Klein.[48]

The calculated impact multipliers are shown in Table II.

The reduced form solution presents a clear picture of the immediate impact of immigration on all the important economic variables. This effect, when present, operates in a depressing way except in the case of business investment in fixed capital and, of course, imports. The underlying reason for this is the relatively high stimulating effect of immigration on the demand for imports which swamps the positive effect of immigration on business investment in fixed capital. The impact effect of current exports is obviously stimulating; the impact multiplier of exports with respect to G.N.P. is equal to 1·2. Previous year's exports have a depressing effect through the positive influence on current imports. The impact multiplier of government expenditure on G.N.P. is estimated to be about 2·5.

The actual contribution of a predetermined variable to the explanation of the movement of an endogenous variable depends not only on the size of the impact multiplier, but also upon the movement of the predetermined variable during the sample period. Both of these elements should be taken into consideration when making an assessment. A measure of the importance of each of the predetermined variables on the movement in the endogenous variables has been devised by A. S. Goldberger[49] as

$$m_{ij} = \pi_{ij} \sum_t |\Delta z_{jt}|,$$

[47] The relationships involved are (1), (2), (3), (5), (6), (9), (14), and (15). In re-estimating equation (5) the variable $(Y_{t-1} - Y_{t-2})$ was also omitted.

[48] L. R Klein, *A Textbook of Econometrics* (Evanston: Row, Peterson and Co., 1953), p. 121.

[49] *Op. cit.*, p. 72.

## TABLE II

*Impact Multipliers*

| Endogenous Variable | Predetermined Variable | | | | | | |
|---|---|---|---|---|---|---|---|
| | $M_t$ | $E_t$ | $E_{t-1}$ | $(G + \Delta O - R)_t$ | $T_t$ | $p_t^A$ | $(f^N + f^M)_t$ |
| $A_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $B_t$ | −0·4808 | 0·1964 | −0·1392 | 0·3211 | −0·7848 | −0·0705 | 0 |
| $C_t$ | −1·9468 | 0·1771 | −0·5637 | 1·3003 | −3·1779 | −0·6354 | 0 |
| $D_t$ | −2·1375 | 0·1944 | −0·6189 | 1·4276 | −3·4891 | −0·6976 | 0 |
| $F_t$ | 0 | 0·8638 | 0 | 0 | 0 | 0·4887 | 0 |
| $H_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $I_t$ | 0·3869 | 0 | 0 | 0 | 0 | 0 | 0 |
| $J_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| $N_t$ | −0·8734 | 0·0794 | −0·2529 | 0·5833 | −1·4257 | −0·2850 | 0 |
| $Q_t$ | 1·8842 | 0 | 0·4335 | 0 | 0 | 0 | 0 |
| $\Delta S_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $V_t$ | −0·2629 | 0·0239 | −0·0761 | 0·1756 | −2·8733 | −0·0858 | 0 |
| $X_t$ | −2·2951 | 0·2088 | −0·6645 | 1·5328 | −3·7463 | −0·7490 | 0 |
| $Y_t$ | −3·7071 | 1·2010 | −1·0733 | 2·4759 | −6·0512 | −0·7212 | 0 |
| $Z_t$ | 0·0002 | −0·0001 | 0·0001 | 0·0002 | 0·0004 | 0·0000 | 0 |
| $p_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $p_t^H$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $w_t^E$ | −0·2869 | 0·0259 | −0·0830 | 0·1916 | −0·4682 | −0·0936 | 0 |
| $\left(\frac{Y-F}{N}\right)_t$ | −0·0009 | 0·0001 | −0·0002 | 0·0006 | −0·0014 | −0·0003 | 0 |

TABLE II (*continued*)

| Endogenous Variable | Predetermined Variable | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $w_t^N$ | $D_{t-1}$ | $F_{t-1}$ | $J_{t-1}$ | $L_{t-1}$ | $Y_{t-1}$ | $Y_{t-2}$ | $Z_{t-}$ |
| $A_t$ | 0 | 0 | −0·0117 | 0 | 0 | 0·0117 | 0 | 0 |
| $B_t$ | 0 | 0·0362 | −0·0038 | 0·1553 | 0 | −0·0627 | 0·1113 | −1,347 |
| $C_t$ | 0 | 0·1466 | −0·0152 | 0·6290 | 0 | −0·2538 | 0·4507 | −5,457 |
| $D_t$ | 0 | 0·1610 | −0·0167 | 0·6906 | 0 | −0·2787 | 0·4948 | −5,992 |
| $F_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $H_t$ | 0 | 0·1128 | 0 | 0·4838 | 0 | 0 | 0 | 0 |
| $I_t$ | 0 | 0 | 0 | 0 | 0 | 0·1397 | 0 | 0 |
| $J_t$ | 0 | −0·0425 | 0 | 0·8177 | 0 | 0 | 0 | 0 |
| $N_t$ | 0 | 0·0658 | −0·0068 | 0·2822 | 0 | −0·1139 | 0·2022 | −2,448 |
| $Q_t$ | 0 | 0 | 0 | 0 | 0 | 0·3466 | −0·3466 | 0 |
| $\Delta S_t$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | −4,197 |
| $V_t$ | 0 | 0·0198 | −0·0020 | 0·0849 | 0 | −0·0343 | 0·0609 | −7,737 |
| $X_t$ | 0 | 0·1729 | −0·0179 | 0·7416 | 0 | −0·2992 | 0·5312 | −6,433 |
| $Y_t$ | 0 | 0·2793 | −0·0290 | 1·1978 | 0 | −0·4833 | 0·8581 | −10,392 |
| $Z_t$ | 0 | 0·0000 | 0·0000 | −0·0001 | 0 | 0·0001 | 0·0000 | 0 |
| $p_t$ | 0·9016 | 0 | 0 | 0 | 0·3482 | 0 | 0 | 0 |
| $p_t^H$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $w_t^E$ | 0·9886 | 0·0216 | −0·0023 | 0·0926 | 0 | −0·0375 | 0·0664 | −804 |
| $\left(\frac{Y-F}{N}\right)_t$ | 0 | 0·0001 | 0·0000 | 0·0003 | 0 | −0·0001 | 0·0002 | −2 |

where $m_{ij}$ = measure of importance of the $j$-th predetermined variable in explaining the movement in the $i$-th endogenous variable;

