Financial Crisis, Fiscal Policy and the 1995 GDP Contraction in Mexico

Felipe Meza*

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Felipe Meza

Assistant Professor

Department of Economics

Universidad Carlos III de Madrid

fmeza@eco.uc3m.es

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Abstract

In 1995 Mexico experienced its largest contraction of GDP since the early 20th century. I propose a simple mechanism to partially account for the contraction: the effects of changes in fiscal policy. The contraction of GDP was preceded by a financial crisis. The government responded by raising taxes and reducing spending. Using a model with taxation and government consumption, and the business cycle accounting methodology, I measure the impact of fiscal policy. Fiscal policy accounts for 20.7% of the fall in output.

1 Introduction

In 1995 Mexico experienced its largest yearly contraction of real GDP since the early 20th century. GDP per working age person fell 8.7% between 1994 and 1995.[1] This event was preceded by a financial crisis in late 1994.[2] The crisis imposed large costs on the government, who paid them off in part by carrying out changes in fiscal policy. In early January 1995 the government made public several changes in economic policy. First of all, it announced a reduction in spending. The government reduced its consumption, relative to the level in 1994. Real government consumption per working age person fell 3.9% between 1994 and 1995. Additionally, in early March, the government declared its intention to increase the VAT rate. The government wanted to increase the rate from 10% to 15%. This increase was approved by the Mexican Congress and put in practice in April 1995.

In this paper I argue that the fiscal response of the government to the financial crisis contributed significantly to the contraction of output. I use a model of fiscal policy and the business cycle accounting (BCA) methodology of Chari, Kehoe and McGrattan (2006a) to measure the quantitative impact of changes in fiscal policy in deepening the Mexican crisis of 1994. The fiscal policy model includes government consumption and a tax on consumption.

The BCA methodology is based on the idea that many models are equivalent to a prototype growth model with exogenous variables which resemble productivity, labor and investment taxes, and government consumption. BCA measures these wedges from the data. The productivity wedge is related to total factor productivity

(TFP). The labor wedge captures a distortion on the consumption-leisure choice. The investment wedge captures a distortion on the consumption-savings decision. The government consumption wedge captures resources taken away from consumers. These four wedges, introduced into the BCA model as exogenous variables, allow a version of the neoclassical growth model to replicate data on output, labor, investment and consumption.

I quantify the role of fiscal policy by constructing counterfactual wedges that eliminate the effects of changes in fiscal policy. I first measure the efficiency, labor, investment and government wedges, following BCA. Then I construct counterfactual wedges. In particular, the tax on consumption in the fiscal policy model distorts both the consumption-leisure choice and the consumption-savings decision. These distortions are similar to those created by the labor wedge and the investment wedge, respectively, in the BCA model. I use this relation between the two models to construct the counterfactual wedges. Counterfactual wedges eliminate changes in fiscal policy after 1994. When comparing actual and counterfactual wedges, I find, in particular, that the bigger distortion caused by the higher consumption tax in 1995 is a large component of the change in the labor wedge in that year.

The main objective of the paper is to compare output as predicted using the wedges to output predicted using the counterfactual wedges. In this way I start from a benchmark that matches the data to measure the quantitative importance of changes in fiscal policy.[3] If output falls by a smaller amount when using the counterfactual wedges, the remaining fall in output can be attributed to changes in fiscal policy.

I model the change in taxation observed in the data with an ad valorem tax in the fiscal policy model. The increase in the VAT rate affected consumers. The model I use is very simple, as there is only one good in the economy. I assume that there is a tax on the consumption of this good. In the paper I describe a procedure used to map fiscal data into a tax on consumption, following closely Mendoza, Razin and Tesar (1994). I find that the consumption tax increases from 10.4% to 13.3% between 1994 and 1995. I comment on the magnitude of this increase compared to the international experience in the main text. There is evidence that this increase is relatively large.

The main result of the paper is that fiscal policy has a significant quantitative role in the contraction of output, accounting for 20.7% of it. In the main experiment, using the counterfactual wedges, output falls less than observed. The remaining part of the fall in output is due to the changes in fiscal policy that took place after 1994. I also find that the increase in the consumption tax rate, rather than the fall in government consumption, accounts for most of the contraction of economic activity that is due to changes in fiscal policy. The increase in the consumption tax rate affects the consumption-leisure choice, in a similar way as an increase in taxes on labor income. The higher consumption tax rate reduces the amount of labor in equilibrium, which makes output fall.

Regarding other results, I find that fiscal policy accounts for 18.9% of the fall in consumption, 10.2% of the fall in investment and 91.0% of the fall in labor. It is interesting to note that the quantitative role of fiscal policy is larger for labor than for output. The source of this result is related to the effect of different wedges on each one of the variables. After using the BCA methodology to measure wedges and calculate policy functions, I find that the labor wedge has a bigger impact on labor than the efficiency wedge.[4] The reverse is true for output. Recall that the labor wedge captures, in part, the distortion caused by the consumption tax. Given that the labor wedge has a larger impact on labor, and that the change in the consumption tax is a large component of the change in the labor wedge, the contribution of fiscal policy to the fall in labor is larger than the one for output.

The differences in the role of the efficiency and labor wedges on the behavior of output and labor are consistent with the behavior of these variables after the crisis. During 1995 there was a large fall in output and a small fall in labor. Given this behavior, growth accounting would tell us that TFP, or capital utilization, accounts for a large fraction of the fall in output.[5] The Mexican crisis was not unusual, in the sense that large falls in TFP took place in other crises. Meza and Quintin (2007) report large falls in TFP after recent financial crises. Their results indicate that variable capital utilization can account for approximately one third, on average, of the large falls in measured TFP in Argentina, Mexico and Southeast Asia. I use the version of BCA that allows for variable capital utilization.[6]

Other authors have found some evidence of an important quantitative role for changes in consumption taxes. Conesa, Kehoe and Ruhl (2007) study the depression in Finland in the 1990s. They find that a version of the neoclassical model can account for the continued fall in GDP observed between 1989 and 1993, once government consumption and taxes on labor income and on consumption are included. They also report that the addition of fiscal policy variables overestimates the fall in the labor input between 1989 and 1994. Unfortunately, they do not report on the separate contributions to the falls in GDP and in labor of the labor income tax and of the consumption tax. Ohanian, Raffo and Rogerson (2006) study the evolution of hours worked across OECD countries over the period 1956-2004. They find that a version of the neoclassical model can account for this evolution, once taxes on labor income and on consumption are included. Unfortunately, they do not report predictions on GDP. Also, they do not report on the separate contributions to the evolution of labor of each one of the taxes.

The main result, that fiscal policy can account for 20.7% of the fall in output, contributes to filling a gap in the study of financial crises. Overall, referring to recent research on financial crises, Calvo (2000) says that there has been little emphasis on the behavior of output. Authors who focused on the Mexican case have paid little attention to changes in output. Cole and Kehoe (1996) model events in the government bond market at the end of 1994. They assume that, if the government defaults on its debt, there is an exogenous negative shock on output. Atkeson and Rios-Rull (1996) model the Mexican financial crisis as a binding exogenous external borrowing constraint. They construct an equilibrium which is consistent with several aspects of the Mexican crisis. However, theirs is an endowment economy; output is exogenous. Other recent papers are seminal in the study of output in the Mexican case. Mendoza (2002) shows that there can be large falls in output in a flexible-price model with a liquidity constraint. His objective is to show that "sudden stops" of capital flows can be the outcome of the dynamics of a real business cycle model. He calibrates his model using Mexican data and carries out simulations in which the economy goes from a "best" to a "worst" state in terms of high interest rates, low productivity and high consumption taxes. However, he does not simulate the episode of 1994 and compare model predictions to data.[7]

More generally, there is evidence that procyclical fiscal policy plays an important role in exacerbating economic volatility in developing countries. Gavin and Perotti (1997) and Kaminsky, Reinhart and Vegh (2004) document that governments in emerging market economies increase spending and reduce taxes during expansions and the reverse during contractions. This paper contributes to quantifying the impact of such behavior on macroeconomic aggregates, in the case of the Mexican crisis of 1994.

