Macroeconomic Effects of Immigration: Evidence from CANDIDE Model 1.0*

GORDON W. DAVIES†

Introduction

Since 1970 the Economic Council of Canada, in conjunction with the Bank of Canada and several Government Departments, has devoted a major effort to the development of a large scale model of the Canadian economy. "In addition to serving as a description of some salient aspects of the Canadian economy, the model is intended to be useful for policy simulations and for conditional forecasts or projections."[1] The CANDIDE model is structured so that it can be used to test the medium-term macroeconomic effects of changes in the level of gross immigration. This information may be useful in formulating immigration policy.

This paper reports on the use of CANDIDE Model. 1.0[2] to assess the macroeconomic effects of immigration. The objectives of this research are to:

1. outline the basic structure of the relevant portions of the model and the role of immigration in the model;
2. examine and explain the results of simulation experiments with the model;
3. explore a simple policy option to offset the macroeconomic effects of immigration as simulated in the model; and
4. comment briefly on some different interpretations of the results for the formulation of immigration policy.

The basic finding from this research is that an increase in the level of net immigration in the model raises the unemployment rate and marginally lowers constant dollar per capita Gross National Expenditure (GNE) averaged over the simulation period. We also illustrate in this report that these effects may be offset in the model by a policy of increased government spending and indicate some qualifications to the results.

In section two we discuss in some detail the structure of the relevant portions of the model and particularly the role of immigration in the model. In section three we present the results of the basic simulation experiments and in section four we show how a complementary increase in government spending can be used to offset the effects observed. In the final section (five) we make some concluding remarks.

The Role of Immigration in the Model

CANDIDE Model 1.0 is a very detailed representation of the Canadian economy.

*The author wishes to thank Réal Demers for his expert work in producing the simulation results and his comments on the first draft of this paper. H. E. L. Waslander, Stephen M. Tanny, Carlton Braithwaite, and a member of the editorial board of this journal provided detailed and helpful comments on an earlier draft. Their assistance is gratefully acknowledged. The content of this paper is the responsibility of the author and the views expressed herein are in no way endorsed by the Economic Council of Canada or any agency or Department of the Government of Canada.

†University of Western Ontario, London, Canada.

[1] McCracken [4, p. ix].

[2] The designation 1.0 indicates the first version of the model. The experiments reported on in this paper use the September, 1972 version of Model 1.0, which is the same as the first operational version of May, 1972, except for some minor, technical improvements.

This makes it difficult to understand the mechanisms at work in the model and to intuit the results. It is obvious that results from the model have limited value unless we can determine exactly how they come about, which is the basic rationale underlying the discussion in this section. We attempt here to give only a broad outline of the model and to concentrate on the relationships between demographic and economic variables and among economic variables which are important for the purposes at hand.[3]

We consider first the relationship between gross immigration and other demographic variables in the model. The level of gross immigration does not itself appear as an exogenous (or endogenous) variable in the model. Instead, nine female population subgroups and the same number of male subgroups are exogenous. However, in simulating with different levels of immigration, the above eighteen population variables are altered to account for the differential age and sex composition of immigration. Immigration in these experiments therefore does affect the age and sex composition (and size) of the total population, both through its direct effects and through its effects on births and deaths resulting from changes in the age structure and size of the total population. (Fertility and mortality rates are assumed to be exogenous and independent of the level of immigration.)

The model specifies a number of other demographic variables such as elementary and secondary school enrollment, for example, which is defined to be equal to the total population aged 0–19, times the exogenous ratio of total elementary and secondary school enrollment to the total population aged 0–19. The effect of immigration is therefore carried forward to these other variables which are used elsewhere in the model. The role of population and other demographic variables in CANDIDE will be noted as the discussion proceeds. We should point out that, although a number of demographic variables are defined in the model, these are non-behavioral relationships. This implies that there are no "feedback" effects from economic to demographic variables, except for the effect of some economic variables on three labour force participation rates.

We next consider the determination of the unemployment rate in the model. The supply of labour is endogenous in CANDIDE and is determined by applying age/sex specific labour force participation rates to the corresponding population subgroups. Immigration therefore has a direct effect on the supply of labour in the model since it is added directly to the source population.

