Have Swedish Postwar Business Cycles been Generated Abroad or at Home?

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Abstract

This paper investigates the relative importance of foreign and domestic shocks for the Swedish postwar business cycle in a neoclassical stochastic growth model of a small open economy. We extend previous work in the literature by allowing for stochastic fiscal policy, since recent research has shown that fiscal policy shocks may be important for business cycles. It is found that the introduction of fiscal policy improves the empirical fit of the model, but not significantly so. Foreign and domestic shocks are shown to be approximately equally important for fluctuations in output, while foreign shocks are farmost important for fluctuations in the real exchange rate and the current account. Among the domestic shocks, innovations in fiscal policy are found to be of relatively low importance for business cycles.

Keywords: Real Business Cycle model; small open economy; Simulated Method of Moments; variance decomposition.

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1 Introduction

What is the relative importance of domestic and foreign shocks for the Swedish postwar business cycle? In Sweden, it is a common view that business cycles are mainly caused by foreign shocks, such as fluctuations in foreign demand for Swedish export.[1] The validity of this view has been investigated with two types of approaches. One, more empirical, approach to the investigation of the sources of business cycles is that of vector autoregressions (VARs). This approach has been used by, for example, Mellander et al. (1992) and Englund et al. (1994). In general, these studies have found that foreign and domestic shocks contribute about equally to fluctuations in output. Another, more theoretical, approach is the use of fully specified equilibrium models, following Lucas (1977). The only study which has used this approach is that of Lundvik (1992). In an equilibrium small open economy model, Lundvik (1992) finds, on the one hand, that substantial fluctuations in Swedish macroeconomic variables seem to be due to foreign shocks, but, on the other hand, the model is statistically rejected by the data on all reasonable significance levels. Notably, Lundvik (1992) introduced only one type of domestic shocks into his model: innovations in total factor productivity.

Recent research has provided evidence that fluctuations in fiscal policy seem to matter for the business cycle; see for instance Braun (1994), McGrattan (1994) and Jonsson and Klein (1996). In a general equilibrium closed economy setting, Jonsson and Klein (1996) find that the introduction of stochastic fiscal policy can account for some of the key features of the Swedish postwar business cycle. They demonstrate that the empirical fit of the basic neoclassical stochastic growth model is significantly improved when allowing for fiscal policy shocks. But as a consequence of the closed economy setting, they did not account for the presence of foreign shocks. Figure 1, which depicts export and import and the current account as ratios of GDP at factor costs during the postwar period,

[1] See, for example, Lindbeck (1975).

clearly demonstrates that Sweden is better characterized as a open economy than a closed economy during the postwar period.

The ideas of this paper are, then, to set up a equilibrium small open economy model with stochastic fiscal policy incorporated to, first, test whether the introduction of fiscal policy significantly improve the empirical fit of the model in an open economy framework, and second, investigate whether either foreign shocks or domestic shocks are most important for the Swedish postwar business cycle.

The equilibrium model used draws on the small open economy model in Lundvik (1992), and incorporates fiscal policy in the same spirit as Jonsson and Klein (1996). I follow the strategy used by Lundvik (1992) and Jonsson and Klein (1996) and estimate the model with Simulated Method of Moments (SMM) with and without fiscal policy, to see whether the model without fiscal policy is significantly outperformed by the model with fiscal policy in a small open economy framework. To quantify the contribution of foreign and domestic shocks to fluctuations in Swedish key macroeconomic variables, the simulated volatilities are decomposed into fractions explained by domestic and foreign innovations.

The main results in the paper are as follows. First, I find that the introduction of fiscal policy improves the empirical fit of the small open economy model, but not significantly in contrast to the findings of Jonsson and Klein (1992). Both versions of the model are rejected by the data. One possible explanation for this failure is that the model is not capable of capturing the increased standard deviations in private consumption, private investment and employment, caused by the deep recession in Sweden during the beginning of the 1990s.

Second, by decomposing the simulated volatility in output per capita, the real exchange and the current account attributed to various foreign and domestic shocks, I find that foreign shocks contribute with 43 percent to the volatility in output in the long run.

This figure compares well with the findings of the studies which have used VARs; see Mellander et al. (1992) and Englund et al. (1994). Of the domestic shocks, innovations in total factor productivity are most important, and contribute to 57 and 45 percent of the fluctuations in output in the short and long run respectively. Innovations in fiscal policy only account for around 10 percent of the fluctuations in output both in the short and long run. For fluctuations in the real exchange rate and the current account, foreign shocks are utmost important, both in the short and long run. The latter result is nice since it is an identifying assumption in the VAR study by Mellander et al. (1992).

The structure of the paper is as follows. In section 2, I present the equilibrium model. The data set and some basic stylized facts for the Swedish postwar period are reported in section 3. In section 4, I discuss various issues regarding calibration and estimation of the deep parameters and processes for the exogenous variables in the model. The SMM estimation results and the variance decompositions are then reported in section 5. Section 6 concludes.

2 The equilibrium model

In this section, I construct a neoclassical stochastic growth model for a small open economy with infinitely many identical agents. This set-up implies that each agent takes all aggregate variables as given. There are two goods in the model, one domestic good which can be used for private and public consumption, investment and export, and one foreign good which can be used for consumption and as intermediate input in production. The price of the foreign good in terms of the domestic good, the real exchange rate, is endogenously determined in the economy. The foreign demand of the domestically produced good is determined by the exogenous foreign income level and the real exchange rate. Foreign income is assumed to be exogenous since Sweden can be characterized as a small open economy. The individuals have access to an international market for one period real bonds with an exogenously given real interest rate. However, as in Lundvik (1992), the economy as a whole is assumed to affect the interest rate the country faces via a risk premium. There are two main sources of domestic disturbances in the economy: fluctuations in fiscal policy and the technology level. As in the "best" version of the models with fiscal policy in Jonsson and Klein (1996), I account for three types of fiscal policy disturbances.[2] On the income side I have shocks to payroll and consumption taxes, which, in 1996, covered over 50 percent of the public sector incomes. I do not include income taxes in the model, since good data does not exist on (marginal) labor income taxes and the capital stock in Sweden during the whole postwar period. On the expenditure side, I model public consumption expenditures exogenously, while public transfers to the agents are endogenous and equal to the difference between tax incomes and public consumption expenditures.[3] By this procedure, then, the public debt is always zero in every time period.

In the model, I abstract from population growth and represent all variables in per capita terms.

Finally, a notational comment; in the following, capital letters denote economy wide averages which the agent takes as given and small letters individual specific values which the agent internalizes.

2.1 An equilibrium model for a small open economy

Infinitely many identical infinitely lived agents maximize expected utility given by

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, c_t^*, h_t\right), \tag{1}$$

[2] "Best" in the sense that it mimiced the Swedish postwar business cycle best.

[3] Note that Jonsson and Klein (1996) considered the ratio of public consumption expenditures to GDP, denoted g_t, to be exogenous. This assumption may be valid in the long run, but in a business cycles analysis it seems more reasonable to assume that g_t is endogenous and the level of public consumption expenditures to be exogenous.

$$u\left(c_t, c_t^*, h_t\right) \equiv \frac{\left[\left(c_t^{\eta}\left(c_t^*\right)^{1-\eta}\right)^{\alpha}\left(1-h_t\right)^{1-\alpha}\right]^{1-\sigma}-1}{1-\sigma}$$

where c_t is consumption of the domestically produced good in time period t, c_t^* is consumption of the foreign good and h_t is the share of available time spent in employment. In (1), $\frac{1}{\sigma}$ is the intertemporal elasticity of substitution between consumption and leisure and β the subjective discount factor, while α and η reflect the trade-off between consumption and leisure, and the foreign and domestic consumption good respectively.

The flow budget constraint facing the agent is

$$\left(1+\tau_t^c\right)\left(c_t+Q_t c_t^*\right)+i_t+Q_t b_{t+1}^*=\frac{W_t}{1+\tau_t^w} h_t+R_t^K k_t+Q_t\left(1+R_t^{B^*}\right) b_t^*+TR_t \tag{2}$$

where τ_t^c and τ_t^w are the exogenous consumption and payroll tax, both formally paid by the households.[4] Thus, W_t is interpreted as a gross wage. Q_t denotes the real exchange rate; a higher value means a real depreciation, or equivalently, that the terms of trade is worsened. i_t is the agent's investment and R_t^K, given by (6), is the gross real return on the capital stock k_t. b_{t+1}^* denotes the agent's holding of the foreign bond at the beginning of time period $t+1$ bought in time period t, and $R_t^{B^*}$, given by (14) below, the real interest rate received on the stock of foreign bonds bought in t. From (2), it is clear that b_t^* is not a risk free asset; the return on it will fluctuate because of changes in Q_t and $R_t^{B^*}$. Finally, TR_t is the lump-sum transfer from the public sector to the agent.

The production function is assumed to have constant returns to scale and be of Cobb-Douglas type

$$Y_t = e^{\ln Z_t}\left(IM_t^{\theta_{IM}} K_t^{1-\theta_{IM}}\right)^{\theta}\left(T_t^H H_t\right)^{1-\theta} \tag{3}$$

where Y_t is output, IM_t intermediate input, Z_t the technology level and T_t^H the deterministic labor-augmenting technological level which follows

$$T_t^H = (1+\gamma) T_{t-1}^H = (1+\gamma)^t . \tag{4}$$

[4] Equivalently, I could let the firms pay the payroll tax.

