# A Small-Open-Economy Analysis of Migration

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## Abstract

The standard small-open-economy framework is extended to incorporate migration and job search. The model has a dynamic optimization setup with migration costs, where a simple mechanism of job search interacts with the migration decision. The balanced-growth population size is undetermined in this model. However, when conditioned on the current population size, the expected long-run population is finite. The developed framework is used to analyze, both theoretically and quantitatively, the effects of the ongoing immigration influx to Israel from the C.I.S., treated as exogenous. The outcome of the model is a set of paths for endogenous emigration, domestic population size, and unemployment.

# 1 Introduction

A small open economy is subject to a large exogenous influx of immigrants. How many of these immigrants will stay in the country over the long-run? What is the dynamic path of unemployment and emigration generated by this event? These questions are motivated by the ongoing immigration influx into Israel from the former Soviet Union. About half a million immigrants, which amounts to 10 percent of the 1989 population, have arrived since the influx began at the end of 1989.

To analyze these questions, both theoretically and quantitatively, the standard small-open-economy framework is extended to incorporate migration and job search. The model has a dynamic optimization setup with migration costs. The job-search process interacts with the migration decision. On the one hand, potential migrants take into account real wages and probabilities of employment in both countries over the entire future. On the other, the number of migrants affects individual probabilities of employment through congestion in the labor market. The job-search process is introduced since it is an important consideration for the migration decision. The Israeli experience indicates that variation in the probability of employment is significantly larger than the cyclical variation of real wages. In the model this is emphasized by assuming perfect capital mobility, which renders the real wage endogenously rigid.

The outcome of the model is a set of stochastic processes for domestic population size, migration flows, employment and unemployment. In the steady state, the model has positive unemployment and zero migration flow. The long-run population size is undetermined, although when conditioned on the current population size, the expected long-run population is finite. Under certain assumptions, the population size will follow a random walk process.

The only source of shocks in the present model is exogenous immigration from the "East", a migration-restricted part of the world. Migration between the "Home" country and another part of the world - the "West" - is free (although not free of cost) and endogenous. In the Israeli case, the "East" would correspond to Asia, Africa (except South Africa) and Eastern Europe until 1990.

The present analysis, which concentrates on the dynamic behavior of population size, can be seen as complementing the existing economic literature on migration that focuses on steady-state implications. Galor (1986) analyzed the world equilibrium migration pattern in a two-country model, and the welfare implications of such migration flows. Chiswick, Chiswick and Karras (1992) conducted a macroeconomic analysis of immigration, focusing on the long-run implications of immigration for physical and human capital accumulation. Hercowitz and Pines (1991) dealt with the dynamic individual decision about migration, but also focused on steady-state population distribution under fiscal externalities. Hercowitz, Kantor and Meridor (1993) addressed the dynamics of population growth, focusing on the effects of imperfect capital mobility on the recent influx of immigrants into Israel.

The following section presents the model, and Section 3 addresses the balanced-growth path and the main stochastic characteristics of the model, which are shown in the context of a simplified version. Section 4 reports the estimation and calibration of the model's parameters with Israeli data, and the dynamic quantitative results are discussed in Section 5. Section 6 concludes the paper.

# 2 The model

This framework analyzes the dynamic determination of population size in a small open economy, referred to as the "Home" country. The rest of the world consists of two areas: the "West" and the "East". There is free, although costly, migration between the Home country and the West, which is characterized as a large economy, while the East is thought of as a low-income, emigration-restricted area.

The population of the Home country comprises a constant number of identical "extended families", some of whose members are abroad, both in the West and the East. Exit of family members from the East is stochastic and exogenously routed to the Home country. Since the West is a large economy, incorporating direct exit from the East to the West would not alter the analysis. Income in the East is small enough, so that migration to this area never takes place.

Let $N_t$ be the number of members of the representative family residing in the migration-free area - the Home country and the West - in period $t$. The exogenous number of family members arriving in the Home country from the East is $a_t$. The natural growth rate of the family is $\mu$, assumed to correspond to population growth worldwide.

## 2.1 The Home country

In the domestic economy a large number of identical families and firms interact in a competitive environment. At time t the representative family has $n_t$ of its members in the Home country and $N_t - n_t$ in the West. The family determines in each period the number of emigrants from the Home country to the West, denoted as $e_t$, which can be negative. The population of the representative family in the Home country evolves as

$$n_t = (1 + \mu)n_{t-1} + a_t - e_t. \tag{1}$$

An important characteristic of the model is that migration involves costs, specified as $(\theta/2)e_t^2$, with $\theta > 0$. This formulation implies increasing marginal migration costs, and captures the realistic feature that the migration of a single family member (probably young) is much simpler than moving an entire family.

The family's utility function is

$$E_0 \sum_{t=0}^{\infty} \beta^t [\ell_t w_t + \ell_t^* w_t^* + \pi_t - \frac{\theta}{2} e_t^2], \tag{2}$$

where $0 > \beta > 1$ is the rate of time preference, $\ell_t$ and $\ell_t^*$ are employed family members in the Home country and the West respectively, and $w_t$ and $w_t^*$ are the corresponding real wages. The profits from ownership of domestic firms - which in equilibrium equal zero - are $\pi_t$. Income of family members in the East is not included since the number of residents in that area is not a decision variable, and, given the linear utility used, it does not affect the family's decisions.

