Faculty Working Papers

THE OVERALL EFFECT OF IMMIGRANTS UPON NATIVES' INCOMES

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College of Commerce and Business Administration
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Summary

See next page for abstract.

Abstract

This paper inquires into the effect of an additional immigrant upon the incomes of natives in the U.S. It arrives at estimates of the composite impact in each year following the immigrant's entry, and then a present-value estimate of the entire stream of positive and negative effects in various years.

The paper first discusses the most important elements separately: the capital dilution effect in Part II, where a new approach to estimating the proportion of the returns to capital captured by immigrants who arrive without capital is sketched out; social security savings transfers in Part III; and the impact on productivity in Part IV, the sum of learning by doing, creation of new knowledge, and economies of scale of various sorts. Comparison of these partial analyses shows that the life-cycle saving-and-transfer process works in a positive direction for natives, and is of the same order of magnitude as the capital-dilution effect, if immigrants are assumed to receive a realistic proportion of the returns to capital.

The effect of the immigrant upon productivity, however, must also be taken into account though it has been omitted from previous theorizing about the effects of immigrants. Assessment of this effect together with the others requires a dynamic macro-model, and a simple one is simulated here. The results indicate that within a few years, the productivity effect comes to dominate the results and thereafter dwarfs the capital-dilution and saving-and-transfer effects. Seen as an "investment", immigrants yield a very high rate of return to natives, on any reasonable parameters.

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THE OVERALL EFFECT OF IMMIGRANTS UPON NATIVES' INCOMES*

Julian L. Simon

I. INTRODUCTION

One of the two major aims of inquiry into the economic effects of immigrants is to assess the overall effect of the newcomers upon the average income of natives. To do so, one must take into account all of the important effects, rather than focusing only on those most easily embraced by theoretical and empirical devices. And these important effects must be combined in order to arrive at an overall net calculation. To do this is the aim of this paper. The other main aim, understanding the distributive effects, is left to other papers in this volume.

Section II reviews the theory of the effect of the allocation of capital ownership, and sketches a new way of calculating that effect for the U.S. Section III discusses the intergenerational transfer effect. Section IV discusses the effect of immigrants upon productivity, which has hitherto not been included in discussions of the topic, but which is likely to be the most important of all effects in the long run. And then Section V combines all these elements into a simulation model that estimates the net on-balance effect of immigrants on the incomes of natives.

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*I appreciate a helpful corrective reading by Paul Beckerman, capable computer programming by Joseph Ben-Ur, criticism at the Conference by Warren Sanderson and other attendees, and useful suggestions by Barry Chiswick.

II. THE CAPITAL-OWNERSHIP EFFECT

Notation

A = level of technology and scale effects

d = discount factor

D_t = increase in total output in t due to immigrant, equal to $(Y_t^m - Y_t^n)$.

G_t = gross income in year t

K = capital

L = labor force

m = index indicating a situation with immigration

n = index indicating a situation without immigration

s = savings rate

T = taxation

v = index for native population

Y = national income

Z_m^v = lifetime income of natives if there is migration

Z_n^v = same but without migration

The prevailing theoretical approach from Malthus until recently—and still the prevailing popular view--is that immigrants lower the income of "natives"* through capital dilution and diminishing returns.

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*By "native" I mean those residing in the country previous to the arrival of the immigrant in question. There is no good term in English to cover this concept. Israeli writers on immigration use "veteran", but this sounds unfamiliar in English. "Citizen" focuses attention on legal rather than residential status. "Native" seems to exclude prior immigrants, which I do not intend to do, but it seems to be the best term nevertheless.

The given endowment of capital, combined with more workers, yields less output per average worker.

Then Borts and Stein (1964) and Berry and Soligo (1969) pointed out that if immigrants do not share in the returns to capital, and yet are paid their marginal product, the total returns to capital are increased by more than the sum by which natives' wages are lowered; hence immigrants increase the average income of natives under these conditions. This proposition is shown in Figure 1, taken from Berry and Soligo, where the approximate-triangle X represents the gain to natives as a whole.*

Figure 1

Berry and Soligo made it clear that whether immigrants obtain rights to the returns to the existing capital affects their impact upon natives' average income. But Usher suggested that the gain to natives from the "triangle" X is small compared to the loss to natives if immigrants cap-

*This line of reasoning implicitly assumes that there is only one wage-earning occupation in the economy. If this assumption is relaxed, the analysis is more complex. If there are a variety of occupations and the immigrants come with the same distribution of skills as the natives, then the result is the same as if there is only one occupation. But if the immigrants come with a different distribution of skills, then there are the same sorts of overall gains to trade that occur in international trade of goods. On the other hand, the occupations that are disproportionally represented by the immigrants suffer worse wage declines than does the average. The Vietnamese immigrants of the late 1970's, and the Cuban immigrants of 1980, seem to have a broad spectrum of occupations, whereas the Mexican seem to be largely semi-skilled laborers, so both sorts of cases seem to be important. The general question of an effect analogous to gains to trade was raised in conversation by Mark Rosenzweig, and to my knowledge has not been analyzed. Hence I have no feeling for how important it may be. But to the extent that it operates, it has a beneficial effect on the average native's income.

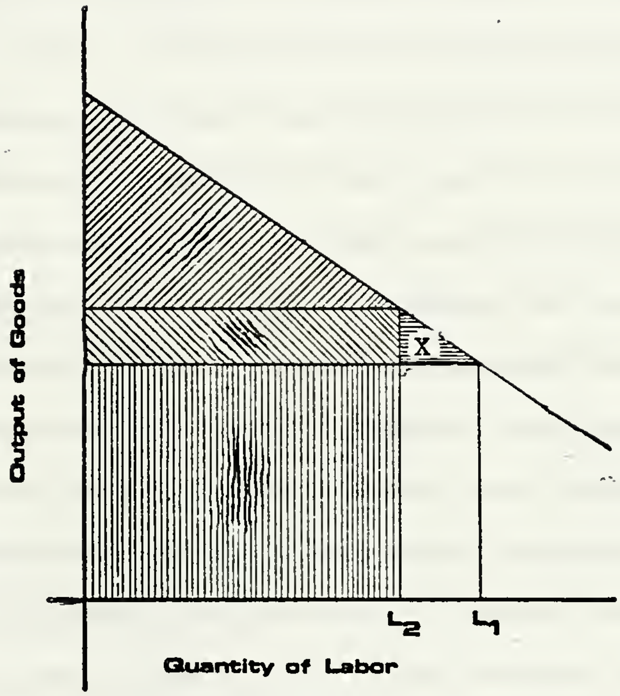

FIG. 1

ture part of the returns to capital, a demonstration I also made quantitatively in an analysis of the effect of Russian immigrants upon "veteran" Israelis' incomes (Simon, 1976). The task, then, is to estimate the proportion of the return to capital that go to immigrants. And this is not a simple or straightforward task.