In (4), γ is the deterministic labor-augmenting rate of technological change. Accordingly, the perfect competition zero profit maximizing conditions for the representative company are

$$W_t = (1-\theta)\, e^{\ln Z_t} \left(\frac{IM_t^{\theta_{IM}} K_t^{1-\theta_{IM}}}{T_t^H H_t} \right)^{\theta} T_t^H, \tag{5}$$

$$R_t^K = \theta\,(1-\theta_{IM})\, e^{\ln Z_t} \left(\frac{IM_t^{\theta_{IM}} K_t^{1-\theta_{IM}}}{T_t^H H_t} \right)^{\theta} \frac{T_t^H H_t}{K_t} \tag{6}$$

and

$$Q_t = \theta\theta_{IM} e^{\ln Z_t} \left(\frac{IM_t^{\theta_{IM}} K_t^{1-\theta_{IM}}}{T_t^H H_t} \right)^{\theta} \frac{T_t^H H_t}{IM_t}. \tag{7}$$

The technology level is assumed to be exogenous and the natural log of it to follow a stationary AR(1)-process

$$\ln Z_{t+1} = \rho^{\ln Z} \ln Z_t + \varepsilon_{t+1}^{\ln Z},\ \varepsilon^Z \sim i.i.d.\ N\left(0, \sigma_{\ln Z}^2\right). \tag{8}$$

Individual and aggregate investment in period t produces productive capital in period $t+1$ according to

$$k_{t+1} = (1-\delta)\, k_t + i_t \tag{9}$$

and

$$K_{t+1} = (1-\delta)\, K_t + I_t. \tag{10}$$

where δ is the rate of capital depreciation.

The government's budget constraint is

$$\tau_t^c \left(C_t + Q_t C_t^*\right) + \frac{\tau_t^w W_t}{1+\tau_t^w} H_t = G_t + TR_t \tag{11}$$

where G_t is exogenous public consumption expenditures. Since τ_t^c and τ_t^w are exogenous too, TR_t can have the interpretation of government budget deficit. Consequently, the government debt is always zero in this economy.[5]

[5] Note that, given sequences for $\{G_t\}_{t=1}^{\infty}$, $\{\tau_t^c\}_{t=1}^{\infty}$ and $\{\tau_t^w\}_{t=1}^{\infty}$, Ricardian equivalence holds in this economy, since households and the government pay the same interest rate, $R_t^{B^*}$. Therefore, it does not matter whether the government has a debt or not.

As noted earlier, domestic production can either be used for private and public consumption, investment or export. Foreign demand of the domestically produced good, denoted X_t, is assumed to be determined by foreign income and the real exchange rate according to

$$X_t = Y_t^* Q_t^{\epsilon_X} \tag{12}$$

where Y_t^* denotes the exogenous foreign income level, assumed to grow at the same rate as domestic output in steady state.[6] In (12), the income elasticity is assumed to be equal to unity and ϵ_X denotes the price elasticity. The specification (12) can be derived in an optimizing framework; see Armington (1969). The stochastic part of Y_t^* in natural logs, $\widetilde{Y}_t^*$, is assumed to evolve according to

$$\widetilde{Y}_{t+1}^* = \rho^{\widetilde{Y}^*} \widetilde{Y}_t^* + \varepsilon_{t+1}^{\widetilde{Y}^*}, \, \varepsilon^{\widetilde{Y}^*} \sim i.i.d.\ N\left(0, \sigma_{\widetilde{Y}^*}^2\right), \; -1 < \rho^{Y^*} < 1. \tag{13}$$

As in Lundvik (1992), it is assumed that there is only one foreign one period real bond denominated in the foreign good, which pays a given world interest rate R_t^*. In order to get a stationary solution for the foreign bondholdings and the real exchange rate, I adopt the assumption in Lundvik (1992), and specify exogenously a economy specific risk premium on the given world interest rate as

$$R_t^{B^*} = \frac{\omega_0 \bar{Y}_t + \omega_1 B_t^*}{\omega_0 \bar{Y}_t + B_t^*} R_t^* \tag{14}$$

where $\omega_1 < 1$, B_t^* denotes aggregate foreign bondholdings and $\bar{Y}_t$ the steady state value of GDP in time period t. The motivation for this specification is that the larger the aggregate debt as a percentage of long run expected GDP, the larger the risk premium that all the agents in the economy must pay.[7] $R_t^{B^*}$ is then interpreted as a risk adjusted

[6] Formally, as noted below, this implies that $Y_t^* = T_t^H \exp\left(\tilde{Y}_t^*\right)$.

[7] Another, less economic, motivation for this assumption is that, without it, the decision rules would have to be calculated again in every time period, which is an extremely time consuming procedure when the parameters in the model are estimated with SMM.

interest rate.[8] The world real interest rate is assumed to be exogenously given by the stationary process

$$R^*_{t+1} = \left(1 - \rho^{R^*}\right)\overline{R^*} + \rho^{R^*} R^*_t + \varepsilon^{R^*}_{t+1}, \varepsilon^{R^*} \sim i.i.d.N\left(0, \sigma^2_{R^*}\right)$$

which is a standard small open economy assumption.

On the aggregate level, the change in real foreign bond holdings in domestic terms is given by

$$Q_t\left(B^*_{t+1} - B^*_t\right) = X_t - Q_t\left(C^*_t + IM_t\right) + Q_t R^{B^*}_t B^*_t \tag{15}$$

where $Q_t\left(C^*_t + IM_t\right)$ is aggregate import of the foreign good. It is then natural to think of $X_t - Q_t\left(C^*_t + IM_t\right)$ as the trade balance and $Q_t\left(B^*_{t+1} - B^*_t\right)$ as the current account.

The aggregate resource constraint

$$Y_t = C_t + I_t + G_t + X_t \tag{16}$$

also holds in every period

As stated in the introduction, the model will be solved with and without fiscal policy incorporated. If the notation $\boldsymbol{\tau}_t \equiv \left[\tilde{G}_t\ \tau^c_t\ \tau^w_t\right]^T$ is introduced, where $\tilde{G}_t$ denotes the stochastic part of public expenditures in natural logs, the model without fiscal policy is straightforward, and obtained by setting $\boldsymbol{\tau}_t = [-\infty\ 0\ 0]^T$ for all time periods t.

In the version of the model with fiscal policy, fiscal policy is treated as an exogenous VAR(p) model

$$\boldsymbol{\tau}_t = \boldsymbol{\upsilon} + \sum_{i=1}^{p} \boldsymbol{\varphi}_i \boldsymbol{\tau}_{t-i} + \boldsymbol{\varepsilon}^{\tau}_t, \boldsymbol{\varepsilon}^{\tau}_t \sim i.i.d.\ N\left(\mathbf{0}, \boldsymbol{\Sigma}\right) \tag{17}$$

as in Jonsson and Klein (1996).

[8] (14) implies that, if $B^*_t = 0$, then $R^{B^*}_t = R^*_t$, but if $B^*_t \to \infty$, then $R^{B^*}_t = \omega_1 R^*_t < R^*_t$. Finally, if $B^*_t \to -\omega_0 \bar{Y}_t$, then $R^{B^*}_t \to \infty$. As in Lundvik (1992), I set the parameters governing the risk premium, ω_0 and ω_1, to 5 and 0.99 respectively.

2.2 Solution of the model

A well-known feature of the solution to the model is that output, consumption, investment, public expenditures, export, import, capital stock and foreign bondholdings grow at the deterministic rate γ in steady state, while the share of available time spent in paid employment, the real exchange rate and the current account are constant over time; see Hansen and Prescott (1995). In this paper, I have followed the convention in the literature and growth-adjusted the model by dividing the following variables with the constant growth factor:

$$\begin{aligned} \hat{Y}_t &\equiv \frac{Y_t}{T_t^H},\ \hat{C}_t = \frac{c_t}{T_t^H},\ \hat{c}_t = \frac{c_t}{T_t^H},\ \hat{C}_t^* = \frac{c_t^*}{T_t^H},\ \hat{c}_t^* = \frac{c_t^*}{T_t^H},\ \hat{I}_t = \frac{I_t}{T_t^H}, \\ \hat{i}_t &= \frac{i_t}{T_t^H},\ \widehat{IM}_t = \frac{IM_t}{T_t^H},\ \hat{K}_t = \frac{K_t}{T_t^H},\ \hat{k}_t = \frac{k_t}{T_t^H},\ \hat{B}_t^* = \frac{B_t}{T_t^H} \text{ and } \hat{b}_t^* = \frac{b_t}{T_t^H}. \end{aligned}$$

We then interpret the new defined variables as per efficiency units of labor.