There are four age/sex specific participation rates in the model, three of which are endogenous. The participation rate for young and old males together (ages 14 to 24 and 55 and over) is negatively related to per capita disposable income and positively to the ratio of total employment to the civilian source population fourteen and over. If immigration decreases per capita income, it therefore has the second-order effect of increasing this participation rate, which results in a higher employment rate, *ceteris paribus*. The effect of the dependence of this participation rate on the ratio of total employment to the civilian source population will depend on the size of the increase in total employment which results from immigration relative to the size of the increase in the civilian source population which results directly from increased immigration. The participation rate for prime-age males (aged 25 to 54) is exogenous in the model. This participation rate has been high and fairly

[3]A more detailed discussion may be found in McCracken [4] and the other CANDIDE Project Papers published by the Economic Council of Canada, on behalf of the Interdepartmental Committee on CANDIDE.

stable on an annual basis in the postwar period. The participation rate for females under thirty-five years of age depends positively on real service sector income per employed person and negatively on a four period distributed lag of the unemployment rate. If immigration causes real service sector earnings per worker to decrease, this participation rate is therefore lower which results in a lower unemployment rate, *ceteris paribus*. Also, any effect that immigration has on the unemployment rate is offset slightly by the negative relationship between this participation rate and the unemployment rate. The fourth participation rate in the model, for females thirty-five years of age and over, also depends positively on real service sector income per worker and, in this case, positively on a distributed lag of the unemployment rate.

In CANDIDE there is one employment function for each of twelve sectors, except for the service sector where there are two such functions. The basis for most of these functions is that desired labor demand is an inverted production function and that actual labour demand adjusts with a lag to desired labor demand. Eleven of the functions therefore relate employment by sector positively to sectoral output and negatively to the sectoral stock of capital. Therefore, if immigration increases aggregate demand, employment will increase, but a portion of this increase in output is added to the capital stock in the next period which reduces employment, *ceteris paribus*. The net effect of an increase in output on employment is positive in all cases, however.

The specification for agricultural employment is somewhat different from the above forms. Employment in agriculture is positively related to the unemployment rate, reflecting increased rural to urban migration as employment opportunities in general improve. This mechanism therefore tends to offset any effect that immigration has on employment because if the unemployment rate falls because of the overall employment-generating aggregate demand effects of immigration, the decrease in the unemployment rate in this particular equation causes agricultural employment to fall, resulting in a second-order increase in the unemployment rate. In addition, an increase in the unemployment rate in a given period causes public administration employment to fall slightly in the next period but to rise in the next three periods. The steady state effect of an increase in the unemployment rate on employment in this sector is positive. The net effect of this mechanism is therefore the same as for the positive relationship between agricultural employment and the unemployment rate.

The unemployment rate is defined conventionally in the model as $\left(\frac{L-E}{L}\right)\cdot 100$, where L is the supply of labour and E is employment.

We now outline briefly the determination of the components of aggregate real GNE and consider first the determination of real consumption expenditures. Total real savings in the model are estimated as a function of total income. Total real consumption is then obtained as the difference between disposable income and savings. Total consumption is further disaggregated into a number of expenditure categories using functional forms that relate per capita expenditure by category to lagged per capita consumption and to other variables. These disaggregated per capita values are then multiplied by the total population and summed to get a new value for total consumption expenditures. The total of these values and total consumption as originally determined are then adjusted so that they are equal. The effect of the population on this category of expenditures is therefore

mainly on the distribution of total consumption among categories. However, any effect which immigration has on total output elsewhere in the model is reinforced in the consumption sector. This mechanism is analogous to the standard working of the multiplier: if immigration causes some other category of output to rise, increased consumption is added to total product, which has a further effect on consumption expenditures, and so on.

Before proceeding, we note that the model does not take account of any possible difference between the marginal propensity to consume of recent immigrants and of others. There is some evidence from household expenditure surveys that very recent immigrants tend to dissave more, at given income levels, than do earlier immigrants or the native population.[4] However, expenditures in these surveys include payments for rent or mortgages and possibly down-payments as well. Consumption in the national accounts, on the other hand, correctly includes actual and imputed expenditures on rent but not payments of interest and principal on mortgages nor down-payments on the purchase of a house. To the extent that the observed extraordinary dissaving of recent immigrants arises from atypical mortgage payments, and not from differences in real consumption propensities, the model will not understate the impact of immigration on consumption expenditures as defined in the national accounts. Furthermore, immigrants do have a direct impact on residential construction expenditures in the model, as discussed below. Finally, we will illustrate in section four that any possible understatement of the spending propensities of new immigrants in the model is quite unlikely to be large enough to give rise to effects which are in different directions from the ones observed in our experiments with the model.

Residential construction expenditures in CANDIDE are indirectly a positive function of the total number of households (which are directly increased by immigration) and of per capita disposable income. Immigration therefore increases residential construction expenditures through its effect on the number of households and this increase has a multiplier effect on total income. Whatever effect immigration has on per capita disposable income is reinforced by the effect of this variable on housing starts: for example, if immigration tends to reduce per capita disposable income, this reduction is reinforced here, because lower per capita disposable income reduces housing starts and hence residential construction expenditures.