Usher's approach was to estimate the value of the capital stock. This method necessarily is fraught with all the well-known difficulties of valuing existing industrial capital, plus the special difficulties of valuing the physical and organizational capital of government, and of farms and other land whose market price depends largely upon the value of product rather than the cost of producing the capital. Usher's calculation of effective public ownership was therefore quite delicate and judgmental. Nevertheless, Usher made a back-of-the-envelope calculation that 58% of the capital in the U.K. is in effect publicly owned. If this were the appropriate figure, the loss to natives from immigrants would indeed be very large relative to the "triangle" gain that would result if effective public-capital ownership by immigrants were zero.

Working with the streams of payments to capital owners and to labor would avoid some of the difficulties of valuing cpaital that arise in Usher's method, and I tried to do this earlier. But both this and Usher's method now seem to me misdirected for illuminating the particular problem at hand. The reasoning is as follows.

Recall that the aim here is to determine the effect of immigrants <u>upon natives' incomes</u>. A calculation of the sort that Usher made (based on the concept that I, too, used in my 1976 paper), or the sort of calculation that I made working with streams of payments for the conference version of this paper, may reveal something about the benefits obtained from the capital by the immigrants themselves. But the benefits to the immigrant are not the obverse of costs to natives.

Consider Usher's central statement: "When a man migrates from one country to another, he abandons his share of public property--the use of roads and schools, the rights to a share of revenue from minerals in the public domain and so on--in the former country and acquires a share of public property in the latter, conferring a benefit upon the remaining results of the country from which he comes and imposing a cost upon the original residents of the country to which he goes." (p. 1001) This assertion by Usher, to which I also subscribed earlier (1976), no longer seems correct to me. The most obvious defect is that there are economies of scale in true public goods. For example, the benefit the immigrant receives when he or she sees the Statue of Liberty is not balanced by a corresponding cost to natives, even before or after the immigrant becomes a citizen and a part owner of the Statue. And to a greater or lesser extent the same is true of roads, public television transmitters, museums, military real estate, and wilderness. Furthermore, there is no clear correspondence between the contemporary market value or the original cost of such public capital, and the benefits derived from it. Therefore we need a method that directly estimates the effect upon natives rather than an indirect estimate by way of the benefits obtained by immigrants. And more specifically, we want to know the effects upon natives' money incomes, because estimating the costs or benefits to them of changes in physical and cultural environment caused by immigrants is not presently possible.

The matter turns out to be less inscrutable than it seems at first, however. The key to the analysis is observing that the total output of business need not be divided conceptually between the shares of capital and labor, i.e., the return to labor and capital do not "exhaust the product" in this context. To put it differently, with respect to the difference D between total output Y^m with an immigrant and Y^n without him or her, the part that goes to capital and the part that goes to labor do not account for the whole. Rather, government gets a share, and this share need not be seen as on a different footing than capital's and labor's shares. Rather, government can be seen as providing a third sort of service--security, organization, or whatever--for which it is paid the indirect and corporate taxes it receives. Government is providing a factor of production which a given business decides not to avoid using and paying for by moving offshore; the fact that the business decides to remain in the U.S. and pays for the privilege of doing so, just as it pays for private capital as labor, makes clearer the status of the government services (or simply permission to do business) as a factor of production.*

This leaves us with difficulty only (!) in the task of interpreting the business tax payments with respect to beneficiaries. The amounts

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*Access to the labor and services markets within the country are part of the decision to remain, of course, and one may not wish to consider these as a governmental service. This is a murky matter conceptually, but the argument does not depend upon this point. The important fact for the argument is that the firm must pay the government if it is to conduct its business, and the size of the payment depends on the size of the output, which in turn is influenced by the presence or absence of the immigrant.

paid by private business to immigrants can be interpreted as their marginal product, and the returns to capital are capital's share. That is, on this interpretation, private capital's share is the amount that private capital receives, and the same for labor.

The government's take--14.5% of GDP*--goes mostly for current expenditures, and the extra taxes on account of immigrants surely are mostly offset by current expenditures on immigrants. But some of the tax payments finance government capital. Only the latter part of the government's share, out of the entire additional output D, is a "return to capital" which the immigrant gets a piece of, and this is likely to be small relative to D.

There is, however, a "return to capital" which immigrants employed by government obtain; for such immigrants there is no yield from capital that natives get and immigrants do not. So the relevant estimate is the proportion of immigrants who work for the government, together with the return to government capital through taxes on private business--the latter a small part of the 14.5% government share, say 5% of D. Of the former, in 1979, 2,773 million persons and 12,840 million persons respectively worked in federal and state-and-local government, which is 17.4% of a total of 89,497 million employed persons (Economic Report of the President, 1979, p. 242). And a lower proportion of new immigrants than natives work for government. All told, this analysis suggests that immigrants capture less than 17.4% plus 5% of the "return to capital", which is much less than the 35% which is the basic "conservative" or upper-limit figure used in the simulation.

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*In 1979 $126.3 billion indirect taxes plus $75.4 billion corporate taxes divided by $1,380.3 GDP of non-financial corporate business (Economic Report of the President, 1980, p. 216).

The analysis given above is much compressed, and a satisfactory treatment must be of article length elsewhere. I am reasonably confident, however, of the basic conclusion that the benefits to natives from the immigrants through the extra returns to private capital are not overstated by this analysis and by the 35% figure used; I hope the reader agrees.

The importance for natives' incomes of the extent of capital-returns captured by immigrants can be derived from a Cobb-Douglas model to be developed later. This partial effect corresponds to the proportion of the average immigrant's income that is transferred to or from the immigrant on one or another assumption of capital-returns capture. If the immigrant captures none of the returns to capital, the immediate effect* is very slightly positive (equal to .1% of the immigrant's income). If the immigrant captures <u>all</u> the returns, there is a negative effect equal to 32% of the immigrant's income. For other capital-capture proportions, the effects on natives as proportions of the immigrant's first-year income are, respectively: 10%, -4%; 20%, -8%; 30%, -12%. At the 35%-capture rate that I judge is an upper bound, the effect is a transfer to the immigrant equal to 14% of the immigrant's income.**

These calculations agree with Usher's conclusion that the triangle of benefit to natives in the absence of returns to existing capital

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*The longer-run effects in years after entrance, and as the immigrant grows older, will be analyzed later.