The rest of the paper is divided as follows. Section 2 presents the fiscal policy model. Section 3 describes the method used to measure the contribution of fiscal policy to changes in output and other aggregates. I first use the BCA methodology to measure wedges that replicate the data. Then I relate the wedges to fiscal policy variables. Afterwards, I calculate counterfactual wedges that eliminate changes in fiscal policy. Section 4 presents results. The main one is the comparison between output predicted with actual and with counterfactual wedges. Section 5 presents some sensitivity analysis. Section 6 concludes.

2 A model of fiscal policy

I present a version of the stochastic growth model with an ad valorem tax on consumption and government consumption. I will use this model to derive a relation between fiscal policy variables and the BCA methodology.

2.1 Environment

Time is discrete. I use a stochastic framework. There are three exogenous variables that follow a stochastic process: a tax on consumption τ_c, government consumption G and productivity z. The initial state of the economy s_0 is $\{K(s_{-1}), \tau_{c0}, G_0, z_0\}$, where $K(s_{-1})$ denotes initial aggregate capital. The state of the economy in period t is s_t. The history of exogenous stochastic shocks and endogenous capital up to period t is $s^t = \{s_0, s_1, ..., s_t\}$. A representative consumer has an expected intertemporal discounted utility function which includes as arguments sequences of per capita consumption, $c(s^t)$ and per capita leisure, $1-l(s^t)$. Population N_t grows at an exogenous constant rate $g_n \geq 0$. The utility function of the consumer is

$$E\sum_{t=0}^{\infty}\beta^t\left[\frac{\left(c(s^t)(1-l(s^t))^{\psi}\right)^{1-\sigma}-1}{1-\sigma}\right]N_t, \tag{2.1}$$

where E is the expectations operator, σ determines the elasticity of intertemporal substitution, $0 < \beta < 1$ is the discount factor and $\psi > 0$ stands for the weight of leisure in utility. Firms operate a technology that uses capital and labor as inputs.

There is exogenous technological change. Output is given by

$$Y(s^t) = F(K(s^{t-1}), Z(s^t)L(s^t)), \tag{2.2}$$

where $K(s^{t-1})$ denotes beginning-of-period aggregate capital stock, $Z(s^t)$ represents technological change and $L(s^t)$ is aggregate labor input. Technological change $Z(s^t)$ evolves according to

$$Z(s^t) = z(s^t)(1 + g_z)^t, \tag{2.3}$$

where $g_z \geq 0$ is an exogenous constant growth rate. I assume that the consumer owns capital and rents it to the firm. Capital depreciates at rate $0 < \delta < 1$. The representative consumer chooses contingent sequences of per capita consumption, labor and gross investment $x(s^t)$ to solve

$$\max_{\{c(s^t),l(s^t),x(s^t)\}_{t=0}^{\infty}} E \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(c(s^t)(1 - l(s^t))^{\psi}\right)^{1-\sigma} - 1}{1 - \sigma} \right] N_t, \tag{2.4}$$

subject to

$$(1 + \tau_c(s^t))c(s^t) + x(s^t) \leq r(s^t)k(s^{t-1}) + w(s^t)l(s^t) + T(s^t) \tag{2.5}$$

$$k(s^t) = \frac{(1-\delta)k(s^{t-1}) + x(s^t)}{(1+g_n)(1+g_z)} \tag{2.6}$$

$$c(s^t) \geq 0, \forall s^t, \forall t, k(s_{-1}) > 0. \tag{2.7}$$

The beginning-of-period per capita capital stock is denoted by $k(s^{t-1})$, $r(s^t)$ represents the rental rate of capital and $w(s^t)$ is the wage rate. Variable $T(s^t)$ is a per capita transfer from the government to the consumer. The government's budget constraint is

$$G(s^t) + N_t T(s^t) = \tau_c(s^t) C(s^t), \tag{2.8}$$

where $C(s^t)$ denotes aggregate consumption. The resource constraint of the economy is

$$C(s^t) + X(s^t) + G(s^t) = Y(s^t), \tag{2.9}$$

where $X(s^t)$ denotes aggregate investment.

2.2 Equilibrium

A competitive equilibrium for this economy is a sequence of control variables for the consumer $\{c(s^t), l(s^t), x(s^t)\}_{t=0}^{\infty}$, a sequence of the state variable of the consumer $\{k(s^t)\}_{t=0}^{\infty}$, a sequence of allocations for firms $\{K(s^t), L(s^t)\}_{t=0}^{\infty}$ and a sequence of rental rates $\{w(s^t), r(s^t)\}_{t=0}^{\infty}$. These elements have to satisfy five conditions: given the sequence of rental rates and the sequence of the tax and government consumption $\{\tau_c(s^t), G(s^t)\}_{t=0}^{\infty}$, the representative consumer solves her maximization problem, firms minimize costs subject to the technological constraint, factor markets clear, the resource constraint is satisfied, and transfers $T(s^t)$ are given by the government's budget constraint, for all s^t and all $t \geq 0$.

3 Business cycle accounting and fiscal policy

In this section I use the BCA methodology of Chari, Kehoe and McGrattan (2006a) to measure the quantitative impact of changes in fiscal policy in deepening the Mexican crisis of 1994. I first measure the investment, labor, efficiency and government consumption wedges. Then I construct counterfactual wedges that eliminate the effect of changes in fiscal policy. I compare the actual versus the counterfactual wedges.

3.1 Preliminaries: data and parameter values

The BCA methodology uses as basic data time series on output, investment, labor, government consumption and capital. The other basic component of the methodology is a version of the stochastic growth model that includes four variables as an exogenous stochastic process: the level of technology z_t, a tax on labor income τ_{lt}, a tax on investment τ_{xt} and government consumption g_t. These four variables are related to four wedges: the efficiency wedge z_t, the labor wedge $1-\tau_{lt}$, the investment wedge $1/(1+\tau_{xt})$ and the government consumption wedge g_t. Using the data and the model, together with values for parameters in the utility function and the technology, I follow BCA and estimate a VAR that governs the stochastic process driving the four wedges.[8]

The BCA methodology allows for a version with variable capital utilization. Chari et al. (2006a) use as production function $y = k^{\theta} z l$, where y, k and l are per capita output, capital and labor, and z is the efficiency wedge. I use this version of BCA because, as mentioned in the introduction, there is evidence that the measurement of TFP, which is related to the efficiency wedge, is sensitive to variable capital utilization.[9]

3.1.1 Empirical counterparts of variables in the BCA model

When implementing the methodology, I use the following mapping between data and model variables: GDP corresponds to output, hours worked corresponds to labor input, gross capital formation plus purchases of durable goods plus net exports corresponds to investment, and government consumption corresponds to the same variable in the data.[10]

Given that the BCA model is a closed economy, I have to take a stand on where to assign net exports. In the BCA model, output is split into three variables: consumption, investment and government consumption. The BCA methodology chooses as empirical counterpart of government consumption the sum of the same variable in the data and net exports. I choose to add net exports to my measure of investment. I do not follow exactly the BCA procedure because I want to analyze the role of actual fiscal policy. Following directly BCA would lead me to construct a measure of government consumption that is different from the actual sequence of government consumption observed in the data.[11]

I construct the capital stock using the standard perpetual inventory approach with geometric depreciation. There are no official statistics on the capital stock of Mexico. I assume that capital depreciates at a yearly depreciation rate of 5%.[12]

Regarding the labor input, I use the number of total hours constructed in Bergoeing et al. (2002).[13] Their labor input is the product of total employment and a measure of average hours per worker in the manufacturing sector.[14] This measure of the labor input falls by a small amount in 1995. Data on hours worked in Mexico for all sectors are not available. A potential concern is that the fall in average hours worked in manufacturing may understate its aggregate counterpart. This would overstate the fall in TFP. However, manufacturing GDP and total GDP behave similarly in Mexico after 1994. During the second and third quarters of 1995, manufacturing GDP and total GDP fell more than 8.0% on a yearly basis. These large falls suggest that the manufacturing sector did not outperform the rest of the economy.[15] It is unlikely that average hours worked in manufacturing significantly outperformed aggregate average hours worked.

