

# Do recessions permanently change output?\*

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This paper examines whether negative innovations to GNP are more or less persistent than positive innovations. We find that once we allow for the impulse response of GNP to be asymmetric, negative innovations to GNP are observed to be much less persistent than positive ones. In particular, the effect of a recession on the forecast of output is found to be negligible after only eight to twelve quarters, while the effect of a positive shock is estimated to be persistent and amplified over time. Our results may therefore help reconcile two antagonistic views about the nature of business cycle fluctuations.

*Keywords:* Economic fluctuations; Asymmetries; Persistence

## 1. Introduction

The purpose of this paper is to examine whether previous results on the persistence of output fluctuations have been biased by the imposition of symmetry. Although the persistence literature is voluminous [see, for example, Nelson and Plosser (1982), Campbell and Mankiw (1987), Watson (1986), Cochrane (1988), and Diebold and Rudebusch (1989)] and authors frequently

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criticize each other, there seems to be considerable agreement that post-war output fluctuations are highly persistent. For example, at horizons that are typically associated with a downturn (e.g., 8 quarters), the literature almost never finds significant evidence of dampening. In fact, disagreements in this literature revolve almost exclusively around very long horizons (more than 16 quarters). Therefore, it is generally agreed that explaining why recessions have such a long impact is a necessary requirement of any macroeconomic theory.

One potential problem with the empirical literature cited above is that it imposes symmetry on the measure of persistence. That is, a positive shock and a negative shock to output are restricted to have identical impulse responses. However, there are reasons for questioning this assumption. For example, if one believes technological regress to be unlikely, then only positive innovations in output reflect technological progress and therefore should affect one's forecast of long-run output differently, and probably to a greater extent, than do negative innovations.<sup>1</sup>

In this paper, we extend the standard ARMA representations of output growth in order to examine the possibility of asymmetric persistence in GNP. Our specification allows for the conditional expectation of future output to depend on whether current output is above or below its previous maximum. We estimate two classes of models for output growth where asymmetric dynamics are generated by allowing the depth of a current recession to affect the time path of future fluctuations. In order to facilitate comparison with previous work, we restrict our analysis to a class of parameterizations of the same order of complexity as that used by Campbell and Mankiw (1987). Our main finding is that previous estimates of persistence have been severely biased due to the imposition of symmetry. In particular, we find the persistence of positive innovations to have been underestimated and the persistence of negative innovations to have been overestimated. In fact, our estimate of the 12-quarter-ahead forecast of output is essentially unaffected by a negative shock of the magnitude observed at the onset of a recession. The result is potentially important for macroeconomic research since it suggests that theories of recession that predict only temporary losses in output may be appropriate even if output is not trend-stationary.

The results of the paper highlight one source of asymmetry in business cycle dynamics. In this regard, the paper is closely linked with previous studies of business cycle asymmetries such as Neftci (1984), Falk (1986), DeLong and Summers (1986), Sichel (1989), Hamilton (1989), Diebold and Rudebusch (1990),

<sup>1</sup>The gap versus cycle decomposition of output fluctuations emphasized by DeLong and Summers (1988) also suggests that there may exist asymmetries in persistence. However, the evidence provided by DeLong and Summers in favor of the gap versus cycle view is very different to that presented here. In particular, they do not question the persistence of post-war output fluctuations and do not discuss asymmetries in persistence. They do nevertheless suggest that output may react asymmetrically to monetary shocks and may have an asymmetric time path around trend.

and Terasvirta and Anderson (1991). The main novelty of the approach is its emphasis on asymmetry in persistence and its main finding is that such asymmetries do exist. In contrast, the previous literature on asymmetries has concentrated primarily on examining whether contractions are short and swift and expansions are long and gradual.<sup>2</sup> It is worth emphasizing that the type of asymmetry examined in the previous literature can be present with or without there being asymmetries in persistence. For example, impulse responses could be asymmetric but have similar long-run persistence, as would be the case if negative shocks initially affect the economy more than positive shocks, but then the economy bounces back faster after negative shocks.