**These calculations arise from runs of the model with a 4% savings rate. At a more realistic higher savings rate, the capital-dilution effect on natives is less over the years.

captured by immigrants is small relative to the capital dilution cost to natives at even small proportions of capital-returns capture. But as we shall see, this effect is swamped by the sum of the other effects.

III. THE INTERGENERATIONAL TRANSFER EFFECT

Modigliani (1966) and Samuelson (1975) have shown in a different context that an additional person--and more generally, a positive population growth rate--will have a positive partial effect on incomes by way of existing patterns of life-cycle saving and consumption. This argument has not previously been applied to immigrants, but in fact it applies even more strongly to immigrants than to native births because the childhood public-consumption portion of the life cycle is not present with immigrants, as we shall see later in the data on the age distribution of immigrants.

Though Modigliani and Samuelson talk about the saving of an additional person that makes him or her increase the incomes of others, we must notice that _pure_ saving is not meant here, but rather a retirement system based on transfer payments. If you immigrate, build a barn with your own hands (saving and investment), and then sell milk from it, no one benefits from the saving other than you. Or if you build the barn and rent it to me, no one else's income is raised more than if you did the same construction work on salary for a construction company. It is your immigrating and then _giving ten percent of your salary_ to the already-fixed number of native retirees that increases the average income of your age cohort (by decreasing their contributions to the retirees), and therefore the incomes of the natives as a group.

The existence of this benefit from immigration depends on two assumptions: (1) The public consumption patterns of children, adults, and retirees are such that an additional complete native family with a larger number of children than retirees--a family typical of population growth--transfers more to the rest of the economy in social security payments in a given year than it consumes in public expenditures on children plus transfers to retirees; this is the case in the United States (Clark and Spengler, 1979), though less so in European countries where child-support transfers are relatively larger than in the U.S. (2) The age distribution of immigrants when they arrive has more workers and fewer dependents than the age distribution of the native population. These are the most important reasons why this second assumption is overwhelmingly true: (a) Even those retirees who do come with immigrant families are not entitled to old-age benefits. (b) The age distribution of immigrants is much more heavily concentrated in the prime working ages than is the native population, as may be seen in Table 1. On average, it is the young, strong, and single who migrate. (This is especially true of illegals; more than 80% are male, half are single [most of the married men leave their wives and children in Mexico, for example], and most are youthful--less than 20% of the workers are over 35, and they average perhaps 27.) Among the Vietnam refugees, only 12% are 45 or over, compared to 32% for the 45-and-over age group in the U.S. population as a whole. (There is, however, a larger proportion of young children among the Vietnam refugees than in the citizen population.)

As to actual employment, a survey (Opportunity Systems, Inc., 1975-1977) showed that 47% of the Vietnamese males 14 years or older were working within 3 months of entry. This rapid job-finding jibes with the results of studies of immigrant employment in Canada (Manpower and Immigration, 1974), Israel (Russian immigrants, Shuval et al., 1973) and United Kingdom (New Commonwealth immigrants, Jones and Smith, 1970).

These data imply that immigrants constitute a class which, on net balance, contributes to natives by age-and-youth transfer payments. Section VI will discuss whether there are offsetting negative transfer effects of immigrants through other social-welfare channels.

Table 1

One may wonder whether the net flow of transfers caused by the immigrant cohort tends to balance out when the immigrants get older. This seems so if one looks only at the immigrants themselves rather than at the whole sequence of events caused by the entry of the immigrants, which includes their children who then grow up into productive workers. When the immigrants get older, the immigrants' own offspring more than supply the necessary retirement transfers ("more" rather than "equal to" because of the effect in (1) above). Were this system to be considered in an equilibrium context, this would not seem to be true. But it is in the very nature of the entry of each immigrant that it is a one-time disequilibrium event, and it is the gains from the difference between it and an otherwise comparable equilibrium--that is, the system without the immigrant--that constitute the transfers captured by the natives.

Table 1

Distributions by Age of Legal Immigrants at Entry, and U.S. Population

Age	U.S. Population, 1970 (*Social Indicators*, 1976, p. 32)	Legal Immigrants to U.S., 1967-1973 (INS Data from Keely and Kraly, 1978)
0-19	38.0	35.5
20-39	25.6	46.4
40-59	22.2	13.8
60+	14.2	4.3

Perhaps a hypothetical example will clarify this important but elusive point. Imagine that a "native" family consists of you and your spouse, both now age 35, your three-year-old twins, and your retired grandfather. My immigrant family consists of my spouse and I, both age 25. Both families pay 20% of our $20,000 yearly incomes in taxes. Your family now receives Social Security for the grandfather (and various minor support for the twins) whereas my family receives no such payments, so on balance you gain from me now. After a few years the balance will become slightly more even as my spouse and I also have two children, and forty years later the yearly balance will become roughly equal after my spouse and I retire and collect Social Security. But since your family was the net gainer in the early years--the years which weigh heaviest in a present-value calculation of the "investment" value to natives of admitting my family as immigrants, a calculation properly made at the time of the admission decision--the calculation is influenced positively by the Social Security effect (and to a much smaller extent, by the child welfare programs). And the calculation for this one immigrant family is in no way altered by the fact that other immigrants may or may not enter in future years.

In passing, it is interesting to notice that the immigrant-saving effect is the opposite of the negative child-dependency effect that has been the mainspring of the Coale-Hoover argument against population growth in less-developed countries. And the life-cycle facts may well be such that, even in LDC's, over its lifetime an additional child has a positive net transfer effect on the income of others.

The actual magnitude of the life-cycle saving effect is roughly equal to the proportion of an immigrant's salary that goes to fund social security and other federal old-age programs. At present this is upwards of 10% of the average salary (Economic Report of the President, 1977) and the schedule is such that immigrants, who have relatively low incomes, pay a larger percentage than the average native. And the social-security percentage is almost sure to rise in the next few years. So we see that this positive effect is large, and of the same order of magnitude as the negative capital-returns-capture effect seen in Section II.*

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*No mention is made here of other taxes and transfers with respect to immigrants. For citizens as a whole, these flows balance out. Because of the "favorable" age distribution of immigrants and their high rate of employment, the net effect is almost surely that immigrants pay more in taxes than the cost of the other services they use. See Simon (1978) for more details.

