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THE MACROECONOMIC EFFECTS OF MASS
IMMIGRATION TO ISRAEL

by

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ABSTRACT

This paper attempts to model and simulate realistically the macroeconomic process generated by the massive immigration of Soviet Jews to Israel, which started at the end of 1989. The framework is a dynamic optimization model of an open economy calibrated to Israeli data — including the national income accounts, tax rates, and projections of immigration from 1990 to 1994. The aim of this analysis is to analyze the quantitative effects of different policy instruments the adjustment process triggered by the immigration.

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THE MACROECONOMIC EFFECTS OF MASS IMMIGRATION TO ISRAEL

The massive immigration of Soviet Jews to Israel that started at the end of 1989 has dramatic macroeconomic implications. By the middle of 1991, over 300,000 immigrants arrived (about 7 percent of the population at the end of 1989). The forecasts on the total number of immigrants vary, but a total of one million immigrants during a period of five to six years seems plausible. This would amount to 22 percent of the population. Moreover, the present immigration has three salient characteristics: (a) a high level of human capital, the level of education of the new immigrants being substantially higher than that of the local population – 14.5 years of schooling compared with 12; (b) a virtually zero level of physical or financial capital; and (c) a high labor–force participation rate, due mainly to the demographic characteristics of the immigrants. Therefore, on the one hand the immigration wave increases the effective labor force – and by much more than its contribution to population growth – and on the other it does not contribute to the capital stock. It is the resulting decline in the capital/labor ratio that has strong macroeconomic implications. It triggers a dynamic adjustment process involving key variables such as real wages, unemployment, capital formation, and the foreign debt. The government can play a major role in providing better conditions for this adjustment, in particular through the provision of infrastructure.

The present paper attempts to model and simulate realistically the macroeconomic process generated by the immigration, and to analyze the quantitative effects of different policy instruments. The framework used is a neoclassical growth model of an open economy with dynamic optimization over savings and labor. The only exogenous process in this framework is the immigration. The model is calibrated to Israeli data – including the national accounts, tax rates, and projections of immigration from 1990 to 1994. The output of this analysis is a set of paths for the relevant variables over a 25–year horizon. Hence, both the immediate future and the longer run can be analyzed in this framework. However, the analysis focuses only on the first 15 years, since we believe that for longer periods the adequacy of the model declines.

The main policy instrument is the dynamic behavior of public investment in infrastructure. The considerations pertaining to optimum public investment are the following. The decline in the capital/labor ratio generates a decline in real wages, and, if these are not fully flexible – higher unemployment. The faster private capital formation, the shorter the adjustment process. The role of the public infrastructure here is to increase the productivity of private inputs, thereby accelerating private capital formation and facilitating the absorption of the new immigrants. However, if the world capital market is not perfect, i.e., it is not possible to borrow any desired amount at the going real interest rates – the financing of public infrastructure investment will, to some extent, interfere with private borrowing. Hence, optimal government behavior has to take into account these two conflicting considerations.

We also consider changes in tax rates. In these exercises, the government's intertemporal budget constraint is kept by appropriate adjustment of government transfers. As expected, lowering taxes increases the speed of adjustment. The main purpose of these exercises is to obtain estimates of the magnitude of the effects.

The theoretical framework is described in section 1. Two versions are considered. One involves a perfect capital market and full employment, and the other incorporates constraints regarding both the amount that can be borrowed abroad and the extent to which the real wage can decline. This version of the model therefore generates unemployment. Section 2 presents and discusses the simulations of the dynamic processes triggered by the immigration. Section 3 presents the macroeconomic implications of different government policies, and section 4 contains final remarks and conclusions.

1. THE CONCEPTUAL FRAMEWORK

The analytical framework is a small open–economy growth model adapted to the analysis of immigration. We begin by presenting the basic model and its parametric form and then add an exogenous influx of immigrants.

The basic model (without immigration)

A small open economy consists of a government and a large number of households and firms, with a constant population $N_t = N$. In this section we discuss the setup of the model and behavior of the private and public sectors. The formal solution of the model is presented in Appendix B.

The representative firm's production function exhibits three factors of production: tangible private capital, labor, and infrastructure (whose services are a public good):

$$(1) \qquad Y_t = F(K_{pt}, L_t, K_{gt}; \bar{Y}_t) = [\alpha K_{pt}^{\sigma} + (1-\alpha)L_t^{\sigma}]^{1/\sigma} K_{gt}^{\gamma} / \bar{Y}_t^{\epsilon},$$

$$0 < \alpha < 1, \ \gamma < 1, \ \epsilon > 0,$$

where Y is the firm's output (excluding housing services), K_p is the private nondwelling stock of capital at the beginning of period t, L is total labor input in manhours, and K_g is the public capital stock, or infrastructure, at the beginning of t. The term $\bar{Y}$ is the average output across firms, which the single firm takes as given.

This function satisfies constant returns to scale on the private inputs, K_p and L. However, when the infrastructure stock is constant, it displays decreasing returns at the social level, resulting from externalities of congestion represented by Y_t. At the level of the firm, the functional form is CES, the elasticity of substitution between K_p and L being $1/(1-\sigma)$. For example, if $\sigma = 1$ the elasticity is infinite, and the smaller σ the smaller the degree of substitutability. The expression $K_g^{\gamma}/Y^{\epsilon}$ determines the productivity of the private factors of production (see Hercowitz and Huffman, 1990). If $\gamma > \epsilon$, the function has increasing returns to scale. Factor productivity is stationary in this model. There is no exogenous technological progress, and γ is assumed not to be large enough so as to generate endogenous growth.

The evolution equations for the two capital stocks are given by

$$(2) \qquad K_{it+1} = K_{it}(1-\delta_i) + I_{it} \qquad 0 < \delta_i < 1,\ i = p,g$$

where the δ_i are the depreciation rates of private and public capital stocks and the I_{it}, are private and public gross capital formation. In both cases a change in the capital stock entails the adjustment costs,

$$J_{it} = J_i(K_{it+1}, K_{it}) = \tfrac{1}{2}\phi(K_{it+1} - K_{it})^2/K_{it}.$$

In addition to the capital stocks used to produce output, there is a stock of housing, H_t, proportional to the population, N_t, i.e.,

$$(3) \qquad H_t = N_t h,$$

where h represents the resources required to produce one housing unit. Housing investment is accordingly given by

(4) $$I_{ht} = (N_t - N_{t-1})h.$$

In the absence of immigration, therefore, $I_h = 0$.

The utility function describing household welfare is

(5)
$$\sum_{t=1}^{\infty} \beta^{t-1} U(C_t, L_t) \qquad 0 < \beta < 1$$
$$U(C_t, L_t) = \log(C_t - \mu L_t^{\psi}), \qquad \psi > 1,\ \mu > 0$$

where C_t is household consumption and L_t is the household's labor supply in manhours. This utility function has the property that wealth and the rate of interest do not affect the supply of labor; that is, the rate of substitution between leisure and consumption is

$$\frac{U_1(C_t, L_t)}{U_c(C_t, L_t)} = \psi\mu L_t^{\psi-1} .$$

Since the individual equates this rate of substitution to the real wage, L_t is affected only by the latter.

Government behavior

In each year t, the government is involved in the following exogenously determined activities: consumption, G_t, payment of transfers to households, X_t, taxation at rates $\tau_{\ell t}$ on labor income $(w_t L_t)$, τ_{kt} on gross returns to capital $(\pi_t K_t)$, and τ_{ct} on consumption. The government sets I_{gt} optimally. It is assumed that infrastructure investment is determined by a large number of local authorities and not by a central decision–maker. As shown in Appendix B, this asumption makes possible a simple derivation of optimum I_{gt}. Each unit of capital invested by the government entails an excess burden of v; that is, the cost of private capital is 1, and of public capital, 1 + v; this distinction is designed to capture the difference in efficiency of planning and execution between the government and private entrepreneurs. The difference between government receipts and expenditures is financed by net borrowing (at home and abroad), $D_{gt} - D_{gt-1}$ and by unilateral transfers, Z_{gt}. The government budget in period t is thus

$$G_{gt} + I_{gt}(1+v) + J_{gt} + X_t - \tau_{\ell t} w_t L_t - \tau_{kt}\pi_t K_{pt} - \tau_{ct} C_t - Z_{gt}$$

$$+ rD_{gt-1} = D_{gt} - D_{gt-1},$$

and the intertemporal budget constraint is

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[G_t + I_{gt}(1+v) + J_{gt} + X_t - \tau_{\ell t} w_t L_t - \tau_{kt}\pi_t K_{pt}$$

(6)

$$- \tau_{ct} C_t - Z_{gt}] + D_{g0}(1+r) = 0,$$

where r is the constant interest rate derived from the world capital market and D_{g0} is the initial net debt of the government (internal and external).

Household behavior

The intertemporal budget constraint of households is

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[C_t(1+\tau_{ct}) + I_{pt} + J_{pt} + I_{ht} - (1-\tau_{Lt})w_t L_t^S - d_t -$$

(7)

$$- (1 - \tau_{kt})\pi_t K_{pt}^S - X_t - Z_{pt}] + D_{p0}(1 + r) = 0$$

where L_t^S is the supply of labor, K_{pt}^S is the private capital stock, which is owned by the households, d_t is firms' profits, Z_{pt} is unilateral transfers to households from the rest of the world and D_{p0} is the private sector's net indebtedness (a magnitude which can, of course, be negative).

The household determines L_t^S, C_t, and I_{pt} so as to maximize the utility function, (5), subject to the budget constraint, (7) and the values of d_t, Z_{pt}, X_t, τ_{Lt}, τ_{ct}, τ_{kt}, and D_{p0} for $t = 0, 1, 2, \ldots$.[1]

The behavior of firms

The firm purchases labor and capital services from households and maximizes the present value of its profits,

(8) $$\sum_{t=1}^{\infty} \frac{d_t}{(1+r)^{t-1}},$$

[1]Note that in this model a tax increase is not neutral in the Ricardian sense, since the taxes are distortionary.

(9) $$d_t = Y_t - w_t L_t^d - \pi_t K_{pt}^d,$$

where L_t^d and K_{pt}^d are the demand of firms for labor and capital respectively.

Equilibrium

Equilibrium requires

$$L_t = L_t^s = L_t^d,$$

$$K_{pt} = K_{pt}^s = K_t,$$

at every t, subject to the behavior of households, government, and firms.

The current–account deficit of this economy is given by

$$D_t - D_{t-1} = C_t + G_t + I_{pt} + I_{gt}(1 + v) + J_{pt} + J_{gt} + I_{ht} - Y_t - Z_t + rD_{t-1},$$

where $D_t = D_{pt} + D_{gt}$ and $Z_t = Z_{pt} + Z_{gt}$. Correspondingly, the intertemporal resource constraint is

(10) $$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[C_t + G_t + I_{pt} + I_{gt}(1+v) + J_{pt} + J_{gt} + I_{ht} - Y_t - Z_t] + D_0(1 + r) = 0$$

where D_0 is the country's initial foreign debt.