The remaining sections of the paper are organized as follows. In section 2 we introduce a simple nonlinear approach for assessing the possibility of asymmetric persistence in output fluctuations. Although the approach is adopted without theoretical justification, it nests standard ARMA representations of growth and allows for relatively diverse types of asymmetry. In particular, it allows for positive innovations to be more or less persistent than negative innovations at different forecast horizons. In section 3, a large class of models are estimated and different parameterizations are compared using conventional model selection criteria. Section 4 presents impulse responses for several different parameterizations. By comparing the impulse responses for positive and negative shocks we can evaluate the degree of asymmetry in persistence. Since the models are nonlinear, the properties of the impulse response functions depend on the size of innovations; hence we present results for shocks that are calibrated to match initial downturns in post-war recessions. In order to provide some evidence of the robustness of our results, section 5 repeats the impulse response analysis of section 4 using a switching regressions model. Section 6 concludes.

## 2. A nonlinear framework

Consider the standard ARMA representation of output growth given by

$$\Phi(L)\Delta Y_t = \text{Drift} + \Theta(L)\varepsilon_t. \quad (1)$$

The lag polynomial of the moving average representation for (1) is defined by

$$\Psi(L) = \frac{\Theta(L)}{\Phi(L)} = \sum_{i=0}^{\infty} \psi_i L^i. \quad (2)$$

<sup>2</sup>One exception is Hamilton (1989) who does address the issue of persistence in a nonlinear framework. However, his estimates of persistence do not allow for asymmetries between positive and negative shocks.

At any horizon  $j$ , the effect of an innovation  $\varepsilon_t$  on the forecast of the level of output is given by  $\sum_{i=1}^j \psi_i \varepsilon_t$ . This type of time series representation imposes a symmetric updating rule for forecasting output, that is, both a positive and a negative innovation lead to the same size update for future output. It is clear that imposing this type of symmetry can cause severe biases in the characterization of persistence and, for this reason, should be tested and not assumed.

There are many ways to introduce nonlinearities or asymmetries in the time domain representation of a series. Since our goal is to examine whether innovations that lead to recessions imply the same degree of persistence as do those leading to expansions, we believe that it is potentially useful to exploit information on the current depth of a recession. We define the current depth of a recession (denoted  $CDR_t$ ) as the gap between the current level of output and the economy's historical maximum level, that is,  $CDR_t = \max\{Y_{t-j}\}_{j \geq 0} - Y_t$ . The values taken by the  $CDR_t$  variable over the period 1947:1–1989:4 are plotted in fig. 1, where the output measure is real quarterly GNP (Citibase GNP82). A very simple way to extend (1), which both nests the ARMA model and allows for asymmetries, is to treat the current depth of a recession as one would treat extra information in a transfer function model. Correspondingly, we use the representation of output growth given by eq. (3) as our framework for evaluating asymmetries in persistence,

$$\Phi(L)\Delta Y_t = \text{Drift} + \{\Omega(L) - 1\} CDR_t + \Theta(L)\varepsilon_t, \quad (3)$$

where the polynomial  $\Phi(L)$  is of order  $p$ ,  $\Theta(L)$  is of order  $q$ ,  $\Omega(L)$  is of order  $r$ , and  $\Omega(0) = 1$ . We denote a particular parameterization of (3) by the tuple  $(p, q, r)$ .

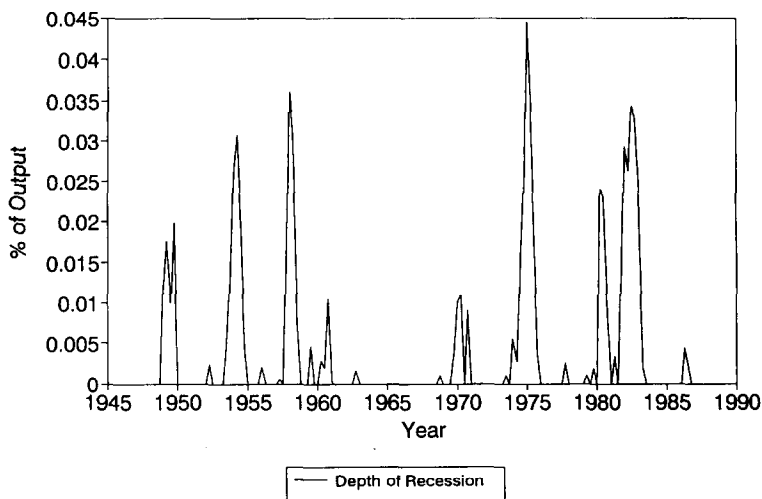


Fig. 1.  $CDR$  variable, 1948–1989.