Business fixed investment in the model is disaggregated by type (non-residential construction and also machinery and equipment) and by sector. Most of the functions relate investment to output. Also, some of the functions contain the relevant lagged capital stock and the unemployment rate as explanatory variables. Investment is positively related to output. This implies that, if increased immigration raises total output elsewhere in the model, this increase in output results in a rise in investment. Where the lagged capital stock appears in an investment equation, it also has a positive sign, reflecting replacement demand. These two relationships therefore reinforce the effects of immigration on total output because, as noted, investment depends positively on total output and it is added to the stock of capital in the next period which provides a further stimulus to aggregate demand in that period, and so on. The unemployment rate in these equations is a proxy for a capacity utilization variable—higher values of the unemployment rate (lower rates of capacity utilization) reduce investment. If immigration produces "excess" supply in the sense of raising the unemployment rate, investment will be lower, *ceteris paribus*. This relationship therefore works in the opposite direction to the two described above.

[4] See Neilson [5].

Exports in the model are in general determined by indices of industrial production abroad and domestic relative to foreign prices. The one exception of interest to us is that the equation for exports of non-ferrous metals includes the Canadian unemployment rate as an explanatory variable. If immigration increases the unemployment rate, these exports increase, which causes employment to be higher and the unemployment rate to be lower than it would be in the absence of this mechanism.

Imports are disaggregated into a number of categories. Of the fifteen behavioral equations determining imports, fourteen relate the import category to a measure of domestic output and some price variables. In all cases the relationship between imports and output is positive, which tends to reverse any positive effect immigration may have on excess demand since imports are subtracted from the domestic demand components of GNE. Five of these import categories are also related negatively to the unemployment rate. In this case, if immigration raises the unemployment rate, imports are reduced which increases GNE, resulting indirectly in an increase in employment which reduces the unemployment rate. Finally, imports of non-competing products are directly related positively to the total population. The population variable is included here as a measure of domestic demand for products only available from other countries.

The government sector in CANDIDE is almost fully endogenous. Among the explanatory variables are school enrollment and a weighted average of school enrollment. Both of these variables are definitionally related to the total population or subgroups of the total population. The school enrollment variable enters into the determination of school construction expenditures, a component of government fixed capital formation, with a four-period distributed lag. The coefficient on the first period lag of the variable is high and anomalously) negative, but the coefficients on the second, third, and fourth period lags are positive. The initial effect of a permanent increase in school enrollment on this category of government spending is therefore negative, but the steady state effect is positive and fairly substantial. Provincial and local wages and salaries, a component of government current expenditures, are also positively related to weighted school enrollment. Because immigration increases the population and population subgroups, it has a direct, positive effect on government expenditures.

The unemployment rate also enters into the determination of two categories of government expenditure. In the equation for other engineering construction expenditures, the coefficients on a three-period distributed lag of the unemployment rate are positive and quite high. Federal non-defense expenditures on other goods and services depend positively on the first difference in the unemployment rate in periods t, t-1, and t-2. Using the definition of first difference, this implies that the level of the unemployment rate in period t has a strong positive effect, in t-1 a small positive effect, in period t-2 a small negative effect, and in t-3 a strong negative effect. The steady-state effect is exactly zero. The inclusion of the unemployment rate here is an important aspect of CANDIDE. If immigration tends to raise the unemployment rate, then these categories of government spending are increased, which results in a further increase

in final expenditure and employment. The outcome of this will be a smaller increase (or a net decrease) in the unemployment rate as a result of immigration. In Davies [1], immigration increased the unemployment rate and we noted that one way of viewing this result was that immigration produces excess supply, which could be utilized by a complementary increase in government spending. In CANDIDE this fiscal reaction on the part of the government is at least partly automatic. In addition, seven components of government spending are related positively to current or lagged values of GNE. Any increase in aggregate output therefore has an induced effect on government spending in the model.

There are six behavioral equations in CANDIDE which explain the values of the physical changes in inventories by sector. Among the variables included in these inventory investment equations are a measure of output, the lagged stock of inventories, and the unemployment rate. In one equation, inventory investment depends on the first difference of gross domestic product in the current period and in the three previous periods. The first two coefficients are positive and the last two negative with an overall positive steady state effect. Three other categories of inventory change are positively related to some measure of output. Any direct effect which immigration has on total output elsewhere in the model is therefore reinforced because of these positive relationships. In two cases, however, inventory investment depends negatively on the lagged stock of inventories, which tends to offset the positive reinforcing effect noted above. Finally, one inventory equation relates inventory change negatively to the unemployment rate. This reinforces any effects which immigration has on the unemployment rate: for example, if immigration causes the unemployment rate to increase, inventory investment declines, which causes employment to decrease resulting in a higher unemployment rate.