The evolution of employment per family is given by:

$$\ell_t = (1-\epsilon)\ell_{t-1} + \gamma_t[n_t - (1-\epsilon)\ell_{t-1}], \tag{3}$$

with $\epsilon$ as the constant rate of separations, exogenous to the model, and $\gamma_t$ as the probability of finding a job in period $t$. Equation (3) says that current employment equals the number of employed persons in the last period who still hold a job, $(1-\epsilon)\ell_{t-1}$, plus the fraction $\gamma_t$ of job seekers at the beginning of the current period, $n_t - (1-\epsilon)\ell_{t-1}$, who are hired during the period. The probability of being hired is modeled below.

The profits of the representative firm are given by

$$\pi_t = y_t - w_t\ell_t - r_t k_t, \tag{4}$$

where $y$ is output, $k$ is the capital stock, and $r$ is the real interest rate. Capital is assumed not to depreciate, and to be freely adjustable each period. For simplicity, it is assumed that the capital stock equals the firm's foreign debt, and hence, capital income flows abroad.

The production technology available to the firm is described by

$$y_t = z_t k_t^{\alpha} \ell_t^{1-\alpha}, \tag{5}$$

affected by the exogenous productivity variable $z$, which grows at the average rate $\omega$.

The setup of the Home country is completed by specifying the function governing the probability of being hired, $\gamma_t$, during period $t$:

$$\gamma_t = \gamma_0 - \gamma_1 u_t + d_t, \quad \gamma_0, \gamma_1 > 0, \tag{6}$$

where $u_t$ is the unemployment rate and $d_t$ is white noise. This specification, intended to achieve both theoretical and econometric simplicity, links $\gamma_t$ to congestion in the labor market, as represented by the unemployment rate. Since all families are identical, $u_t$ equals the family's unemployment rate, $(n_t - \ell_t)/n_t$.

## 2.2 The West

The West enters the model through the capital and labor markets. The capital market is very simple: capital can be borrowed abroad at the fixed rate $r$. Hence $r_t = r$ for all $t$.

The production and job-search technologies in the West are the same as those specified for the Home country. The West, however, is on a balanced growth path. The implications of this assumption will become clear in the next section, where the balanced-growth path of the Home country is derived.

The real wage in the West is $w_t^*$, and the employment of family members in the West (as well as general employment there) follows a similar process to that in the Home country:

$$\ell_t^* = (1-\epsilon)\ell_{t-1}^* + \gamma[(N_t - n_t) - (1-\epsilon)\ell_{t-1}^*], \tag{7}$$

with the constant probability $\gamma$ of finding a job during a period and the same separation rate $\epsilon$ as in the Home country.

## 2.3 The family's decision making

The family's problem is to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t [\ell_t w_t + \ell_t^* w_t^* + \pi_t - \frac{\theta}{2} e_t^2], \quad 0 < (1+\mu)\beta < 1,^1 \tag{8}$$

subject to the employment evolution equations

$$\ell_t = (1-\epsilon)\ell_{t-1} + \gamma_t[n_t - (1-\epsilon)\ell_{t-1}], \tag{9}$$

$$\ell_t^* = (1-\epsilon)\ell_{t-1}^* + \gamma[(N_t - n_t) - (1-\epsilon)\ell_{t-1}^*], \tag{10}$$

and taking the probabilities $\gamma_t$ and $\gamma$ as given. The decision variable in each period is $n_t$ , or alternatively $e_t$. To facilitate the presentation of the optimality conditions, note that in the

[1]This restriction is necessary for the utility function to be finite.

employment equation (9) $\ell_t$ depends on $n_t$ and $\ell_{t-1}$, while the latter depends correspondingly on $n_{t-1}$ and $\ell_{t-2}$, and so on. Current employment can therefore be expressed as

$$\ell_t = \gamma_t n_t + (1-\epsilon)(1-\gamma_t)\gamma_{t-1}n_{t-1} + (1-\epsilon)^2(1-\gamma_t)(1-\gamma_{t-1})\gamma_{t-2}n_{t-2} + \ldots \qquad (11)$$

Similarly, $\ell_t^*$ in the West is given by

$$\begin{aligned} \ell_t^* = \gamma_t(N_t - n_t) + (1-\epsilon)(1-\gamma)\gamma(N_{t-1} - n_{t-1}) \\ +(1-\epsilon)^2(1-\gamma)^2\gamma(N_{t-2} - n_{t-2}) + \ldots \end{aligned} \qquad (12)$$

The interpretation of the coefficients in these equations will be addressed below.

Using $e_t = (1+\mu)n_{t-1} + a_t - n_t$ from (1), and substituting (11) and (12) into the maximand (8), the dynamic optimality conditions to this problem, i.e., the partial derivatives with respect to $n_t$, $t = 1, 2, \ldots$, are

$$\begin{aligned} &\gamma_t w_t + \underset{t}{E}\,[(1-\epsilon)\gamma_t(1-\gamma_{t+1})\beta w_{t+1} + (1-\epsilon)^2\gamma_t(1-\gamma_{t+1})(1-\gamma_{t+2})\beta^2 w_{t+2} + \ldots] \\ &= \gamma w_t^* + \underset{t}{E}\,[(1-\epsilon)\gamma(1-\gamma)\beta w_{t+1}^* + (1-\epsilon)^2\gamma(1-\gamma)^2\beta^2 w_{t+2}^* + \ldots] + \theta(-e_t) + \\ &\qquad +(1+\mu)\beta\theta\,\underset{t}{E}\,e_{t+1}, \quad t = 1, 2, \ldots \end{aligned} \qquad (13)$$

These conditions equalize the expected additional income from increasing $n_t$ to the expected forgone income abroad, plus the marginal migration costs. Given the uncertainty in the job market, the equation incorporates the probabilities attached to wage receipts at home and abroad in the present and future periods.