Incorporating immigration into the model

The economy described in the preceding section receives an influx of immigrants numbering a_t in year t (= 1, 2, ...). Hence $N_t = N_{t-1} + a_t$. It is assumed that the immigrants do not bring any tangible capital. Half of them enter the labor force within one year of arrival; the rest (less emigration at a rate n) enter after one year. The entry assumption is based on 6 months' full–time attendance at language classes.

In order to calibrate the model, we used the emigration rate of the Soviet immigrants of the 1970s (10 percent after one year). The number of immigrants in the labor force, A_t, is therefore

$$A_t = 0.5a_t + 0.4a_{t-1} + A_{t-1} \,. \tag{11}$$

During their first year, immigrants receive a grant g_a for living expenses (including accommodation). In order to make the model more realistic, we distinguish between the established private sector and the immigrants. The established private sector optimizes its activities as described in the preceding section. For simplicity of the calculations, the behavior of the immigrants is not derived from optimization. Instead, their behavior is assumed to be determined as follows: the number of hours worked is given by $L_{at} = pL_t$, where p is the labor force participation rate of immigrants relative to that of the established population.[2] The effective labor input of immigrants in terms of efficiency units is sL_{at}, where s represents the immigrants' relative return to schooling. The findings of Mark (1990) make it possible to derive s under the assumption that Israel and

[2]The data on the 1970s immigrants indicate that $p = 1.2$. However, we ignore externalities associated with human capital. If they exist, there is an additional offsetting bias.

the Soviet Union provide schooling of the same quality. Mark's findings imply that $s = 1.23$; that is, one immigrant manhour produces 23 percent more than one manhour of an established resident. This estimate is likely to contain an upward bias, since the quality of schooling is in fact higher in Israel. Hence, the immigrants' contribution to output may, on this account, be exaggerated.[3]

It is assumed that immigrants save only for housing purposes, an assumption that seems realistic for the first 10–15 years of residence. Note that it restricts the model to a horizon of this length. The consumption function for immigrants is accordingly

$$C_{at} = (1-\tau_{\ell t})w_t sL_{at} - m_t,$$

where m_t is annual mortgage payments (a function of h, r, and the term of the loan).

The introduction of immigration alters the framework presented above as follows. Production is now expressed as

$$Y_t = [\alpha K_{pt}^{\sigma} + (1-\alpha)(NL_t + A_t L_{at})^{\sigma}]^{1/\sigma} K_{gt}^{\gamma} / \bar{Y}_t^{\epsilon},$$

and the resource constraint is

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[C_t + A_t C_{at} + G_t + a_t g_a + I_{pt} + I_{gt}(1+v) + a_t h + J_{pt} + J_{gt} - Y_t - Z_t] + D_0(1+r) = 0. \tag{12}$$

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[3]However, we ignore externalities associated with human capital. If they exist there is an offsetting bias. On the effect of human capital on economic growth, see for example Lucas (1988), Romer (1990) and Baldwin (1989).

It is assumed that the dwellings required by the immigrants are completed within a year of their arrival.

Foreign borrowing constraints

We have so far assumed a perfect world market in which there are no restrictions on the volume of loans that can be obtained at the given rate of interest. Assume now that the capital market is imperfect, so that the net external debt cannot be increased by more than a given amount, taken to be \$25 billion. This constraint is introduced in the form of adjustment costs on domestic capital formation, determined by a parameter which is increased to the point where the debt increment does not exceed the amount stated. The longer the period over which the investment is spread (owing to the additional adjustment difficulties), the greater the proportion of investment that can be financed out of domestic sources, given GNP growth. Obviously, this procedure is not ideal, but it provides a simple way of introducing, in addition to the total borrowing constraint, the realistic property that it is difficult to raise \$25 billion in a short time. The borrowing–based adjustment costs are modelled similarly to the ordinary adjustment costs,

$$\tfrac{1}{2}\tilde{\phi}(K_{it+1} - K_{it})^2/K_{it} \qquad\qquad i = p,g.$$

It is assumed that these costs do not entail real resources (the formal assumption is that the additional costs enter the social utility function additively). This assumption is made so as to better capture the properties of an administrative constraint, as distinct from ordinary physical adjustment costs.

The parameter $\tilde{\phi}$ receives the value 22, much higher than in the case of ordinary adjustment costs ($\phi = 1$).

Unemployment

Two assumptions are considered regarding the labor market — market clearing and rigid real wages. The latter is implemented by postulating that the real wage cannot decline by more than 5 percent of the initial level. Wage rigidity imposes unemployment in the classical sense of a gap between the supply and demand for labor, with employment determined by demand at a given wage rate. The unemployed are assumed to receive unemployment benefits.

For computational purposes, unemployment is derived by first specifying the unemployment path, its parameters being chosen so that the resulting wage path satisfies the wage rigidity constraint.

The unemployment rate, u, is specified as follows, starting from the first year of the influx of immigrants:

$$\mu_1 = (1-q)A_1 \qquad \text{year 1}$$

$$\mu_2 = (1-q)(A_2-A_1) + [1-q-q(1-q)]A_1 \qquad \text{year 2}$$

$$\mu_3 = (1-q)(A_3-A_2) + [1-q-q(1-q)](A_2-A_1) + \\ + (1-q-q(1-q) - q(1-q)^2 A_1 \qquad \text{year 3}$$

$$\mu_t = (1-q)(A_t-A_{t-1}) + [1-q-q(1-q)](A_{t-1}-A_{t-2}) + \\ + [1-q-q(1-q)-q(1-q)^2](A_{t-2}-A_{t-3}) + \\ + [1-q-q(1-q)-q(1-q)^2 - q(1-q)^3](A_{t-3}-A_{t-4}) + u^* . \qquad \forall t > 3$$

That is, a proportion $0 < q < 1$ of immigrant labor force entrants in year t find a job in the same year; another $q(1-q)$ find work in the next year; $q(1-q)^2$, after two years, and $q(1-q)^3$ after 3 years; from then on there will be a constant unemployment core of u^*.

In practice, the exercise is carried out as follows. Initially, u^* is set to zero, that is, all immigrants find work within three years. The values of q are scanned, by solving the model for each of them in order to see whether the real wage has fallen by less than 5 percent of the initial wage for any value of q. If no such value is found this process is repeated with $u^* = 0.01$, $u^* = 0.02$, and so on, until the constraint is satisfied. Hence, the chosen value of u^* is the lowest, and of q the highest, that satisfy the constraint. In other words, this procedure searches for the lowest unemployment satisfying the wage–rigidity constraint.

2. RESULTS OF THE SIMULATIONS

The main simulations are carried out assuming a total influx of one million immigrants over five years. The annual flows assumed are 60,000 in 1990, 360,000 in 1991, 340,000 in 1992, 210,000 in 1993, and the remaining 30,000 in 1994. Without immigration the population and productivity are constant in the model. Hence, the simulations can be interpreted as changes due to immigration, relative to a normal trend that may reflect population and productivity growth.

The basic path (scenario 1)

The basic path is derived from the model under two main assumptions:

1. Real wages are flexible and the labor market is at full employment at all points of time.

2. There is no foreign borrowing constraint. In other words, economic agents can borrow any amount abroad, at the going rate of interest.

Figures 1 through 6 and 8 present the development of the major macroeconomic variables according to this path. For 1990, there is a striking discrepancy between the prediction of the model and what actually happened: actual investment, both private and public, are much lower than in the model. This has probably to do with sub–optimal government policy, but also with the existence of various rigidities which the current version of the model does not take into account.

The salient feature of the basic path is the large volume of resources required in the first 8–10 years (figure 3). The increase in resource requirements has several components:

Gross nondwelling investment: There is massive private investment, and the capital stock grows by $20 billion within 15 years (figures 1 and 2; dollar figures are at 1989 prices).

Infrastructure: The government triples its infrastructure investment, with a high level in the first five years, which subsequently tapers off.

Immigrant housing: About 4.5 percent of GNP are devoted to housing in the first five years.

Direct absorption outlays: Funding of immigrants' living expenses in their first year in the country comes to 2.5 percent of GNP.

The total excess demand for resources is summed up by the external debt, which rises by $40 billion in the first 10 years, most of it incurred in the first five (figure 4). This is, for Israel, an unprecedented scale of borrowing which may not be feasible. We return to this issue below.

GNP, productivity, and welfare

An important element of this framework is the economies of scale arising from the public goods' aspect of the infrastructure. The exogenous population growth enables the government to realize these economies by expanding the infrastructure. As a result, private factor productivity rises, and with it per capita GNP, wages, and welfare. However, if the infrastructure does not grow enough, there are in fact diseconomies of scale due to congestion. The rise in productivity is also due to the high level of human capital embodied in the present immigration; the results combine these two effects. Note that the productivity rise due to immigration is understated here for two reasons. First, the elasticity of the infrastructure in the production function is likely to be above the figure of 0.095 used by us;[4] second, the model does not include any externalities associated with the immigrants' human capital. The figures discussed below must therefore be regarded as the lower bound of the effect of immigration.

The absorption process gives rise to a substantial increase in GNP (figure 5). Over ten years, GNP comes to 33 percentage points (11 points per capita) beyond 'normal' growth; real wages decline by no more than 4 percent in the first four years, rising subsequently to a permanent level which is above the pre–immigration figure.

The small decline in real wages is at first sight surprising: how can the large incremental labor supply be fully integrated with such a small decline in real wages? The latter is due to the large increase in labor productivity generated by the massive capital formation, in whose absence wages would fall by much more. For example, if the capital stock did not grow at all, the incremental manpower could not be employed in its entirety

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[4]Results for the United States in Aschauer (1989) do suggest a higher figure.

unless the real wage fell by over 15 percent.

The effect on the welfare of established residents is reflected in the level of per capita consumption, which rises permanently by 12 percent (figure 8). This is due to a combination of several factors: (a) the economies of scale mentioned above; (b) the reduction in the per capita defense burden (aggregate defense outlays are assumed to remain at their 1989 level); (c) since the immigrants do not bring tangible capital, the additional labor creates a producers' surplus, given that the wage rate is determined by labor's marginal productivity. Immigrant absorption expenditure constitutes a burden, but this effect is outweighed by (a)–(c).

An important distributive implication emerges from the analysis. As mentioned, the immigrants bring no tangible capital with them, and this substantially alters the capital–labor ratio. During the process, the real wage declines, while capital income rises. The income distribution therefore changes at the expense of households whose principal income is from labor.

The constrained path (scenario 2)

As stated, the basic path ignores the possible limitations on foreign borrowing and the possibility of unemployment, resulting from downward rigidity of the real wage. These constraints are now introduced.