Regarding additional aspects of the data, I measure all variables in per capita terms. I use the population of age 15 to 64 years old as a measure of working age population.[16] Also, the BCA methodology uses data detrended by an average growth rate of technological change. For Mexico the growth rate of GDP per capita between 1980 and 1994 is approximately zero. Therefore I do not detrend the per capita data. Finally, I scale the empirical counterparts of output, investment, government consumption and capital in the model by the value of GDP in 1994.

3.1.2 Parameter values for the BCA model

I assign values to parameters in the BCA model. The population growth rate g_n is 3.2%, the average geometric rate between 1980 and 1994. The growth rate of technological change g_z is 0, which corresponds to the average geometric growth rate of GDP per capita.[17] I set the discount factor β equal to 0.9615. This value of the discount factor is consistent with an annual real interest rate of 4%. I set the yearly depreciation rate δ equal to 5%. This is the same rate as used by Bergoeing et al. (2002). This is also approximately the value used by Chari et al. (2006a). I set the weight of leisure in the utility function ψ equal to 2.24. I set the weight of capital in production θ equal to 0.35. Chari et al. (2006a) use these values. Finally, I set σ, the parameter that determines the intertemporal elasticity of substitution $1/\sigma$, equal to 2.5. This matches the estimations of the elasticity in Ostry and Reinhart (1992).[18]

3.1.3 Measuring the consumption tax

When using the BCA methodology to measure wedges and construct counterfactual wedges, I need a time series for the consumption tax from the data. I describe my measurement of the consumption tax. I assign values to the sequence of the consumption tax between 1988 and 2000.

The procedure is to use the method described by Mendoza, Razin and Tesar (1994). They use OECD data to measure tax rates consistent with representative agents in general equilibrium models. They take into account the items "General taxes on goods and services", and "Excise taxes". They exclude the item "Other taxes". In Mexico the tax revenue from this source has a significant magnitude, in relation to other taxes on consumption or sales. Therefore I include it.[19] I find that the consumption tax increases from 10.4% to 13.3% between 1994 and 1995.[20]

Regarding the magnitude of this increase, Asea, Mendoza and Milesi-Ferretti (1997) report measured consumption taxes for 18 OECD countries for the years 1965-1991. There are very few observations across countries and across time for which the increase in the tax on consumption is at least as large as it was in Mexico between 1994 and 1995.[21] Most absolute increases in consumption tax rates have a value smaller than two percentage points. As mentioned, in the case of Mexico in 1995 the increase was 2.9 percentage points. I interpret this as evidence that the tax increase in the Mexican episode is large, compared to the international experience.

3.2 Measuring wedges

Once having constructed empirical counterparts of theoretical variables and assigned parameter values of the BCA model, I measure the wedges. As a first step, I verify that the wedges, once inserted into the model, reproduce the path of GDP, and the other aggregates, in the data. To do this, I use log-linear policy functions. In an intermediate step, BCA solves for the log-linear policy functions of capital, labor and investment. I calculate the Theil inequality coefficient between observed and predicted output. The coefficient is 4.7463×10^{-15}. I obtain similar values for other variables; for example, the coefficient for labor is 2.6761×10^{-17}.[22]

I use log-linear policy functions because I will use them later to obtain an analytical relation between τ_{xt} and fiscal policy variables. I will use this relation to construct counterfactual wedges that keep fiscal policy constant. It is not possible to obtain analytical expressions for nonlinear policy functions.[23]

In Figure 1a I plot the efficiency wedge z_t, the labor wedge $1 - \tau_{lt}$ and the government consumption wedge g_t. In Figure 1b I plot the investment wedge $1/(1 + \tau_{xt})$. I scale all wedges so that they equal 1 in 1994.

[Figure 1a. Labor, efficiency and government consumption wedges]

[Figure 1b. Investment wedge]

The labor, efficiency and government consumption wedges would induce a fall in output in 1995, as the distortions they generate become larger in that year. The investment wedge would increase output, as the implicit distortion becomes smaller.

3.3 Counterfactual wedges

In this section I construct counterfactual wedges that eliminate the effect of changes in fiscal policy. I construct counterfactual investment, labor and government consumption wedges. To do so, I first find the relationship between wedges and fiscal policy variables. The counterfactual wedges are those in which I keep fiscal policy constant after 1994.

An intermediate step in finding the relation between wedges and fiscal policy variables is to solve the fiscal policy model. I find the log-linear policy functions of the fiscal policy model presented in the first part of the paper. I assume the same technology and the same parameter values as in the BCA model. Following BCA, I estimate a VAR process that governs three exogenous variables: the logarithm of the technology shock z_t, the consumption tax τ_{ct} and the logarithm of government consumption g_t. Values of coefficients in the log-linear policy functions depend on the parameter values chosen for utility and technology and on the estimated VAR parameters.

3.3.1 The labor wedge

I first describe how to decompose the labor wedge into two parts, one of which is related to the consumption tax. I describe this decomposition in a nonlinear setup. Note that in the fiscal policy model the consumption tax induces a distortion on the consumption-leisure choice similar to the one created by the labor wedge.

I define the consumption wedge in period t as

$$\frac{1}{1+\tau_{ct}}. \tag{3.1}$$

The labor wedge (the total distortion) is the product of the consumption wedge and that part of the total distortion due to forces other than the consumption wedge.[24] The labor wedge in period t is

$$1 - \tau_{lt} = \frac{1}{1 + \tau_{ct}}(1 - \tau_{ot}), \tag{3.2}$$

where τ_{ot} stands for forces different than the consumption tax.

To calculate the counterfactual labor wedge, I first define the counterfactual consumption tax as

$$\tau_{ct}^{*} = \left\{ \begin{array}{c} \tau_{ct}^{Data}, t \leq 1994 \\ \tau_{c1994}^{Data}, t > 1994 \end{array} \right\}. \tag{3.3}$$

Let $1 - \tau_{lt}^{Data}$ be the original labor wedge measured in the data. It is equal to

$$1 - \tau_{lt}^{Data} = \frac{1}{1 + \tau_{ct}^{Data}}(1 - \tau_{ot}^{Data}). \tag{3.4}$$

In this expression τ_{ot}^{Data} stands for movements in the labor wedge in the data not accounted for by movements in the measured consumption tax.

In the counterfactual experiments I feed into the model τ_{lt}^{*}, defined by

$$1 - \tau_{lt}^* = \frac{1}{1 + \tau_{ct}^*}(1 - \tau_{ot}^{Data}), \tag{3.5}$$

which captures the changes in the labor wedge associated with keeping the consumption tax constant after 1994.

This is the method I use to construct the counterfactual labor wedge, in a nonlinear setup. In practice, I use a log-linear version of the equation that decomposes the labor wedge. I make this choice to preserve consistency with the log-linear policy functions I use in the experiments that follow.[25]

3.3.2 The investment wedge

I now describe the mapping between the investment wedge and fiscal policy variables. I use a log-linear framework. It is not possible to construct analytically a nonlinear mapping. The log-linear policy function for the logarithm of investment x_t from the BCA model is

$$\log x_t = a\gamma_0 + (a\gamma_k - b)\log k_t + a\gamma_z \log z_t + a\gamma_l \tau_{lt} + a\gamma_x \tau_{xt} + a\gamma_g \log g_t. \tag{3.6}$$

In this expression, coefficients a and b measure the relation between the logarithm of investment and the future and current values of the logarithm of capital, respectively. Coefficients γ measure the effect of exogenous variables on the log-linear policy function for capital. I am using the following equations

$$a = \frac{k}{x}(1+g_n)(1+g_z) \tag{3.7}$$

$$b = (1-\delta)\frac{k}{x} \tag{3.8}$$

$$\log x_t = a \log k_{t+1} - b \log k_t \tag{3.9}$$

$$\log k_{t+1} = \gamma_0 + \gamma_k \log k_t + \gamma_z \log z_t + \gamma_l \tau_{lt} + \gamma_x \tau_{xt} + \gamma_g \log g_t. \tag{3.10}$$

The log-linear policy function for the logarithm of investment x_t in the fiscal policy model is

$$\log x_t = a\omega_0 + (a\omega_k - b) \log k_t + a\omega_z \log z_t + a\omega_c \tau_{ct} + a\omega_g \log g_t. \tag{3.11}$$

In this expression, coefficients a and b are exactly the same as in the BCA model. Coefficients ω measure the effect of exogenous variables on the log-linear policy function for capital.