$\pi_{ij}$ = impact multiplier of $j$-th predetermined variable on $i$-th endogenous variable;

$\sum_t |\Delta z_{jt}|$ = sum of the absolute values of the annual changes in the $j$-th predetermined variable over the sample period.

The results of the calculations and the ranking of the predetermined variables according to their individual contributions to the changes in the values of the main endogenous variables are shown in Table III.

The calculations clearly show that the immediate impact of immigration has not been, in general, very important in inducing changes in the endogenous variables of the system. Immigration can be found in the front ranks only in the determination of changes in fixed capital investment and in imports—that is, only in the cases where immigration had a direct structural influence. But, even here, immigration was of less importance than other predetermined factors of direct influence. With respect to other endogenous variables, immigration appeared to be overshadowed by past levels of G.N.P. and of inventories, by exports, and by government expenditure. In general, the results demonstrate the importance of foreign trade for the Australian economy. One can see this explicitly in the influence of exports, but it is also implicit in the high rank accorded to $Y_{t-2}$ which appears in the system only through the import demand equation. On the other hand, the influence of $Y_{t-1}$ is relatively suppressed because of its positive effect on the demand for imports. Coming to general price level changes, we find that the cost-push element represented by $w^N$ was considerably more influential than the demand-pull element $L_{t-1}$. Similarly, changes in average wage earnings were mainly affected by changes in $w^N$, other predetermined variables being of much less importance.

So far we have investigated the short-run responses of the endogenous variables to changes in the predetermined variables. Our results enable us to estimate the effects on the economy of each of the exogenous forces for a *given* immediate past history of all the relevant variables. This is, in fact, formally identical with *ex post* forecasting. In tracing through the changes in the current endogenous variables we found, quite naturally, that these were largely determined by the history of these variables. An econometrician who is concerned with forecasting need go no further than this since his interest is focussed on the future. For an analysis of the past, however, the results are incomplete. While it is interesting to know the effects of current immigration, one would also want to know how the economy is affected by the past flows of migrants. The question is, of course, one of general concern when studying aggregate econometric models. It is really not very illumi-

## TABLE III

*A. Contributions of Predetermined Variables to Changes in Selected Endogenous Variables: $m_{ij}$*

| Predetermined Variable | Endogenous Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\Sigma \lvert\Delta z_{jt}\rvert$ | $B_t$ | $C_t$ | $I_t$ | $N_t$ | $Q_t$ | $V_t$ | $Y_t$ | $p_t$ |
| $M_t$ | 366 | −176·0 | −712·5 | 141·6 | −319·7 | 689·6 | −96·2 | −1,356·8 | 0 |
| $E_t$ | 1,787 | 351·0 | 316·5 | 0 | 141·9 | 0 | 42·7 | 2,146·2 | 0 |
| $E_{t-1}$ | 1,964 | −273·4 | −1,107·1 | 0 | −496·7 | 851·4 | −149·5 | −2,108·0 | 0 |
| $G_t$ | 881 | 282·9 | 1,145·6 | 0 | 513·9 | 0 | 154·7 | 2,181·3 | 0 |
| $\Delta O_t$ | 691 | 221·9 | 898·5 | 0 | 403·1 | 0 | 121·3 | 1,710·8 | 0 |
| $R$ | 90 | −28·9 | −117·0 | 0 | −52·9 | 0 | −15·8 | −222·8 | 0 |
| $T_t$ | 40·3 | −31·6 | −128·1 | 0 | −57·5 | 0 | −115·8 | −243·9 | 0 |
| $p_t^A$ | 733 | −51·7 | −465·7 | 0 | −208·9 | 0 | −62·9 | −528·6 | 0 |
| $w_t^N$ | 799 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 702·3 |
| $D_{t-1}$ | 1,891 | 68·4 | 277·2 | 0 | 124·4 | 0 | 37·4 | 528·2 | 0 |
| $F_{t-1}$ | 1,959 | −7·4 | −29·8 | 0 | −13·3 | 0 | −3·9 | −56·8 | 0 |
| $J_{t-1}$ | 130 | 20·2 | 81·8 | 0 | 36·7 | 0 | 11·0 | 155·7 | 0 |
| $L_{t-1}$ | 428 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 149·0 |
| $Y_{t-1}$ | 3,950 | −247·7 | −1,002·5 | 551·8 | −449·9 | 1,369·1 | −135·5 | −1,909·0 | 0 |
| $Y_{t-2}$ | 3,760 | 418·5 | 1,694·6 | 0 | 760·3 | −1,303·2 | 229·0 | 3,226·5 | 0 |
| $Z_{t-1}$ | 0·271 | −365·3 | −1,479·0 | 0 | −663·5 | 0 | −199·7 | −2,816·3 | 0 |