Assume that the borrowing constraint permits the economy to borrow a maximum of $25 billion from the rest of the world. This figure is based on the optimistic end of the range of prevailing estimates. When the model is simulated under this constraint, capital formation is reduced substantially. In the absence of downward rigidity, the real wage would then decline sharply (by 10 percent) in the first ten years. The Israeli experience suggests that such a fall in wages may not be feasible. We here adopt the assumption that the rel wage cannot fall by more than 5 percent. Hence, unemployment is generated.

The results are shown in figures 1 through 8. The constrained path is clearly inferior to the basic one. The long–run benefits of immigration fail to materialize in full. The stock of capital grows more slowly and the capital–output ratio takes longer to recover (figures 2 and 6). GNP grows, but less than in the basic path (figure 5), after 10 years reaching only 20 percentage points above the 'normal' rate. The economies of scale are barely realized: per capita GNP rises only slightly.

Figure 7 shows the emergence of unemployment. In the first four years, the unemployment rate rises to 13 percent. Since the results are interpreted as changes relative to the no–immigration situation, a core unemployment rate would have to be added to get actual unemployment. Assuming core unemployment of 5–6 percent, this implies an unemployment rate of 19 percent by 1993. Unemployment declines in the following five years, but remains at a higher level than before the immigration for the entire horizon of the simulation.

Smaller number of immigrants (scenario 3)

The situations discussed so far assume an influx of 1 million immigrants. We look also at a minimalist scenario which assumes a total of only 600,000 immigrants over the same five–year period.

The salient feature of this scenario is the reduction in the growth rate. Aggregate GNP grows by 19 percentage points beyond the 'normal' rate while per capita GNP grows by 8 points. The permanent increase in consumption of established residents is also low, coming to 6 percentage points.

As against this, this scenario requires less investment and hence foreign borrowing does not exceed the $25 billion that can be borrowed. Since the capital–output ratio recovers quite quickly, real wages need not decline by much and the necessary decline is obtained without unemployment.

A qualification is needed here: A smaller number of immigrants yields fewer benefits, and the country's borrowing capacity may also be smaller. In this case, unemployment may also develop in this scenario too.

3. FISCAL POLICIES

In this section we examine alternative fiscal policies, using as a basis the second scenario of Section 2 (one million immigrants, subject to wage and borrowing constraints).

A problem that arises in the foregoing analysis is that the temporary budget deficits increase the internal public debt in the first few years of the influx of immigrants. Moreover the gross debt rises at an unprecedented rate owing to the large volume of housing loans that the government intends to give to immigrants, loans which are not part of the deficit. This could have serious consequences for stability, particularly with regard to inflation, a topic which we have not addressed in the present model. We can, however, analyze the real effects of measures that could be adopted in order to prevent the deficit from rising.

There are several ways of offsetting the expected rise in the budget deficit, two of which are raising the tax rate and not increasing infrastructure investment.

Increase in all tax rates (scenario 4): This measure reduces the deficit at the cost of reducing capital accumulation and growth.

Figures 9 through 12 compare the results of scenarios 2 and 4; the latter assumes a permanent tax increase of 5 percentage points. The first nine years (1990–98) are shown, since this is the period during which most of the differences arise. In the high–tax scenario, the level of GNP and capital stock is lower, as are real wages. The lower private return on capital reduces the demand for it, so that in the short run the economy incurs a smaller external debt. Moreover, slower capital accumulation implies that in the first three or four years the real wage declines by more than in the preceding scenario. If the real wage cannot fall to the extent required, raising taxes will lead to higher unemployment. Solution of the model is nevertheless based on the assumption that unemployment is the same as in scenario 2.

No infrastructure expansion (scenario 5): In scenario 2, the government determines the infrastructure stock optimally, subject to the resource constraint. This implies a large increase in infrastructure investments during the first few (particularly the first six) years. The alternative policy considered here is that for fiscal reasons, i.e., a growing deficit, the government keeps infrastructure investment at the 1989 level.

The most salient consequence of freezing infrastructure investment is that the rate of economic growth slows down. Moreover, real wages have to decline by more. Alternatively, we can conclude that if wages are rigid and the infrastructure stock is constant, unemployment will be higher. The long–run path of real wages is also lower, and the labor supply of established residents therefore contracts. Private investment also declines because of the lower productivity of private capital. Accordingly, there is less foreign borrowing in the short run.

The conclusion emerging from this analysis is that the price of offsetting the rise in the budget deficit has to be paid in the medium and long runs.

4. CONCLUDING REMARKS

This paper has presented simulated dynamic paths for the Israeli economy generated by the current wave of immigration from the Soviet Union. The results about this impact of Soviet immigration to Israel are obtained from a dynamic optimization model that combines theoretical and quantitative considerations. In spite of some strong assumptions — perfect foresight, for example — we believe that this model can serve as a useful benchmark. It is able to highlight the quantitative impact of ongoing and expected events such as the current immigration, and to emphasize the sensitivity of the process to policy instruments.

The projections obtained should not be considered as forecasts. The purpose of the simulations is only to analyze the paths that would result under different assumptions and policies. In any case, given the nature of the model, the numerical results can only be indicative of the relevant orders of magnitude.

The results indicate long–run benefits from immigration. In the short run, however, the sensitive front is the foreign debt. In the basic scenario, without the foreign–borrowing constraint, the external debt reaches an unprecedented level. A borrowing limit of $25 billion is then introduced. Under this constraint, capital formation is slower, and either the real wage declines by much more than in the basic scenario or unemployment increases.

The primary mechanism quantified by the model is very simple. The drastic decline in the capital/labor ratio triggered by the immigration necessitates heavy capital formation, which, in turn, calls for a large increase in foreign borrowing. The tighter the foreign–borrowing constraint, the longer it takes to restore the capital/labor ratio, resulting in lower real wages or higher unemployment. An important complication is that as unemployment increases, so do government unemployment–benefit transfers. In other words, unemployed immigrants consume but they do not contribute to output. This makes capital formation even slower, given the borrowing constraint. A related aspect which the analysis does not take into account is that the hardships of the first few years are liable to reduce the number of immigrants, or increase emigration, or both. In that case, of course, the long–run benefits of the Soviet immigration would be smaller.

APPENDIX A

Variables

C_t	consumption of representative established individual
C_{at}	consumption of representative immigrant individual
L_t	hours of representative established individual
L_{at}	hours of representative immigrant individual
I_{pt}	gross private nondwelling investment
I_{gt}	gross public infrastructure investment (transportation, communications, power, water)
I_h	gross housing investment (exogenous)
K_{pt}	net private capital stock (depreciation rate, δ_p)
K_{gt}	net public infrastructure stock (depreciation rate, δ_g)
J_{pt}, J_{gt}	capital stock adjustment costs (p and g denote private and government respectively)
w_t	real wage for average schooling level of established residents
π_t	rate of return on capital
d_t	firms' profits
Z_{pt}	transfers to private sector from the rest of the world
Z_{gt}	transfers to government from the rest of the world
Z_t	$= Z_{pt} + Z_{gt}$
D_{pt}	net external debt of private sector
D_{gt}	net external debt of government
D_t	$= D_{pt} + D_{gt}$

m_t	total mortgage repayments by immigrants
p	relative labor force participation rate (immigrants/established residents)
s	relative return to schooling (immigrants/established residents)
a_t	number of immigrant arrivals in year t
A_t	number of immigrant labor force entrants up to and including year t
g_a	government outlay on immigrant absorption per immigrant in the first year (aggregate in year t: $a_t g_a$)
G_t	government consumption plus investment other than infrastructure
X_t	government transfers to private sector
$\tau_{\ell t}$, τ_{kt}, τ_{ct}	tax rate on labor income, capital income, and consumption, respectively

Parameter values chosen for the model

$\sigma = -1$	the parameter of the CES production function determining the elasticity of substitution; it is chosen from the range 0 (consistent with the Cobb–Douglas form) to the –1.5 derived from Elkayam (1990).
$\alpha = 0.38$	another parameter of the production function. It is set so as to yield a steady–state share of capital in GNP of 0.3 (the long–run average)
$\delta_p = 0.10$	average depreciation rate of private capital

$\delta_g = 0.02$	average depreciation rate of public infrastructure
$r = 0.055$	real interest rate, based on real world interest rate facing the economy
$v = 0.4$	excess burden per unit of government investment; see the discussion in Hercowitz and Huffman (1990)
$\epsilon = 0.02$	coefficient of congestion of infrastructure use; we had no estimates of ϵ; however, the results were not sensitive to variation within the range [0–0.4]
$\gamma = 0.095$	is determined as follows: in the steady state, the condition for optimality of government investment is $$1+r = \frac{\gamma}{(1+\epsilon)(1+v)} \frac{Y}{K_g} + 1 - \delta_g$$ since in the steady state $I_g = \delta_g K_g$, and $I_g/Y = 0.018$, γ can be solved as a function of the parameters already determined
$\mu = 0.8$	this value is set for convenience; it has no effect on any ratio between variables
$\psi = 3$	derived from Elkayam's (1990) estimate of the supply elasticity of labor with respect to the wage rate, $1/(\psi - 1) = 0.5$
$\beta = 1/1.055$	time preference
$\phi = 1.0$	the coefficient of the capital adjustment cost function
$s = 1.23$	derived from the average years of schooling of immigrants (by occupation) up to February 1990, relative to the established labor force, and estimates of returns on schooling in Mark (1990)

$p = 1.20$	this was the relative labor–force participation rate for the Soviet immigrants of the 1970s
$n = 0.10$	emigration rate after one year; this was the rate for the Soviet immigrants of the 1970s

Base–year data (1989)

$\tau_\ell = 0.24$	tax rate on wage income (based on the 1986–89 average)
$\tau_k = 0.30$	tax rate on income from capital (based on the 1986–89 average)
$\tau_c = 0.246$	rate of indirect taxes on consumption (based on the 1986–89 average), i.e. ratio of indirect taxes (including import duties) to private consumption. Includes all indirect taxes since they fall mainly on consumption.

The following items appear as a percentage of GNP:

Infrastructure investment	1.8
Government consumption and investment other than infrastructure	32.3
As preceding, excluding defense	13.9
Direct government outlay on absorption of 45,000 immigrants in their first year (based on data for 1989)	0.5
Cost of housing construction for 45,000 immigrants (below–average standard)	1.00
Annual mortgage repayments by 45,000 immigrants (based on Bank of Israel, 1990)	0.13
External debt (1989)	38.0

Unemployment benefits for each 1 percentage point of unemployment (based on monthly benefit of NIS700 per unemployed) 0.189

APPENDIX B: SOLUTION OF THE BASIC MODEL

The household's problem is to determine $\{C_t, K^S_{pt+1}, L^S_t\}_{t=1}^{\infty}$ so as to maximize

(A.1) $$\sum_{t=1}^{\infty} \beta^{t-1} U(C_t, L^S_t), \qquad 0 < \beta < 1$$

s.t.