It is important to emphasize that this representation does not implicitly force negative shocks to have only temporary effects. To understand the types of asymmetries in persistence that (3) allows, consider the case where  $\Phi(L)$  and  $\Theta(L)$  are of order zero and  $\Omega(L)$  is of order one. Here positive innovations would have a more persistent effect on output than would negative innovations if  $\Omega_1$  were positive, and the opposite would hold if  $\Omega_1$  were negative. If  $\Omega_1$  were equal to zero, the model would collapse to a random walk. Moreover, if  $\Omega_1$  is positive, this does not necessarily imply that negative innovations have only temporary effects since the model allows for a nonzero drift.

### 3. Estimation

The estimation of (3) requires specifying the order for each of the polynomials  $\Phi(L)$ ,  $\Theta(L)$ , and  $\Omega(L)$ . Following Campbell and Mankiw (1987), we consider all models where  $p$ ,  $q$ , and  $r$  are at most 3 and  $p + q + r$  is at most 6. Each of these

Table 1  
Parameter estimates for preferred models.

	Model <sup>a</sup>					
	(1,0,0)	(0,2,0)	(2,0,1)	(2,0,2)	(2,0,3)	(2,3,1)
Drift	0.005 (0.001)	0.008 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
$-\phi_1$	0.370 (0.072)	—	0.446 (0.082)	0.337 (0.108)	0.345 (0.110)	1.012 (0.229)
$-\phi_2$	—	—	0.263 (0.084)	0.331 (0.089)	0.285 (0.110)	-0.199 (0.225)
$\theta_1$	—	0.307 (0.075)	—	—	—	-0.652 (0.258)
$\theta_2$	—	0.269 (0.070)	—	—	—	0.262 (0.189)
$\theta_3$	—	—	—	—	—	-0.116 (0.094)
$\Omega_1$	—	—	0.380 (0.112)	0.140 (0.190)	0.163 (0.199)	0.209 (0.097)
$\Omega_2$	—	—	—	0.265 (0.170)	0.182 (0.273)	—
$\Omega_3$	—	—	—	—	0.065 (0.167)	—

<sup>a</sup>Models are indicated by  $(p, q, r)$  where  $p$  and  $q$  are the lag AR and MA lengths and  $r$  is the lag length for the depth of recession variable. In all cases the dependent variable is the first difference of  $\ln(\text{GNP})$ . Standard errors of estimates are in parentheses.

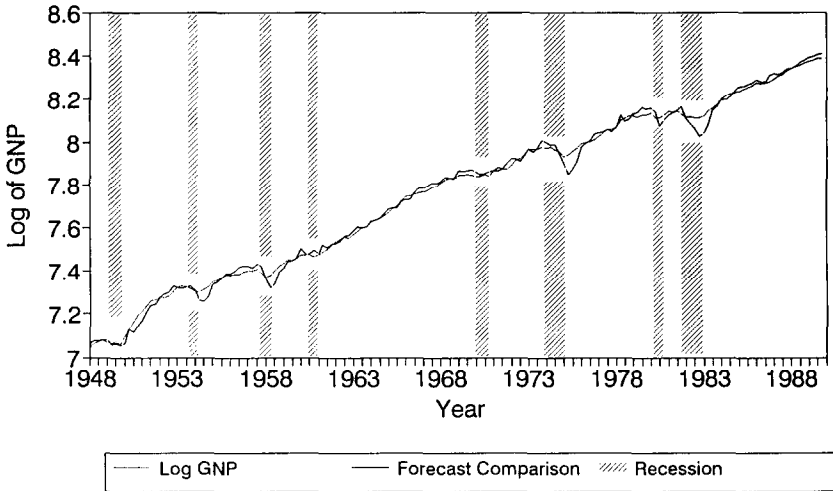


Fig. 2. Comparison of model fit.