To find the relationship between the investment wedge and fiscal policy variables

I set equal the policy functions for investment. Then I express the investment wedge as a function of the other variables

$$\tau_{xt} = \frac{\omega_0 - \gamma_0}{\gamma_x} + \frac{(a\omega_k - b) - (a\gamma_k - b)}{a\gamma_x} log k_t + \frac{\omega_z - \gamma_z}{\gamma_x} \log z_t + \frac{\omega_g - \gamma_g}{\gamma_x} \log g_t + \frac{\omega_c}{\gamma_x}\tau_{ct} - \frac{\gamma_l}{\gamma_x}\tau_{lt}.$$

Using this expression I construct a counterfactual investment wedge $1/(1 + \tau^*_{xt})$ using counterfactual sequences of $\log g_t$, τ_{ct} and τ_{lt}. I described the counterfactual consumption tax sequence, τ^*_{ct}, when constructing the counterfactual labor wedge. The counterfactual sequence of (the logarithm of) government consumption, $\log g^*_t$, is similar. It corresponds to government consumption up to 1994. After that year, this variable takes the value of government consumption in 1994 forever.

I now describe the relation between τ_{xt} and fiscal policy variables. First I describe the values obtained for coefficients from the BCA model. Coefficient γ_x is negative: a higher τ_{xt} makes investment fall, which has a negative impact on capital. Coefficient γ_g is positive: higher government consumption reduces consumption and leisure, leading to higher capital accumulation. Coefficient γ_l is negative: a higher τ_{lt} reduces labor and capital accumulation.

Regarding coefficients in the fiscal policy model, coefficient ω_c is positive: a higher tax on consumption leads to resources being allocated away from consumption. Coefficient ω_g is positive, for the same reason as in the BCA model.

Variable τ_{xt} and fiscal policy variables are related as follows. Under the current parametrization and estimation of VARs, coefficient $(\omega_g - \gamma_g)/(\gamma_x)$ is negative. Therefore higher government consumption leads to a fall in τ_{xt}. Coefficient ω_c/γ_x is negative. Therefore a higher consumption tax leads to a fall in τ_{xt}. Coefficient γ_l/γ_x is positive. Therefore a higher τ_{lt} leads to a fall in τ_{xt}. One way to interpret these results is to keep in mind two things: first, from a static point of view, a tax on consumption and a tax on investment, are inversely related, as a rise in one of them shifts resources towards the other tax base; second, a tax on consumption and a tax on labor income are positively related, as both shift resources away from labor.

3.4 Comparing actual versus counterfactual wedges

I compare graphically the actual and counterfactual labor and investment wedges. I do not carry out the comparison for the government consumption wedge, as the counterfactual one is very simple (corresponding to keeping government consumption constant after 1994 at its 1994 value). I index each wedge, actual and counterfactual, by its value in 1994.

[Figure 2a. Actual versus counterfactual labor wedge]

The increase in the consumption tax can account for approximately 63.7% of the bigger distortion on consumption and leisure implicit in the data in 1995. This is the result of comparing the levels of the actual and counterfactual wedges between 1994 and 1995. The wedge $1 - \tau_{lt}$ falls 3.9% (which means that the distortion is bigger). The counterfactual wedge falls 1.5%. This wedge keeps the consumption tax constant.

The actual wedge is 2.5% lower. Therefore, the contribution of the consumption tax is 2.5%/3.9%, or 63.7% of the fall in the actual labor wedge.

[Figure 2b. Actual versus counterfactual investment wedge]

The counterfactual investment wedge $1/(1+\tau^*_{xt})$ tracks closely the actual investment wedge $1/(1+\tau_{xt})$ in the first two years after 1994. The investment wedge rises 11.9% in 1995 (which means that the distortion is smaller). The counterfactual wedge rises 8.7%. The actual wedge is 3.0% bigger. Therefore, the contribution of fiscal policy is 3.0%/11.9%, or 25.3% of the rise in the actual investment wedge.

4 Results: comparing paths of output, consumption, investment and labor

I now compare the paths of macro aggregates predicted by the actual wedges versus the path of aggregates predicted by the counterfactual wedges. In all of the following experiments I feed into the model the measured efficiency wedge.

First of all, I find a significant impact of changes in fiscal policy on output. Fiscal policy accounts for 20.7% of the fall in output. Recall that the predicted fall in output matches the data very closely using the actual wedges. The predicted fall in output is smaller when I use the counterfactual wedges, which keep fiscal policy variables constant at their 1994 values. Therefore, I attribute the extra fall in output to changes in fiscal policy.

I plot the predicted paths of output in Figure 3. I plot the levels of output predicted by the actual wedges, and by the counterfactual wedges. Recall that I scaled data by the value of GDP in 1994. Therefore the level of plotted GDP is equal to one in that year.

[Figure 3. Predicted paths of output: using actual versus counterfactual wedges]

Actual wedges make output decrease by 8.7%, relative to its value in 1994. Counterfactual wedges make output decrease by 7.0%. Actual wedges make output fall 1.8% more than the counterfactual ones. This quantity represents 20.7% of the actual fall in output. Therefore, changes in fiscal policy can account for a significant fraction of the fall in output. As I discuss later, the change in the consumption tax accounts for most of the effects of fiscal policy. A rise in the consumption tax reduces the labor supply, which makes output fall.

Fiscal policy has a significant quantitative effect on other variables. Fiscal policy accounts for 18.9% of the fall in consumption, 10.2% of the fall in investment and 91.0% of the fall in labor.

In Figure 4 I plot consumption, investment and labor as predicted using actual and counterfactual wedges. The three variables, as predicted using the actual wedges, match the data. I report consumption and investment measured relative to GDP in 1994.

[Figure 4. Predicted paths of consumption, investment and labor: using actual versus counterfactual wedges]

Intuitively, the counterfactual labor wedge has a smaller negative effect on consumption than the actual labor wedge. Fiscal policy accounts for 18.9% of the fall in consumption in 1995.

The intuition in the case of investment is more involved. The change in investment depends on the signs of the coefficients in the BCA log-linear policy function for investment.[26] Given that the counterfactual investment wedge does not rise as much as in the data (i.e the distortion does not become as small), there is a smaller positive effect on investment. This effect should make investment fall more. On the other hand, given that τ_{lt}^* does not rise as much (i.e. the wedge $1 - \tau_{lt}^*$ does not fall as much), there is a smaller negative effect. In the same direction, g_t^* falls less, which has a smaller negative effect. The numerical result of these three effects is that counterfactual investment falls less. Fiscal policy accounts for 10.2% of the fall.

Regarding labor, the counterfactual labor wedge induces a smaller fall than the actual wedge. The behavior of labor input is similar to that of output and consumption. Fiscal policy accounts for 91.0% of the fall in labor.[27]

Let me provide some intuition on the contribution of fiscal policy to the behavior of different variables. In particular, I discuss the different contributions of fiscal policy to the falls in output and labor. The contribution of fiscal policy is related to the magnitudes of coefficients in the respective log-linear policy functions. Coefficients related to wedges have different magnitudes for labor and output.

The policy functions for output and labor are

$$\log y_t = C_y + C_{yk} \log k_t + C_{yz} \log z_t + C_{yl} \tau_{lt} + C_{yx} \tau_{xt} + C_{yg} \log g_t \quad (4.1)$$

$$\log l_t = C_l + C_{lk} \log k_t + C_{lz} \log z_t + C_{ll} \tau_{lt} + C_{lx} \tau_{xt} + C_{lg} \log g_t. \quad (4.2)$$

Parameters C determine the impact of each variable on output and labor. For example, C_{yz} is the elasticity of output to the efficiency wedge, and C_{yl} measures the response of output to changes in the labor wedge.