Following Hansen and Prescott (1995), the representative agents optimization problem can then be expressed as the recursive dynamic programming problem:

$$V\left(\mathbf{S}_t, \hat{K}_t, \hat{B}_t^*, \hat{k}_t, \hat{b}_t^*\right) \equiv \max_{\left\{\hat{c}_t^*, h_t, \hat{k}_{t+1}, \hat{b}_{t+1}^*\right\}} \left[u\left(\hat{c}_t, \hat{c}_t^*, h_t\right) + \tilde{\beta}\mathrm{E}_t V\left(\mathbf{S}_{t+1}, \hat{K}_{t+1}, \hat{B}_{t+1}^*, \hat{k}_{t+1}, \hat{b}_{t+1}^*\right)\right]$$

$$s.t. \tag{18}$$

$$\begin{aligned} \hat{c}_t &= -Q_t\hat{c}_t^* + \frac{1}{1+\tau_t^c}\left[\begin{array}{c} \frac{W_t}{1+\tau_t^w}h_t + \left(1+R_t^K-\delta\right)\hat{k}_t - (1+\gamma)\hat{k}_{t+1} + TR_t + \\ Q_t\left(1+R_t^{B^*}\right)\hat{b}_t^* - Q_t\hat{b}_{t+1}^* \end{array}\right], \\ \mathbf{S}_{t+1} &= \mathbf{A}\mathbf{S}_t + \boldsymbol{\varepsilon}_{t+1}^{\mathbf{S}}, \\ (1+\gamma)\hat{K}_{t+1} &= (1-\delta)\hat{K}_t + \hat{I}_t,\ (1+\gamma)\hat{k}_{t+1} = (1-\delta)\hat{k}_t + \hat{i}_t, \\ \hat{K}_{t+1} &= \hat{K}\left(\hat{K}_t,\ \hat{B}_t^*,\ \mathbf{S}_t\right),\ \hat{B}_{t+1}^* = \hat{B}^*\left(\hat{K}_t,\ \hat{B}_t^*,\ \mathbf{S}_t\right),\ H_t = H\left(\hat{K}_t,\ \hat{B}_t^*,\ \mathbf{S}_t\right). \end{aligned}$$

In (18), $\tilde{\beta} \equiv \beta(1+\gamma)^{\alpha(1-\sigma)}$ is the effective subjective discounted factor and $\mathbf{S}_t$ is a vector which contains all the exogenous aggregate state variables; for instance, if the VAR model in (17) is of order one, then $\mathbf{S}_t$ could be $\left[\ln Z_t,\, \widetilde{Y}_t^*,\, R_t^*,\, \tilde{G}_t,\, \tau_t^c,\, \tau_t^w\right]^T$.[9] In the maximizing of (18), the agent takes the economy-wide average variables W_t, R_t^K, $R_t^{B^*}$, Q_t and TR_t as given. The functions $\hat{K}$, $\hat{B}^*$ and H describe the relationship perceived by agents between the aggregate decision variables and the state of the economy. As the solution to the problem in (18), we have the individual agents decision rules $\hat{k}_{t+1} = \hat{k}\left(\hat{K}_t,\, \hat{k}_t,\, \hat{B}_t^*,\, \hat{b}_t^*,\, \mathbf{S}_t\right)$, $\hat{b}_{t+1}^* = \hat{b}^*\left(\hat{K}_t,\, \hat{k}_t,\, \hat{B}_t^*,\, \hat{b}_t^*,\, \mathbf{S}_t\right)$ and $h_t = h\left(\hat{K}_t,\, \hat{k}_t,\, \hat{B}_t^*,\, \hat{b}_t^*,\, \mathbf{S}_t\right)$. The competitive equilibrium is obtained when the individual and average decision rules coincide for $\hat{k}_t = \hat{K}_t$ and $\hat{b}_t^* = \hat{B}_t^*$.

Since it is impossible to derive the decision rules analytically, I have used the conventional method of calculating the decision rules numerically by approximating the original problem with a second order Taylor expansion around the constant steady state values in the growth-adjusted economy. As a consequence of this approximation, the method produces linear decision rules. The algorithm utilized is documented in Klein (1994). I have also followed the convention in the literature and solved for the decision rules in natural logs for $\hat{k}$ and h. Hence, the competitive equilibrium is computed by solving a fixed point problem where each agent's decision rules must be optimal given the aggregate decision rules in the economy.

3 Data

In this section, I present the annual data set and some stylized facts for the Swedish postwar business cycle from 1950 to 1995. By including the most recent data, I cover the

[9] As a consequence of the growth adjustment, the production function reads $\hat{Y}_t = e^{\ln Z_t}\left(\widehat{IM}_t^{\theta_{IM}}\hat{K}_t^{1-\theta_{IM}}\right)^{\theta} H_t^{1-\theta}$. Hence, the wage rate, real rental price of capital and real exchange rate are now redefined as $W_t = (1-\theta)\, e^{\ln Z_t}\left(\widehat{IM}_t^{\theta_{IM}}\hat{K}_t^{1-\theta_{IM}} H_t^{-1}\right)^{\theta}$, $R_t^K = \theta\,(1-\theta_{IM})\, e^{\ln Z_t}\left(\widehat{IM}_t^{\theta_{IM}}\hat{K}_t^{1-\theta_{IM}} H_t^{-1}\right)^{\theta}\left(H_t/\hat{K}_t\right)$ and $Q_t = \theta\theta_{IM}\, e^{\ln Z_t}\left(\widehat{IM}_t^{\theta_{IM}}\hat{K}_t^{1-\theta_{IM}} H_t^{-1}\right)^{\theta}\left(H_t/\widehat{IM}_t\right)$. Similarly, we have that $R_t^{B^*} = \frac{\omega_0\overline{\hat{Y}}+\omega_1\hat{B}_t^*}{\omega_0\overline{\hat{Y}}+\hat{B}_t^*}R_t^*$.

deep recession in the Swedish economy in the beginning of the 1990s.[10]

3.1 Basic definitions

A major part of the data set are the GDP identities in nominal and real per capita terms. In addition, I have total employment in hours, the total nominal gross wage sum, nominal social insurance contributions, the nominal current account in the data set plus GDP deflators, nominal exchange rates vis-a-vis the Swedish krona and real GDP's at market prices for a number of OECD countries.[11] The measure of output, Y, is nominal GDP at factor costs per capita divided by the deflator for GDP at market prices.[12] The series for private consumption per capita, C, includes durable goods but excludes the net of indirect taxes and subsidies (deflated with the deflator for GDP at market prices). Two reasons for this procedure are, first, that durable goods are subject to consumption taxes and, second, that I want the GDP identity to hold in real terms up to a measurement error in the national accounts. For the latter reason, I have also included inventory investments in the series for private investment per capita, I. Real public expenditures, G, includes both real public consumption and investment. The consumption tax, τ^c, is calculated as the net of nominal indirect taxes and subsidies divided by nominal consumption expenditures, while the payroll tax, τ^w, is calculated as nominal social insurance fees divided by the net of the total nominal gross wage sum and social insurance fees. The share of available time spent in employment, H, is measured as the average total number of hours worked per capita. Foreign demand, Y^*, is calculated as a TCW-weighted average of foreign real

[10] I use only postwar data, since Hassler et al. (1994) have found some instability in Swedish business cycles in connection with World War I and World War II. To provide results that can be compared to the results in the VAR studies, the analyze is therefore restricted to the postwar period. In fact, this is also an additional reason to redo the calculations in Lundvik (1992), since he use data for the period 1871-1988.

[11] See appendix A for sources of the data set and exact definitions of composite variables.

[12] One shortcoming in the national accounts in Sweden is that there are no deflators for GDP at factor costs, or for indirect taxes and subsidies. Therefore, I have had to accept the deflator for GDP at market prices as a proxy for the deflators of GDP at factor costs, and for indirect taxes and subsidies. This has some quantitative importance which is discussed in appendix A in greater detail.

GDP's per capita in Swedish kronor.[13] Finally, the real exchange rate (inverse of the terms-of-trade), Q, and the current account, CA, are calculated as the import deflator divided by the export deflator and the nominal CA divided by the nominal GDP at factor costs respectively.

Figure 2 depicts the variables generated from the raw data set. The variables Y, C, G, I, X, M, H and Y^* are depicted in natural logarithms. Although there is a strong trend in most of the series, the figure clearly demonstrates the deep recession in the 1990s with a large fall in I. Most notably is also the strong declining trend in H over time.

3.2 Filtering and some stylized facts

From Figure 2, it is clear that most of the variables follow, perhaps stochastic, trends. Since the purpose of the paper is to study business cycle fluctuations, not trends, it is desirable to filter the data to extract the business cycle component of the series. There are different filtering methods available and worth considering for this purpose. For ease of comparison, and since Englund et al. (1992) and Hassler et al. (1994) have found that business cycle regularities on Swedish data do not seem to be sensitive to the filtering method, I have followed the convention in the real business cycle literature and applied the Hodrick-Prescott (1997) (H-P) filter on the data in natural logs with the smoothness coefficient λ set to 100.[14] This choice of λ captures what we normally mean with business cycles; that is, it produces cycles with a periodicity of 3-8 years. In the following, I denote a variable which has been H-P filtered with a tilde; for example, H-P filtered output is denoted $\tilde{Y}$. On a priori grounds, and in accordance with the model, I have not H-P

[13] TCW is a totally competitive trading weighted currency basket used by Sveriges Riksbank (Bank of Sweden), and the weights for the countries included to calculate $\tilde{Y}^*$ sum up to 86.5 percent of the basket.