(A.2) $$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[C_t(1+\tau_{ct})+I_{pt}+J_{pt}+I_{ht} - (1-\tau_{\ell t})w_t L^S_t - d_t - (1-\tau_{kt})\pi_t K^S_{pt} - X_t - Z_{pt}] + D_{p0}(1+r) = 0$$

where

$$K^S_{pt+1} = K^S_{pt}(1-\delta_p) + I_{pt}$$

and

$$D_{p0}, K_{p0}, \{X_t, Z_{pt}, I_{ht}, \tau_{ct}, \tau_{kt}, \tau_{\ell t}, d_t, \pi_t, w_t,\}_{t=1}^{\infty}$$

are given.

The first-order conditions are

(A.3) $$\beta^{t-1} U_c(t) - \frac{\lambda(1+\tau_{ct})}{(1+r)^{t-1}} = 0, \qquad t = 1,2,\dots .$$

$$\text{(A.4)} \qquad \beta^{t-1}U_{\ell}(t) - \frac{\lambda}{(1+r)^{t-1}} w_t(1-\tau_{\ell t}) = 0, \qquad t = 1,2,\dots .$$

$$\text{(A.5)} \qquad 1 + J_{pk'}(t+1) - \frac{1}{1+r}[(1-\tau_{kt+1})\pi_{t+1} + 1-\delta_p - J_{pk}(t+1)] = 0 \qquad t = 1,2,\dots .$$

The marginal utilities from consumption and leisure at time t are denoted by $U_c(t)$ and $-U_{\ell t}(t)$; $J_{pt'}(t)$ and $J_{pt}(t)$ are the derivatives of the adjustment cost function with respect to K_{pt+1} and K_{pt}; and λ is the Lagrange multiplier of the constraint.

The firm's problem is to determine $\{K^d_{pt+1}, L^d_t\}_{t=1}^{\infty}$ so as to maximize:

$$\text{(A.6)} \qquad \sum_{t=1}^{\infty} \frac{d_t}{(1+r)^{t-1}},$$

where

$$\text{(A.7)} \qquad \begin{aligned} d_t &= Y_t - w_t L^d_t - \pi_t K^d_{pt} \\ Y_t &= F(K^d_{pt}, L^d_t, K_{gt}; \overline{Y}_t) . \end{aligned}$$

The first–order conditions are

$$\text{(A.8)} \qquad F_{\ell}(t) = w_t = 0 \qquad t = 1,2,\dots .$$

$$\text{(A.9)} \qquad F_{kp}(t) - \pi_t = 0 \qquad t = 1,2,\dots .$$

The equilibrium conditions are:

(1) $$L_t^s = L_t^d = L_t$$

$$K_t^s = K_t^d = K_t \qquad t = 1,2,\dots .$$

(2) Optimality conditions must be satisfied for all economic agents, i.e., (A.3) for C_t and the following equations (A.10) and (A.11) for L_t and K_{pt+1}, respectively:

(A.10) $$\beta^{t-1}U_\ell(t) + \frac{\lambda}{(1+r)^{t-1}} F_\ell(t)(1-\tau_{\ell t}) = 0, \qquad t = 1,2,\dots .$$

(A.11) $$1 + J_{pk'}(t+1) - \frac{1}{1+r}[(1-\tau_{kt+1})F_{kp}(t+1) + 1-\delta_p - J_{pk}(t+1)] = 0 \qquad t = 1,2,\dots$$

which are obtained by substituting (A.8) and $L_t^s = L_t^d = L_t$ into (A.4) and (A.9) and $K_{pt}^s = K_{pt}^d = K_{pt}$ into (A.5).

(3) Budget constraints must be satisfied — (A.2) for households, (A.7) for firms, and the following (A.12) for the government:

(A.12)

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[G_t + I_{gt}(1+v) + J_{gt} + X_t - \tau_{\ell t} w_t L_t - \tau_{kt} \pi_t K_{pt}$$

$$- \tau_{ct} C_t - Z_{gt}] + D_{g0}(1+r) = 0.$$

The economy's resource constraint is obtained by combining these three budget constraints:

(A.13)

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}}[C_t + G_t + I_{pt} + I_{gt}(1+v) + I_{ht} + J_{pt} + J_{gt} - Y_t - Z_t] +$$

$$+ D_0(1+r) = 0.$$

The government's problem is to determine $\{K_{gt+1}\}_{t=1}^{\infty}$ so as to maximize:

$$\sum_{t=1}^{\infty} \beta^{t-1} U(C_t, L_t),$$

subject to constraint (A.13), the production function $Y = F(\cdot)$, and $K_{gt+1} = K_{gt}(1-\delta_g) + I_{gt}$. The condition for optimum K_{gt+1} is similar to that for K_{pt+1} in (A.11):

(A.14) $$\frac{1}{(1+r)^{t-1}}[J_{gk'}(t+1)] - \frac{1}{(1+r)^t}[F_{kg}(t+1) + 1-\delta_g - J_{gk}(t+1)] = 0 .$$

The assumption that infrastructure investment decisions are decentralized is expressed in the condition that only the partial derivative F_{kg} is included in (A.14). If the investment were carried out by a central authority, the indirect welfare effects of K_{gt+1} via private investment and labor would have to be taken into account. Note that (A.14) would also hold for a single central decision–maker if the model did not contain distortionary taxes. In that case, labor and private capital would be determined at the social optimum, and the indirect effect operating through them would tend to zero.

Technical solution of the model

The procedure begins by setting a finite horizon, T = 25 years, as an approximation to the infinite horizon. The variables to be solved for are

$$\{L_t, C_t\}_{t=1}^{T}, \ \{K_{pt+1}, K_{gt+1}\}_{t=1}^{T-1}, \text{ and } \lambda,$$

a total of 4T – 1 variables. The system of nonlinear equations in these variables consists of (A.11) and (A.14), the dynamic equations for the two types of investment for $t = 1, ..., T - 1$, (A.3) and (A.10) for consumption and labor for $t = 1, ..., T$, and the resource constraint (A.13), a total of 4T – 1 variables.

Solution of the model requires two initial and two terminal capital stocks to be determined. The initial stocks are determined as part of the calibration of the model for the base year, 1989. In the basic scenario, the terminal stocks are determined in the new steady state, and in the other scenarios at a lower level which seemed more realistic. A sensitivity test indicates low sensitivity to terminal capital stock in these scenarios.

The external debt/GNP ratio in year T was set at 0.38, which is the initial ratio. This ratio is relevant only for determining the level of consumption, none of the other variables being affected by the terminal external debt (this is because the utility function we use does not include wealth effects on the supply of labor).

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FIGURE 1: NONDWELLING INVESTMENT
$ BILLION (1989 PRICES)

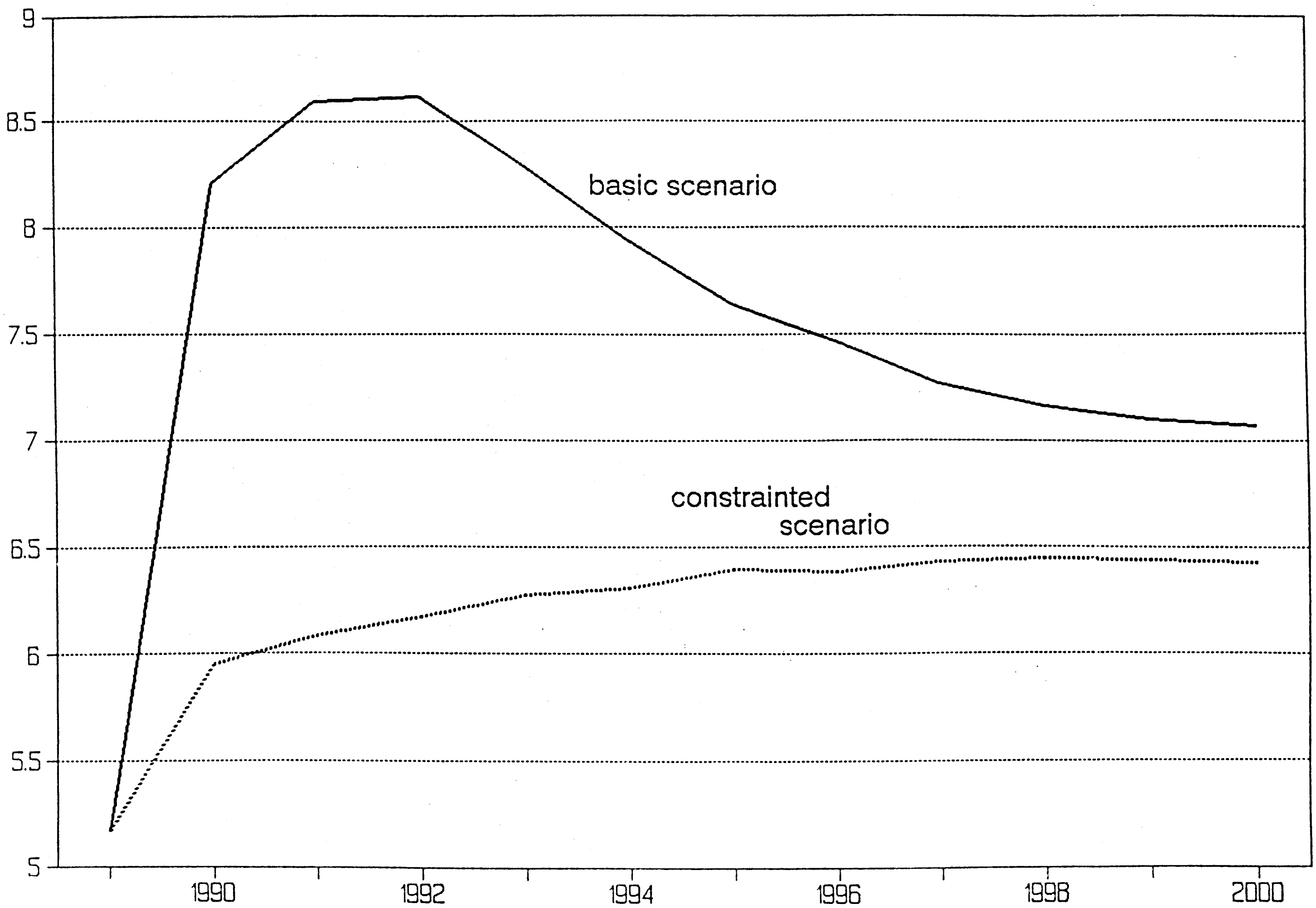

FIGURE 2: NONDWELLING CAPITAL STOCK

$ BILLION (1989 PRICES)