To conclude our discussion of the model we consider the determination of prices. The price determination mechanism in CANDIDE is very complex. The following statements outline, in very simplified form, the determination of the consumer price index:

1. the consumer price index is related to industry value-added deflators through an input-output prices submodel and some autoregressive correction equations;
2. industry value-added deflators are positively related to unit labour costs in the respective industries;
3. unit labour costs are defined as total labour compensation in the industry divided by total output in the industry;
4. total compensation essentially equals the wage rate times total man-hours; and
5. the hourly wage rate is negatively related to the unemployment rate in most cases and to the consumer price index in some cases.

If immigration causes output to increase, this will cause unit labour costs to fall, given labour compensation. Labour compensation is, however, a function of employment and the wage rate. If output increases, so will employment. Suppose that, although employment rises with increased immigration, the rate of unemployment also rises. Then the rate of change of money wages will fall. The net effect on total compensation depends on the magnitude of the less rapid increase in wages relative to the increase in employment. Suppose that wages fall proportionally less than employment rises; this implies that total compensation rises. The net effect on unit labour costs, therefore, depends on the magnitude of the increase in compensation relative to the increase in output. Unit labour costs will fall, by definition, if compensation rises proportionally less than output in the industry. If unit labour costs decrease, the industry value-added deflator will decrease, which will be reflected in a decline in the consumer price index. Note that some industry value-added deflators are also related to the consumer price index: therefore if unit labour costs fall, the consumer price index will be lower which will result in even lower value-added deflators.

This completes the discussion of the structure of the model. The next section contains the results of some simulation experiments with the model and an explanation of the mechanisms in the model which give rise to these results.

Results of Simulation Experiments (Set A)

The procedure followed for this set of simulation experiments (Set A) was to run a number of different simulations with the model where the primary difference between the simulations is the level of gross immigration. We then assessed the macroeconomic effects of gross immigration by comparing the average levels and implied average annual rates of growth of a variety of objective variables for two different levels of immigration.

As noted in the preceding section, gross immigration does not appear as an exogenous variable in the model. Instead, a number of population subgroups are exogenous. Projections of the values of these population subgroups for different levels of immigration over the simulation period (1972–80) were supplied by Statistics Canada and used as inputs into the model. Projections of all other exogenous variables are those supplied by members of the research staff of the CANDIDE project, except for seven variables which were considered to be related to the size of the population (or of some subgroup of the population) and hence to the level of gross immigration.[5] For all of these variables the projected values are therefore different for the different levels of gross immigration.

Table 1 gives the effects of four different levels of immigration for Set A on total real GNE, the components of GNE (also in constant dollars), the total population, real per capita GNE, total employment, total supply of labour, the unemployment rate, and the consumer price index. From this table we see that increased immigration results in higher real total GNE, lower per capita real GNE, higher rates of unemployment, and a marginally lower rate of inflation.[6]

To understand why total GNE rises with increased immigration we consider

[5]The rationale for revising the projections of some of the exogenous variables in addition to the population subgroups is that we would expect these variables to be related to the size of population (or of some subgroup of the population) and hence to the level of gross immigration. For all of these variables the projected values are therefore different for the different levels of net immigration. The seven variables adjusted for the different levels of immigration are as follows:

(1) Constant adjustment to disposable income to take account of funds brought into Canada by immigrants (which was related positively to the level of gross immigration);

(2) Other transfers from government to persons (which were related positively to the total population);

(3) Provincial and local real property taxes (which were related positively to the total population);

(4) Transfers from government to persons (which were related positively to the total population);

(5) Unemployment insurance contributions (which were related positively to the total population);

(6) Canada and Quebec Pension Plan Benefits (which were related to the population aged 65 and over); and

(7) Canada and Quebec Pension Plan Contributions (which were related to the population aged 20–64).

[6]In Tables 1 and 2 the averages and the growth rates in a few instances give conflicting information. This arises because the averages are calculated over the entire simulation period (1972 to 1980) whereas the growth rates shown are calculated as simple end-to-end implied average annual rates of growth, from 1971 to 1980.