[14] Note that the growth part of the model in section 2.1 suggests filtering the data by removing the same log-linear trend from the variables Y, C, I, G, X, M, and Y^* above; but since the growth part of the model is a very crude approximation of reality, I do not consider this to be a good alternative. Another filtering method is simply to take first differences of the variables in natural logs, which is an appropriate method if the variables follow stochastic trends. Both these filters, and the H-P filter, work in the time domain. It is also possible to use the so-called band-pass filter which works in the frequency domain, see Hassler et al. (1992).

filtered τ^c, τ^w, CA and Q.[15] The basic features of the Swedish postwar business cycle are reported in Table 1.

The figures in Table 1 compare well to Englund et al. (1992) and Hassler et al. (1994) in several respects, but there are some exceptions. First of all, while the variability in $\tilde{Y}$ is unchanged, the variability of $\tilde{C}$, $\tilde{I}$ and $\tilde{H}$ relative to $\tilde{Y}$ is larger than previously reported due to the deep recession in the 1990s. The variability in the measure of foreign demand, $\tilde{Y}^*$, is also higher than reported in Hassler et al. (1994) due to the adjustment for the real exchange rate, but has the usual procyclical properties and leads the business cycle. Unlike Hassler et al. (1994), we find evidence that exports, $\tilde{X}$, and the current account, CA, are strongly procyclical and lead the business cycle while $\tilde{H}$ lags the business cycle by including the most recent experience.

4 Estimation and Calibration

The parameters in the model are estimated in two ways. Most of the parameters are estimated with SMM. The rest of the parameters are chosen so that the estimated models' steady state properties are consistent with the data (growth facts). Parameters which falls within the second category are assumed to be independent of whether fiscal policy shocks are considered or not.[16] Since no good data are available on the domestic technology level Z_t and the world real interest rate R_t^*, the parameters in the AR(1)-processes for these shocks are included in the SMM estimations. However, as mentioned in section 3.1, it has been possible to construct a measure of the business cycle component of foreign demand $\tilde{Y}_t^*$. Therefore, I estimate the AR(1)-process for $\tilde{Y}_t^*$ with maximum likelihood.[17]

[15] Note that the share of available time spent in employment per capita, H, does not follow a trend in the model. But since the trend in the Swedish postwar data for this variable is so strong, as can be seen in Figure 2, I have chosen to apply the H-P filter on it.

[16] Formally, these parameters are regarded as part of the null hypothesis in the SMM estimations that a certain subset of the (true) moments in data and the considered model coincide.

[17] The estimation results for $\rho^{\tilde{Y}^*}$ and $\sigma^2_{\tilde{Y}^*}$ are 0.5057 and 0.00148 respectively. I have checked for normality and (absence of) first order autocorrelation of the residuals.

The fiscal policy VAR(p)-model is also estimated with maximum likelihood. To sum up, the basic reason for estimating some of the parameters in the models with SMM is that there exists neither any good information about them nor good data to calibrate them. In addition, since the answer to the question this paper addresses is heavily dependent on the values for these parameters, SMM has the advantage that it provides us with an "objective" set of parameters.

4.1 Calibration

The deterministic steady state growth rate for output, γ, is set to 0.021, which is the average growth rate for Y in the sample. The share of gross labor income to output, θ, is set equal to 0.355, which is the average gross wage sum as ratio of Y in the data. To calibrate δ, I exploited the law of motion for capital in the steady state written as $\delta = \frac{\bar{I}}{\bar{Y}}\frac{\bar{Y}}{\bar{K}} - \gamma$, and used the estimated capital stock in Hansson (1991) , GDP at factor costs and gross investment (private as well as public) for the time period 1960-1988 to compute $\delta = 0.122$ on average. The utility function parameter α, which typically determines the steady state share of available time spent in market activities, $\bar{H}$, is set to 0.33 for reasons discussed in Kydland (1995). The steady state value for public expenditures, $\bar{G}$, is calibrated so that steady state public expenditures as ratio of output, $\bar{g}$, equal 0.299, which is the sample mean of g_t. τ_t^c and τ_t^w are in steady state set to 0.177 and 0.176, which are their sample means. Finally, foreign income is by construction equal to the value of exports.[18]

4.2 The fiscal policy VAR(p)-model

In the estimation of the fiscal policy VAR(p) model, I followed the strategy in Jonsson and Klein (1996), by demeaning the variables in (17) prior to estimation. Different spec-

[18] This means that I consider a steady state where $\bar{B}^* = 0$ and $\bar{Q} = 1$.

ification tests and information criteria suggested setting $p = 1$.[19] The estimate of $\hat{\boldsymbol{\varphi}}_1$ in (17) shows that the autocorrelations for τ_t^c and τ_t^w are high, 0.933 and 0.975 respectively, while the autocorrelation for H-P filtered public expenditures in natural logs, $\tilde{G}_t$, is considerably lower and equal to 0.568. The notably high autocorrelations for τ_t^c and τ_t^w is of course a consequence of not detrending them, although they exhibit strong trends as can be seen in Figure 2.[20]

4.3 The SMM estimation

4.3.1 How SMM works

Broadly speaking, the SMM estimator chooses estimates of the unknown parameters so as to make the chosen moments in the model mimic the corresponding moments in the data. The method uses the complete representation of the stochastic general equilibrium model. Under some certain conditions, provided in Lee and Ingram (1991), the SMM estimator is asymptotically normal and one can therefore use a goodness-of-fit test statistic based on the χ^2-distribution. Let $\mathbf{m}_T$ denote a $j \times 1$ vector with j sample moments in data and $\mathbf{m}_N\left(\hat{\boldsymbol{\beta}}\right)$ the corresponding simulated moments in the model, where T denotes the number of observations in the data, N the considered number of simulated observations in the model and $\hat{\boldsymbol{\beta}}$ the $k \times 1$ vector with estimated parameters. Then, the SMM estimator minimizes the loss-function

$$T * \left(\mathbf{m}_T - \mathbf{m}_N\left(\hat{\boldsymbol{\beta}}\right)\right)' \mathbf{W}_T * \left(\mathbf{m}_T - \mathbf{m}_N\left(\hat{\boldsymbol{\beta}}\right)\right) \tag{19}$$

which is χ^2-distributed with $j - k$ degrees of freedom if $\mathbf{W}_T$ in (19) is a positive definite weighting matrix chosen to give the minimum asymptotic variance of $\hat{\boldsymbol{\beta}}$.[21]

[19] One problem worth mentioning in the determination of a good value for p was the lack of normality for the estimated residuals in the equation for τ_t^w, which was impossible to cure unless very large values of p were considered.

[20] For a constant steady state to exist in the model, it is required that all eigenvalues z satisfy $\det\left(\mathbf{I}_3 z - \hat{\boldsymbol{\varphi}}_1\right) \in (-1, 1)$. This condition is met for $\hat{\boldsymbol{\varphi}}_1$ in (17).

[21] Since I have implemented SMM the same way as Jonsson and Klein (1996), see their excellent summary of SMM in appendix B for more technical details. However, there are two things worth mentioning

4.3.2 Choice of moment vector

I have chosen to use moments which highlight three dimensions in the model; the volatility dimension, the contemporaneous correlation dimension, and the autocorrelation dimension. I have also followed the convention in the literature and related volatilities and contemporaneous correlations for the different variables to output. Since the main interesting variables in the study are considered to be output, private consumption, private investment, hours worked, the real exchange rate and the current account (as ratio of output), the following 17 moments have been included in the SMM estimation

$$\mathbf{m} = \begin{bmatrix} \hat{\sigma}_{\tilde{Y}_t},\ \hat{\sigma}_{\tilde{C}_t}/\hat{\sigma}_{\tilde{Y}_t},\ \hat{\sigma}_{\tilde{I}_t}/\hat{\sigma}_{\tilde{Y}_t},\ \hat{\sigma}_{\tilde{H}_t}/\hat{\sigma}_{\tilde{Y}_t},\ \hat{\sigma}_{Q_t}/\hat{\sigma}_{\tilde{Y}_t},\ \hat{\sigma}_{CA_t}/\hat{\sigma}_{\tilde{Y}_t}, \\ \hat{\rho}_{\tilde{C}_t,\tilde{Y}_t},\ \hat{\rho}_{\tilde{I}_t,\tilde{Y}_t},\ \hat{\rho}_{\tilde{H}_t,\tilde{Y}_t},\ \hat{\rho}_{Q_t,\tilde{Y}_t},\ \hat{\rho}_{CA_t,\tilde{Y}_t}, \\ \hat{\rho}_{\tilde{Y}_t,\tilde{Y}_{t-1}},\ \hat{\rho}_{\tilde{C}_t,\tilde{C}_{t-1}},\ \hat{\rho}_{\tilde{I}_t,\tilde{I}_{t-1}},\ \hat{\rho}_{\tilde{H}_t,\tilde{H}_{t-1}},\ \hat{\rho}_{Q_t,Q_{t-1}},\ \hat{\rho}_{CA_t,CA_{t-1}} \end{bmatrix}'. \quad (20)$$

In (20), the first "row" contains the standard deviation of output, $\tilde{Y}$, and the standard deviations of the other variables relative to $\tilde{Y}$, the second the contemporaneous correlations of the other variables with $\tilde{Y}$ and the third the autocorrelation coefficients one year backwards for all variables.[22] By this choice of moment set, I capture all three dimensions.[23]

4.3.3 The procedure in the estimation

In practice, minimization of the concave loss function (19) is done by a grid search.[24] Since there are $k = 9$ parameters to estimate, it is only computationally possible to consider

in addition to their exposition there. The first thing is that I have followed Newey and West (1994) recommendation in setting the bandwidth $p = 4(T/100)^{2/9}$ for the Bartlett kernel in the calculation of the variance-covariance matrix. Second, I have simulated the model 400 times and skipped the first 100 numbers in each simulation to get a stochastic initial state. Thus $N = 300$ and $T = 46$.