After solving for the policy functions, I find that the coefficients C_{yz} and C_{yl} have relatively similar magnitudes: C_{yz} is 80.3% of C_{yl} in absolute value. In the case of labor, coefficients are relatively different, in terms of magnitudes. The coefficient related to the efficiency wedge, C_{lz} is smaller relative to the coefficient on the labor wedge, C_{ll}. Coefficient C_{lz} is equal to 13.9% of C_{ll} in absolute value.

Therefore, the response of output and labor will be different to changes in z_t and τ_{lt}. If the coefficients were similar in magnitude across variables, then labor would fall by a similar magnitude as output in response to a fall in the efficiency wedge.[28]

The larger contribution of fiscal policy to the fall in labor depends on two things. The first is the magnitude of coefficients, as discussed previously. The second is the relation between the labor wedge and the consumption tax. The labor wedge captures, in part, the distortion caused by the consumption tax. Given that the labor wedge has a larger impact on labor, and that the change in the consumption tax is a large component of the change in the labor wedge, changes in fiscal policy account for more of the fall in labor than of the fall in output.[29]

4.1 Output and the quantitative role of the consumption tax

I study separately the quantitative role of the government consumption wedge, the investment wedge and the labor wedge on output. I carry out experiments in which

1. government consumption moves as in the data, using at the same time the counterfactual labor and investment wedges;

2. government consumption and the investment wedge move as in the data, using at the same time the counterfactual labor wedge.

Therefore, any gap between output predicted in experiment 2. and the data can be attributed to the consumption tax. This is the case because fluctuations in the actual labor wedge beyond those of the counterfactual labor wedge are solely due to the tax on consumption.[30] I report these experiments in Figure 5.

[Figure 5. GDP: letting one wedge at a time move as in data]

Allowing only the government consumption wedge to move as in the data leads to a fall in output bigger than in the main counterfactual experiment. Output falls 7.4% versus 7.0%. As government consumption falls, there is a positive income effect on consumers, which leads to a lower labor supply. Therefore, output falls more.

Allowing the government consumption wedge and the investment wedge to move as in the data leads to fall in output smaller than in the main counterfactual experiment. Output falls 6.7% versus 7.0%. The investment wedge $1/(1+\tau_{xt})$ rises after 1994, which represents a smaller distortion on investment. This force makes output fall less.

From these two results I conclude that the increase in the consumption tax accounts for most of the fall in output that is due to changes in fiscal policy. The effect is transmitted to the economy via the bigger distortion on the consumption-leisure choice.[31]

5 Sensitivity

I have repeated my measurement of the effect of changes in fiscal policy using different combinations of ψ and θ. These parameters are important in the determination of equilibrium labor. The benchmark values are $\psi = 2.24$ and $\theta = 0.35$. I have varied ψ between 2.0 and 2.5 and θ between 0.25 and 0.4. I report the results in the following table.

[Table 1. Sensitivity analysis: contribution, in %, of fiscal policy to fall in macro aggregates]

In all experiments the contribution of changes in fiscal policy to the fall in output is close to 20.0%. The contribution of changes in fiscal policy to consumption and labor is also similar when using different parameter values. The exception is investment. Changing the value of θ affects the contribution of fiscal policy to the fall in investment. In the numerical experiments, a higher value of θ implies that the counterfactual investment wedge is more similar to the actual one. Therefore, counterfactual investment falls by a similar amount to the actual one. This implies that the contribution of fiscal policy is smaller.

6 Conclusions

This paper can be seen as part of a broader research project which tries to account for large falls in output after financial crises. There are few papers on this topic that quantify the consequences of actual shocks at the time of a crisis and compare model predictions to data. This paper carries out such a comparison in the case of the Mexican crisis of 1994.

In this paper I explore the quantitative role of a simple candidate source of the fall in output: the changes in fiscal policy that took place in Mexico during 1995. Results indicate that changes in fiscal policy had a significant impact on economic activity. The main force behind the results in this paper is a bigger distortion on the consumption-leisure choice created by a higher consumption tax rate.

I argue that the fiscal response of the government to the financial crisis contributed significantly to the contraction of output, consumption, investment and labor. I use a model of fiscal policy and the business cycle accounting methodology of Chari et al. (2006a) to quantify the role of changes in fiscal policy. I first measure the investment, labor, efficiency and government wedges. Then I construct counterfactual wedges that eliminate the effects of changes in fiscal policy. I compare the paths of output, consumption, investment and labor as predicted by the wedges versus the path predicted by the counterfactual wedges. I find that fiscal policy has a significant quantitative role in the contraction of output, accounting for 20.7% of it. I also find that the increase in the consumption tax rate, rather than the fall in government consumption, accounts for most of the predicted contraction of economic activity that is due to changes in fiscal policy.

It would be interesting to study the role of changes in fiscal policy in the collapse of economic activity in Asia after 1997. This topic has not been explored. In fact, there is a debate on the role played by fiscal policy in the large contraction of economic activity in Asia after the crisis of 1997. Radelet and Sachs (2000) assert that contractionary fiscal policy was one of the factors behind the large contraction of output. Boorman et al. (2000) pose the question of whether changes in fiscal policy had a negative effect on output or not. They argue that it is unlikely that fiscal policy had an important contractionary effect on output in Indonesia and South Korea, but perhaps it did in Thailand. So far the tools of applied general equilibrium have not been used on these questions.

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Notes

[1]I use the population of age 15 to 64 years old as measure of working age population.

[2]For a detailed account of the events that preceded the financial crisis, consult Calvo and Mendoza (1996).

[3]I thank a referee for suggesting this approach.

[4]The policy functions for output and labor have different coefficients on each wedge. In the case of labor, the coefficient on the efficiency wedge is small compared to the one on the labor wedge.

[5]In the main text I discuss the construction of the labor input.

[6]The measured efficiency wedge falls by a smaller amount in 1995 when using this version of BCA.

[7]The work of Bergoeing et al. (2002) has some similarities with this paper. They analyze different explanations for the different growth paths followed by Chile and Mexico since 1980. They find that total factor productivity can largely account for the behavior of Mexican output. They include in their numerical experiments a tax reform in 1988. However, they do not take into account the change in the value added tax rate in 1995, and do not include a role for government spending.

[8]The source of all data, except capital and labor, is http://dgcnesyp.inegi.gob.mx.

The VAR uses data on the logarithm of the efficiency and government consumption wedges. I use the sample 1981-2000.

[9]In the experiments that follow I use log-linear policy functions. An advantage of using BCA with variable capital utilization is that, by reducing the size of changes in z_t, it reduces numerical error between log-linear and nonlinear policy functions. Using the version of BCA that uses a Cobb-Douglas technology, z_t falls 10.1% between 1994 and 1995. Using the version with variable capital utilization z_t falls 6.1%.

[10]To be more consistent with the model, I could impute the return to government capital and to the stock of durable goods, and the depreciation of the stock of durable goods, adding them to GDP. I could also eliminate indirect business taxes from national accounts. I choose not to do it to keep the exposition short. These adjustments are part of the calibration procedure of a simple version of the neoclassical growth model, described in Cooley and Prescott (1995). Results do not change significantly if I carry out such adjustments. Additionally, I included government investment in total investment. This variable was 5% of GDP in 1994. Therefore any change in this variable had a small level effect on output.

[11]The behavior of the empirical counterparts of investment and capital is linked to this choice. After 1994, Mexican net exports increased. The measure of investment I construct falls less than gross capital formation plus purchases of durable goods in the data. Later I report graphically on actual and counterfactual investment. Both fall after the crisis. The capital stock is linked to the investment series I use. The capital

stock I construct falls by a small amount in 1995. I have constructed an alternative capital stock using as investment the sum of gross capital formation and purchases of durable goods. This alternative capital stock has a very similar value in 1994 to the one I use in this paper. In fact, values for both series are similar throughout the entire sample.