TABLE III

*B. Ranking of Predetermined Variables According to Their Contributions to Changes in Selected Endogenous Variables*

| Predetermined Variable | Endogenous Variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $B_t$ | $C_t$ | $I_t$ | $N_t$ | $Q_t$ | $V_t$ | $Y_t$ | $p_t$ | $w_t^E$ |
| $M_t$ | 8 | 7 | 2 | 7 | 4 | 8 | 8 | | 8 |
| $E_t$ | 3 | 9 | | 9 | | 10 | 4 | | 10 |
| $E_{t-1}$ | 5 | 4 | | 4 | 3 | 4 | 5 | | 5 |
| $G_t$ | 4 | 3 | | 3 | | 3 | 3 | | 4 |
| $\Delta O_t$ | 7 | 6 | | 6 | | 6 | 7 | | 7 |
| $R_t$ | 12 | 12 | | 12 | | 12 | 12 | | 13 |
| $T_t$ | 11 | 11 | | 11 | | 7 | 11 | | 12 |
| $p_t^A$ | 10 | 8 | | 8 | | 9 | 9 | | 9 |
| $w_t^N$ | | | | | | | | 1 | 1 |
| $D_{t-1}$ | 9 | 10 | | 10 | | 11 | 10 | | 11 |
| $F_{t-1}$ | 14 | 14 | | 14 | | 14 | 14 | | 15 |
| $J_{t-1}$ | 13 | 13 | | 13 | | 13 | 13 | | 14 |
| $L_{t-1}$ | | | | | | | | 2 | |
| $Y_{t-1}$ | 6 | 5 | 1 | 5 | 1 | 5 | 6 | | 6 |
| $Y_{t-2}$ | 1 | 1 | | 1 | 2 | 1 | 1 | | 2 |
| $Z_{t-1}$ | 2 | 2 | | 2 | | 2 | 2 | | 3 |

nating to find, as in our case, that the main influences on the current changes in G.N.P. were the past changes in G.N.P. A more profound answer can be obtained by determining the time paths of the endogenous variables in response to autonomous forces alone. Because of the large number of endogenous variables in our system we shall confine our attention mainly to the time path of G.N.P. as an indicator of the level of economic activity. For the remaining endogenous variables, we shall measure only the influence of the migration factor without investigating the specific effects of other exogenous variables.

In the derived reduced form of the model, each current endogenous variable is expressed as a function of lagged endogenous and current and lagged exogenous variables. For given initial conditions (in our case, the appropriate values for the years 1945-46 and 1946-47), the time path of Y can be expressed entirely in terms of current and lagged exogenous variables by an iterative substitution.[50] The coefficients attached to the exogenous variables have been termed "dynamic" or "intermediate-run" multipliers. The unlagged dynamic multipliers are, of course, identical with the impact or short-run multipliers discussed previously. The calculated values of the dynamic multipliers showing current and delayed effects of each of the exogenous variables on the time path of $Y$ are given in Table IV.

It is immediately apparent that all exogenous variables, including immi-

[50] For a detailed description of the procedure, see Goldberger, *op. cit.*, pp. 80-81.

TABLE IV

*Dynamic Multipliers Determining the Time Path of Gross National Product ($Y_t$)*

| Lag k | Exogenous Variable | | | | | | |
|---|---|---|---|---|---|---|---|
| | $M_{t-k}$ | $E_{t-k}$ | $(G + \Delta O - R)_{t-k}$ | $T_{t-k}$ | $p^A_{t-k}$ | $(f^N + f^M)_{t-k}$ | $t -$ |
| 0 | −3·7071 | 1·2010 | 2·4759 | −6·0512 | −0·7212 | 0 | 0 |
| 1 | −1·2322 | −0·8382 | 0·8230 | −2·0114 | −0·3326 | 1·1978 | 2·6 |
| 2 | −1·3326 | 0·0458 | 0·8901 | −2·1753 | −0·2757 | 1·3775 | 3·0 |
| 3 | −0·4150 | −0·2811 | 0·2772 | −0·6775 | −0·0975 | 1·5569 | 3·4 |
| 4 | −0·2577 | −0·0220 | 0·1721 | −0·4206 | −0·0418 | 1·4071 | 3·0 |
| 5 | 0·0275 | −0·0650 | −0·0184 | 0·0449 | 0·0157 | 1·2338 | 2·8 |
| 6 | 0·0884 | 0·0068 | −0·0591 | 0·1444 | 0·0326 | 1·0000 | 2·2 |
| 7 | 0·1496 | 0·0023 | −0·0999 | 0·2442 | 0·0432 | 0·7891 | 1·7 |
| 8 | 0·1468 | 0·0192 | −0·0980 | 0·2396 | 0·0416 | 0·5969 | 1·3 |
| 9 | 0·1391 | 0·0166 | −0·0929 | 0·2270 | 0·0377 | 0·4406 | 0·9 |
| 10 | 0·1168 | 0·0180 | −0·0780 | 0·1906 | 0·0313 | 0·3153 | 0·6 |
| 11 | 0·0954 | 0·0148 | −0·0637 | 0·1556 | 0·0251 | 0·2201 | 0·4 |
| 12 | 0·0737 | 0·0126 | −0·0492 | 0·1203 | 0·0193 | 0·1491 | 0·3 |
| 13 | 0·0556 | 0·0098 | −0·0371 | 0·0908 | 0·0143 | 0·0980 | 0·2 |

gration, have a damped oscillatory effect on $Y$. In the case of immigration, the negative influence turns into a positive one after five years; however, after three years the absolute size of the multipliers becomes rather small. Among all exogenous variables, exports cause the most rapid oscillations, but their effect vanishes relatively early. Government expenditure tends to have a positive influence on $Y$ for five years; after this the effect becomes negative and small. An initial government expenditure, if sustained, would produce a G.N.P. multiplier of 4·6 after 5 years, declining to 4·0 after 14 years. Also of interest to us are the dynamic multipliers of $f^M$, the influx of immigrant families. There the maximum effect appears only after four years and the decline is rather slow.