To obtain additional intuition regarding condition (13), consider, for example, the coefficient accompanying $\beta w_{t+1}$ : $(1-\epsilon)\gamma_t(1-\gamma_{t+1})$ ,which corresponds to the coefficient of $n_{t-1}$ in the $\ell_t$ equation (11). This is the probability of increasing the family's wage bill in $t+1$ by $w_{t+1}$ by raising $n_t$ by one, while holding $n_{t+1}$ constant (since (13) is a partial derivative). The expression can be computed by adding up the probabilities of:

(a) finding a job at $t$ and not being laid off at *t + 1:* $\gamma_t(1-\epsilon)$, (b) not finding a job at $t$ but getting one at *t + 1*: $(1-\gamma_t)\gamma_{t+1}$, (c) finding a job at $t$, being laid off at the end of $t$

and then finding another at $t + 1$: $\gamma_t \epsilon \gamma_{t+1}$, (d) reducing income by lowering the population to keep $n_{t+1}$ constant: $-\gamma_{t+1}$.

An intuitively convenient form of rewriting condition (13) is

$$e_t = -(\gamma_t/\theta)w_t + ... + (\gamma/\theta)w_t^* + ... + (1+\mu)\beta \underset{t}{E}\, e_{t+1}. \tag{14}$$

Current emigration depends negatively on expected domestic wages and positively on expected foreign wages and next-period expected marginal migration cost, which depends positively on $e_{t+1}$.

## 2.4 The firm's decision making

The firm maximizes current profits, as expressed in equation (4), by choosing $k_t$ and $\ell_t$, given the production function (5), and the prices $w_t$ and $r$. Since there are no adjustment costs in either capital or labor, the firm's optimization is carried out separately for each period. The standard optimality conditions are:

$$\alpha y_t / k_t = r, \tag{15}$$

$$(1-\alpha) y_t / \ell_t = w_t. \tag{16}$$

Substituting $k_t$ from (15) into the production function (5) yields

$$y_t = (\frac{\alpha}{r})^{\frac{\alpha}{1-\alpha}} z_t^{\frac{1}{1-\alpha}} \ell_t. \tag{17}$$

Using (17), equation (16) can be written as

$$(1-\alpha)(\frac{\alpha}{r})^{\frac{\alpha}{1-\alpha}} z_t^{\frac{1}{1-\alpha}} = w_t. \tag{18}$$

The optimal adjustment of capital renders production linear in employment, and hence labor demand is completely elastic. The real wage is then endogenously rigid, depending only on the productivity shock.

# 3 Dynamic behavior

The dynamic behavior of population size is determined simultaneously by the optimal emigration conditions (13), the employment probabilities from (6), and the real wages from (18). Since the present model does not have a closed-form solution, we proceed as follows. First, the balanced growth path is computed in Subsection 3.1. Next, the dynamic behavior is analyzed in two steps. In Subsection 3.2 a simplified version of the model - which does have a closed-form solution - is analyzed to obtain insights about the general properties of this framework. Then, the full model is realistically parameterized in Section 4, and simulated in Section 5.

## 3.1 The balanced-growth path

The balanced-growth path is characterized by zero migration. Note that the balanced-growth unemployment rate follows only from the employment evolution equation (3) and the probability of being hired in equation (6). Given the constant rate of population growth, the resulting expression for employment is

$$\ell = \left(\frac{1-\epsilon}{1+\mu}\right)\ell + \left[\gamma_0 - \gamma_1\left(\frac{n-\ell}{n}\right)\right]\left[n - \left(\frac{1-\epsilon}{1+\mu}\right)\ell\right], \tag{19}$$

where probability $\gamma$ equals the steady-state value. Dividing by $\ell$ and rearranging yields

$$0 = \left[1 - \left(\frac{1-\epsilon}{1+\mu}\right) + (\gamma_0 - \gamma_1)\left(\frac{1-\epsilon}{1+\mu}\right) - \gamma_1\right] + [\gamma_1 - \gamma_0]\frac{1}{\ell/n} + \left[\gamma_1\left(\frac{1-\epsilon}{1+\mu}\right)\right]\ell/n,$$

which is a quadratic equation in $\ell/n$, implying two solutions to the balanced-growth unemployment rate.

Since the quadratic nature of (19) pertains only to the form of the employment evolution equation (3) and the specification of the probability of being hired in (6), the characteristics of the two solutions are independent of the migration aspects of the model. We return to this issue in Section 5, after the parameter values are obtained, to characterize the two solutions and determine the economically relevant one. For the moment, we proceed with a balanced-growth unemployment rate, $u = 1 - \ell/n$ , one of the two solutions above. The corresponding long-run probability $\gamma$ - the same as that in the West - is

$$\gamma = \gamma_0 - \gamma_1(1 - \ell/n). \tag{20}$$

The balanced-growth real wage follows from (18) and the trend in z:

$$(1-\alpha)\left(\frac{\alpha}{r}\right)^{\alpha} e^{\frac{\mu}{1-\alpha}t} = w_t. \tag{21}$$

Given that the West possesses the same technologies of production and job search, and that it is always on the balanced-growth path, $w_t^*$ equals $w_t$ in (21). In addition, the unemployment rate there is $u^* = 1 - \ell/n$.