A traditional but fallacious related argument in favor of immigration must be dealt with here. It has been alleged at least since Francis Walker, the first president of the American Economic Association, that immigrants are a better "buy" than additional children because immigrants arrive with the publicly-financed portion of their educations already paid for by another country's public (or in more modern arguments, at a lower cost). This argument may be appropriate and relevant when historians (e.g., Neal and Uselding, 1972) look backward, assume some substitution between additional children and additional immigrants, and reckon the advantage to having had immigrants. But the argument is not relevant when the discussion is forward-looking (e.g., Blitz, 1977), and the native fertility of the country of immigration is assumed invariant to immigration; it is then not reasonable to calculate apparent savings on the education of immigrants, because sunk costs are sunk for decision-making purposes; the only question for policy purposes is whether the future native incomes and outgoes will be on balance more positive or negative with the immigrant's presence than without it. Of course an immigrant's education and human capital have an effect though the gains to capital discussed earlier, as well as through possible gains to trade (see footnote on page _____). But these effects cannot be estimated by valuing the cost of the immigrant's education or the cost of the same education in the country of immigration.

IV. THE MOST IMPORTANT EFFECT: LONG-RUN PRODUCTIVITY

The likely most important long-run effect of immigrants has yet to be mentioned, here or in previous economic theorizing on immigration. This is the effect of immigrants (in their role of additional workers and consumers) upon the productivity of the country of immigration. To calculate the importance of this effect on native incomes over the years requires a dynamic analysis of the sort I have made elsewhere for general population growth in MDC's (Simon, 1977, chapters 4-6) though with a technical progress function less sensitive to population than used earlier. As we shall see in Section V, this factor dwarfs all the others in a reasonably short span of time. This section lays the groundwork for the assumptions that are built into the model in Section V.

Aside from their special characteristics as cultural newcomers and as non-owners of capital, immigrants represent additional people *as people*. Additional people are additional workers and consumers who increase the size of the markets in which they produce and consume.

Productivity per worker is the key factor in the standard of living of a country. And economists at least as early as William Petty and Adam Smith have emphasized the importance of the size of the market in influencing productivity, due to the division of labor and other economies of scale. In more recent years, economists have also noted the influence of the size of the market--the total output and income in a market--on the decision to invest. "The inducement to invest is limited by the size of market."* Yet recent economists have not drawn the most

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*Nurkse (1952) quoted by Agarwala and Singh (1963).

obvious conclusion from this reasoning: Additional people lead to faster economic growth by increasing the size of the market, and hence boosting productivity and investment.

Economies associated with larger plants are usually one's first thought when considering economies of market scale. And indeed, larger plants are more efficient, up to a point. But the most important and interesting productivity advantages of larger markets arise at the industry level, or even the level of the market as a whole. Retail goods, and even most services, are distributed more cheaply in larger communities, once the wage effect is allowed for (Love, 1978). And in a general study of the costs of manufacturing production, Sveikauskas (1975) found an economically-important advantage in efficiency in larger cities. There is also evidence that less capital is needed to produce a given amount of output in larger cities (summarized by Alonso, 1975). And the cost of capital is lower in larger communities, as measured by bank rates (Stevens, 1978, and references therein).

Another important element is the greater density of communications and transportation networks that accompanies denser population. This may be seen casually in the larger number of radio and television stations in larger cities. And Segal (1976) found that SMSA's with populations of two million or more have 8% higher productivity than smaller SMSA's because "economies exist in transport and communications in the very largest cities..." A related phenomenon is the greater propensity to produce new ideas that accompanies living in larger MDC cities (Higgs, 1971; Kelley, 1972), and the greater propensity for new ideas and trends to diffuse and be adopted in larger cities (Fischer, 1978). And in LDC's, Glover and

Simon (1976) have shown in a cross-country study how denser road networks--a vital factor for agricultural development--are more dense where population is more dense.

Larger markets also induce faster gains in productivity due to competition, and to "learning by doing". An example of the competitive effect: The January White Sale--a costless commercial innovation--was adopted decades earlier in big cities than in small cities, on the average (Simon and Golembo, 1967); the obvious explanation is the pressure of competition. As to learning: the more television sets or bridges or airplanes that a group of people produces, the more chance those people have to improve their skills with learning by doing, a very important factor in the increase of productivity. The increased efficiency of production within firms and industries as experience accumulates has been well documented in many industries starting with the air-frame industry in the 1930's (see e.g. references in Rosen, 1972, p. 369). The bigger the population, the more of everything that is produced, which promotes learning by doing.

The most relevant evidence on market size and economies of scale comes from studies of industries as wholes. It is an important and well-established phenomenon that industries which grow faster increase their efficiency faster--even compared with the same industries in other countries. The most complete analysis is that of Clark (1967, p. 265), who compares the productivity of U.S. industries in 1950 and 1963 (and of U.K. industries in 1963), against U.K. industries in 1950.* The larger

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*The US-UK comparisons in the same year are relatively free of the potential bias arising from the fact that those industries where world technology grew faster exogenously were also those whose scale of production therefore expanded faster, a bias which afflicts analogous time-series studies within a single country.

the industry relative to the 1950 U.K. base, the greater is the productivity difference, and the effect is large. This argues that faster population growth--which causes faster-growing industries--leads to faster growth of productivity.

How do immigration, population size, and population growth come into the picture?* The source of improvements in productivity is the human mind, and the human mind seldom is found apart from the human body. And because improvements--their invention and their adoption--come from people, it seems reasonable to assume that the amount of improvement depends on the number of people available to use their minds.

This is an old idea, going back at least as far as William Petty in 1682:

> "As for the Arts of Delight and Ornament, they are best promoted by the greatest number of emulators. And it is more likely that one ingenious curious man may rather be found among 4 million than 400 persons . . . And for the propagation and improvement of useful learning, the same may be said concerning it as above-said concerning . . . the Arts of Delight and Ornaments . . . " (1682)

More recently, this effect of population size has been urged upon us by Kuznets (1960).

It cannot be emphasized too strongly that "technological advance" does not mean "science", and scientific geniuses are just one part of the knowledge process. Much of technological advance comes from people who are neither well-educated nor well-paid--the dispatcher who develops a slightly better way of deploying taxis in his ten-taxi fleet, the

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*The following paragraphs are taken from Simon (forthcoming).

shipper who discovers that garbage cans make excellent cheap containers for many items, the supermarket manager who finds a way to display more merchandise in a given space, the supermarket clerk who finds a quicker way to stamp the prices on cans, the market researcher in the supermarket chain who experiments and finds more efficient and cheaper means of advertising the store's prices and sale items, and so on.