[22] The reason not to include the corresponding moments for export, $\tilde{X}$, import, $\tilde{M}$, and foreign demand $\tilde{Y}^*$ in the SMM estimation, is that there must be as many shocks as endogenous variables in the model, otherwise the model is singular and impossible to estimate as demonstrated by Ingram et al (1994).

[23] Of course, it would be of interest to extend the moment set for the model with fiscal policy with the variables $\tilde{G}_t$, τ_t^c and τ_t^w to be able to ensure that the propagation mechanisms in the model are correct. But since they are not the target variables here, and it is of interest to compare the goodness-of-fit criterion in the model with fiscal policy with the one without, I have chosen not to include them.

[24] Since the loss function is not sufficiently smooth in the parameters θ_{IM}, η, ϵ^X, σ and β, it has not been possible to use a simple optimization algorithm, such as the steepest descend, to find the SMM estimates.

3 values for each parameter in the final grid. To obtain the final grid, I considered large variations at a time for the parameters θ_{IM}, η, ϵ^X, σ, β, ρ^{R^*}, $\sigma^2_{R^*}$, $\rho^{\ln Z}$ and $\sigma^2_{\ln Z}$ in that order, updating the parameter values recursively, to find the centre and the steps of the final grid.[25]

5 Empirical results

5.1 SMM estimation of the models

The results of the SMM estimation are reported in Tables 2 and 3.

On the whole, the point estimates in Table 2 are reasonable and could be the outcome of an ordinary calibration procedure, at least for the version of the model with fiscal policy. However, comparison of the models with and without fiscal policy reveals some differences of importance. First of all, the estimated price elasticity for export demand, $\hat{\epsilon}_X$, is rather low in the model without fiscal policy. This will tend to lower the export fluctuations, and thereby also the volatility in output. Second, the estimated inverse of intertemporal elasticity of substitution, $\hat{\sigma}$, in the model without fiscal policy is lower. This will tend to raise the relative volatility of consumption to output in that version of the model compared to the fiscal policy one. Third, $\hat{\rho}^{R^*}$ and $\hat{\sigma}^2_{R^*}$ are higher in the model with fiscal policy, implying that interest rates shocks are more important in that model compared to the model without fiscal policy.

Turning to Table 3, we see that both versions of the model underestimate the standard deviation in $\tilde{Y}$ and the relative volatilities for private investment and hours worked to $\tilde{Y}$ in the data, although the version with fiscal policy to a lesser extent. However, both models reproduce the relative volatilities in private consumption, the real exchange rate

[25] Since the loss function is globally concave in each parameter, the estimation ordering of θ_{IM}, η, ϵ^X, σ, β, ρ^{R^*}, $\sigma^2_{R^*}$, $\rho^{\ln Z}$ and $\sigma^2_{\ln Z}$ to obtain the final grid does not matter.

and current account to $\tilde{Y}$ remarkably well. Most surprisingly, the relative volatility in $\tilde{C}$ to $\tilde{Y}$ is as high as 1.27 in the model without fiscal policy. This means that, although fluctuating consumption taxes and the higher variance for the foreign real interest rate tend to drive up the relative volatility of consumption to output in the fiscal policy version of the model, they just compensate for the higher estimate of σ reported in Table 2. Both models exaggerate the contemporaneous correlation between $\tilde{Y}$ and Q but track the rather low correlation between $\tilde{Y}$ and CA well. The estimated correlation between $\tilde{H}$ and $\tilde{Y}$ is too low in the model without fiscal policy. In general, the autocorrelations are slightly better tracked by the model with fiscal policy. It is remarkable, how well the very high autocorrelation in Q is tracked in the model with fiscal policy.

Finally, a few comments upon the χ^2-statistics in Table 3 are in order. As in Jonsson and Klein (1996), Table 3 reveals that the introduction of stochastic fiscal policy improve the empirical fit of the model. But in contrast to their findings, it does not enter in any significant way when one considers a broader set of moments which also contains open economy variables. Both models are strongly rejected by the data using asymptotic significance levels.[26] In light of the most recent experience in the Swedish economy, this is not very surprising; Table 1 displayed that the standard deviations in many variables are much higher when including the deep recession in the 1990s. Of course, every model is in some sense a crude approximation of the economy; they do better in some aspects than others. Here, the model with fiscal policy above does a fairly good job for the variables $\tilde{Y}$, Q and CA, which is a good thing since we are particularly interested in investigating what the forces behind the fluctuations in these variables are. For the variables $\tilde{C}$, $\tilde{I}$ and $\tilde{H}$, the model perform less well; but before rejecting the properties of the model in this sense, the impact of the deep recession should kept in mind.

[26] Of course, it is very likely that the small sample distribution of the χ^2-statistic deviates significantly from it's asymptotic distribution, but since it take about 1 day to estimate the model on a very fast computer, it is not computationally possible to investigate this issue.

5.2 Variance decomposition of the volatilities

To investigate the relative importance of foreign and domestic shocks for the key macro variables $\tilde{Y}$, Q and CA, which were reasonably well tracked by the model, I follow Sims (1980) and use the variance decomposition method. By not including more variables in the SMM estimation of the model than shocks, I avoid the critique against the variance decomposition method raised by Ingram et al. (1994). The variance decomposition method is attractive since it measures the fraction of simulated volatility in a variable k years ahead accounted for by different shocks in a very precise way. However, it has one drawback; the identifying assumptions are, in general, of substantial importance for the obtained results. In the setting here, it is the ordering of the shocks that matter since the estimated disturbance vector is orthogonalized by a cholesky decomposition. But since the innovations in the processes for R^*, $\tilde{Y}^*$ and $\ln Z$ are uncorrelated with other shocks, the ordering of these variables do not matter. Thus only the ordering of the fiscal policy variables matter for the results here. Since the focus of the paper is to investigate the relative importance between foreign and domestic shocks, and thus the fiscal policy innovations as a whole rather than the relative importance among them, the effects of different ordering of the innovations have no importance here. Completely arbitrarily, then, I chose the following order: R^*, $\tilde{Y}^*$, $\ln Z$, $\tilde{G}$, τ^c and τ^w.

In Table 4, I present the results for different horizons. The short run impact of a shock is captured by k equal to 1, 5 and 10, and the long run by k equal to 50 and ∞. Before turning to the results reported in Table 4 below, it should be emphasized that the figures presented there are point estimates, which are sensitive to the parameterization of the model. Therefore, one should interpret the exact figures with a grain of salt, but take the main features in the table more seriously. From Table 4, we see that domestic shocks account for most of the volatility in output per capita, $\tilde{Y}$. In the short run, innovations in productivity are most important, and account for over 50 percent of the volatility in

$\tilde{Y}$. But in the long run, fiscal policy shocks, in particular shocks to τ^w, become the most important source of output fluctuations.[27] Fluctuations in the real exchange rate, Q, are to a large extent caused by foreign shocks in the short run, but in the long run, domestic shocks become more important. For the current account, we find, essentially, that only fluctuations in foreign variables matter.[28]

The results in Table 4 are in line with Jonsson and Klein (1996) in the sense that it seems like innovations in fiscal policy are very important for the business cycle, especially in the long run. However, they differ in one important aspect. Jonsson and Klein found that it was innovations in the exogenous ratio of government expenditures to output, g, which contributed to most of the fluctuations in output in the long run among the fiscal policy variables. Here, I find, with the same ordering of the fiscal policy variables, that innovations in the level of government expenditures, are unimportant in the long run. There are two possible explanations to this inconsistency. First, it might be that I keep the level of government expenditures exogenous, rather than g as Jonsson and Klein. But when I reestimated the model with SMM with $\tilde{G}$ in (17) replaced with H-P filtered $\ln g$, denoted $\tilde{g}$, as exogenous variable and decomposed the simulated variance again, the results in Table 4 were practically unchanged.[29] The remaining possible explanation is that Jonsson and Klein do not H-P filter g, a priori and in accordance with the model they treat it as a stationary variable together with τ^c and τ^w, while I H-P filter the level of exogenous government expenditures here. A closer look at Table 4 reveals that this

[27] Although not reported in Table 4, I have performed variance decompositions for $\tilde{C}$, $\tilde{I}$ and $\tilde{H}$. Quite naturally, innovations in foreign demand and, in particular, the foreign real interest rate are most important for fluctuations in $\tilde{I}$, and together they account for over 70 percent of the fluctuations in both the short and long run. For $\tilde{C}$, innovations in τ^c account for approximately 46 of the fluctuations in the short run, and for $\tilde{H}$ innovations in τ^w are most important.

[28] I have tested the sensitivity of the results in Table 4 w.r.t. the ordering of the fiscal policy variables. It turned out that the relative importance of innovations in $\tilde{G}$, τ^c and τ^w crucially depended on the ordering of these variables, in contrast to Jonsson and Klein (1996). For instance, if τ^w change place with $\tilde{G}$, it becomes the only important source of fluctuations among the fiscal policy variables.