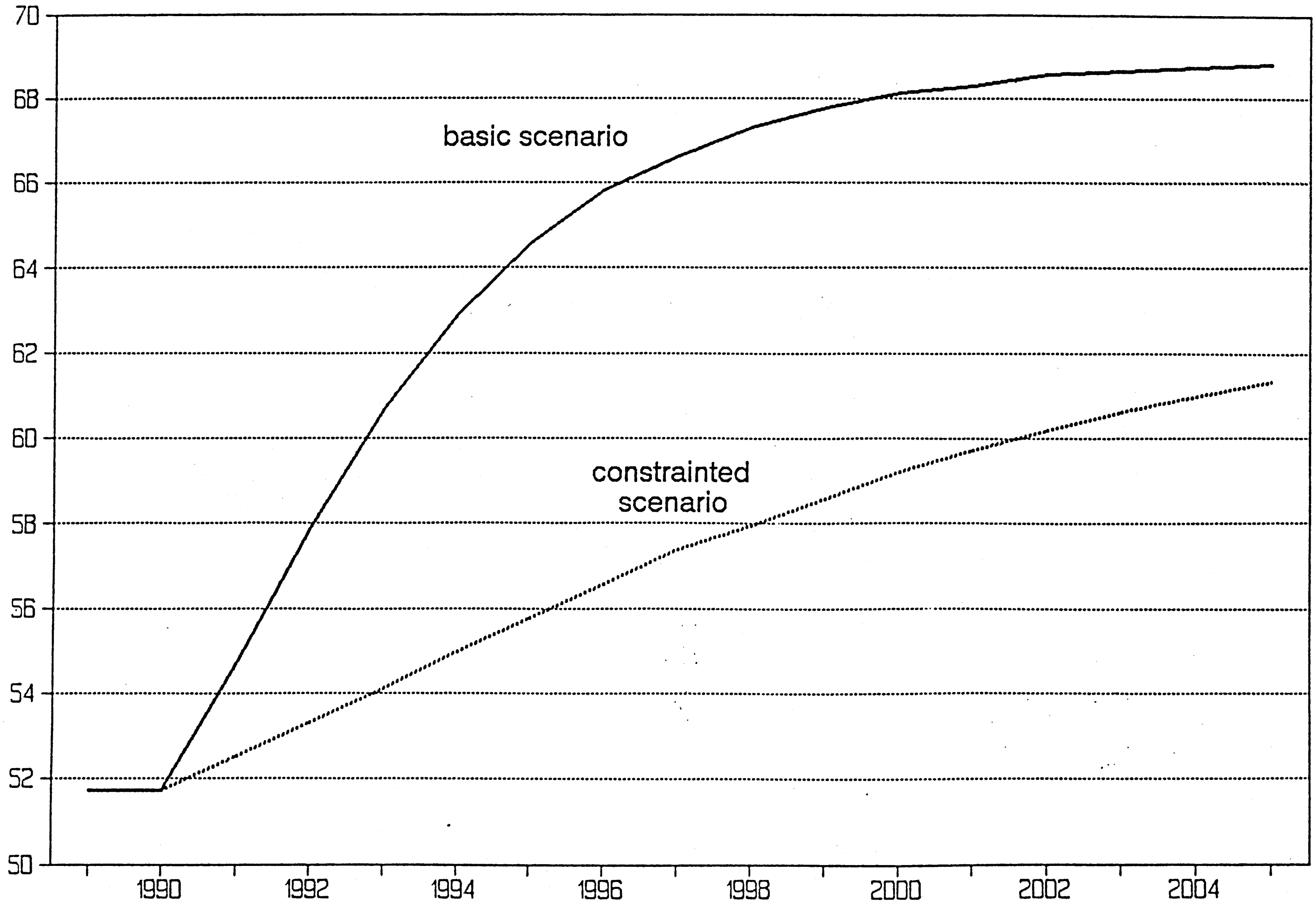

FIGURE 3: BALANCE OF PAYMENTS DEFICIT

$ BILLION (1989 PRICES)

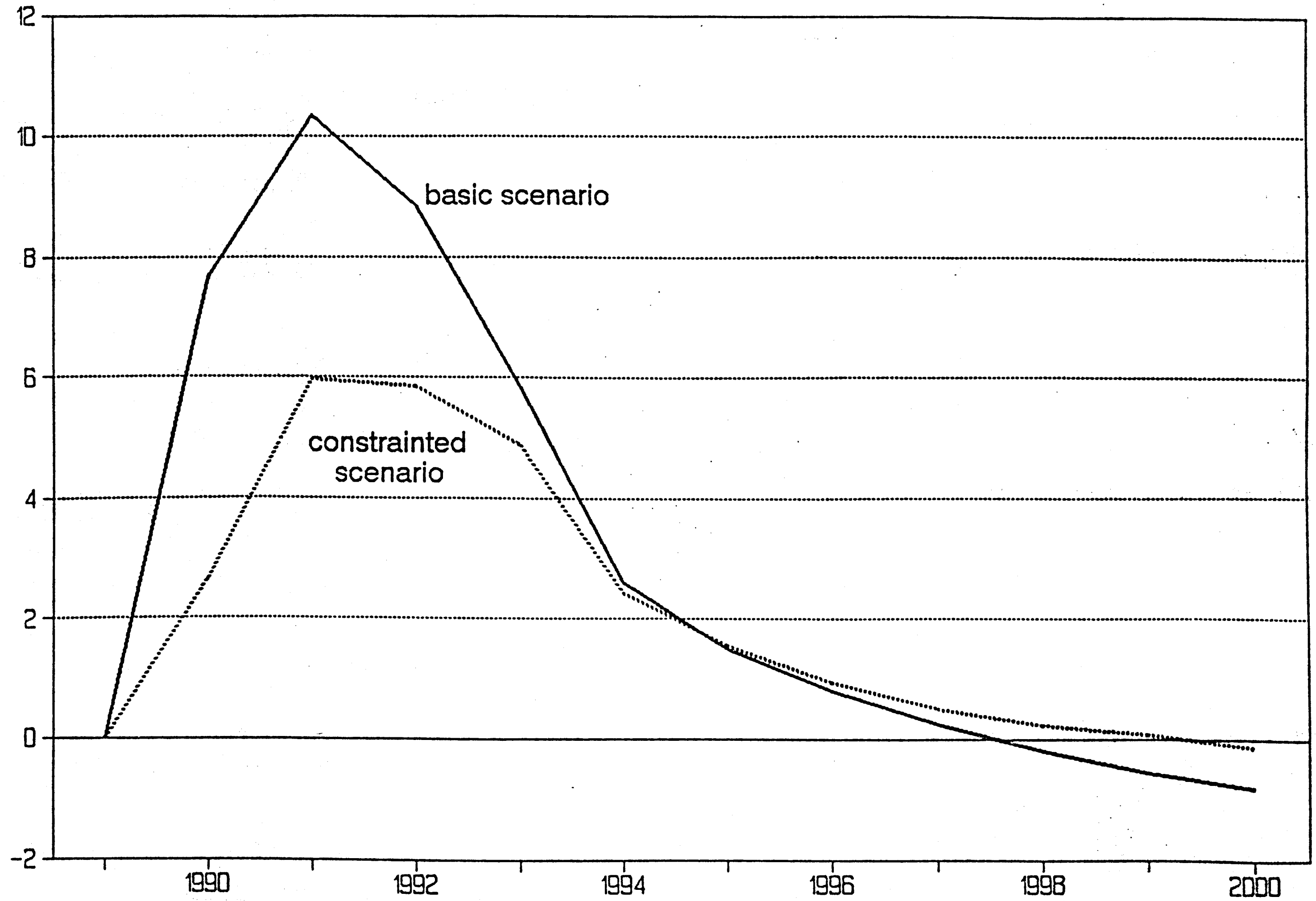

FIGURE 4: ADDITIONAL EXTERNAL DEBT
$ BILLION (1989 PRICES)

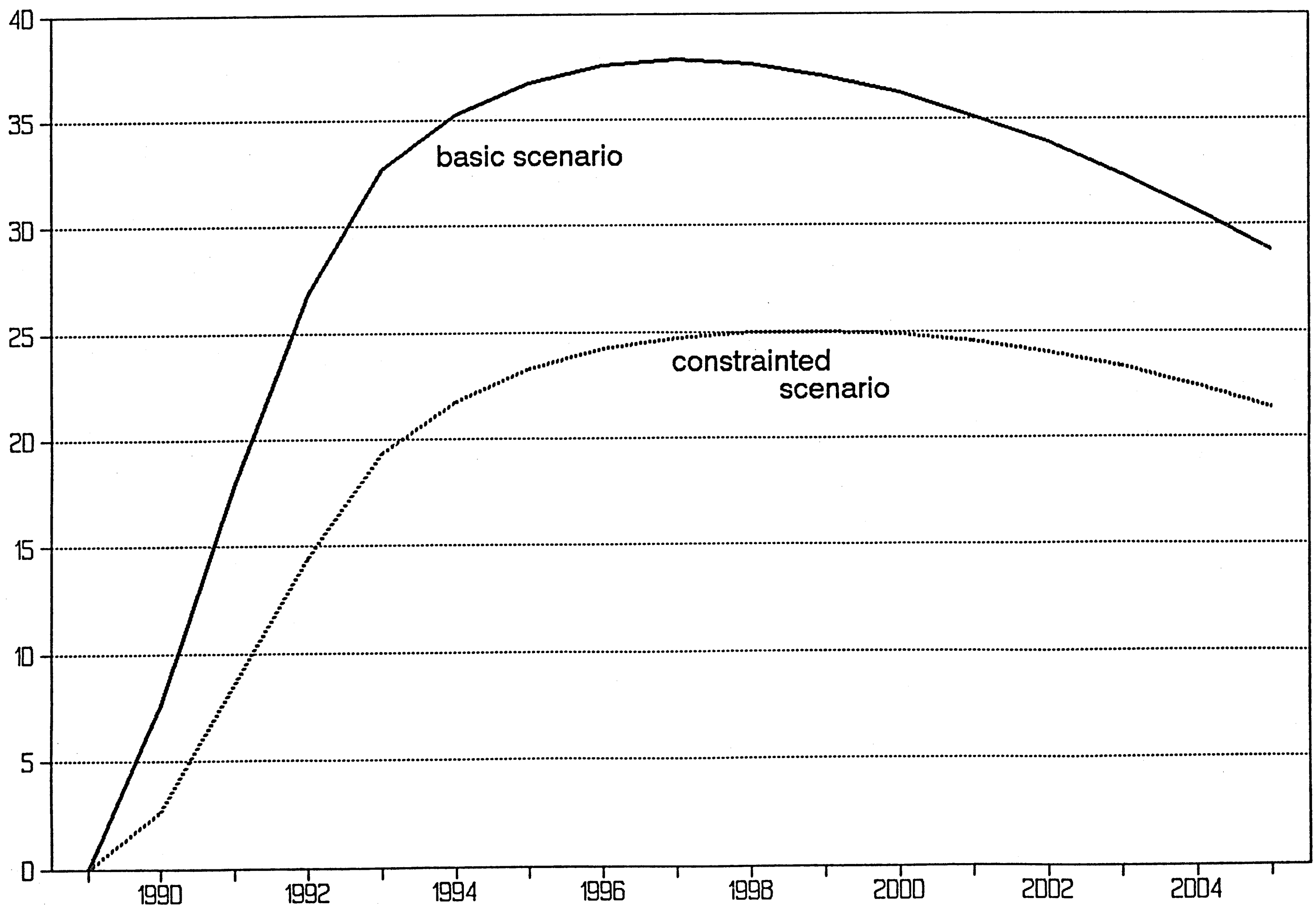

FIGURE 5: ADDITIONAL OUTPUT
(PERCENT)