The potential contribution of additional producers of knowledge to resources and the economy is manifest. Bethe, who has excellent credentials to speak on the topic, says that the future cost and availability of nuclear power--and hence the cost of availability of energy generally--would be a better prospect if the population of scientific workers were larger. Talking specifically about nuclear fusion and a device called Tokamak by the Russians:

> Work on machines of the Tokamak type is also going forward in many other laboratories in the U.S., in the U.S.S.R. and in several countries of western Europe. If the problem can be solved, it probably will be. Money is not the limiting factor: the annual supuport in the U.S. is well over $100 million, and it is increasing steadily. Progress is limited rather by the availability of highly trained workers, by the time required to build large machines and then by the time required to do significant experiments. (1976)

A casual inspection of the historical record confirms this speculation. There have been many more discoveries and a faster rate of growth of productivity in the past century, say, then in previous centuries, when there were fewer people alive. True, ten thousand years ago there wasn't much knowledge to build new ideas upon. But seen differently, it should have been all the easier ten thousand years ago than now to find important improvements because so much still lay undiscovered. Progress surely was agonizingly slow in pre-history, however; for example, whereas we develop new materials (metal and plastic) almost every day, it was centuries or thousands of years between the discovery and use of, say, copper and iron. It makes sense that if there had been a larger population then, the pace of increase in technological practice would have been faster.

For the twentieth century there is some statistical evidence. For the period 1950-1962 for the U.S., Denison (1967, pp. 287, 298, 300) estimated yearly growth in output of .76% due to "advances in knowledge" (which excludes the effect of education on the labor force), and .30% due to "economies of scale", for a total just over 1%. For Northwest Europe he estimated .76% due to "advances in knowledge", .56% due to "changes in the lag ik application of knowledge, general efficiency, and errors and omissions", and .41% due to "economies of scale", for a total of something over 1.5% per year. Solow's estimate of the increase in output in the U.S. due to increases in technical knowledge for the 40 years from 1909 to 1949 is about 1.5% per year.

If a larger labor force cuases a faster rate of productivity change, one would expect to see this reflected in observed changes in the rate of productivity advance over time in the United States as population has grown. And indeed, Solow (1957, p. 320) concludes that the yearly rate of change of productivity went from 1% to 2% between the 1909-1929 and 1929-1949 periods, and Fellner (1970, p. 11-12) found these rates of productivity increase: 1900-29: 1.8%; 1929-48: 2.3%; 1948-66: 2.8%.

These results are consistent with the assumption that the rate of increase of productivity is indeed higher when population is larger.*

The connections between numbers of scientists, inventors, ideas, adoption and use of new discoveries are difficult to delineate clearly. But the crucial links needed to confirm this effect seem very obvious and strong. For example, the data show clearly that the bigger the population of a country, the greater the number of scientists and the larger the amount of scientific knowledge produced; more specifically, scientific output is proportional to population size, in countries at the same level of income (Price, 1967; 1975; Love and Pashute, 1978). The U.S. is much larger than Sweden, and it produces proportionately more scientific knowledge.

In brief, the knowledge that leads to technological advance is created by people. Various readers may have reservations about one or another of the lines of evidence presented above. But they all fit together and confirm each other. Taken altogether, the evidence seems to me irresistible that the more people, the more technological advance and productivity increase, ceteris paribus. And immigrants are people.

V. THE INTEGRATED MODEL INCLUDING THE PRODUCTIVITY EFFECT

If an economist is to be worth his (her) keep, she (he) must take account of the size and importance of the various effects, and calculate the

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*The recent downturn in U.S. productivity change may be seen by some as a reversal in the long-term trend of an increasing rate of productivity change. In my view, however, to the extent that the data are meaningful rather than showing compositional effects, this downturn is more likely to be a pause than a basic change. I think that the very-longest-term trends are the most reliable basis for characterizing basic economic forces, and productivity seems to have been increasing at an increasing rate for hundreds of years.

ket effect. One can only obtain a satisfactory overall assessment of the effect of immigrants on the standard of living of citizens by constructing an integrated model of the economy, and then comparing the incomes produced by the economy under various conditions of immigration and population growth.*

For simplicity and clarity, the model deals with a single cohort of immigrants; a continuous analysis yields similar results, however. Also for simplicity, I sometimes talk of a representative family instead of the cohort as a whole.

The question is whether the native population--that is, the people living in the U.S. <u>before</u> the immigrant family arrives--are better off or worse off economically if the immigrant comes or does not. In more precise terms, we wish to know if the lifetime income of the (average member of the) native population is higher or lower if the immigrant comes, that is, whether

$$Z_m^v > Z_n^v \quad \text{or} \quad Z_n^v > Z_m^v \, .$$

Lifetime incomes with and without the immigration are, for our purposes here, functions of gross income less taxes

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*After finishing this article I discovered an interesting model by Ekberg (1977) which also makes technical progress endogenous in a migration context. Ekberg uses a Kaldor-like function, where the increment to technical progress depends upon the percentage change in the stock of capital, which I elsewhere argue is not very appropriate for a study of this sort. My 1976 article on Russian immigration into Israel is the only other study of the sort of I know of.

$$Z_m^v = (G_{m,t=1}^v - T_{m,t=1}^v) + d(G_{m,t=2}^v - T_{m,t=2}^v) + \ldots$$

and

$$Z_n^v = (G_{n,t=1}^v - T_{n,t=1}^v) + d(G_{n,t=2}^v - T_{n,t=2}^v) + \ldots$$

Therefore, we must estimate the natives' yearly gross incomes and taxes if there are, and if there are not, immigrants.

The Effect of Immigration Upon Gross Incomes of Natives. We start with the effect of the immigrant on natives' incomes through the two major lines of influence: a) the capital-dilution effect, and b) the economies-of-scale-and-productivity effect. I have estimated the combined effect of these two forces in a simple macro-model. The main conventional element is a Cobb-Douglas function whose labor and capital coefficients add to unity, and where saving is a fixed steady-growth proportion of the prior year's output. A less-conventional element is the effect of output and labor force on the technological-level coefficient, as discussed in Simon (1977, chapters 4-6). In other recent work I have explored a wide variety of technological process functions, and have found that, in a policy context such as this one, the result is rather insensitive to the choice of function. I have chosen Phelp's well-known and elegant function,* which is "conservative" in this sense: Phelp's function indicates that technical progress should have been progressively lower as population growth has declined in the 20th century in the U.S. and in the Western world generally. In fact, technical progress has apparently been higher in the more recent decades than in the early decades of this century as discussed earlier. This implies that Phelp's function understates the contribution of population size and growth to the advance of economic welfare.**

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*Phelps' original function is

$$\frac{A_t - A_{t-1}}{A_{t-1}} = \left(\frac{A_{t-w-1}}{A_{t-1}}\right) h \left(\frac{R_t}{A_{t-w-1}}\right)$$

The number of research workers, R, may be considered proportional to the labor force, and w is a "retardation factor" to represent the delay in adoption of newly produced knowledge. Phelps makes $h\left(\frac{R_t}{A_{t-w-1}}\right)$ a concave argument because, he says, this assumption is necessary if "an exponential growth of researchers will produce an exponential increase of the level of technology" (p. 134).