[29] I have also reestimated the model with SMM with $\tilde{G}$ in (17) replaced with $\ln g$ as exogenous variable. Shocks to $\ln g$ are then, as in Jonsson and Klein, found to be the outstanding source of business cycles among the fiscal policy variables. For instance, shocks to $\ln g$ then account for 71 and 48 percent of the fluctuations in $\tilde{Y}$ and Q respectively in the long run.

seems to be correct. In the table, we see that innovations in τ^c and τ^w become more and more important relative to $\tilde{G}$, and the other shocks too, when k increases since the autocorrelations are so high for these variables (as noted in section 4.2) due to the strong trends in them (see Figure 2).

But this, then, raises doubts about the result that fiscal policy is very important for the business cycle, since it may be the case that this result crucially depends on the assumption of treating τ^c and τ^w as stationary variables, thereby not removing the strong trends in them with the H-P filter. In the next section, I therefore test to what extent the results change if one relaxes this assumption and H-P filters them.

5.3 Sensitivity analysis

In this section, I reestimate the model with SMM when τ^c and τ^w in (17), together with Q and CA, are H-P filtered to examine the robustness of the results in Table 4.[30] Before turning to the results of the variance decompositions in Table 5, I want to comment briefly on the SMM estimation results. Again, all the SMM estimated parameters are reasonable, except $\hat{\rho}^{\ln Z}$ which equal 0.57, a rather low estimate (corresponds to 0.87 on quarterly data). The computed chi-square statistic is 103.04. Thus, the empirical fit of the model is clearly worsened. However, it is still the case that the version of the model with fiscal policy outperforms the one without, but not significantly so, using asymptotic critical values.

Turning to Table 5, we see that the variance decomposition results changes completely. Innovations in fiscal policy are now only of moderate importance for output fluctuations. Instead, productivity shocks are of greater importance for fluctuations in $\tilde{Y}$. Foreign shocks are also more important for fluctuations in $\tilde{Y}$ and the real exchange rate, both in

[30] I have also H-P filtered Q and CA in the reestimation of the model. Thus, in this section, all variables used in the SMM estimation are H-P filtered.

the short and long run. As in Table 4, it is still the case that foreign shocks are the only source of fluctuations in the current account.[31]

So what are the general impressions of Table 5? First of all, the figures compare qualitatively well with the results of Lundvik (1992), although it seems like foreign shocks are found to be slightly more important here. In the short-run, we see that domestic shocks are, quite naturally, found to be slightly more important, and account for 67 percent of the fluctuations in output. The results also compare well with the papers which have exploited vector autoregressions (VARs) to investigate the sources of business cycles. Englund et al. (1994) find that foreign shocks account for 13 percent of the fluctuations in output in the short-run and 47 percent in the long-run. For the long-run, Mellander et al. (1992) find that foreign shocks account for 57 percent of output fluctuations. Mellander et al. (1992) also find that foreign shocks account for all the variability in the real exchange rate in the long run.

6 Concluding remarks

In Sweden, it is, or at least has been, a common view that most of the business cycles are caused by foreign shocks, such as shocks to foreign demand for Swedish export. In this paper, I have investigated the validity of this view by computing the relative importance of foreign and domestic shocks for the Swedish postwar business cycle 1950-1995 using a stochastic growth model designed for a small open economy. I have extended previous work by Lundvik (1992) by allowing for stochastic fiscal policy, since recent research by Jonsson and Klein (1996) suggests that innovations in fiscal policy might be important for postwar business cycles in Sweden. By using data up to 1995, this is the first study which take the deep recession in the beginning of the 1990s into account. I have also

[31] Foreign shocks also now account for more than 70 percent of the fluctuations in $\tilde{I}$ and $\tilde{H}$, and 36 percent of the fluctuations in $\tilde{C}$.

tested whether the introduction of stochastic fiscal policy improves the empirical fit of the model in a significant way by estimating most of the parameters in the model with SMM.

The main results in the paper are as follows. First, it is shown that fiscal policy shocks improve the empirical fit of the model, but not significantly so using asymptotic critical values. The main reason for rejecting the model is the increased standard deviations in private consumption, private investment and employment per capita due to the deep recession in the 1990s. It also turns out that the empirical improvement of the model with fiscal policy is dependent on whether the fiscal policy variables are H-P filtered or not. If they are H-P filtered, the fit is clearly worsened in comparison to if they are not. The reason why this result is obtained, are that the fiscal policy variables contain strong trends during the postwar period due to the public sector expansion in Sweden. This finding casts some doubts as to whether the results provided in Jonsson and Klein (1996) are robust with respect to detrending and choice of sample period.

Second, by decomposing the simulated volatility in output per capita, the real exchange rate and the current account attributed to various foreign and domestic shocks, I find that the relative importance of foreign and domestic shocks, and in particular the importance of fiscal policy shocks, for fluctuations in output are heavily dependent on whether the fiscal policy variables are filtered with the H-P filter or not. If the fiscal policy variables are left unfiltered, as in Jonsson and Klein (1996), then innovations in fiscal policy are found to be very important for output fluctuations, and account for over 50 percent of the fluctuations in output in the long run. But if the fiscal policy variables are filtered, fiscal policy shocks only account for 12 percent of the fluctuations in output in the long run. In this case, foreign shocks account for 43 percent of the output fluctuations, while domestic productivity shocks account for 45 percent. Foreign shocks are, independent of whether the fiscal policy are filtered or not, found to be most important for fluctuations in the real exchange rate and, in particular, the current account. The reason why these differences occur for output fluctuations is that the fiscal policy variables contain strong trends during the postwar period, due to the public sector expansion in Sweden. Therefore, it is the latter results that are valid, and these results compare well to the findings of the VAR studies in the field.

To conclude, it seems to be a robust finding, both in the empirical and theoretical literature, that foreign and domestic shocks contribute about equally to output fluctuations, and that foreign shocks contribute by far the most to fluctuations in the real exchange rate and the current account.

What about the limitations of the paper? As in all other papers in the previous literature, fiscal policy is treated as an exogenous, non-optimal, process since it is not an easy task to attach a stable loss-function to the government. It would be an interesting extension to consider the effects of endogenous, optimal, fiscal policy on the business cycle within a certain regime. However, for the purpose of parameter estimation (with SMM perhaps) and hypotheses testing, one must develop an algorithm to solve the government's and household's problem simultaneously, because an iterative procedure which (*i*) calculates household decision rules given a fiscal policy decision rule, (*ii*) check how the governments loss-function can be improved on the margin by changing parameters in the fiscal policy decision rule, (*iii*) repeat (*i*) and (*ii*) until convergence would be far to slow. In a recent paper, Söderlind (1998) shows how this can be done. More specifically, Söderlind (1998) shows how to solve and estimate a linear rational expectations model with optimal policy on data using the Kalman filter.

Another possible limitation is that there are no money shocks in the model. The reason for this is that only real variables are of interest here, and unless one imposes (*ad hoc*) some rigidities, money shocks seems to be unimportant for real variables in both the short and the long run. Even if one impose some rigidities, money only seems to have a limited effect in the short run and be neutral in the long run. See Cooley and Hansen (1995) for further details. However, one extension of the work here would be to consider the short run effects of money shocks on the real exchange rate and the current account in a model with nominal price and/or wage rigidities.

Appendix A Data sources and definitions

In this appendix, I present exact sources for the data set and exact definitions of the composite variables used. Table A.1 display the exact sources of the data. In Table A.2, I provide exact definitions of composite variables, following the notation in section 2.1.

To give a motivation for the definitions of the variables in the national account block, I start out from the nominal

$$P_t^{Y^M} Y_t^M = P_t^{CP} CP_t + P_t^{CG} CG_t + P_t^{IG} IG_t + P_t^{IP} IB_t + P_t^{II} II_t + P_t^X X_t - P_t^M M_t \quad \text{(A.1)}$$

and real

$$Y_t^M = CP_t + CG_t + IG_t + IB_t + II_t + X_t - M_t \quad \text{(A.2)}$$

GDP identities where the nominal holds for the whole sample period while the real only holds from 1990 to 1995. In addition, it is the case that

$$P_t^{Y^M} Y_t^M = P_t^{Y^F} Y_t^F + P_t^{T^I} T_t^I - P_t^{T^S} T_t^S \quad \text{(A.3)}$$

holds in the data 1950 to 1995. Unfortunately, no data on $P_t^{Y^F}$, Y_t^F, $P_t^{T^I}$, T_t^I, $P_t^{T^S}$ and T_t^S exists. It is only possible to acquire data on $P_t^{Y^F} Y_t^F$, $P_t^{T^I} T_t^I$ and $P_t^{T^S} T_t^S$. This creates a data problem since the most adequate measure of production in the model, Y_t, is Y_t^F in the data. As noted in Hassler et al. (1994) and Englund et al. (1992), the way one handles this problem is also of quantitative importance. Here, I have followed the strategy in Hassler et al. (1992) and accepted the GDP-deflator at market prices, $P_t^{Y^M}$, as proxy for $P_t^{Y^F}$, $P_t^{T^I}$ and $P_t^{T^S}$. By combining (A.2) and (A.3), I then obtain

$$\frac{P_t^{Y^F} Y_t^F}{P_t^{Y^M}} = CP_t - \frac{P_t^{T^I} T_t^I - P_t^{T^S} T_t^S}{P_t^{Y^M}} + CG_t + IG_t + IB_t + II_t + X_t - M_t \quad \text{(A.4)}$$

which forms the basis for the definitions of many variables used.[32]

[32] However, it should be emphasized that by using (A.4), one still has a considerable measurement error between 1950 and 1989 due to the measurement error for (A.2) in the. An alternative way then, to get rid of the measurement error, would be to combine (A.1) and (A.3) and divide through with $P_t^{Y^M}$ as in Englund et al. (1992).