[12]Bergoeing et al. (2002) use such depreciation rate.

[13]I use the hours reported as "Labor (new)" in the data set constructed by Bergoeing et al. (2002).

[14]Both employment and average hours worked fell after the crisis.

[15]This behavior is reported in Meza and Quintin (2007).

[16]I use population data for Mexico as reported by Bergoeing et al. (2002).

[17]The growth rate of GDP per capita between 1980 and 2000 is also approximately equal to zero.

[18]This elasticity was estimated for a set of Latin American economies.

[19]Due to data constraints, I cannot construct a time series for the consumption tax that starts before 1988.

[20]It would be interesting to use the method of Mendoza et al. (1994) to measure other taxes. These authors measure a tax on labor income and a tax on capital income. However, this cannot be done in a straightforward way, because of the quality of tax

data. There are no data on income tax revenue for households and firms, separately, which is necessary to carry out the calculations.

[21]These authors follow the methodology in Mendoza et al. (1994). The data are available at http://www.bsos.umd.edu/econ/mendoza/.

[22]Using this coefficient is one way to measure the difference between predicted and actual variables. The Theil inequality coefficient is used, for instance, for forecast evaluation in econometrics. It is scale invariant. The coefficient always lies between zero and one, where zero indicates a perfect fit. In the experiments carried out, the coefficient takes a very small value. I have also verified that the model reproduces observed GDP with nonlinear policy functions, which are calculated numerically in a further step in BCA.

[23]A second difficulty is related to one of the intermediate steps in BCA. When going from linear to nonlinear experiments, one of the steps is to construct a nonlinear investment wedge using as initial guess the linear one (i.e. the one consistent with log-linear policy functions). The procedure is to guess the nonlinear investment wedge and verify that data is matched more closely. See Chari et al. (2006b). I have found a nonlinear investment wedge that reduces the discrepancy between nonlinear prediction and data. However, the mapping between the linear and nonlinear investment wedges is itself nonlinear. There is no analytical way to relate the final nonlinear investment wedge to fiscal policy variables.

[24]I thank a referee for this decomposition.

[25]The log-linear approximation leads to $\tau_{ot} = \tau_o + (1-\tau_o)((\tau_{lt}-\tau_l)/(1-\tau_l) - (\tau_{ct} - \tau_c)/(1+\tau_c))$. In this expression τ_o, τ_l and τ_c represent the long run values of each one of the variables. The calculation of τ_l is part of the BCA methodology. The value it takes depends on the estimates for parameters of the VAR process that governs the four wedges. I calculate the long run value of exogenous shocks in the fiscal policy model following the BCA methodology. I obtain similar results in the experiments that follow if I simply use $\tau^*_{lt} = \tau^*_{ct} + \tau_{ot}$.

[26]Recall that an increase in τ_{xt} has a negative effect on investment, an increase in τ_{lt} has a negative effect on investment, and an increase in g_t has a positive effect on investment.

[27]As a check on the results in this section, I have verified that plugging inputs into the production function I recover output, both using variables predicted with actual or counterfactual wedges. I have also verified that the market clearing condition holds in all cases.

[28]The different contribution of fiscal policy to these two variables is not related to the investment wedge or to the government consumption wedge. The related coefficients in the policy functions for labor and output are of similar magnitude, relative to the respective coefficients on the labor wedge.

[29]The size of the distortion induced by the consumption tax can be seen by comparing the actual and the counterfactual labor wedge. Recall that the counterfactual labor wedge eliminates changes in the consumption tax.

[30]In all of these experiments I also feed in the measured efficiency wedge.

[31]I have ignored the role of government investment. Government investment represented 5% of GDP in 1994. Therefore, even though per capita government investment fell by 33% in 1995, a large effect on output is not expected, because the level fall is small. I have verified this in previous versions of this paper.

	Benchmark	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	$\psi = 2.24$ $\theta = 0.35$	$\psi = 2.0$ $\theta = 0.25$	$\psi = 2.0$ $\theta = 0.4$	$\psi = 2.5$ $\theta = 0.25$	$\psi = 2.5$ $\theta = 0.4$
Output	20.7	21.2	19.8	21.6	18.8
Consumption	18.9	17.5	19.1	16.7	18.4
Investment	10.2	18.7	6.7	22.7	8.8
Labor	91.0	93.3	87.4	95.2	82.8

Table 1. Sensitivity analysis: contribution, in %, of fiscal policy to fall in macro aggregates