54 parameterizations was estimated using maximum likelihood for the growth rate of real, seasonally adjusted, quarterly GNP from 1947:4 to 1989:4. The estimated models with the highest likelihood for each number of parameters are respectively the models (1,0,0), (0,2,0), (2,0,1), (2,0,2), (2,0,3), and (2,3,1). This set of parameterizations will be referred to as the set of preferred models. Since we focus our discussion on these six models, parameter estimates for each of these cases are presented in table 1. Within this set of preferred models, the only two where the  $CDR$  variable is excluded [ $\Omega(L)$  is of order zero] are the two most parsimonious parameterizations. However, both of these parsimonious parameterizations are strongly rejected in favor of less parsimonious parameterizations that include at least one lag of  $CDR_t$ . In the remaining four parameterizations the estimated polynomial  $\Omega(L)$  is jointly significant at conventional levels.<sup>3</sup>

Within this class of representations, our overall preferred parameterization is the (2,0,1) model. Of the 54 cases considered, this model is selected by Akaike's information criterion [Akaike (1974)], the Schwarz criterion [Schwarz (1987)], and the classical method of iteratively deleting insignificant coefficients. In order to visualize how the introduction of nonlinearities improves the manner in which our preferred model tracks the data, fig. 2 highlights the difference in fit

<sup>3</sup>The  $p$ -values associated with the significance of  $\Omega(L)$  are respectively 0.001 and 0.003 for the models (2,0,2) and (2,0,3).  $P$ -values for the other models can be inferred from standard errors in table 1.

between a (2,0,0) model and the (2,0,1) model. In fig. 2, the difference in absolute prediction error between the (2,0,1) model and the (2,0,0) model has been added to the time path for output.<sup>4</sup> The resulting series, which is referred to as the Forecast-Comparison series, allows an easy assessment of when one model outperforms the other. For example, when the difference in prediction error is positive, the (2,0,0) model is outperforming the (2,0,1) model and the Forecast-Comparison series lies above the output series. The opposite holds when the difference is negative. As is clear from the graph, there is very little difference between the two models in most of the sample. However, for several quarters following the trough of a cycle, the (2,0,1) clearly outperforms the (2,0,0) in regards to the size of the prediction error. This can be seen from the fact that the Forecast-Comparison series lies well below the output series after the end of most recessions.

#### 4. Impulse responses

In this section we describe impulse response functions for the four preferred models listed in table 1 that imply asymmetries. We omit representing the impulse responses for the (1,0,0) model and the (0,0,2) model since these are well-known. An impulse response function describes the incremental effect of an innovation at time  $t$  on future values of a variable. Impulse responses can be calculated by forecasting from a base case and a perturbed case and then taking the difference. When ARIMA models are used, impulse response functions are independent of both the state of the system (lagged values before the shock) and the size of the shock (i.e., doubling the size of a shock will double the whole impulse response function). However, this is not the case when nonlinear models are used.<sup>5</sup> The fact that the size of a shock should matter cannot be considered a drawback of our approach since it is a necessary condition for asymmetric impulse responses. However, the fact that the impulse response function depends on the state of the system does force us to choose a base case with which to compare the effect of a shock. The most natural base case is the steady-state growth path given by the convergent state of the system when past  $\varepsilon_{t-j}$  are zero. In the following pages, all impulse responses are evaluated relative to this base case.

Since the nonlinearities of (3) imply that the size of a shock affects the nature of the impulse response, it is necessary to determine the size of shocks that are of interest. The case that is of particular interest for our purposes is when the initial shock is comparable in size to those observed at the beginning of recessions.

<sup>4</sup>The difference is magnified by a factor of 3 to help visualize the difference between the two models.

<sup>5</sup>For a general discussion of nonlinear impulse response functions, see Potter (1991).

Before analyzing the effects of such a shock, it is helpful to investigate the general behavior of the impulse response function for the  $(2,0,1)$  specification associated with various sizes of shocks.