Table A.1: The data set.

Variables	Sample period	Source
GDPMN and GDPM	1950-1995	SCB TSDB
GDPFN	1950-1995	SCB TSDB
TINDN and TSUBN	1950-1995	SCB TSDB
CPN and CP	1950-1995	SCB TSDB
CGN, IGN, CG and IG	1950-1995	SCB TSDB
IBN, IIN, IB and II	1950-1995	SCB TSDB
XN, MN, X and M	1950-1995	SCB TSDB
MFMT	1950-1995	SCB TSDB
HWT	1950-1969	Jonsson and Klein (1996)
HWT	1970-1979	SCB, N10 SM 8901 Table H:5 last row
HWT	1980-1995	SCB, N10 SM 9601 Table 6 last row
WSISIFN and SIFN	1950-1969	SCB, N 1971:11 Table 5 rows 1, 14
WSISIFN and SIFN	1970-1979	SCB, N10 SM 8601 Table H:12 rows 1, 19
WSISIFN and SIFN	1980-1995	SCB, N10 SM 9601 Table 7, rows 1, 19
CAN	1950-1995	Sveriges Riksbank, Fredrika Röckert
PFOR	1950-1995	OECD MEI
ESWEFOR	1960-1995	OECD MEI
GDPFOR	1950-1995	OECD MEI

Note: All real macroeconomic variables are measured in 1991 prices in millions. SCB stands for Statistics Sweden, TSDB for SCB's time series database, Sveriges Riksbank for Bank of Sweden. Abbreviations; GDPMN and GDPM denotes GDP at market prices in nominal and real terms; GDPFN nominal GDP at factor prices; TINDN and TSUBN nominal indirect tax revenues and various subsidies; CPN and CP nominal and real private consumption expenditures; CGN, IGN, CG and IG public consumption and investment in nominal and real terms; IBN, IIN, IB and II nominal and real business and inventory investments; XN, MN, X and M nominal and real exports and imports; MFMT average population in thousands; HWT total hours worked in millions; WSISIFN and SIFN total nominal wage sum including social insurance fees and nominal social insurance fees respectively; CAN the nominal current account; **PFOR**, **ESWEFOR** and **GDPFOR** are 11×1 vectors with GDP deflators, nominal exchange rates vis-a-vis the Swedish krona and real GDP's per capita for the U.S., U.K., Germany, France, Japan, Italy, Finland, Norway, Denmark, Belgium and Canada, respectively.

Table A.2: Generation of composite data series.

Variable	Calculation formula
Y	GDPFN/(GDPMN/GDPM)/MFMT
C	CP/MFMT-(TINDN-TSUBN)/(GDPMN/GDPM)/MFMT
G	(CG+IG)/MFMT
g	(CG+IG)/(GDPFN/(GDPMN/GDPM))
I	(IB+II)/MFMT
X	X/MFMT
M	M/MFMT
H	HWT*1000/MFMT
Y^*	$\sum_{i=1}^{11} \omega_i \left[\mathbf{PFOR}_i * \mathbf{GDPFOR}_i * \mathbf{ESWEFOR}_i / (\text{GDPMN/GDPM})\right]$
CA	CAN/GDPFN
Q	(ZN/Z)/(XN/X)
τ^c	(TINDN-TSUBN)/CPN
τ^w	SIFN/(WSISIFN-SIFN)

Note: Y, C, G, I, X, M, H and Y^* are then subject to Hodrick-Prescott filtering in natural logs, as described in section 3.2. The ω_i weights from the TCW currency basket index are normalized so that they sum to 1.

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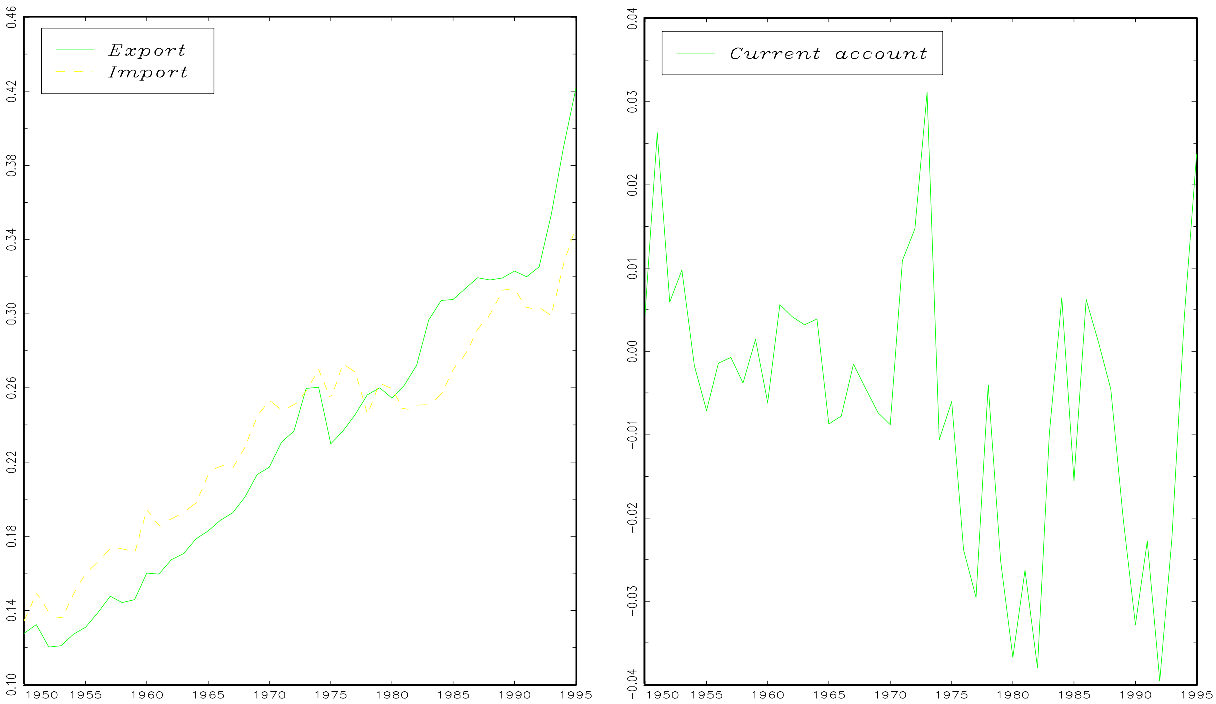

Figure 1: Export, import and the current account as ratios of GDP.