Note that the equalities of real wages and employment probabilities imply in (14) that the only value at which emigration can be constant is zero. Nothing pins down long-run population size: any initial population will be consistent with balanced growth.

### 3.2 An example

Given that the domestic population size is not determined in the long run, in the stochastic version of the model the population is non-stationary. From the model in its present form it is not possible to derive a closed-form population process. However, this can be done in a simpler version, on which we focus in the following example.

Assume that $\gamma_1 = 0$, i.e., $\gamma_t = \gamma_0, \mu = 0$, and $a_t$ and $z_t$ are i.i.d., the first with mean zero and the second with mean one. The resulting form of equation (14) is

$$e_t = \left(\frac{\gamma}{\theta}\right)(w_t - w^*) + \beta \underset{t}{E}\, e_{t+1}, \tag{22}$$

where, from (18), $w_t$ is now serially uncorrelated, and $w^*$ is both the foreign wage and the mean of $w_t$. Given that $w_t - w^*$ has zero mean ex-ante, equation (22) can be expressed as

$$e_t = \left(\frac{\gamma}{\theta}\right)(w_t - w^*).^2 \tag{23}$$

Substituting (23) into (1), the population process becomes

$$n_t = n_{t-1} + a_t - \left(\frac{\gamma}{\theta}\right)(w_t - w^*),$$

which is a random walk. Although the population size is not determined in the long run, its expected value is related to the current $n_t$. In the present example, due to the random walk behavior, this expected value is simply $n_t$. In the general case, i.e., with serially correlated shocks, and/or unemployment effects on $\gamma_t$, the expected population growth rates will not be zero in general, even in the case of zero natural population growth.

# 4 Estimation and calibration

To implement the model in the Israeli case, values of the different parameters are computed based on Israeli data. These parameters are:

| | |
|---|---|
| Production | $\alpha$ |
| Foreign Interest Rate | r |
| Preferences | $\beta$ |
| Migration Costs | $\theta$ |
| Labor Market | $\epsilon, \gamma_0, \gamma_1$ |

The productivity growth parameter $\omega$ is set to zero, given that growth is unnecessary for the current analysis.[3]

The capital elasticity in production $\alpha$ corresponds to capital share in income, which is about 0.3. Hence, this value is chosen. The real interest rate, $r$, is taken as 0.05, which matches the value of 0.95 at which the time preference parameter $\beta$ is set.

[2]This can be verified by expressing (22) as $(1 - \beta L^{-1})e_t = \left(\frac{\gamma}{\theta}\right)(w_t - w^*)$, with $L$ as the lag operator. Dividing through by $1 - \beta L^{-1}$ yields (23), since the expectations of leads of $w_t - w^*$ have zero value.

[3]Productivity growth affecting both the domestic and the world economy would leave the long-run wage differential at zero, without affecting migration.

The value for $\theta$ was calibrated in the dynamic simulation (see following section), so that emigration in the period corresponding to 1990 fits actual data. The resulting value of $\theta$ (1.15) does not carry information in itself. However, it implies that the marginal cost of emigration for a labor force participant, which in the model equals $\theta e_t$, is 23 percent of the gross average annual salary.[4]

The turnover rate $e$ is set at 0.07, which is the approximate turnover rate in Israeli manufacturing, and the natural population growth rate $\mu$ at 0.014, the average projected natural population growth rate for the 1991-2000 period.[5]

Finally, the parameters of the $\gamma(\cdot)$ function are estimated econometrically. The regression equation is

$$\gamma_t \equiv [\ell_t - (1-\epsilon)\ell_{t-1}]/[n_t - (1-\epsilon)\ell_{t-1}] = \gamma_0 - \gamma_1 u_t + d_t.$$

The data is annual, with total employment used for $\ell_t$ and the labor force for $n_t$. The sample is 1980-1992, which is obviously a short one. Previous years were not included because of the clear break (increase) in unemployment levels in 1980. Given that the unemployment rate is not independent of $d_t$, lagged unemployment is used as an instrument. The resulting estimates are:

$\gamma_0 = 0.73$

(12.7)

$\gamma_1 = 2.6$

(3.2)

$R^2 = 0.47$, D.W. = 1.83,

[4]This calculation was carried out as follows. Emigration (those who did not return within 12 months) in the 1985-1989 period was, on average, 14,200 individuals per annum. The labor force/population ratio was 0.35 during this period, implying that the relevant value of $e$ was 4,970 labor force participants. The 23 percent figure was obtained by dividing $\theta$x4,970 by the average gross salary in 1989, which was 24,200 Israeli Sheqels.

[5]From the Central Bureau of Statistics Special Series No. 913, "Projection of Population in Israel up to 2005", 1992.

where the t-statistics appear in parentheses. These estimates imply, for example, that if the unemployment rate is 10 percent, the probability of being hired during one year of search is 46 percent. If unemployment goes down to 6 percent, the probability increases to 56 percent. Note that these probabilities are averages over the total population of searchers, which include "chronically" unemployed.