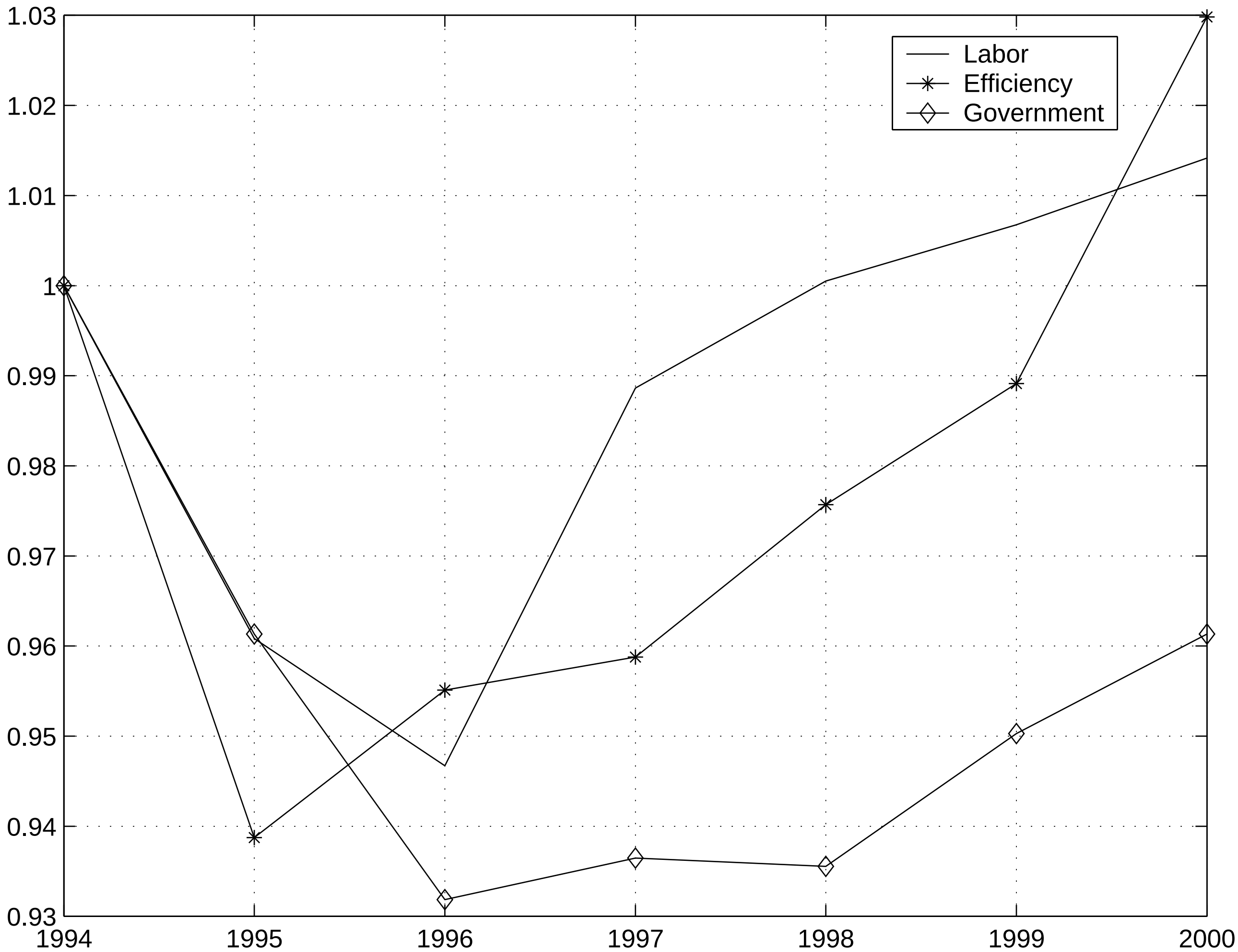

Figure 1a. Labor, efficiency and government consumption wedges

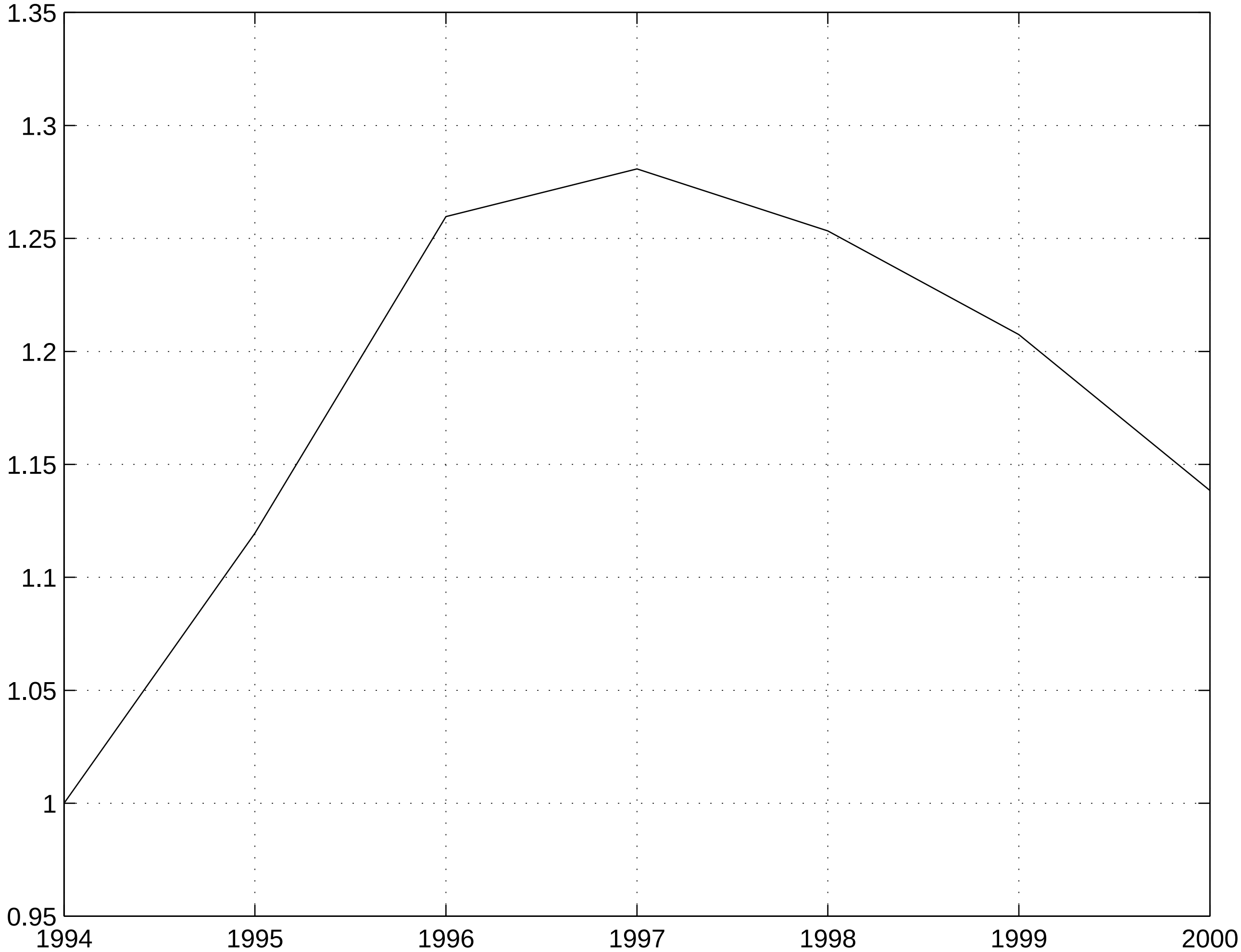

Figure 1b. Investment wedge

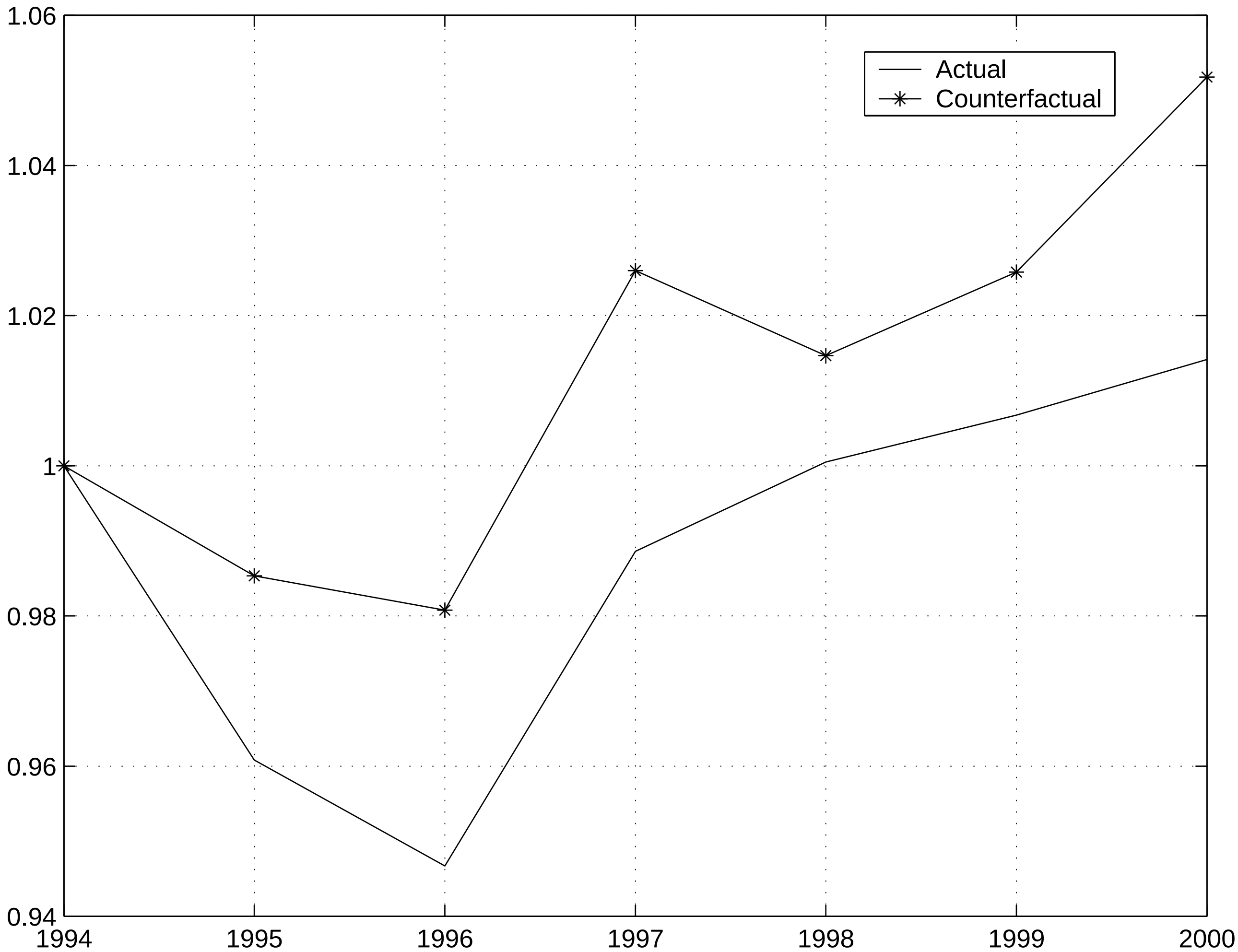

Figure 2a. Actual versus counterfactual labor wedge

Figure 2b. Actual versus counterfactual investment wedge

Figure 3. Predicted paths of output: using actual versus counterfactual wedges

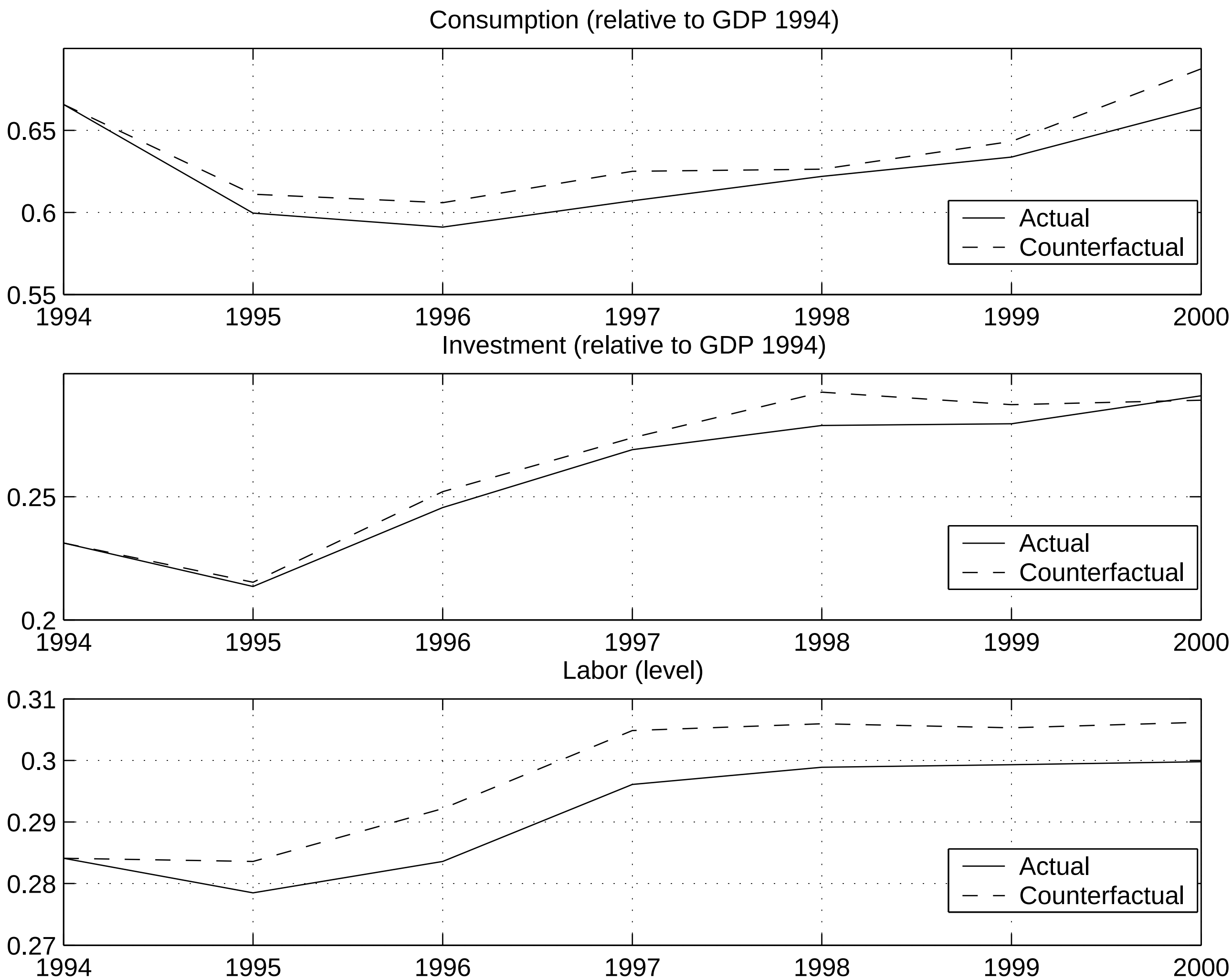

Figure 4. Predicted paths of consumption, investment and labor: using actual versus counterfactual wedges