TABLE 1
Effects of Immigration on Selected Variables, 1972–80
(Set A)

Variable (Constant dollar values for National Accounts aggregates)	*Level of Gross Immigration (Assuming 60,000 emigration)* 80,000	120,000	160,000	200,000
Gross National Expenditure				
Average ($ billions)	86.186	86.788	87.415	88.058
Growth (%)	5.20	5.28	5.38	5.48
Total Consumption				
Average ($ billions)	54.180	54.465	54.781	55.117
Growth (%)	5.11	5.16	5.23	5.31
Residential Investment				
Average ($ billions)	3.479	3.693	3.906	4.117
Growth (%)	3.64	4.43	5.15	5.82
Investment in Non-residential Construction				
Average ($ billions)	5.492	5.533	5.574	5.614
Growth (%)	5.79	5.93	6.06	6.19
Investment in Machinery and Equipment				
Average ($ billions)	6.410	6.453	6.501	6.553
Growth (%)	6.55	6.57	6.63	6.70
Exports				
Average ($ billions)	19.883	19.886	19.888	19.891
Growth (%)	6.28	6.28	6.28	6.28
Imports				
Average ($ billions)	18.078	18.123	18.180	18.245
Growth (%)	5.99	5.98	5.98	6.01
Government Current Expenditures				
Average ($ billions)	12.700	12.773	12.848	12.924
Growth (%)	4.23	4.32	4.41	4.51
Government Fixed Capital Formation				
Average ($ billions)	3.460	3.473	3.487	3.500
Growth (%)	4.41	4.51	4.59	4.68
Inventory Change				
Average ($ billions)	.996	1.008	1.024	1.041
Growth (%)	10.39	10.22	10.18	10.22
Total Population				
Average (millions)	22.835	23.050	23.266	23.481
Growth (%)	1.17	1.36	1.54	1.72
Per Capita GNE				
Average ($ thousands)	3.764	3.753	3.744	3.736
Growth (%)	3.98	3.87	3.78	3.69
Supply of Labour				
Average (millions)	9.581	9.665	9.751	9.837
Growth (%)	2.40	2.56	2.72	2.88

TABLE I (continued)
Effects of Immigration on Selected Variables, 1972–80
(Set A)

Variable (Constant dollar values for National Accounts aggregates)	*Level of Gross Immigration (Assuming 60,000 emigration)* 80,000	120,000	160,000	200,000
Employment				
Average (millions)	9.157	9.212	9.268	9.326
Growth (%)	2.65	2.74	2.83	2.93
Unemployment Rate				
Average (%)	4.45	4.71	4.96	5.20
Consumer Price Index				
Growth (%)	2.27	2.23	2.20	2.19

first the components of GNE which are affected directly by the total population or by a weighted average of population subgroups. For each 40,000 immigrants added to the total population in each year, the average population from 1972 to 1980 is higher by just over 200,000 and the implied average annual rate of growth of population from 1971 to 1980 higher by just under .2 of one per cent. Table 1 reveals that the response of residential investment to increased immigration is quite robust. This results from the fact that residential investment depends indirectly on the total number of households, which is increased directly by immigration. Likewise, we have seen that some components of government current expenditures and government fixed capital formation depend positively on the size of the population. These two components of GNE therefore increase with higher levels of immigration although the response here is not as substantial as for residential investment.

The only other direct relationship between population and aggregate demand in CANDIDE is the effect that the total population has on imports of non-competing products, which increase with higher levels of immigration. The increase in total imports is not very great, however, and is largely a result of the dependency of most import categories on some measure of output. Some import categories are also related negatively to the unemployment rate, which increases slightly with higher levels of immigration. The net effect, as noted, is for imports to increase slightly. Since imports are subtracted from the domestic demand components of GNE, the effect of immigration on imports causes GNE to be slightly lower.

Looking at the other components of GNE, we see that they all increase with higher levels of immigration. Total consumption, which depends positively on total income, is slightly higher. The response of investment in non-residential construction is relatively stronger but this is a much smaller component of GNE. Similarly, investment in machinery and equipment rises with increased immigration, but here the response is only marginal. The increases in these two categories of investment result from the induced effect that higher levels of output have on private capital formation. Exports increase marginally with increased immigration as a result of a slight decrease in domestic relative to foreign prices and the

increase in the unemployment rate, which raises exports of non-ferrous metals.[7]

Each addition of 40,000 immigrants causes a reduction of eight to nine constant dollars in average per capita income. In other words, the increase in total product is proportionally less than the increase in the total population. It is worth noting here that, although per capita GNE falls slightly with increased immigration, there are a greater number of people around to enjoy that slightly lower level of per capita output. As an illustration, the total population in 1980 is higher by 401,000 persons for the 120,000 level of immigration than the 80,000 level. The increase in the total population of 401,000 is greater than the total number of immigrants admitted (40,000 per year for nine years, or 360,000) because the crude birth rate is higher than the crude death rate or, equivalently, because there are more children born to immigrants than there are deaths of immigrants and of children born to immigrants in the country.