# 5 Dynamic simulation analysis

The analysis in this section addresses the dynamic response to an exogenous influx of immigrants from the East, $a_t$, which is particularly relevant to the Israeli case.

The response of the endogenous variables is obtained by computing the deterministic convergence path of the economy after the initial state is altered by the shocks. This calculation is similar in essence to estimating impulse responses. However, the current procedure has three important advantages. One is that it avoids the far more demanding task of solving the stochastic model, which is required to compute an impulse response. Another is that the dynamic effects of the shock can be computed without a linear approximation that makes the impulse response independent of the values of the state variables. In the present case this characteristic is important, because the base year of the simulation has a high unemployment rate. The third advantage is related to the feature that the shocks to the model are current as well as expected future events. In the present context this feature is relevant, because the influx of immigrants is taken as lasting several years into the future.

The simulation consists in solving forward the deterministic counterpart of the difference equation (14) simultaneously with the population evolution equation (1), the employment evolution equation (3), and the $\gamma_t$ equation (6) - as estimated in Section 5. Given that the estimates of (6) were obtained in two stages using $\widehat{u}_t$ - where $\widehat{u}_t = b_0 + b_1 u_{t-1}$, with $b_0$ and $b_1$ as regression estimates - the simulation is carried out with $\widehat{u}_t$ values constructed in the same way.

In order to conduct the simulation analysis, it is necessary to provide quantitative content for both (a) the balanced growth-path to which the economy converges, and (b) the base period of the simulation, taken as 1989.

## 5.1 The steady state

As Section 3 showed, the steady state is characterized by zero migration, but nothing pins down population size, and the quadratic form of the long-run employment equation (19) yields two solutions for the unemployment rate. Using the estimates of the $\gamma(\cdot)$ function given above, these solutions are: $u_1$ =0.059 and $u_2$ = 0.16. To determine which of these two solutions is the relevant one, we first address the dynamics of unemployment around the two: the unemployment rate will either converge to a stable solution or diverge. Given that the quadratic form of (19) is unrelated to migration, this can be checked in a simple way by letting $n_t$ grow at the natural rate $\mu$. Substituting the $\gamma(\cdot)$ function from (6) into (3) and dividing by $n_t$, the dynamic equation for the employment rate is

$$\frac{\ell_t}{n_t} = \left(\frac{1-\epsilon}{1+\mu}\right)\frac{\ell_{t-1}}{n_{t-1}} + \left[\gamma_0 - \gamma_1\left(1-\frac{\ell_t}{n_t}\right)\right]\left[1-\left(\frac{1-\epsilon}{1+\mu}\right)\frac{\ell_{t-1}}{n_{t-1}}\right]. \tag{24}$$

Solving for $\ell_t/n$ yields:

$$\frac{\ell_t}{n_t} = \frac{\left(\frac{1-\epsilon}{1+\mu}\right)(\ell_{t-1}/n_{t-1}) + (\gamma_0-\gamma_1)\left[1-\left(\frac{1-\epsilon}{1+\mu}\right)(\ell_{t-1}/n_{t-1})\right]}{1-\gamma_1\left[1-\left(\frac{1-\epsilon}{1+\mu}\right)(\ell_{t-1}/n_{t-1})\right]},$$

which is an equation of the $\ell_t/n_t = g(\ell_{t-1}/n_{t-1})$ type. The stability of $\ell/n$ around the two solutions above is checked in a standard way by computing $g'(\cdot)$ at these values: $g'$(1-0.059) = 0.6, and $g'$(1-0.16) = 1.6. Hence, the low-unemployment solution, $u$ = 0.059, is stable, while the high unemployment solution is not. The economy will then either converge to the unemployment rate of 5.9 percent or diverge to 100 percent.

## 5.2 The base period

The values of the state variables in the base period are taken from the 1989 data. The unemployment rate $u_{89}$ is 0.089 and the real wage variable $w_{89}$ is the average annual salary, 24,200 sheqels. The productivity level $z$ is obtained backwards from $w_{89}$, $r$, and $\alpha$, using equation (18).

The 1989 population is 4.5 million and the labor force, $n_{89}$, is 1.6 million. Given the unemployment rate of 8.9 percent, employment, $\ell_{89}$, is 1.45 million.

## 5.3 Results

The first step of the simulation is to compute the convergence path of the economy from the base period to balanced growth, with the immigration shocks set at zero. In the second step, the shocks are introduced, and their effect measured by comparing the variable of interest to the corresponding one on the basic path.

The basic path for the key variables is shown in Figures 1-3. Since this is a hypothetical case, it is not of special interest, except for the consequences of the high initial (1989) unemployment rate, 8.9 percent. As shown in Figure 1, emigration along the basic path is positive and converges relatively quickly to zero.

Then, the exogenous immigration flows are introduced. The figures correspond through 1993 to the actual immigration from the C.I.S.: 195,000 in 1990, 175,000 in 1992, 80,000 in 1992, 80,000 in 1993, and projections for 1994 and 1995 of 80,000 per annum. The total number of immigrants is thus 690,000[6]. First, these immigration figures are multiplied by the average labor force/population ratio of 0.35 (corresponding to the pre-immigration years, 1985-1989). Additionally, according to available figures, the participation rate of new immigrants is 13 percent higher than the established population, and 25 percent of immigrants do not enter the labor force until the second year after arriving. From the model's

[6]Hercowitz, Kantor and Meridor analyze the size of the immigration flows from the C.I.S. from 1993 onwards, given imperfect capital mobility from abroad. In that model, therefore, the immigration flows are endogenous results to exogenous capital inflows.

point of view the relevant number of immigrants and the timing of arrival are those relevant for the labor market, and, hence, the $a_t$ numbers incorporated in the simulation are adjusted according to those rates.