When analysing the impact multipliers we pointed out that the actual effect of the predetermined variables during the sample period depends not only on the size of the multiplier but also on the amount of change displayed by the predetermined variables. The same applies in the present case with respect to exogenous variables. Further, with the help of the dynamic multipliers, we are able to estimate the present and also the accumulated past effects of changes in the exogenous variables. An explanation of the procedure is given below.

The dynamic solution for $Y$ in period $t$ is

$$\begin{aligned} Y_t = \alpha_{o,t} &+ \beta_1 M_t + \beta_2 M_{t-1} + \ldots + \beta_t M_1 \\ &+ \gamma_1 E_t + \gamma_2 E_{t-1} + \ldots + \gamma_t E_1 \\ &+ \delta_1 G_t + \delta_2 G_{t-1} + \ldots + \delta_t G_t \\ &+ \ldots \end{aligned}$$

and in period $(t-1)$,

$$\begin{aligned} Y_{t-1} = \alpha_{o,t-1} &+ \beta_1 M_{t-1} + \beta_2 M_{t-2} + \ldots + \beta_{t-1} M_1 \\ &+ \gamma_1 E_{t-1} + \gamma_2 E_{t-2} + \ldots + \gamma_{t-1} E_1 \\ &+ \delta_1 G_{t-1} + \delta_2 G_{t-2} + \ldots + \delta_{t-1} G_1 \\ &+ \ldots \end{aligned}$$

The change in $Y$ then is

$$\begin{aligned} Y_t - Y_{t-1} = (\alpha_{o,t} - \alpha_{o,t-1}) &+ \beta_1 (M_t - M_{t-1}) + \beta_2 (M_{t-1} - M_{t-2}) \\ &+ \ldots + \beta_t M_1 \\ &+ \gamma_1 (E_t - E_{t-1}) + \gamma_2 (E_{t-1} - E_{t-2}) + \ldots + \gamma_t E_1 \\ &+ \delta_1 (G_t - G_{t-1}) + \delta_2 (G_{t-1} - G_{t-2}) + \ldots + \delta_t G_1 \\ &+ \ldots \end{aligned}$$

The accumulated contributions of exogenous variables to changes in $Y$ in period $t$ are

$$\begin{aligned} &M: \beta_1 (M_t - M_{t-1}) + \beta_2 (M_{t-1} - M_{t-2}) + \ldots + \beta_t M_1, \\ &E: \gamma_1 (E_t - E_{t-1}) + \gamma_2 (E_{t-1} - E_{t-2}) + \ldots + \gamma_t E_1, \\ &G: \delta_1 (G_t - G_{t-1}) + \delta_2 (G_{t-1} - G_{t-2}) + \ldots + \delta_t G_1, \\ &\quad \text{etc.} \end{aligned}$$

The calculations are shown in Table V.

TABLE V

*Accumulated Contributions of Exogenous Variables to Changes in Gross National Product ($Y_t$)*

| Year | $M$ and $f^M$ | $E$ | $G$ | $\Delta O$ | $R$ | $T$ | $p^A$ | $f^N$ | $t$ |
|---|---|---|---|---|---|---|---|---|---|
| 1948–49 | −151 | −578 | 586 | −244 | −35 | 20 | −249 | 55 | 3 |
| 1949–50 | −421 | −18 | 768 | −186 | −39 | −13 | −327 | 62 | 5 |
| 1950–51 | −166 | 203 | 638 | −186 | −27 | 4 | −16 | 69 | 9 |
| 1951–52 | 40 | −1,078 | 593 | 39 | −9 | −49 | −18 | 62 | 12 |
| 1952–53 | 66 | 582 | 112 | 32 | −29 | −21 | 94 | 58 | 15 |
| 1953–54 | 268 | −291 | −30 | 13 | 21 | −4 | 154 | 43 | 18 |
| 1954–55 | 17 | 143 | 65 | −50 | −18 | −1 | 131 | 32 | 18 |
| 1955–56 | −23 | −8 | 89 | 53 | 16 | −17 | 91 | 26 | 21 |
| 1956–57 | 15 | 271 | −45 | −123 | 24 | −64 | 79 | 21 | 21 |
| 1957–58 | 30 | −303 | 57 | −51 | −19 | −24 | 47 | 15 | 22 |
| 1958–59 | 67 | 172 | 159 | 226 | −10 | −21 | 58 | 12 | 22 |
| 1959–60 | −45 | 76 | 181 | −146 | −39 | −5 | 31 | 10 | 23 |
| 1960–61 | −33 | −57 | 157 | 109 | −33 | −17 | 6 | 8 | 23 |

The detailed analysis of the influences of individual exogenous variables on changes in $Y_t$ sheds light on the importance of immigration compared to other autonomous factors. It is clear that immigration ranked among the more important influences only in a very few years of the postwar period. In 1949-50 the accumulated effect of immigration on the G.N.P. was stronger than that of any other factor except government expenditure; in 1953-54 only exports had a greater influence than the immigration factor. The year 1953-54 provides an interesting example of the combination of current and delayed reaction of $Y$ to immigration. In this year immigration declined to about half of the previous year's level and the five-year lag positive multiplier caught the high wave of immigration of 1949-50. The joint effect was a stimulation of economic activity. In all years other than those mentioned, immigration apparently has not been an important contributor to the movement in the G.N.P. The main determinants of this movement were, in general, governmental expenditure, exports, and changes in farm stocks.