The total supply of labor over the simulation period rises by an average of approximately 85,000 persons for each 40,000 increase in the level of gross immigration. This is because every 40,000 immigrants added to the source population remain in it for the rest of the simulation period except for a portion of them who die. The participation rates for young and old males and women under thirty-five decrease very slightly and the rate for women thirty-five and over increases slightly. Total employment also rises with increased immigration, by about 55,000 on average for every extra 40,000 immigrants per year: the higher level of output demanded as a result of immigration requires a higher level of employment for that output to be produced. Since employment rises proportionally less than the supply of labor, the unemployment rate is higher as a consequence. The increase in the unemployment rate is about one-quarter of one percentage point for each increase of 40,000 in the level of immigration.

Finally, the rate of inflation in consumer prices is slightly lower as a result of increased immigration. This results from lower unit labor costs in ten out of fourteen industries. Unit labor costs fall because total labour compensation by industry rises proportionally less than output by industry. In fact, wage rates are comparatively lower and employment by industry is higher with increased immigration, which results in a net increase in labour compensation, which is the product of the two.

In brief, the results from the model indicate that increased immigration lowers average per capita GNE slightly, raises the unemployment rate, and lowers the rate of inflation in consumer prices. Immigration has a direct positive impact mainly on aggregate residential investment and government spending. An increase in these components of GNE induces increases in most of the other components, mainly consumption and business fixed investment. The overall increase in aggregate real output is proportionally less than the increase in the total population so that real GNE per capita averaged over the simulation period falls. The higher level of output induces a higher level of employment. Also, the supply of labour increases because immigrants are added directly to the source population.

[7]It may be noted that the relationship between exports of non-ferrous metals and the unemployment rate is used to capture the cyclical effect of domestic competition for exports of these products: a higher unemployment rate is a proxy for lower domestic capacity utilization and lower competing domestic demand, which results in increased exports of these products. The effect on the unemployment rate of an autonomous injection of immigrants therefore may not entail the same reaction by this category of exports as would a cyclical change in the unemployment rate. In any case, these exports are a very small component of total GNE.

Again, the increase in employment is proportionally less than the increase in the supply of labor so that the unemployment rate rises. Prices fall slightly because unit labor costs decline. In the next section we examine a second set of experiments with the model.

Results of Simulation Experiments (Set B)

In this section we report on some simulation experiments in which an increase in immigration is accompanied by an exogenous increase in government spending. In these experiments we implicitly solve for the increase in government fixed capital formation which is necessary to bring the average unemployment rate for the three higher levels of immigration down to the average unemployment rate over the simulation period for the lowest level of gross immigration (80,000). The purpose of this exercise is two-fold. First, it illustrates the point that, although immigration alone may adversely affect the unemployment rate and per capita GNE, it is possible to compensate for these effects with expansionary fiscal policy and be no worse off than with a lower level of immigration in the sense that the unemployment rate would remain unchanged. Second, we can use the amount of extra spending required per extra immigrant to achieve this objective as a measure of how much aggregate spending as a result of immigration the model would have to miss in order to give qualitatively different results. For example, if we believe that the model understates the impact of one immigrant on aggregate demand by a small amount, but we find that it requires a very large exogenous increase in spending per immigrant to reverse the effects observed, then we can be more confident that at least the observed *direction* of the effects of immigration on the objective variables is correct.

Table 2 gives the results of these experiments (Set B) and the corresponding results for the previous set. To clarify this table, observe, for example, that in Set A increasing immigration from 80,000 to 120,000 raises average real GNE over the simulation period from \$86.186 billion to \$86.788 billion. In Set B, increasing immigration by the same amount plus increasing government fixed capital formation by \$.190 billion in constant dollars results in an increase in average real GNE over the simulation period from \$86.186 billion to \$87.381 billion.[8]

Because government spending is endogenous, the final increase in government real capital formation is greater than the constant dollar adjustment. Also, because government revenues are positively related

[8]To increase government capital formation it is necessary to increase its components, as the total does not enter directly into the input-output conversion submodel. We distributed the desired increase to total capital formation among its components according to the relative shares of the components in the total in 1971. This is identical to the procedure used in McCracken [4, p. 100] to calculate multipliers with CANDIDE. Since these components are endogenous in the model, we simply add a constant amount in every year to the equation as follows:

$$G_{t,i} = f_i(Y) + \alpha_i \bar{k}$$

where $G_{t,i} = f_i(Y)$ is the behavioral equation for the i^{th} component of government capital formation, α_i is the ratio of capital formation of type i to total capital formation in 1971, and $\bar{k}$ is the total exogenous increase in government capital formation.