This function has the realistic properties that (a) more persons imply more knowledge, (b) there are diminishing returns at a given moment, and (c) a larger stock of knowledge to a larger increment of knowledge.

**Phelps' function can be made more realistic with the addition of arguments representing the effect of educational level and national income on the production of technology, with the function still retaining its convenient mathematical properties. See Steinmann and Simon (forthcoming).

In place of the size of the research force in Phelps' function, I have for simplicity used the size of the labor force, and the function was written in Cobb-Douglas form to make its meaning obvious:

$$A_t - A_{t-1} = bA_{t-1}^{\gamma} L_{t-1}^{\Delta} \qquad \gamma, \Delta = .5$$

The exponents are those that fit Phelps' requirement that the function be homogeneous of degree one, and his assumption that "if the technology level should double we would require exactly twice the amount of research to double the absolute time rate of increase of the technology" (p. 135). The assumption of the steady-state savings rate is also "conservative" in the sense that it is less advantageous to a larger population (and hence to immigrants) than would be a higher savings rate; this is reasonably clear upon inspection, and is verified in other work by this writer. The coefficient b is that complement of the initial values chosen for A and L which starts the simulation smoothly into motion and which corresponds to the steady-state rate of change of A in the non-immigrant case, which is equal to the rate of growth of the labor force in Phelps' model; it is kept the same in the plus-immigrants case so as to hold all initial conditions exactly the same in the two cases except the growth of the labor force; this, too, is a "conservative" assumption in the sense explained above.

An iterative program is used to make investment approximately a function of current-period income rather than prior-period income, so that the computer model would approximate the steady-state analytic model; the results are much the same with and without this refinement, however.

The other equations and parameters of the model are as follows:

$$Y_t = A_t L_t^{\alpha} K_t^{\beta}$$

$$K_t = sY_{t-1} + K_{t-1}$$

$$L_t = L_{t-1} + .02\ L_{t-1}$$

The initial values are $A_t = 1.0$, $K_t = 1000$, $Y_t = 500$, $\alpha = .67$, $\beta = .33$, $\gamma = .5$, $\Delta = .5$, and b is chosen so the initial rate of change of A = .02 yearly. The initial L = 1000 for the without-immigration case, and 1020 for with immigration case.*

For the income-effect calculations the increment of immigrant workers in period t=1 must be large enough so that the effects are not obscured by rounding error. It was therefore set equal to the 2% increase in native labor force in year t=1 (10% in some runs to show that the size of the increment matters little). Then the difference in citizens' incomes in future years between the situations (a) if the immigrants do come in t=1, and (b) if they do not come, are calculated. The final calculation is in terms of the effect of one additional immigrant.

Because there is many a possible slip between the theoretical conception of a model, and the results as produced by a computer simulation,

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*There would appear to be no danger here that the choice of production function forces the outcome, as in some studies of distributive shares. The cohort of immigrants whose effect is analyzed is small relative to the native population, and hence its effect upon the overall distribution between capital and labor.

Additionally, Ekberg (1977) experimented with a CES function and obtained the same results as with a Cobb-Douglas model.

and also because this simulation program is so easy to decipher, the program is attached as an appendix and the researcher is offered the opportunity to inspect it himself or herself.

Section III discussed the extent to which immigrants gain the returns from the capital with which they work. Table 2 shows various calculations which should cover all possible values; 35% is the value that I have continued to work with because I now think it is at the very high end of probable values for the U.S., in light of the earlier discussion; any lower value shows immigrants to be even more favorable for natives' incomes.* On the latter assumption, the pre-tax effects on citizen's incomes amount to the percentages of the immigrant's net income shown in Column 4. Those figures may be interpreted as follows: In year 1, citizens' incomes are (in the aggregate) lower by 14% of the income of the average immigrant, aside from taxes (though ~~that~~ the effect on individual natives is very small because of the small proportion of immigrants relative to natives). By year 12, citizens' net incomes are higher than they would otherwise be, because of the immigrants. By year 19, citizens' incomes are higher by an amount equal to 10% of the income of each immigrant who arrives in year 0.

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*The reader may wonder about how the representative immigrant's share of capital, and the returns to it, changes with years of residence in the U.S., and whether this is reflected in the model. With time, the immigrant's share rises to 100%, of course. But this is counterbalanced by purchase payments by immigrants which are necessarily financed by higher-than-average saving. Hence the result should be the same whether this is explicitly shown in the model, or implicitly as in the present model.

Table 2

Now we must take account of the immigrants' saving-and-transfer effect as discussed in Section III. Social security is the main issue. Immigrants collect no social security, both because of age distribution and because of not obtaining any benefits in the present. But the immigrant family's contributions will be roughly 10% of earnings. This makes the overall accounts be positive in year 5 and thereafter, and just slightly negative in years 1-4, as seen in Column 6.

The stream of negative and positive effects may be evaluated just like any other investment with negative outgoes at the beginning and positive incomes later on. On a capital-returns assumption of 35%, the rate of return on the "investment" decision to bring in an immigrant is 9.3% per annum without the social security effect, and 19.3% with it, an excellent investment by any standard.*

The results of a variety of other specifications of the basic model with respect to savings rate, initial rate of technical progress, proportion of returns to capital captured by immigrants, and exponents of the technical progress function are shown in Table 3. The very lowest rate of return for any reasonable set of parameters is 0% (not a negative rate, however) for the results without the transfer-payment effect, and 10% with it. So immigrants are an excellent 10%-return-per-annum investment even under these most "conservative" of parameters.

Table 3

*11.1% and 21.1% for the larger increment of immigrants.