We may also inquire about the response of the G.N.P. to immigration under "controlled" circumstances. For this purpose two hypothetical situations have been devised for illustration. In Case I, we assume all exogenous variables constant at the levels represented by (approximate) averages for the sample period, except for time.[51] The initial conditions are taken to be represented by the actual values for 1945-46 and 1946-47. In Case II we let government expenditure increase from £450 million in period 0 by constant

[51] The exact assumed values are: $E = 934$, $(G + \Delta O - R) = 814$, $T = 20$, $p^A = 1{,}000$, $f^N = 45$, and $t = 1, 2, 3, \ldots$. To obtain the combined effect of $M$ and $f^N$ we assume $f^M$ to be 15 per cent of $M$; the actual ratio during the sample period has never deviated very much from this value.

annual increments of £50 million, and keep the values of other exogenous variables as in Case I.[52] In either case, we shall examine the effect on the G.N.P. of the following net immigration flows:

(a) $M_t = 0$ $f^M_t = 0$
(b) $M_t = 100,$ $f^M_t = 15$
(c) $M_t = 10, 20, 30, \ldots,$ $f^M_t = 1{\cdot}5, 3{\cdot}0, 4{\cdot}5, \ldots$

The simulated time paths of the G.N.P. for each of the migration streams are depicted by Chart I.

In Case A in which all exogenous variables are held constant, the path of $Y$ in the absence of immigration is one of damped oscillations. The "jolt" of the early periods is due to the increase in the values of the exogenous variables from the pre-1947-48 levels to the average values for the postwar period. Towards the end $Y$ tends to settle around £5,120 million. The presence of a constant flow of immigration leaves the changes in $Y$ largely unaffected, but it shifts the level downward. The final equilibrium value of $Y$ is, therefore, lower (about £4,750 million). If immigration is increasing, the accumulated effect soon begins to exercise a strong downward push on the value of $Y$, although toward the end of the period the decline tends to slow down somewhat.

Case B, in which government expenditure increases by constant amounts, presents a different picture. After short initial oscillations, the growth of $Y$ becomes highly explosive, regardless of immigration. If immigration is increasing (flow [c]), the rate of growth of $Y$ is still explosive and is only slightly lower than if migration is constant (flow [b]). This is an interesting situation since the assumed change in government expenditure did, on the average, approximately correspond to the actual changes during the period. The complete swamping of the effect of immigration by government expenditure reinforces our conclusion about the relatively minor influence of immigration on the level of economic activity.

The response of G.N.P. to various flows of immigration is, of course, conditioned by the structure of the model which refers to the narrowly circumscribed experience of the postwar years. It is quite conceivable that the structure might change if the hypothetical policies were to be adopted.

The preceding analysis brings to our attention a more general question concerning the dynamic movement in the G.N.P. when abstracted from the influence of exogenous shocks and of initial conditions. That is, we may wish to find a precise answer to the question of inherent stability or instability of the Australian postwar economy. The answer can be obtained in terms of a dynamic solution for $Y$ as given by the appropriate difference equation.[53]

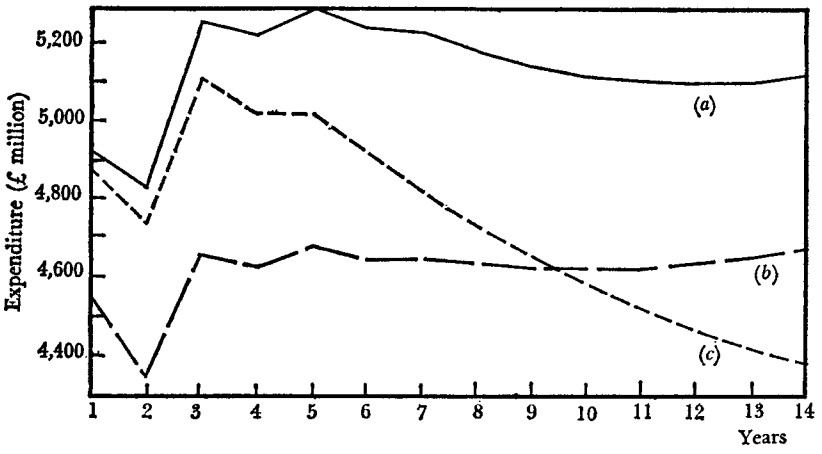
[52] During the sample the average annual increase in $G$ was, in fact, about £50 million. The values assumed to be taken by $\triangle$ $O$ and $R$ are £14·4 million and £54·5 million respectively.

[53] See, *e.g.*, R. G. D. Allen, *Mathematical Economics* (London: Macmillan, 1956), pp. 176-195.