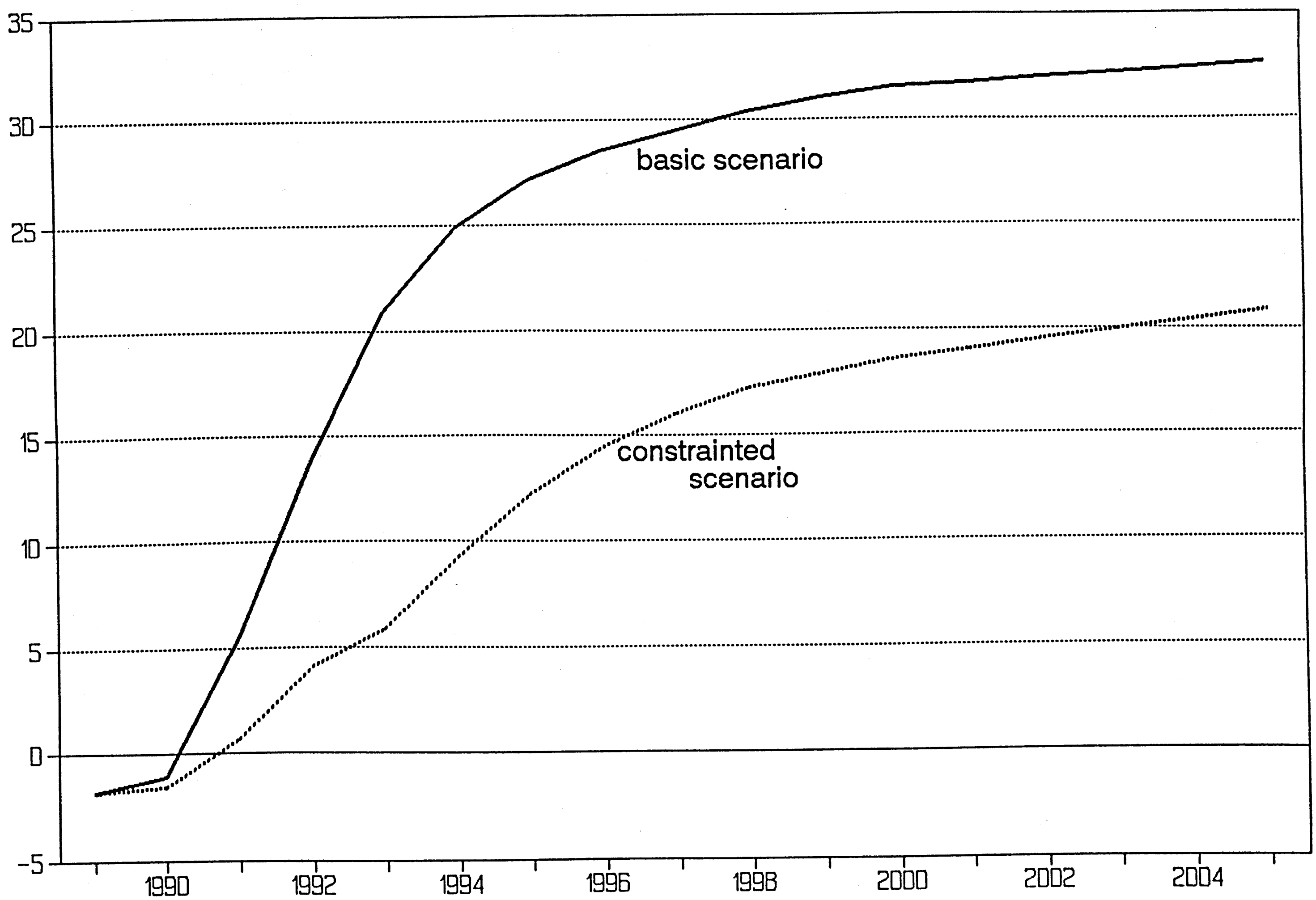

FIGURE 6: CAPITAL / OUTPUT RATIO

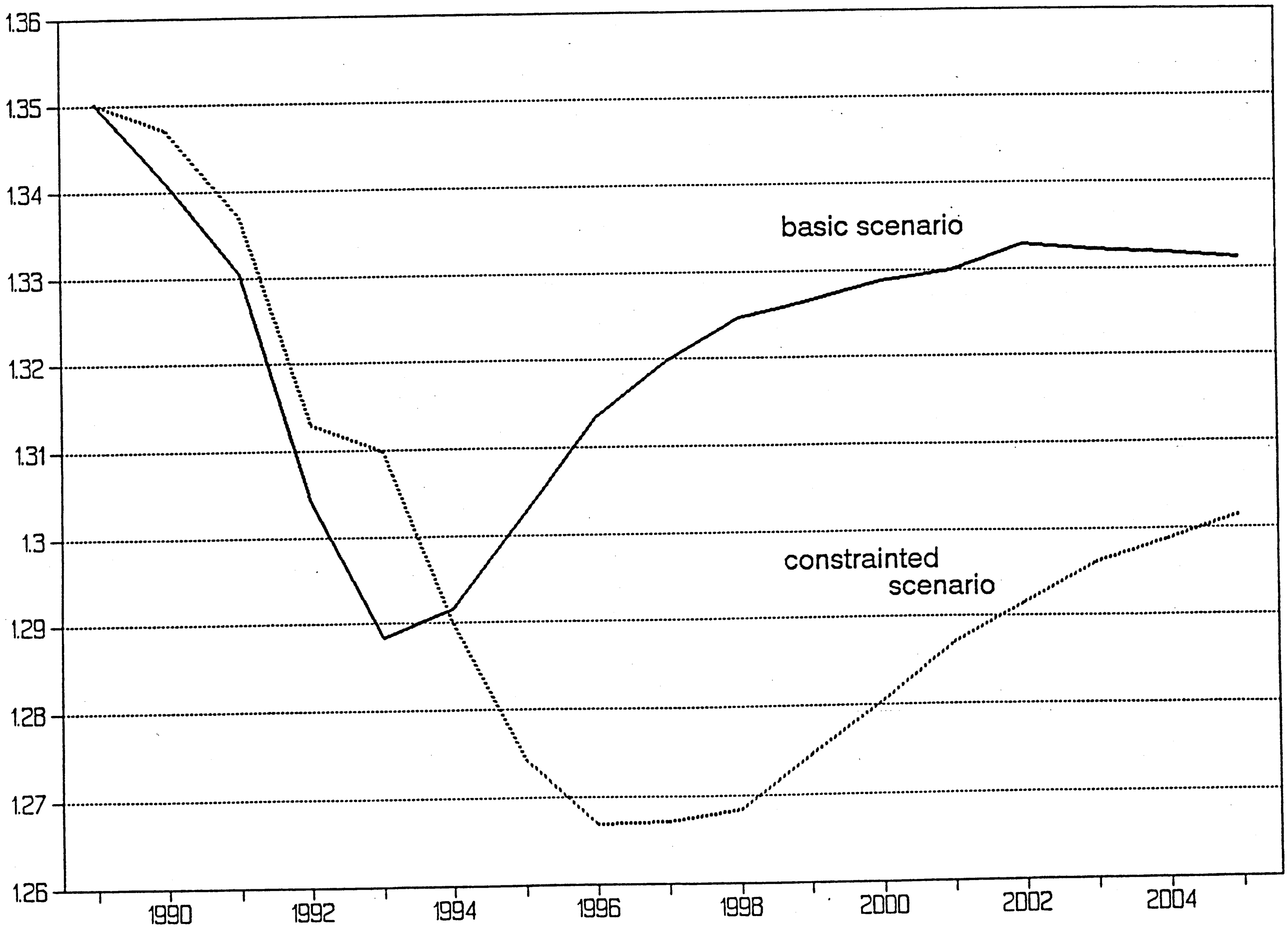

FIGURE 7: ADDITIONAL UNEMPLOYMENT RATE
(PERCENT)