Table 2

ASSUMPTIONS ABOUT THE CAPTURE OF RETURNS TO CAPITAL

	20%			35%			50%		
Year	(1) Income Effect in %	(2) Social Security	(3) Total	(4) Income Effect in %	(5) Social Security	(6) Total	(7) Income Effect in %	(8) Social Security	(9) Total
1	- 7	+10	+ 3	-14	+10	- 4	-19	+10	- 9
2	- 7	+10	+ 3	-12	+10	- 2	-18	+10	- 8
3	- 5	+10	+ 5	-11	+10	- 1	-16	+10	- 6
4	- 4	+10	+ 6	-10	+10	0	-15	+10	- 5
5	- 2	+10	+ 8	- 8	+10	+ 2	-14	+10	- 4
6	- 1	+10	+ 9	- 7	+10	+ 3	-12	+10	- 2
7	1	+10	+11	- 5	+10	+ 5	-11	+10	- 1
8	2	+10	+12	- 4	+10	+ 6	-10	+10	0
9	4	+10	+14	- 3	+10	+ 7	- 8	+10	+ 2
10	5	+10	+15	- 1	+10	+10	- 7	+10	+ 3
11	7	+10	+17	0	+10	+12	- 6	+10	+ 4
12	8	+10	+18	+ 2	+10	+13	- 4	+10	+ 6
13	10	+10	+20	+ 3	+10	+14	- 3	+10	+ 7
14	11	+10	+21	+ 4	+10	+16	- 2	+10	+ 8
15	13	+10	+23	+ 6	+10	+17	- 1	+10	+ 9
16	14	+10	+24	+ 7	+10	+18	1	+10	+11
17	16	+10	+26	+ 8	+10	+20	2	+10	+12
18	17	+10	+27	+10	+10	+21	3	+10	+13
19	18	+10	+28	+11	+10	+22	4	+10	+14
20	20	+10	+30	+12	+10	+24	6	+10	+16
21	21	+10	+31	+14	+10	+25	7	+10	+17
22	23	+10	+33	+15	+10	+26	8	+10	+18
23	24	+10	+34	+16	+10	+28	9	+10	+19
24	25	+10	+35	+18	+10	+29	11	+10	+21
25	27	+10	+37	+19	+10	+30	12	+10	+22
26	28	+10	+38	+20	+10	+31	13	+10	+23
27	30	+10	+40	+21	+10	+33	14	+10	+24
28	31	+10	+41	+23	+10	+34	15	+10	+25
29	32	+10	+42	+24	+10	+35	17	+10	+27
30	34	+10	+44	+25	+10	+10	18	+10	+28

THE EFFECT OF AN IMMIGRANT UPON THE INCOMES OF NATIVES
AT VARIOUS ASSUMPTIONS ABOUT THE PROPORTION OF CAPITAL RETURNS THAT GO TO IMMIGRANTS
(EXPRESSED AS A PERCENTAGE OF THE IMMIGRANT'S EARNINGS)

Table 3

Rates of Return on Investment in Immigrants for a Variety of Models (Increment of Immigrants Equal to 2% of Labor Force in t=1)

b	s	γ,Δ	Capital Capture %	Rates of Return Per Annum in Percents: Without Social Security	Rates of Return Per Annum in Percents: With Social Security
.02	.04	.5	.2	18.4	28.4
.02	.04	.5	.35	9.3	19.3
.02	.04	.5	.5	5.1	15.1
.02	.07	.5	.35	12.2	22.2
.02	.07	.5	.5	7.3	17.3
.02	.10	.5	.35	14.8	24.8
.01	.04	.5	.5	1.5	11.5
.01	.04	.4	.5	0.0	10.0

VI. DISCUSSION

In discussions of the economic impact of immigrants on natives' standard of living, transfer payments and social welfare programs (other than social security) are often suggested as a negative offset to the positive effects of the immigrants. In fact, however, immigrants seem to have an overall positive effect through these other transfers. One reason in the case of the U.S., is the simplest kind of economies of scale with respect to the defense budget--which is likely to be invariant to the number of immigrants, in which case immigrants reduce defense expenditures per citizen.

As to whether immigrants are disproportionate gainers from transfers because of having low income, Chiswick (1978) has shown that only a few years after entry into the U.S. immigrants typically approach or equal natives in income, at which time their taxes should be roughly equal. And preliminary findings from my analysis of the 1976 Survey of Income and Opportunity show that the difference between other welfare payments to immigrants and to natives is small compared to the difference in Social Security payments.

Concerning illegals, North and Houston (1976) found that 73% of illegal aliens had Federal income tax withheld, and 77% paid Social Security tax--even though they can never collect on it. On the other hand, the proportions who use welfare services are small: medical, 27%; unemployment insurance, 4%; child schooling, 4%; federal job training, 1%; food stamps, 1%; welfare payments, 1%. And practically no illegals or Cubans or Indo-Chinese are in a position to avail themselves of the most expensive welfare programs of all: Social Security and other aid to the elderly.

The reader may wonder whether a person need live in the United States in order that the U.S. get the benefit of the person's impact on productivity. The answer differs somewhat depending on the person's origin, whether a more-developed or a less-developed country. The answer may also depend on the person's education and occupation, but the former is more clear-cut and probably much more important.

Recall that a person may influence technical progress through both his/her demand for goods and her/his supply of knowledge. Let us consider each of these separately beginning with the more problematic case, that of the person who already lives in a more-developed country such as Sweden or Japan.

It is indeed true that there is international trade, and a Swede's demand for goods may be satisfied in the U.S. But it is also true, and more relevant, that only a very small proportion of U.SI goods are sold abroad. It is more likely that an increment of U.S.-made autos or newspapers or smoke detectors will be sold if a given person chooses to reside this year in the U.S. rather than in Sweden. This should be enough to make the point. But an even more conclusive argument comes from a more general view of trade: If a person comes to the U.S. and still imports a Swedish auto, Sweden's imports (directly or indirectly) from the U.S. will rise by the amount of other goods equal in value to the auto. Therefore total production in the U.S. will rise by the amount of the immigrant's output and income, along with an effect through learning-by-doing and other demand-induced productivity-increasing mechanisms.

We must also consider, however, whether the flow of technology from among developed countries is so free that it does not matter in which country the technical progress is first made. By now there seems to be consensus among students of the subject that it does matter, for a variety of reasons. For one thing, there is a time lag of, say, a minimum of three years. Second, much technical progress is a matter of local adaptation, such as new agricultural varieties and techniques that depend on particular soil and climatic conditions; this is why even individual states within the U.S. can get a high return on R&D in agriculture (Griliches, 1958; Evenson, 1968).

If a person goes from a poor country where little new technology is being created, to a rich country where much technology is being created, the argument above is obviously even stronger. Here the U.S. benefits not merely by the person contributing to technology that will be differentially helpful to the U.S., but also by the absolute increment of technology that the person creates. The more technically advanced (relative to the state of the art) is the industry a person works in, the greater the opportunity for that person to advance the state of the art, it would seem.

It is not a contradiction to this line of thought that the rate of economic growth per capita has been as high or higher in the poorer countries as in the U.S. in the post-World War II period. The poorer countries can take advantage of the technological progress in the richer countries much more than the reverse.

A more difficult question is: Should not the larger of two countries that is at the same level of per capita income grow faster, if this line of thought is correct? Yes it should--and the evidence, sketchy as it is, seems to show that absolute size is an economic advantage, ceteris paribus (Chenery, 1960; Denison, 1967).

In brief, on reasonable assumptions immigrants have a positive discounted effect on citizens' incomes, starting almost immediately and getting large quite rapidly.