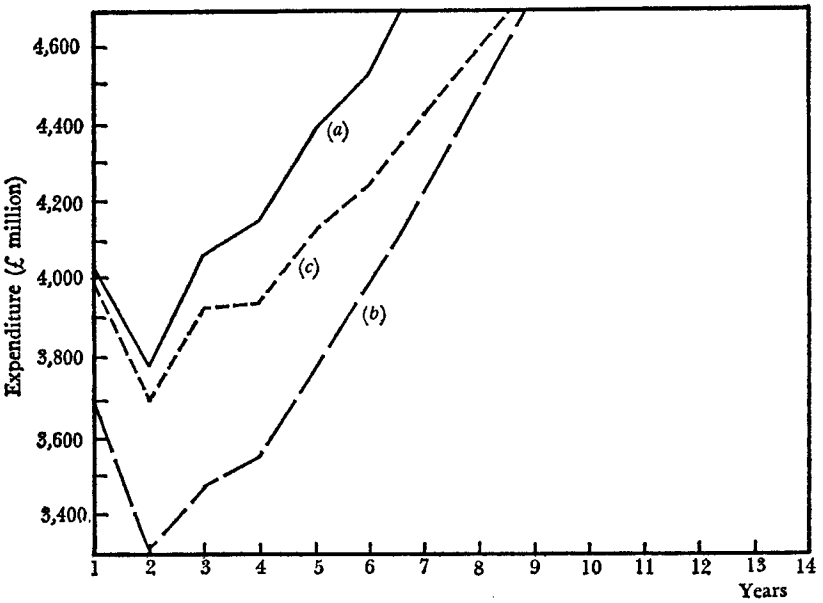
CHART I

TIMEPATHS OF GNP FOR DIFFERENT RATES OF IMMIGRATION

*A.* CONSTANT GOVERNMENT EXPENDITURE




*B.* INCREASING GOVERNMENT EXPENDITURE




——— (*a*) No immigration

— — — (*b*) Constant immigration of 100,000 persons per annum

– – – – (*c*) Immigration increasing by 10,000 persons each year

The characteristic equation, found to be

$$\lambda^4 - 1{\cdot}2284\,\lambda^3 + 0{\cdot}1504\,\lambda^2 + 0{\cdot}2912\,\lambda - 0{\cdot}0802 = 0,$$

has the following roots:

$$\lambda_1 = -0{\cdot}477, \qquad \lambda_3 = 0{\cdot}6215 + 0{\cdot}3488\,i,$$
$$\lambda_2 = 0{\cdot}331, \qquad \lambda_4 = 0{\cdot}6215 - 0{\cdot}3488\,i$$

Thus, the basic solution for the time path of $Y$—apart from the influence of the exogenous variables and of the initial conditions—is one of damped oscillations because both the largest real root and the modulus of the conjugate complex roots are less than unity in absolute magnitude. The part of the oscillatory movement arising from the complex roots has a period of about 13 years and is subjected to a damping factor of $(0{\cdot}712)^t$ [54]. It appears then that the system is basically stable and that the sources of instability, inasmuch as they exist, have to be sought in the stimuli from the exogenous shocks and/or in the inherited initial conditions.[55] This is a different result from that obtained by J. W. Nevile, who found that "the rate of growth of $Y$ will constantly increase, and eventually approach 145 per cent per annum. Of course, long before this astronomical rate of growth is reached the rise of gross national product will be checked by the full employment ceiling."[56] The difference between Nevile's and our conclusion may partly be due to the different methods of estimation, but the main reason is undoubtedly the difference in the structure of the model and, in particular, Nevile's treatment of imports as exogenously determined. Growing gross national product increases the demand for imports and this, in turn, may provide a check on the rate of growth of the G.N.P. According to our estimates, this check is sufficiently strong to create an inherent stability.

As a final matter of interest we may examine the dynamic effects of immigration on endogenous variables other than G.N.P. With the structure of the economy as described by our model, the dynamic multiplier effects of immigration on $B$, $C$, $D$, $N$, $V$, $X$, and $w^E$ (linearized version) will be proportionate to the dynamic multipliers for $Y$. The dynamic multipliers of $M$ and $f^M$ for the remaining endogenous variables are illustrated by Chart II.[57] When the effects of $M$ (migrants) and $f^M$ (migrant households) are

[54] The modulus is $\sqrt{(0{\cdot}6215)^2 + (0{\cdot}3488)^2} = 0{\cdot}712$. The period is given by 360° divided by arctan (0·3488/0·6215).

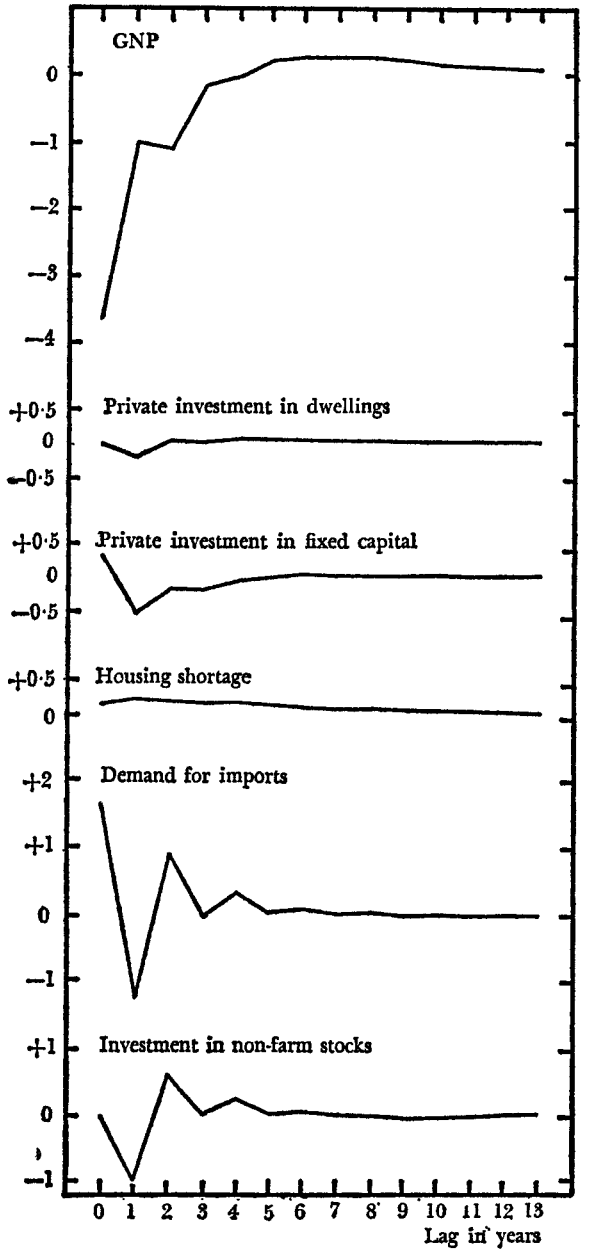
[55] It is, of course, possible that instability may arise as a result of random disturbances. See I. Adelman and F. Adelman, "The Dynamic Properties of the Klein-Goldberger Model", *Econometrica*, XXVII, 1959. It should be noted that the structure of our model is such that $A$, $B$, $C$, $D$, $I$, $N$, $V$, $X$ and $w^E$ (linearized approximation) have the same characteristic equation as the one for G.N.P, discussed in the text.