Since the government does not in fact spend constant dollars (although it may make decisions in these terms), a preferable procedure might have been to use

$$G_{t,i} = f_i(Y) + (\alpha_i \bar{k}^*)/P_{t,i}$$

where P is the appropriate deflator and $\bar{k}^*$ the total current dollar adjustment. This method would have been considerably more difficult because it would have involved modifying the actual model code in the computer for all of the relevant equations. In any case, we can calculate the implied current dollar equivalent of the constant adjustment by multiplying by the appropriate price index, which is endogenous in the model. This implied average current dollar adjustment is given in row two of Table 2.

TABLE 2
Effect of Exogenous Increase in Government Fixed Capital Formation on Objective Variables

Variable	*Set*	*Level of Gross Immigration (Assuming 60,000 Emigration)* 80,000	120,000	160,000	200,000
Exogenous Increase in Government Fixed Capital Formation					
Per Annum ($ billions)[a]	B	0	.190	.370	.550
Per Annum ($ billions)[b]	B	0	.300	.584	.868
Total Government Fixed Capital Formation					
Average ($ billions)[a]	A	3.460	3.473	3.487	3.500
	B	3.460	3.682	3.893	4.104
Growth (%)	A	4.41	4.51	4.59	4.68
	B	4.41	5.10	5.73	6.32
Government Surplus					
Average ($ billions)[b]	B	2.451	2.290	2.146	2.002
Gross National Expenditure					
Average ($ billions)[a]	A	86.186	86.788	87.415	88.058
	B	86.186	87.381	88.562	89.757
Growth (%)	A	5.20	5.28	5.38	5.48
	B	5.20	5.39	5.58	5.77
Per capita GNE					
Average ($ thousands)[a]	A	3.764	3.753	3.744	3.736
	B	3.764	3.779	3.793	3.808
Growth (%)	A	3.98	3.87	3.78	3.69
	B	3.98	3.98	3.98	3.98
Supply of Labour					
Average (millions)	A	9.581	9.665	9.751	9.837
	B	9.581	9.691	9.800	9.910
Growth (%)	A	2.40	2.56	2.72	2.88
	B	2.40	2.60	2.81	3.01
Employment					
Average (millions)	A	9.157	9.212	9.268	9.326
	B	9.157	9.263	9.367	9.471
Growth (%)	A	2.65	2.74	2.83	2.93
	B	2.65	2.83	3.01	3.19
Unemployment Rate					
Average (%)	A	4.45	4.71	4.96	5.20
	B	4.45	4.45	4.45	4.44
Consumer Price Index					
Growth (%)	A	2.27	2.23	2.20	2.19
	B	2.27	2.37	2.47	2.58

a = in constant dollars.
b = in current dollars.

to product, the government surplus decreases by less than the exogenous increase in government capital formation.[9]

The unemployment rate, as intended, is the same, rounded to the first decimal point, for all levels of immigration in Set B. Constant dollar per capita incomes averaged from 1972 to 1980 are higher for higher levels of immigration in Set B, although the implied average annual rate of growth is the same for all levels of immigration.[10] The rate of inflation is slightly higher for higher levels of immigration in Set B, which might be regarded as a possible cost of offsetting the higher unemployment rates accompanying increased immigration flows. The acceleration is very small in any case, especially in the context of actual experience in the mid-1970's.

The first implication of these experiments is that it would be possible to have increased immigration, which, if accompanied by expansionary fiscal policy, would result in the same unemployment rate and higher real average per capita incomes. From Table 2, we see that $190 million of extra government spending is required (in constant dollars) in each year of the simulation period with the 120,000 level of gross immigration, in order to have the same average unemployment rate over the simulation period as with the 80,000 level of gross immigration. Similarly, for the 160,000 level of gross immigration, extra spending of $370 million is required to have the same unemployment rate as for the 80,000 level and, for the 200,000 level, the same effect requires extra spending of $550 million.