Figure 1 shows the resulting emigration flows and Figure 2 portrays the total population. By the year 2000, when population growth is close to convergence to the natural rates, the population is 626,000 higher than on the basic path. This is the vertical distance between the two population paths in Figure 2. Given that the total immigration influx is 690,000, the additional cumulative emigration until year 2000 is little more than 9 percent of the total number of immigrants.

The net migration flows are positive until 1995, so long as the influx continues, and became negative later on. Correspondingly, the total population growth is lower then the long-run natural rate of 1.4 percent starting in 1996–being 1.2 percent in this year–approaching the long-run rate asymptotically. Note that, since all families are identical in the present model, opposite migration flows are possible only in relation to different parts of the world: exogenous immigration from the East and endogenous emigration to the West. However, the model can be easily extended to incorporate idiosyncratic shocks that would generate endogenous migration in the two directions, without affecting the aggregate results.

Figure 3 shows the effect of the immigration influx on unemployment. The simulated unemployment rate increases to a peak of 10.8 percent in 1992, starting to decline later on. Unemployment did in fact peak in 1992, although at the higher rate of 11.2 percent. In 1993, actual unemployment declined to 10 percent, while in the model the decline corresponding to 1993 is much smaller. The larger actual decline in unemployment in 1993 may be due to government policies, such as heavy subsidization of employment expansion, a partial ban on employment of workers from the West Bank and Gaza, and temporary make-work programs. Furthermore, the stickiness of unemployment in the model may be related to the assumption of homogeneity in the labor force/household size ratio across households. If this ratio was allowed to differ, the households more likely to emigrate would be those with higher participation rates, which have more to gain in terms of expected income and less to lose in terms of per-capita emigration costs. In this case, the same emigration figures would have a higher impact on the aggregate labor force, and unemployment would therefore decline faster in the years of higher emigration, 1990-1995.

# 6 Concluding remarks

The present paper develops and simulates a macro model of migration calibrated to Israeli data. The model is an extension of the dynamic small open economy framework incorporating migration and a simple job-search mechanism.

The main theoretical property of the model is the nonstationarity of population size, temporary shocks have permanent effects. This is due to increasing marginal migration costs, which tend to smooth out the planned future size of the representative household - just as decreasing marginal utility smooths out consumption in a simple intertemporal optimization model.

In its present form, the model emphasizes the role of the probability of employment in the migration decision, ignoring short-run real wage fluctuations. This modeling strategy is adopted for two reasons. One is the observation that the variation in the probability of employment is much greater than the cyclical variation in the real wage. The other follows from the presumption that a low probability of unemployment for, say, two or three years, has a much more negative impact on the migration decision than a low real wage during the same period. Simple regression analysis of emigration from Israel and immigration to it from Western countries supports this presumption. The unemployment rate has a significant effect in the expected directions, but cyclical variations in the real wage appear to be insignificant.

Endogenously rigid real wages were generated by the assumption of perfect capital mobility, which is obviously unrealistic. Nevertheless, the quantitative results are still of interest given the empirical estimates of the probability of employment–which depends on the unemployment rate. Given that this equation was estimated with actual data, it should reflect the actual factors, as gradual capital accumulation, operating in reality regarding the probability of employment as a function of the unemployment rate.

The model is used to simulate the unemployment and emigration paths following a large exogenous influx of immigrants such as the one reaching Israel from the C.I.S. The model predicts that by the year 2000 the emigration generated by this influx will amount to 9 percent of the total number of immigrants. The nonstationarity of population size implies that the high unemployment rate prevailing in the base year, 1989, has negative long-run effects on population size. Given the correspondingly low employment probabilities the emigration flows are relatively high, permanently reducing the domestic population.

The unemployment rate predicted by the model is quite high until 1995, albeit declining gradually from 1992 to 1995, and drops sharply in 1996. This prediction is due mainly to the assumption that the influx of immigrants - with a high labor-force participation rate - lasts until 1995, coupled with the projected natural growth rate of 1.4 percent. Furthermore, the increased number of job seekers decreases the individual probability of being hired, which, in turn, exacerbates unemployment.