[56] J. W. Nevile, *op. cit.*, p. 90.

[57] A few of the remaining endogenous variables are omitted: $F$ and $p^E$ are presumably free of any direct or indirect influence of immigration; the multipliers for $A$ are proportionate to those of $Y$ lagged by one period (the unlagged multiplier being zero); the multipliers for $Z$ (linearized version) are related to those for $\triangle S_u$. No dynamic multipliers can be determined for $p$ (general level of prices) since our model is in this respect dynamically incomplete.

The vertical scale in Chart II is discontinuous. For all variables except "housing shortage" the units are additional £m. at constant prices per additional thousand immigrants. For "housing shortage" the units are additions to the housing shortage per additional immigrant.

CHART II
DYNAMIC MULTIPLIERS OF IMMIGRATION FOR SELECTED ENDOGENOUS VARIABLES



combined, the negative influence of *M* during the first five years is only slightly mitigated, while its positive influence in latter years is only slightly enhanced. The total effect of immigration on investment in private dwellings, *H*, comes from two causes operating in opposite directions. Stimulation comes through the effect of migration on the housing shortage, *J*, and reduction arises through the effect of immigration on aggregate personal income. The combination of the two forces produces a very small overall effect on *H*, at first negative and later positive.

A similar situation arises in connection with business investment in fixed capital equipment, *I*, where migration has a direct positive influence, and an indirect negative influence through its effect on G.N.P. The indirect negative effect of migration on *I* is stronger than its direct positive effect, but since the G.N.P. enters into the investment equation with a lag, whereas *M* is unlagged, the overall negative effect does not appear until the second year and it lasts, as with G.N.P., for five years.

## V. Concluding Remarks

In this paper we have attempted to examine the effects of immigration on the structure of the Australian economy. With the help of a small aggregate econometric model we have found that the structural effects of immigration have been limited to changes in demand for fixed capital equipment and for imports. Through the effect on these two relationships, and also by contributing to the housing shortage, immigration has had an indirect influence on the time paths of most of the endogenous variables of the system. Since the influence of immigration on import demand considerably outweighed its influence on the demand for fixed capital equipment (and for housing), the overall effects of immigration tended to damp the level of economic activity, although in an oscillatory way. However, the impact effect of immigration was, on the average, relatively unimportant, while the accumulated dynamic effect tended to be of importance in only a few years of the postwar period.

At times when the Australian economy was highly stimulated by government expenditure and the influx of immigrants was relatively high (such as the period from 1948-49 to 1950-51), immigration had some depressing effect. For the greater part of the postwar period, the influence of immigration on the level of economic activity has been overshadowed by other autonomous forces, in particular by government expenditure and by exports. A more detailed analysis of the period under observation revealed that had the autonomous forces been held at a constant level, a steady flow of immigrants would have tended to lower the equilibrium level of G.N.P. On the other hand, had the real government expenditure been allowed to increase by constant annual increments, neither a steady nor a moderately increasing influx of immigrants may have been strong enough to prevent explosive growth.

The impact of immigration on the real variables of the system other than the G.N.P. has probably been relatively minor, with the exception of imports and investment in fixed capital equipment. The dynamic effect of immigration on all the real variables of the system appeared to be of a damped oscillatory kind, with varying periods and amplitudes.

Our analysis failed to reveal any direct structural influence of immigration on prices and wages. No attempt has been made to trace out indirect, dynamic effects of immigration on the level of prices; it is possible that these appeared through the explanatory variable representing lagged excess demand for goods and services. Wages have been subjected to an indirect negative influence of immigration through the effect on the productivity of labour.

In the process of examining the effects of immigration we have developed a system describing the interdependences of the Australian postwar economy and uncovered the relative importance of many different autonomous factors. In this context, the calculated estimates of impact and dynamic multipliers such as government expenditure and exports on the G.N.P. are of particular interest. Further, in contrast to previous studies which treated imports as an exogenous variable and concluded that the system was highly explosive, our results show that imports have, in fact, a stabilizing effect which tends to turn the explosive growth of the gross national product into a damped oscillatory path. Finally, in examining the process of price determination during the postwar period, we found that the movements in the minimum wage rate have been of considerably greater importance in effecting changes in prices than movements in demand.

Perhaps the most appropriate way to conclude this study is by stressing its limitations. The specification and estimation of an econometric model is conditioned by the institutional and behavioural circumstances of the period under investigation. A change in these may affect the values of the parameters, alter the classification of exogenous and endogenous variables, or make the specification of the structure incorrect. If this happens, the value of the model for the purpose of forecasting is seriously impaired. Our estimated model may be a case in point. Indeed, the avowed purpose of the paper was to make statements about the past rather than about the future. At the same time, the model may be useful as a starting base of a more ambitious project to develop an effective forecasting tool for the purpose of policy decisions.