The second implication relates to the amount of extra spending necessary per extra immigrant in order to leave the average unemployment rate over the simulation period unchanged. If we believe that the model understates the effect of immigrants on consumption expenditures only in their first year in the country, we can use the above estimate to judge whether it is likely that the actual effect of immigration on the unemployment rate is in the direction determined by the model. It requires $190,000,000/40,000 = $4,750 extra spending per immigrant per year to bring the average unemployment rate down from 4.71 per cent for 120,000 gross immigration (in Set A) to 4.45 per cent for 80,000 immigration. Likewise, extra annual spending of $370,000,000/80,000 = $4,625 is required to get the same result for the 160,000 level of gross immigration and $550,000,000/120,000 = $4,583 for the 200,000 level of gross immigration. Since it is highly unlikely that the model understates the spending propensities of immigrants by these amounts, we can be reasonably confident that immigration by itself does in fact raise the unemployment rate. (The implied amount of extra spending per immigrant which would be necessary is greater than average per capita incomes in any of the simulation experiments.)[11]

Concluding Remarks

In the above sections we discussed in some detail the relevant structure of CANDIDE

[9]The reduced government surplus will imply that less government debt may be retired than otherwise would be the case. The effects of different levels of government debt on the money market are not taken into account by the model, as the surplus or deficit of the federal government does not appear in the monetary sector of CANDIDE.

[10]The identical growth rates of per capita GNE for the different levels of immigration in Set B are coincidental.

[11]This statement must be qualified somewhat since an autonomous injection of government spending on current account, as opposed to capital goods, has a greater impact on GNE in the model. Our estimates of the extra spending which would be required by immigrants therefore overstate to a certain extent the additional amounts which would be required in order to reverse the direction of the effect on the unemployment rate.

Model 1.0, showed how it may be used to test the medium-term macroeconomic effects of changes in the level of gross immigration, and illustrated the result that expansionary fiscal policy can offset the increase in the unemployment rate and the decrease in real per capita GNE which were observed, in the model, to result from increased immigration. One very narrow interpretation of the results is that immigration should be discouraged because of its detrimental effects on the unemployment rate and real per capita GNE. A second interpretation is that if immigration is to be encouraged on the basis of other information about its effects on economic growth (or for other reasons), it would be desirable to accompany it by an appropriate fiscal response by the government.

We emphasize that output in the CANDIDE model is determined essentially by demand factors. The model does *not* measure the microeconomic supply or growth effects of immigration. It is entirely possible that actual output per capita may fall with increased immigration but that potential output per capita may rise with increased immigration, even in the absence of compensating fiscal policy.

It must also be emphasized that the model does not measure the impact of immigration on the size distribution of incomes. For example, with increased immigration we observe an increase in the unemployment rate but we do not know whether it is immigrants or earlier residents who are subjected to increased unemployment. Nor are any other structural or regional effects on labour markets taken into account by the model. Also, although per capita output averaged over the simulation period is lower with increased immigration, we do not know who is better or worse off as a result. In fact, immigration may conceivably lower real output per capita but result both in an improvement in immigrant incomes relative to their previous incomes in the sending country and in an improvement in incomes of native Canadians or prior residents. Most likely, however, even if per capita income were to rise with increased immigration, some prior residents would be made better off and some worse off and this is one factor which makes the decision about the level or composition of immigration difficult.[12]

To conclude, we acknowledge that the model used for these tests has certain limitations, as do all such models. For example, immigrants are assumed to have the same spending propensities as prior residents. We have noted that this assumption is not entirely validated by the information which is available, but we also have shown that any understatement of the spending habits of immigrants appears unlikely to be large enough to reverse the direction of the effects of immigration, as measured in the model. There are other possible weaknesses of the model for our purposes: as suggested earlier, the effect of a change in the unemployment rate on exports of non-ferrous metals may depend on the nature of the increase in the unemployment rate. Also, any possible financial effects of the change in the government surplus are not taken into account by the model. Finally, the model does not allow for the effects of changes in economic variables on demographic variables, except labour force participation rates. Although the results are therefore not entirely conclusive, it is nevertheless of interest to note that two other recent investigations of the same problem in Canada using entirely different models (Davies [1] and Marr [3]) also found that immigration influences the unemployment rate and real per capita GNE in the same direction as has been observed in the experiments with CANDIDE.

[12] A thorough statement of the factors which determine the effects of immigration on the distribution of income may be found in Frankena [2].

References

[1] Davies, Gordon W., "A Simulation Model to Test the Effects of Immigration on the Canadian Economy," Department of Economics, University of Western Ontario (mimeo, March 1974).

[2] Frankena, Mark, "Immigration Policy and the Distribution of Income in Canada," University of Western Ontario (mimeo, January 1974).

[3] Marr, William L., "The Economic Impact of Canadian Inward and Outward Migration and their Determinants, 1950–1967," Department of Economics, University of Western Ontario (unpublished Ph.D. dissertation, November 1972).

[4] McCracken, M. C., *An Overview of CANDIDE Model 1.0*, CANDIDE Project Paper No. 1, Economic Council of Canada, Ottawa, Canada (1973).

[5] Neilson, Soren T., "An Examination of Household Expenditure Patterns of Canadian Immigrants," Department of Economics, Simon Fraser University (mimeo, June 1973).