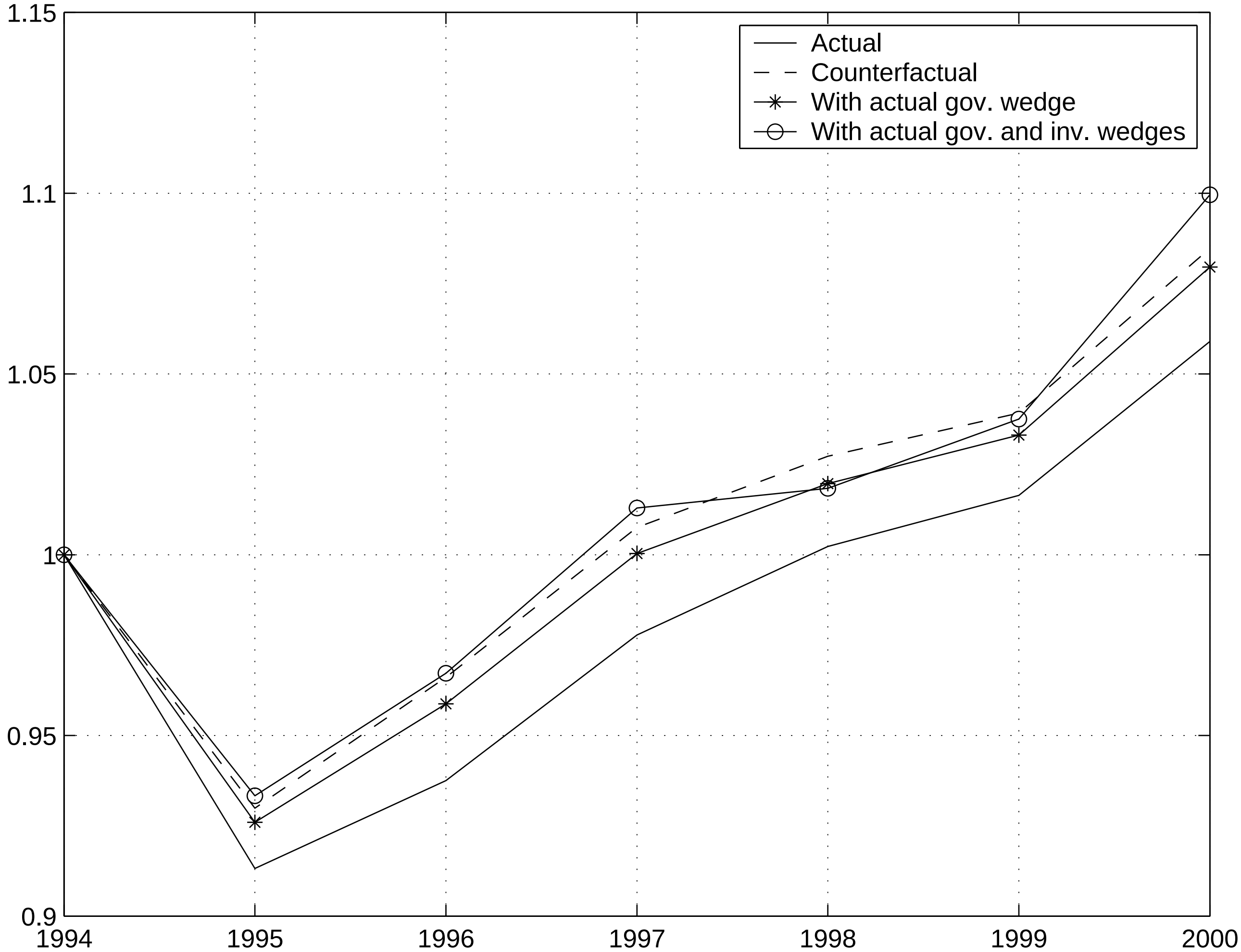

Figure 5. GDP: letting one wedge at a time move as in data

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Figure 1a. Labor, efficiency and government consumption wedges

Figure 1b. Investment wedge

Figure 2a. Actual versus counterfactual labor wedge

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Figure 3. Predicted paths of output: using actual versus counterfactual wedges

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