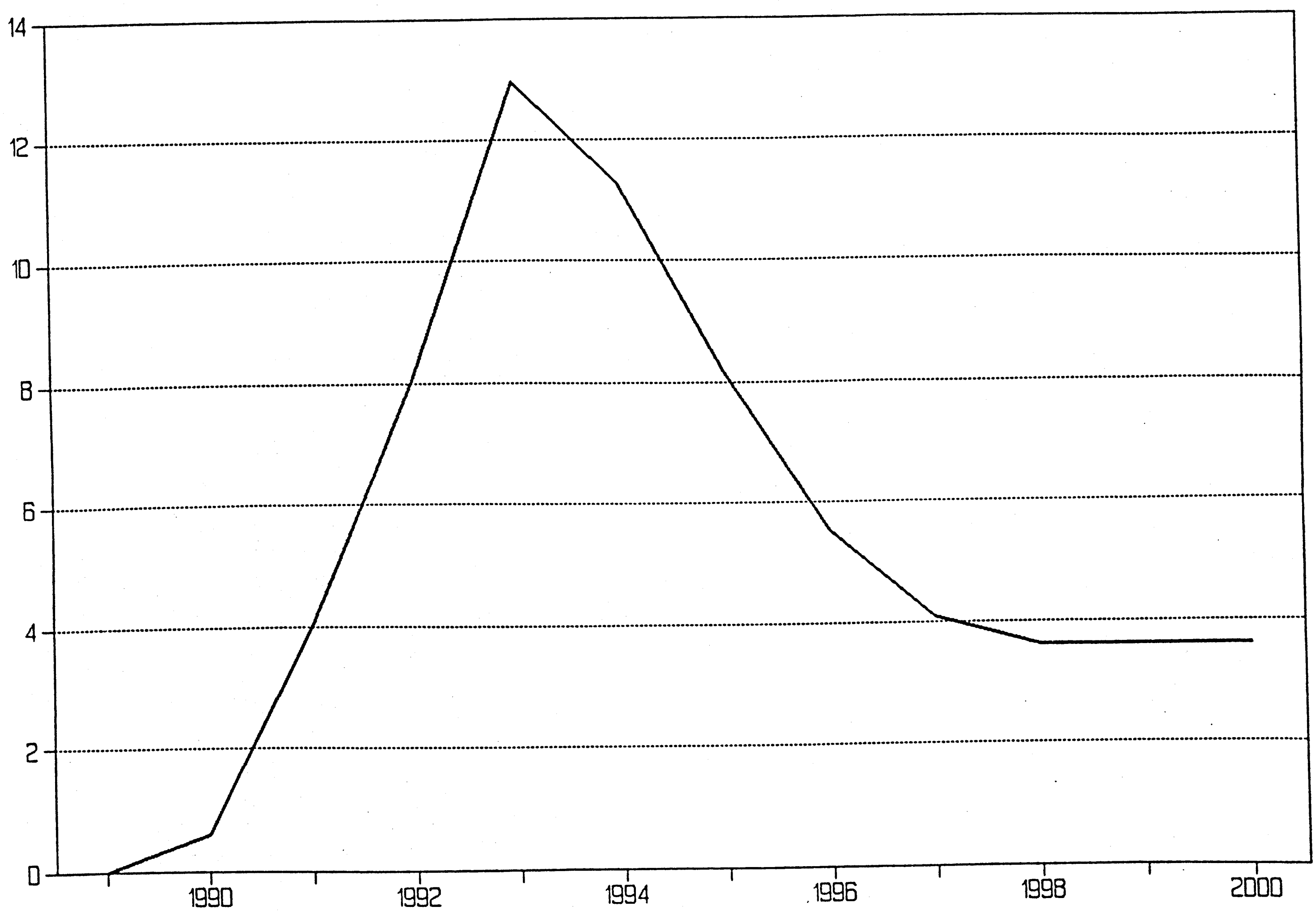

FIGURE 8: PRIVATE CONSUMPTION
(PER VETERAN)

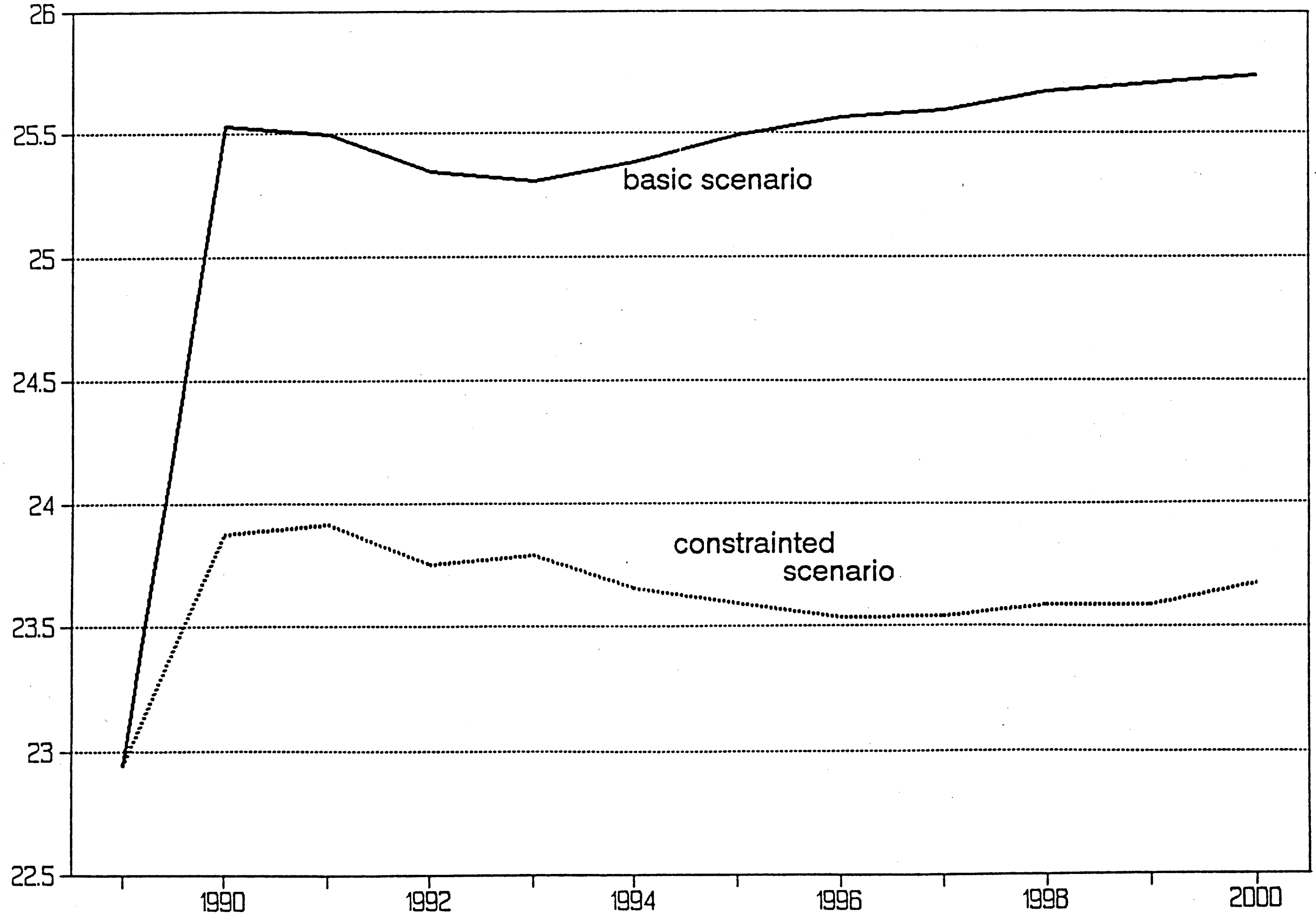

FIGURE 9: ADDITIONAL OUTPUT
(PERCENT)