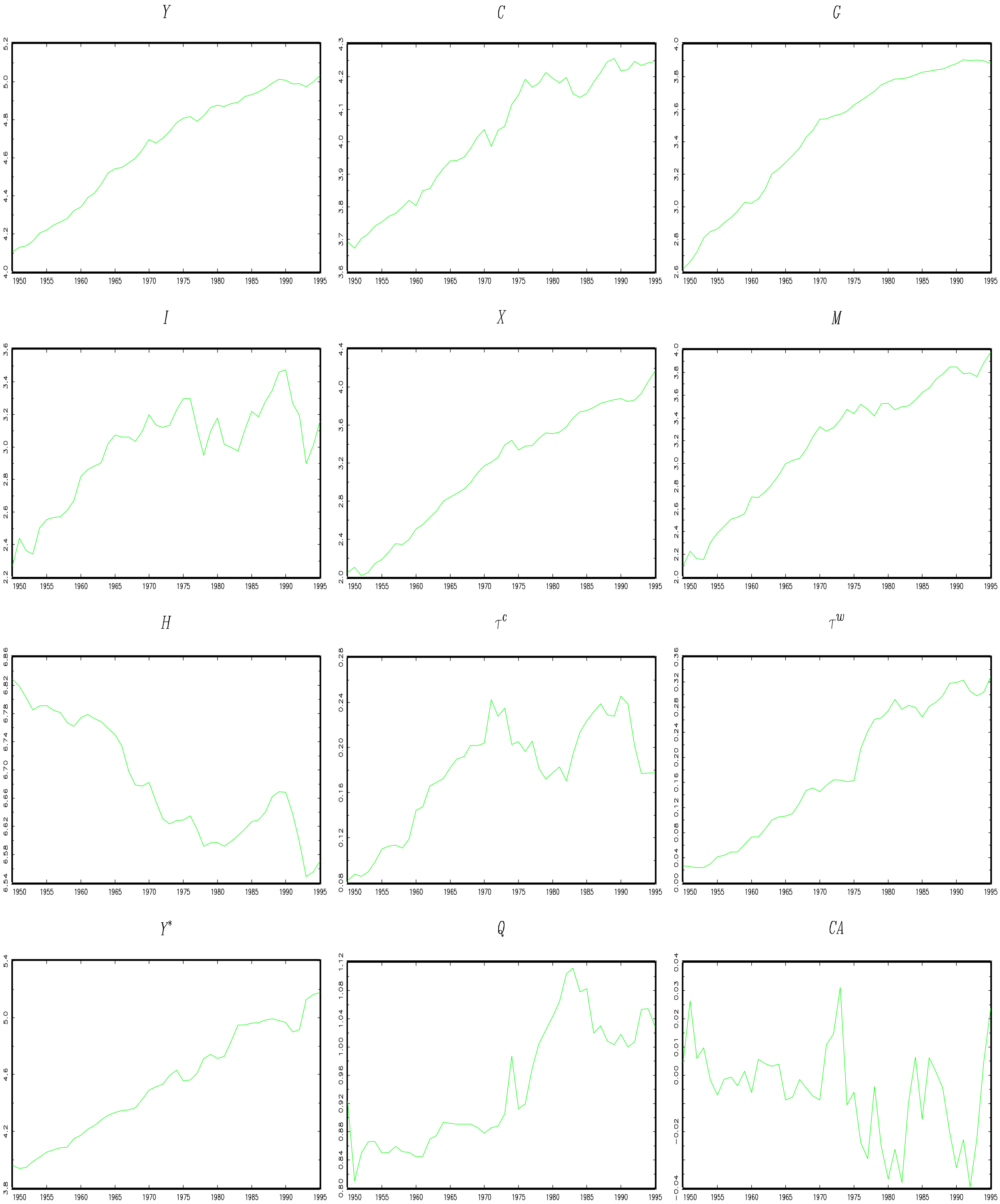

Figure 2: The data.

Table 1: Basic stylized business cycle facts for Sweden 1950-1995.

	Std. dev. in %	Std. dev. to $\tilde{Y}$	Correlation of variable with itself in t at					$\tilde{Y}_t$ at				
			$t-2$	$t-1$	t	$t+1$	$t+2$	$t-2$	$t-1$	t	$t+1$	$t+2$
$\tilde{Y}$	1.56	1	-0.20	0.38	1.00	0.38	-0.20	-0.20	0.38	1.00	0.38	-0.20
$\tilde{C}$	2.25	1.44	0.14	0.46	1.00	0.46	0.14	-0.21	0.12	0.49	0.17	0.13
$\tilde{I}$	9.39	6.01	-0.06	0.48	1.00	0.48	-0.06	-0.24	0.12	0.76	0.64	0.06
$\tilde{G}$	1.88	1.20	0.06	0.56	1.00	0.56	0.06	-0.22	-0.08	0.04	0.05	0.15
$\tilde{X}$	4.41	2.82	-0.16	0.48	1.00	0.48	-0.16	0.28	0.49	0.41	-0.16	-0.55
$\tilde{M}$	4.61	2.95	-0.17	0.33	1.00	0.33	-0.17	-0.16	0.20	0.67	0.41	-0.16
$\tilde{H}$	1.68	1.08	0.17	0.68	1.00	0.68	0.17	-0.16	0.17	0.64	0.62	0.17
$\tilde{Y}^*$	4.43	2.83	-0.14	0.50	1.00	0.50	-0.14	0.45	0.45	0.06	-0.43	-0.59
Q	8.54	5.46	0.90	0.94	1.00	0.94	0.90	0.05	0.03	-0.06	-0.13	-0.09
CA	1.61	1.03	0.32	0.58	1.00	0.58	0.32	0.39	0.38	0.03	-0.29	-0.31

Note: $\tilde{Y}$, $\tilde{C}$, $\tilde{I}$, $\tilde{G}$, $\tilde{X}$, $\tilde{M}$, $\tilde{H}$ and $\tilde{Y}^*$ are the business cycle components of the H-P filtered series Y, C, I, G, X, M, H and Y^* in natural logs with the smoothness parameter, λ, set to 100. See appendix A for a detailed description of the data set and exact definitions of variables.

Table 2: SMM estimates.

In the model	SMM point estimate of θ_{IM}	η	ϵ_X	σ	β	ρ^{R^*}	$\sigma^2_{R^*}$	$\rho^{\ln Z}$	$\sigma^2_{\ln Z}$
Without F.P.	0.016	0.702	0.590	1.70	0.987	0.245	0.0016	0.950	0.00010
With F.P.	0.025	0.570	0.928	2.45	0.979	0.460	0.0020	0.910	0.00012

Note: F.P. is shorthand notation for fiscal policy.

Table 3: SMM estimated moments and goodness-of-fit statistics.

	Model with		
Moment	No fiscal policy	Fiscal policy	Empirical
$\hat{\sigma}_{\tilde{Y}_t} * 100$	1.01	1.26	1.56
$\hat{\sigma}_{\tilde{C}_t}/\hat{\sigma}_{\tilde{Y}_t}$	1.27	1.29	1.44
$\hat{\sigma}_{\tilde{I}_t}/\hat{\sigma}_{\tilde{Y}_t}$	1.91	2.95	6.03
$\hat{\sigma}_{\tilde{H}_t}/\hat{\sigma}_{\tilde{Y}_t}$	0.39	0.77	1.08
$\hat{\sigma}_{Q_t}/\hat{\sigma}_{\tilde{Y}_t}$	7.02	6.22	5.49
$\hat{\sigma}_{CA_t}/\hat{\sigma}_{\tilde{Y}_t}$	1.08	0.76	1.03
$\hat{\rho}_{\tilde{C}_t,\tilde{Y}_t}$	0.72	0.73	0.49
$\hat{\rho}_{\tilde{I}_t,\tilde{Y}_t}$	0.55	0.62	0.77
$\hat{\rho}_{\tilde{H}_t,\tilde{Y}_t}$	0.19	0.59	0.64
$\hat{\rho}_{Q_t,\tilde{Y}_t}$	0.08	0.24	-0.06
$\hat{\rho}_{CA_t,\tilde{Y}_t}$	0.02	0.08	0.02
$\hat{\rho}_{\tilde{Y}_t,\tilde{Y}_{t-1}}$	0.46	0.49	0.38
$\hat{\rho}_{\tilde{C}_t,\tilde{C}_{t-1}}$	0.38	0.46	0.46
$\hat{\rho}_{\tilde{I}_t,\tilde{I}_{t-1}}$	0.33	0.34	0.48
$\hat{\rho}_{\tilde{H}_t,\tilde{H}_{t-1}}$	0.40	0.45	0.68
$\hat{\rho}_{Q_t,Q_{t-1}}$	0.80	0.84	0.94
$\hat{\rho}_{CA_t,CA_{t-1}}$	0.58	0.50	0.58
χ^2_{obs}	172.62	63.54	
p-value	0.00	0.00	

Note: The standard deviation in $\tilde{Y}$ and the relative standard deviations in $\tilde{C}$, $\tilde{I}$, $\tilde{H}$, Q and CA to $\tilde{Y}$ are somewhat different than the one reported in Table 1 since the first year have been left out here for estimation technical reasons. The same explanation applies for the contemporaneous correlations between these variables.

Table 4: Variance decomposition k years ahead.

Due to	$\tilde{Y}$ k=1	5	10	50	∞	Q k=1	5	10	50	∞	CA k=1	5	10	50	∞
R^*	0.09	0.10	0.08	0.05	0.05	0.93	0.78	0.70	0.57	0.56	0.47	0.45	0.45	0.45	0.45
$\tilde{Y}^*$	0.09	0.03	0.02	0.01	0.02	0.05	0.13	0.15	0.16	0.16	0.53	0.54	0.54	0.54	0.54
$\ln Z$	0.52	0.52	0.50	0.38	0.37	0.01	0.05	0.08	0.09	0.09	0.00	0.00	0.00	0.00	0.00
$\tilde{G}$	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
τ^c	0.14	0.16	0.17	0.17	0.16	0.00	0.02	0.03	0.07	0.08	0.00	0.01	0.01	0.01	0.01
τ^w	0.12	0.17	0.22	0.38	0.39	0.00	0.02	0.04	0.11	0.11	0.00	0.00	0.00	0.00	0.00
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Fraction of simulated volatility k years ahead in variable.

Note: The variance decomposition has been made in natural logs for Y around its trend and in natural numbers for the stationary variables Q and CA. The fractions reported above have been calculated by analyzing the effects of a one standard deviation increase in each of the shocks at a time.

Table 5: Variance decomposition k years ahead: all variables H-P filtered.

Due to	$\tilde{Y}$ k=1	5	10	50	∞	Q k=1	5	10	50	∞	CA k=1	5	10	50	∞
R^*	0.06	0.10	0.10	0.10	0.10	0.75	0.51	0.45	0.38	0.31	0.12	0.11	0.11	0.11	0.11
$\tilde{Y}^*$	0.27	0.20	0.23	0.28	0.33	0.23	0.43	0.49	0.57	0.65	0.88	0.89	0.89	0.89	0.89
$\ln Z$	0.57	0.57	0.53	0.49	0.45	0.01	0.04	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.00
$\tilde{G}$	0.02	0.07	0.08	0.08	0.07	0.01	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00
$\tilde{\tau}^c$	0.04	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\tilde{\tau}^w$	0.04	0.04	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Fraction of simulated volatility k years ahead in variable.

Note: The variance decomposition has been made in natural logs for Y around its trend and in natural numbers for the stationary variables Q and CA. The fractions reported above have been calculated by analyzing the effects of a one standard deviation increase in each of the shocks at a time.