## APPENDIX
### *Data*

| | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* | *L* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946–47 | 30 | 321 | 2,147 | 2,104 | 661 | 349 | 454 | 68 | 217 | 401 | 26·7 | 0 |
| 1947–48 | 34 | 354 | 2,375 | 2,295 | 858 | 653 | 472 | 89 | 257 | 406 | 71·8 | 10 |
| 1948–49 | 35 | 360 | 2,486 | 2,446 | 975 | 540 | 552 | 113 | 301 | 408 | 94·1 | 48 |
| 1949–50 | 38 | 387 | 2,577 | 2,582 | 1,009 | 686 | 666 | 136 | 371 | 421 | 85·1 | 148 |
| 1950–51 | 39 | 513 | 2,715 | 2,763 | 1,398 | 1,005 | 804 | 167 | 444 | 423 | 106·6 | 153 |
| 1951–52 | 41 | 413 | 2,609 | 2,721 | 814 | 479 | 915 | 180 | 463 | 408 | 71·7 | 109 |
| 1952–53 | 40 | 378 | 2,540 | 2,661 | 933 | 572 | 859 | 160 | 387 | 388 | −38·4 | 97 |
| 1953–54 | 41 | 467 | 2,753 | 2,874 | 889 | 493 | 814 | 168 | 420 | 363 | 4·9 | 42 |
| 1954–55 | 46 | 508 | 3,025 | 3,148 | 843 | 438 | 875 | 188 | 484 | 351 | 40·4 | 68 |
| 1955–56 | 51 | 515 | 3,103 | 3,279 | 830 | 417 | 931 | 184 | 523 | 345 | 28·5 | 95 |
| 1956–57 | 52 | 534 | 3,123 | 3,290 | 992 | 467 | 911 | 175 | 514 | 345 | −17·3 | 86 |
| 1957–58 | 53 | 521 | 3,324 | 3,404 | 836 | 311 | 947 | 200 | 545 | 343 | −38·8 | 77 |
| 1958–59 | 55 | 565 | 3,440 | 3,539 | 839 | 405 | 1,023 | 215 | 547 | 331 | −44·4 | 64 |
| 1959–60 | 65 | 658 | 3,713 | 3,791 | 939 | 402 | 1,078 | 237 | 616 | 316 | −22·6 | 83 |
| 1960–61 | 62 | 647 | 3,752 | 3,862 | 919 | 404 | 1,111 | 243 | 642 | 297 | −31·3 | 92 |

| | $O$-$O_{-1}$ | *Q* | *R* | *S* | *T* | *V* | *X* | *Y** | *Z* | $f^N$ | $f^M$ | *p* | $p^A$ | $p^H$ | *t* | $w^E$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946–47 | 4 | 498 | 92 | 876 | | 40 | 2,369 | 3,244 | 0·270 | | | 498 | 1,070 | | 0 | |
| 1947–48 | 97 | 726 | 45 | 1,064 | 20·0 | 63 | 2,539 | 3,662 | 0·290 | 46 | 2 | 536 | 1,367 | 2·089 | 1 | 50 |
| 1948–49 | −34 | 801 | 44 | 1,128 | 10·0 | 91 | 2,690 | 3,738 | 0·302 | 45 | 8 | 594 | 1,082 | 2·229 | 2 | 56 |
| 1949–50 | 50 | 956 | 44 | 1,182 | 8·4 | 147 | 2,778 | 4,048 | 0·292 | 44 | 24 | 653 | 1,144 | 2·482 | 3 | 62 |
| 1950–51 | −17 | 1,142 | 50 | 1,287 | 9·6 | 154 | 2,968 | 4,617 | 0·279 | 44 | 24 | 752 | 1,062 | 2·504 | 4 | 74 |
| 1951–52 | −1 | 1,334 | 49 | 1,464 | 17·5 | 153 | 2,977 | 3,968 | 0·369 | 47 | 15 | 920 | 1,060 | 2·338 | 5 | 91 |
| 1952–53 | 31 | 617 | 59 | 1,249 | 19·0 | 109 | 2,948 | 4,168 | 0·300 | 44 | 13 | 1,000 | 1,000 | 2·075 | 6 | 1,00 |
| 1953–54 | 23 | 759 | 48 | 1,310 | 16·7 | 142 | 3,133 | 4,504 | 0·291 | 42 | 8 | 1,013 | 879 | 2·252 | 7 | 1,05 |
| 1954–55 | −2 | 935 | 57 | 1,458 | 16·7 | 177 | 3,398 | 4,792 | 0·304 | 45 | 11 | 1,020 | 851 | 2·748 | 8 | 1,10 |
| 1955–56 | 26 | 888 | 52 | 1,498 | 20·0 | 174 | 3,565 | 4,922 | 0·304 | 46 | 14 | 1,062 | 854 | 2·813 | 9 | 1,18 |
| 1956–57 | −25 | 758 | 43 | 1,528 | 30·0 | 162 | 3,587 | 5,132 | 0·298 | 45 | 12 | 1,113 | 829 | 3·076 | 10 | 1,24 |
| 1957–58 | −36 | 836 | 57 | 1,591 | 30·0 | 184 | 3,706 | 5,223 | 0·305 | 46 | 14 | 1,116 | 827 | 3·221 | 11 | 1,27 |
| 1958–59 | 76 | 836 | 61 | 1,618 | 30·0 | 192 | 3,850 | 5,517 | 0·293 | 47 | 11 | 1,124 | 787 | 3·071 | 12 | 1,30 |
| 1959–60 | −12 | 952 | 73 | 1,666 | 30·0 | 237 | 4,109 | 5,896 | 0·283 | 47 | 13 | 1,156 | 782 | 3·164 | 13 | 1,40 |
| 1960–61 | 26 | 1,046 | 81 | 1,820 | 32·5 | 229 | 4,204 | 6,011 | 0·303 | 48 | 12 | 1,201 | 798 | 3·084 | 14 | 1,48 |

* The value of *Y* for 1945-46 was 3,055.