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Figure 1: Emigration

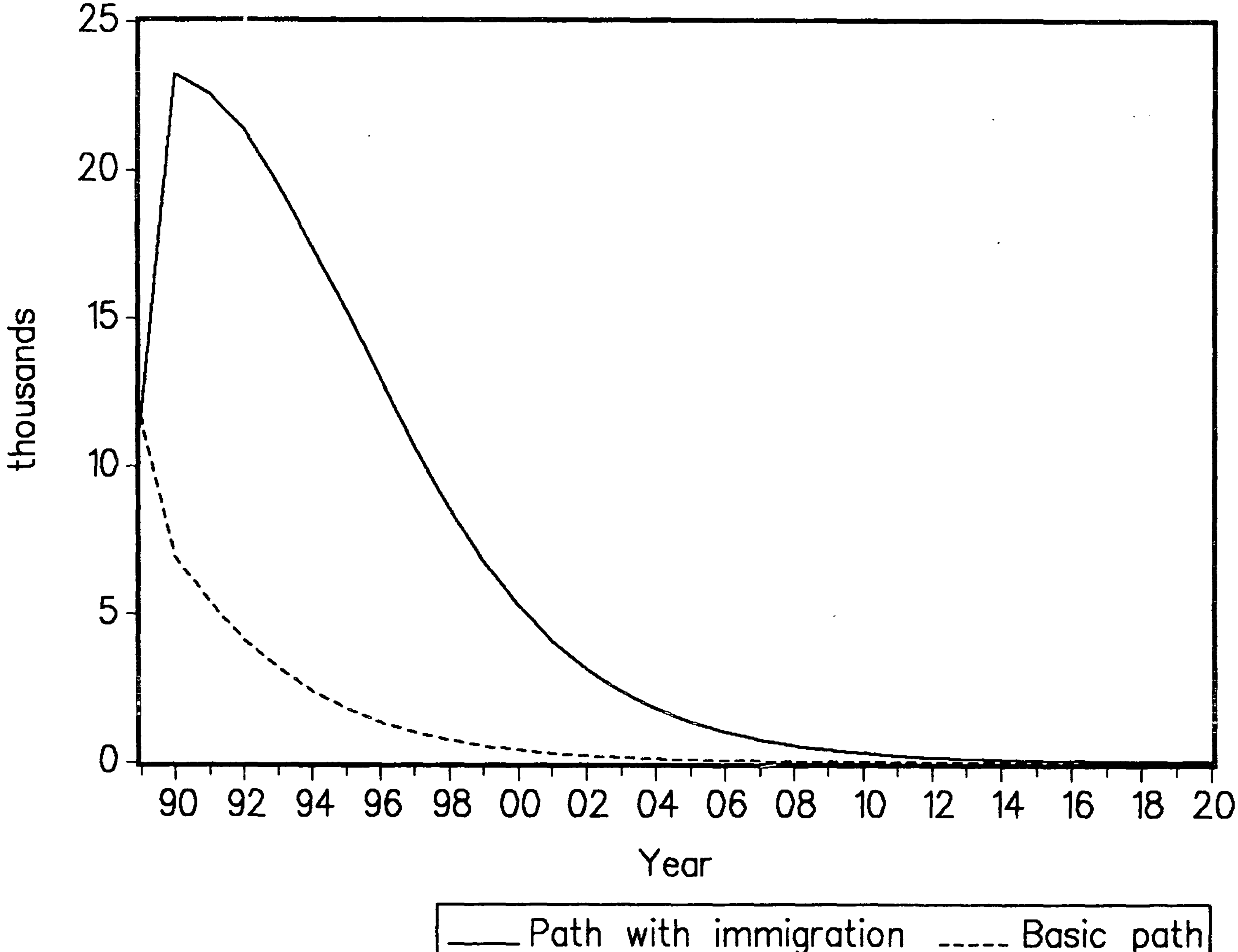


Figure 2: Total population