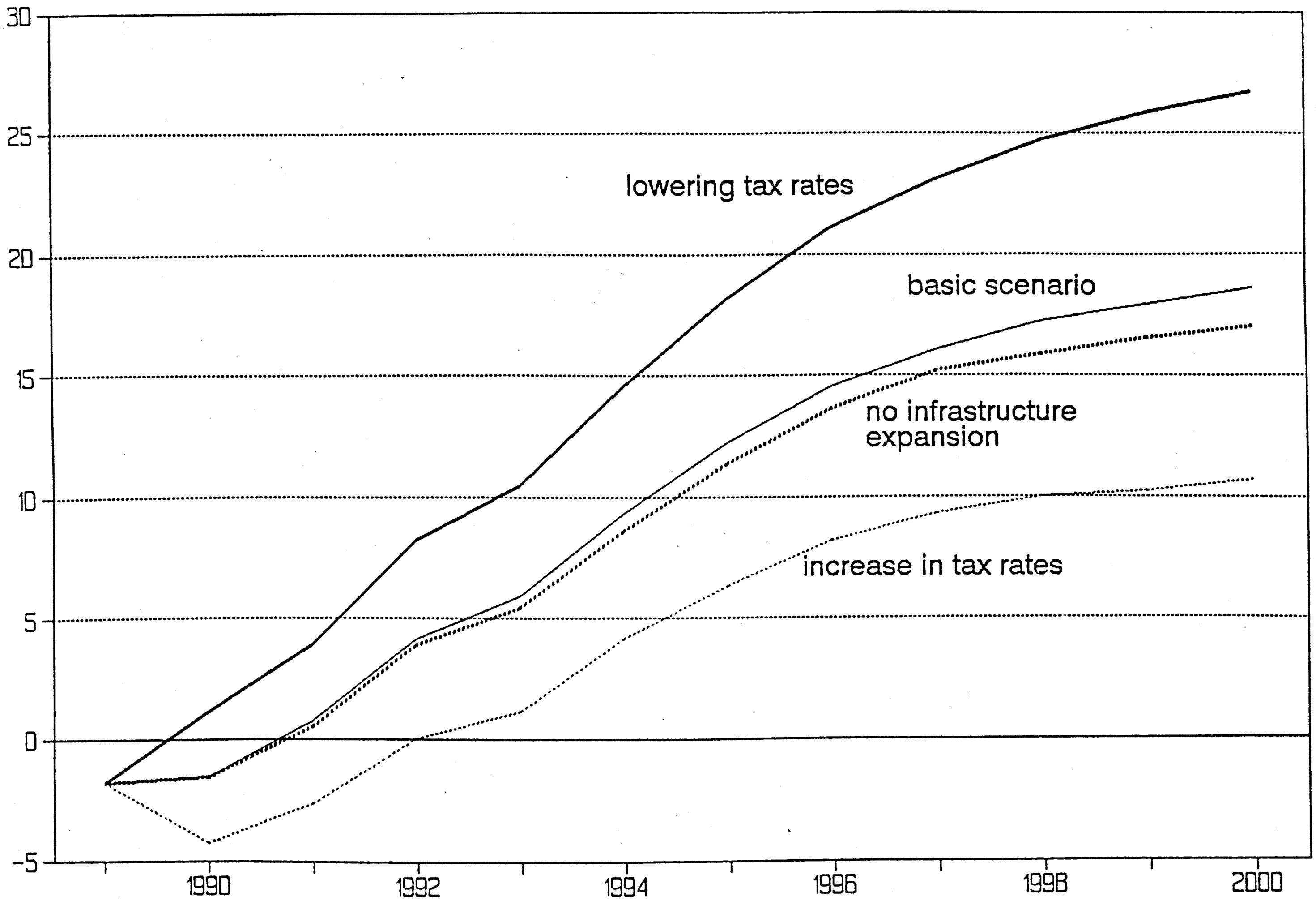

FIGURE 10: NONDWELLING INVESTMENT

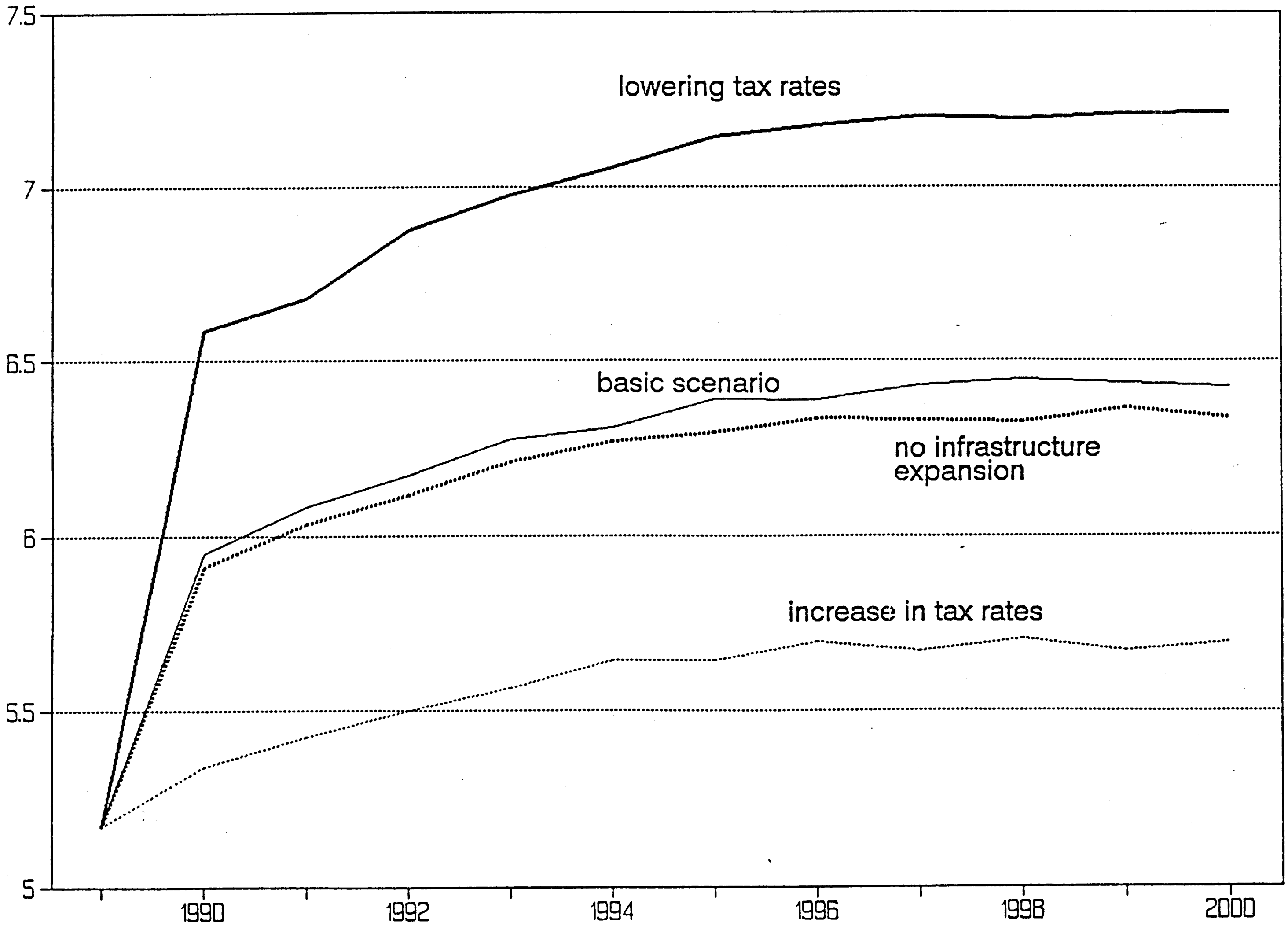

FIGURE 11: PUBLIC SECTOR DEFICIT
(PERCENTAGE OF GNP)

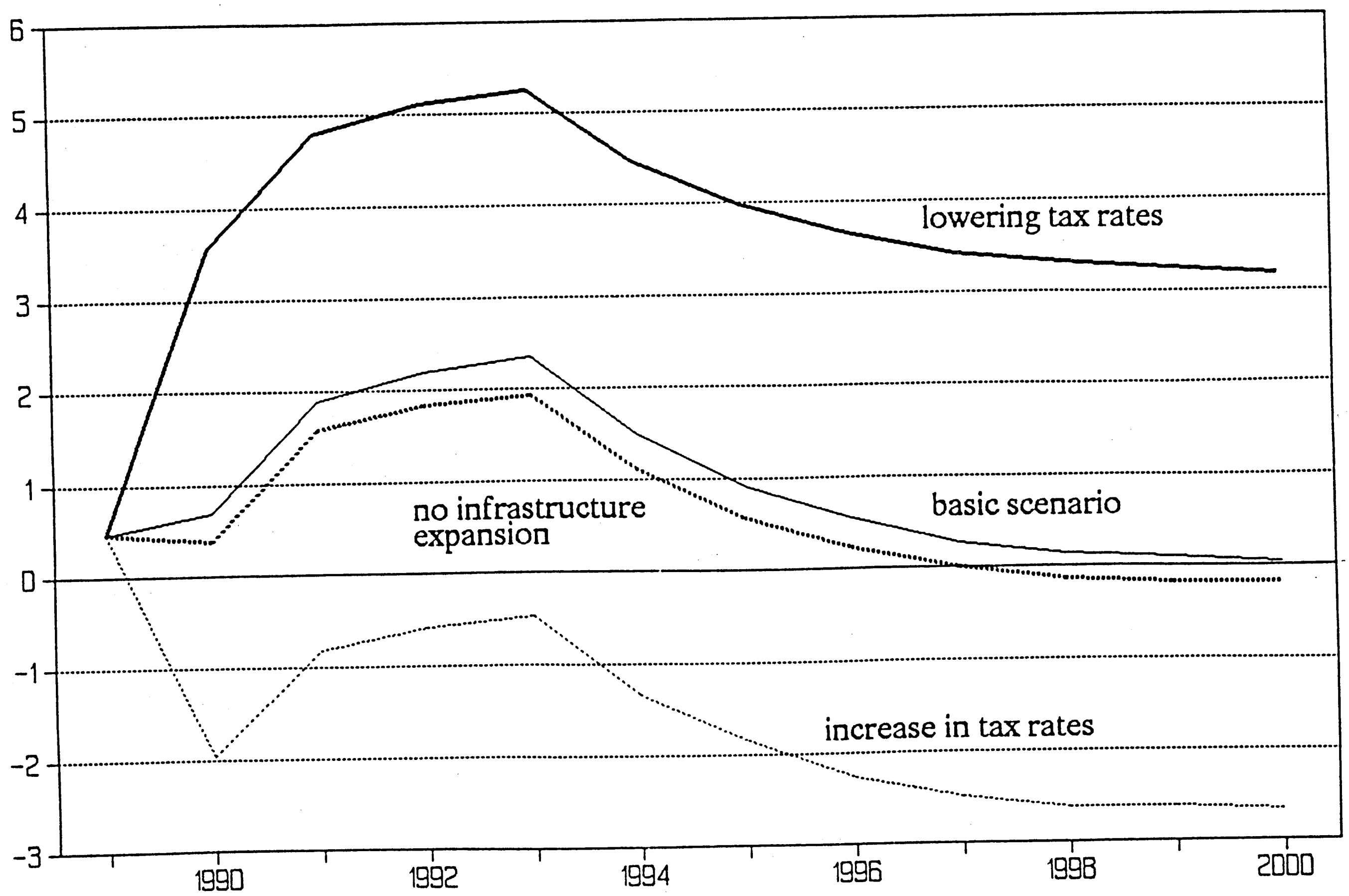

FIGURE 11a: ADDITIONAL INTERNAL DEBT

$ BILLION (1989 PRICES)

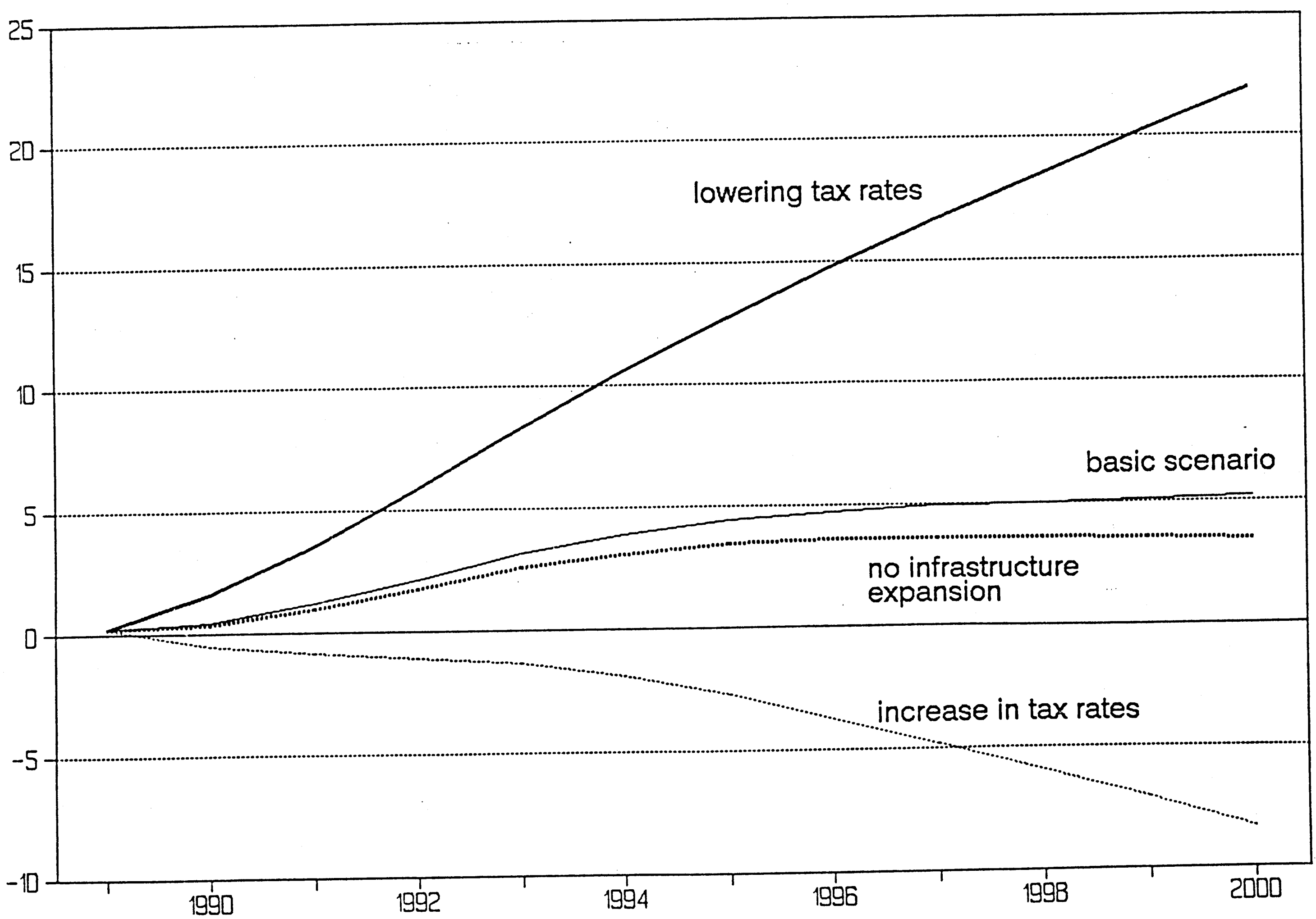

FIGURE 12: REAL WAGE