SUMMARY AND CONCLUSIONS

The subject is the effect of an additional immigrant upon the incomes of "natives" of a country like the U.S. This model confirms that the possible gain through increased returns to native capital if the immigrants receive only their marginal product is small relative to the loss if immigrants receive a realistic proportion of the returns to capital, as argued by Usher. But the lifecycle saving-and-eransfer process works in a positive direction for natives, and is of the same order of magnitude as the capital-dilution effect. Hence adding the saving-and-transfer process almost, or more than, offsets the capital-dilution effect.

The effect of the immigrant upon productivity, however, must also be taken into account though it has been omitted from previous theorizing about the effects of immigrants. This is the sum of learning by doing, creation of new knowledge, and economies of scale of various sorts. Within a few years, the productivity effect comes to dominate the results and dwarf the capital-dilution and saving-and-transfer effects, yielding a very high rate of return to natives on "investment" in immigrants, on any reasonable parameters.

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APPENDIX : BASIC SIMULATION COMPUTER PROGRAM

```
      PROGRAM POPOLIM (OUTPUT)
      REAL B,ALPHA,BETA,GAMMA,DELTA,A,L,K,X,Y,YL,KY,PLC,DY,DK,IL,M,CA,CS
      REAL KK,YY,INVET,CPTSH
      REAL NPV,ANPV,RATE,RATE1,RATE2,DNPV,ADNPV
      INTEGER I,J,S,YEAR,D,N
      DIMENSION M(200,2),K(200,2),L(200,2),Y(200,2),X(200,8),YEAR(200)
      DIMENSION DY(200,2),YL(200,2),PLC(200,2)
      DIMENSION KK(200,2),YY(200,2),INVET(200),IL(2)
      N=100
      CPTSH=.35
      IL(1)=.02
      IL(2)=.04
      CA=.5
      CS=.04
      ALPHA=.67
      BETA=.33
      GAMMA=.5
      DELTA=.4
      A=1.
      M(1,1)=1.
      M(1,2)=1.
      L(1,1)=1000.
      L(1,2)=1000.
      K(1,1)=1000.
      K(1,2)=1000.
      Y(1,1)=500.
      Y(1,2)=500.
      DY(1,1)=.02
      DY(1,2)=.02
      B=.02/(L(1,1)**.5)*(M(1,1)**.5)
      YL(1,1)=Y(1,1)/L(1,1)
      YL(1,2)=Y(1,2)/L(1,2)
      PLC(1,1)=.5
      PLC(1,2)=.5
      YEAR(1)=1
      INVET(1)=1.
      RATE1=.0001
      RATE2=4.
      RATE=(RATE1+RATE2)/2.
      PRINT 21
      PRINT 22
      PRINT 20,YEAR(1),M(1,1),L(1,1),K(1,1),Y(1,1),YL(1,1),PLC(1,1),M(1,
     12),L(1,2),K(1,2),Y(1,2),YL(1,2),PLC(1,2),INVET(1)
      DO 12 I=2,N
      YEAR(I)=I
      IF(I.GT.2)IL(2)=.02
      S=I-1
      DO 10 J=1,2
      M(I,J)=M(S,J)+B*(L(S,J)**.5)*(M(S,J)**.5)
      L(I,J)=L(S,J)+IL(J)*L(S,J)
      KK(I,J)=CS*Y(S,J)+K(S,J)
      YY(I,J)=CA*A*(M(I,J)*L(I,J))**ALPHA*KK(I,J)**BETA
      K(I,J)=CS*YY(I,J)+K(S,J)
      Y(I,J)=CA*A*(M(I,J)*L(I,J))**ALPHA*K(I,J)**BETA
      YL(I,J)=Y(I,J)/L(I,J)
10    PLC(I,J)=(Y(I,J)-(K(I,J)-K(S,J)))/L(I,J)
      INVET(I)= (Y(I,2)-(Y(I,2)*.67*(L(I,2)-L(I,1))/L(I,2)))/L(I,1)
12    PRINT 20,YEAR(I),M(I,1),L(I,1),K(I,1),Y(I,1),YL(I,1),PLC(I,1),M(I,
     12),L(I,2),K(I,2),Y(I,2),YL(I,2),PLC(I,2),INVET(I)
      DO 11 I=2,N
      X(I,2)=YL(I,1)*100./YL(1,1)
      X(I,3)=INVET(I)*100./INVET(1)
      X(I,4)=YL(I,2)*100./YL(1,2)
      X(I,5)=(X(I,3)*(1-CPTSH))+(X(I,4)*CPTSH)
      X(I,6)=L(I,1)*(INVET(I)-YL(I,1))/(L(I,2)-L(I,1))/YL(I,2)/.67
      X(I,7)=(L(I,1)*(YL(I,2)-YL(I,1)))/((L(I,2)-L(I,1))*YL(I,2))
      X(I,8)=(L(I,1)*((INVET(I)*(1-CPTSH))+(YL(I,2)*CPTSH)-YL(I,1)))/((L
     1(I,2)-L(I,1))*((YL(I,2)*.67*(1-CPTSH))+(YL(I,2)*CPTSH)))
11    PRINT 23,YEAR(I),(X(I,D),D=2,8)
      DO 41 J=1,20
      NPV=0.
      DO 40 I=2,50
      DNPV=X(I,8)/(1.+RATE)**I
      ADNPV=ABS(DNPV)
      IF(ADNPV.LT..0001) GOTO 43
40    NPV=NPV+DNPV
43    ANPV=ABS(NPV)
      IF(ANPV.LT..0001)GO TO 42
      IF(NPV.GT..0) GO TO 60
      RATE2=RATE
      RATE=(RATE1+RATE2)/2.
      GO TO 41
60    RATE1=RATE
      RATE=(RATE1+RATE2)/2.
41    PRINT 50,RATE,NPV
42    PRINT 50,RATE,NPV
50    FORMAT(2X,5HRATE=,F9.7,10X,4HNPV=,F10.4)
20    FORMAT (I4,F9.4,3F8.1,2F9.4,4X,F9.4,3F8.1,3F8.4/)
21    FORMAT(1H1,14X,17HWITHOUT IMIGRANTS,41X,14HWITH IMIGRANTS/)
22    FORMAT(2X,4HYEAR,9H      M  ,8H    L   ,8H    K   ,8H    Y   ,
     18H  Y L   ,8H  PLC   ,4X,8H    M   ,8H    L   ,8H    K   ,
     28H    Y   ,8H  Y L   ,8H  PLC   ,6H INVET  /)
23    FORMAT(/,I4,4F9.2,3F9.4)
      STOP
      END
```