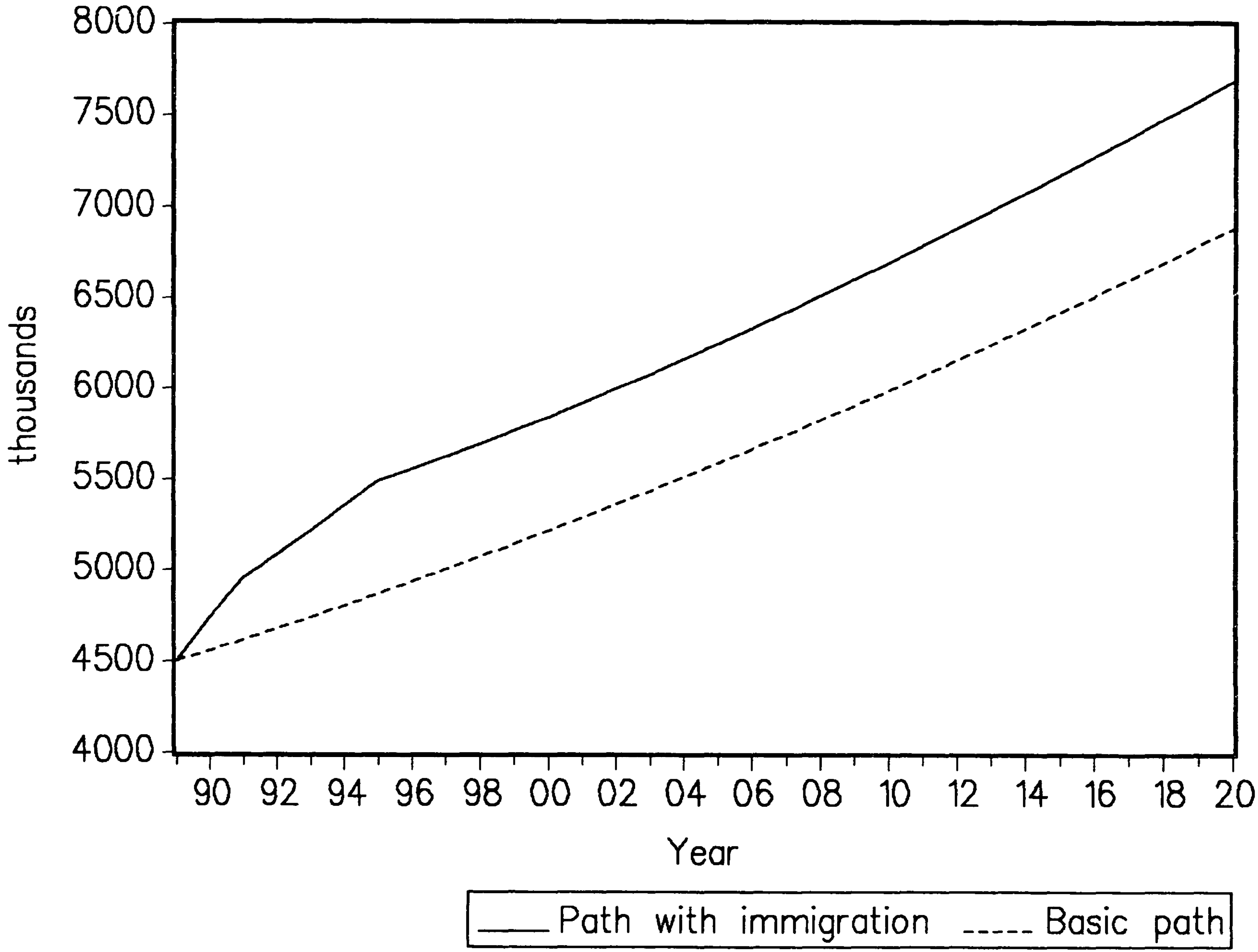
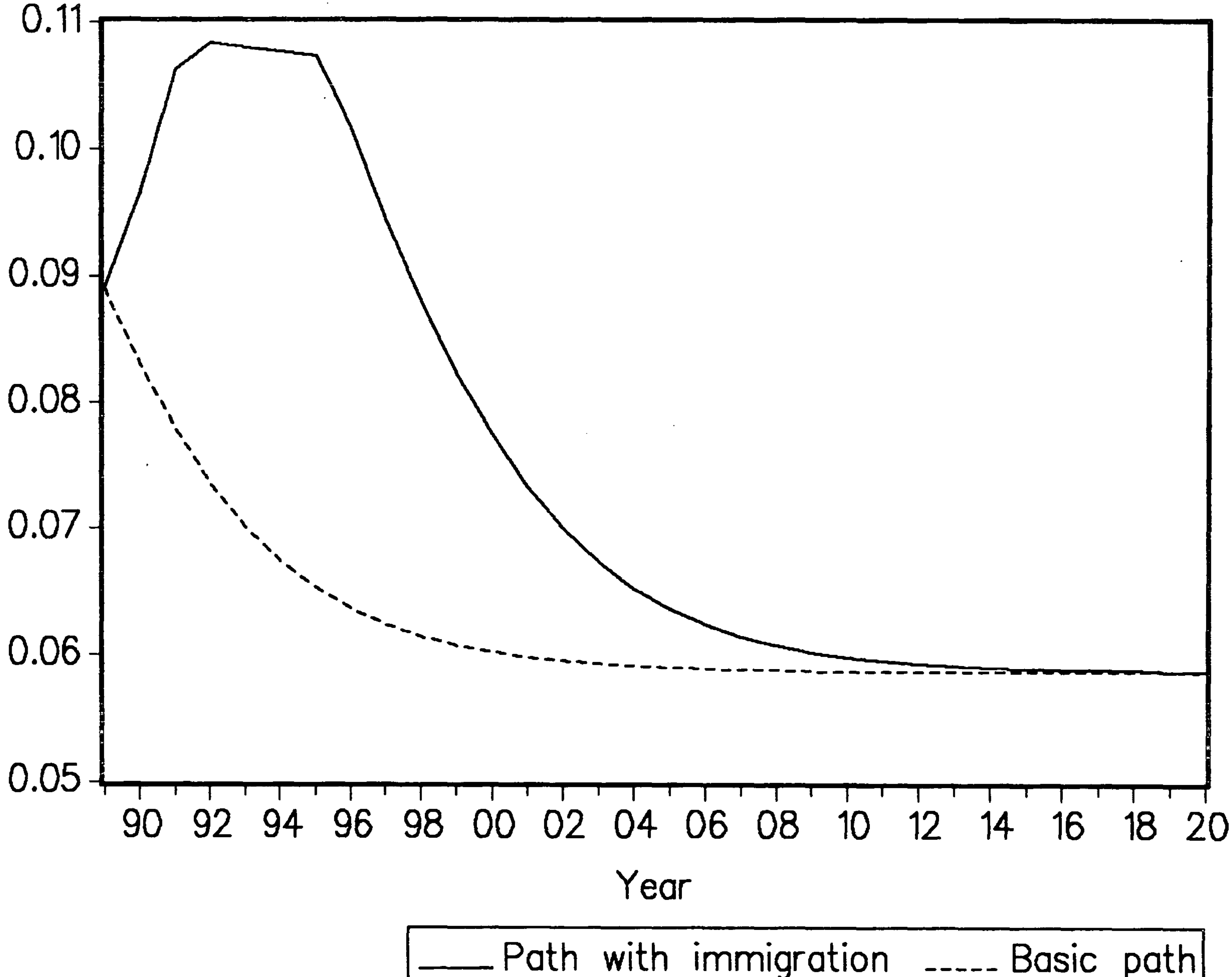


Figure 3: Unemployment rate



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