Let us define the 'persistence factor at quarter  $t$ ' as the revision of the  $t$ -quarter-ahead forecast of real GNP following a shock, where this factor is expressed in percentage terms relative to the initial shock. Fig. 3 plots the persistence factor at quarter 12 as a function of the size of the shock for the  $(2,0,1)$  parameterization. For positive shocks, the persistence factor turns out to be independent of the size of the shock since the  $CDR_t$  variable never becomes positive following a positive shock. Our estimates indicate that the effect of all positive shocks is not only persistent but is magnified by a factor of 3.3 after 12 quarters. It is important to note that this estimate is almost twice as large as that given in Campbell and Mankiw (1987), indicating that the imposition of symmetry on impulse response functions may have caused researchers to underestimate the persistence of positive shocks. In contrast, we find that the persistence factor for negative shocks decreases as the size of shock increases. In particular, if the initial shock is less than  $-1.2\%$  of GNP, the persistence factor at quarter 12 for a negative shock is no longer statistically significant. For initial shocks less than  $-1.8\%$ , the point estimates of this persistence factor even becomes negative. Therefore, at least in the case of the  $(2,0,1)$  model, we have strong indication that negative shocks are much less persistent than positive shocks.

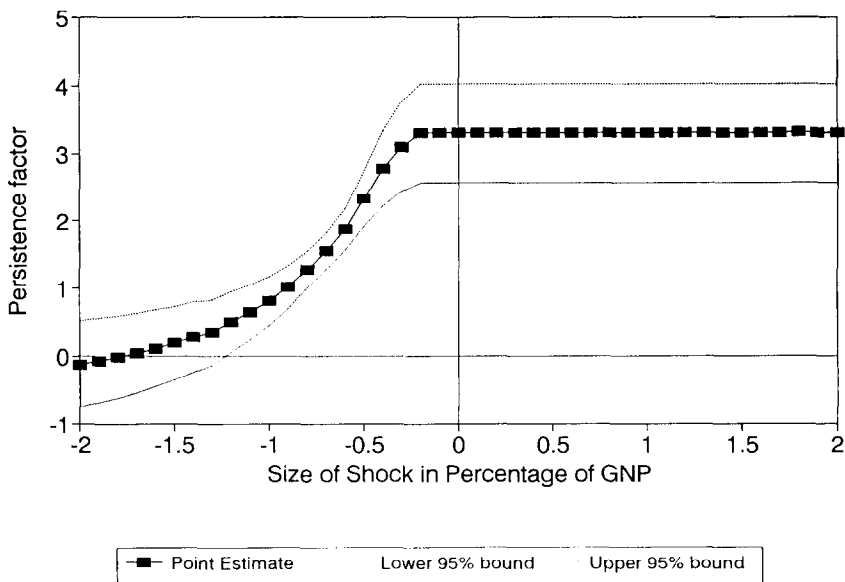


Fig. 3. Persistence factor at 12 quarters.



Table 2  
Impulse responses for preferred models.

Quarters	Model <sup>a</sup>							
	(2,0,1)	(2,0,2)	(2,0,3)	(2,3,1)				
	(1.26,0.72)	(-,-)	(1.33,0.66)	(-,-)	(1.35,0.69)	(-,-)		
	Shock size <sup>b</sup>							
1	2.54 (0.10)	-2.16 (0.11)	2.44 (0.14)	-2.30 (0.13)	2.50 (0.15)	-2.33 (0.14)	2.51 (0.11)	-2.30 (0.11)
2	3.45 (0.23)	-2.26 (0.23)	3.23 (0.26)	-2.54 (0.26)	2.50 (0.26)	-2.33 (0.26)	3.34 (0.18)	-2.56 (0.18)
4	4.76 (0.43)	-1.50 (0.45)	4.29 (0.43)	-1.68 (0.45)	4.30 (0.45)	-1.77 (0.45)	4.35 (0.28)	-1.75 (0.28)
8	6.04 (0.64)	-0.41 (0.55)	5.22 (0.59)	-0.22 (0.56)	5.15 (0.62)	-0.20 (0.57)	5.07 (0.40)	-0.06 (0.42)
12	6.52 (0.72)	0.00 (0.59)	5.51 (0.64)	0.24 (0.60)	5.40 (0.67)	0.27 (0.62)	5.29 (0.45)	0.49 (0.53)
16	6.70 (0.75)	0.15 (0.61)	5.61 (0.66)	0.39 (0.62)	5.47 (0.69)	0.40 (0.63)	5.36 (0.46)	0.66 (0.56)
20	6.77 (0.76)	0.20 (0.62)	5.64 (0.67)	0.44 (0.63)	5.49 (0.69)	0.44 (0.63)	5.38 (0.46)	0.71 (0.47)

<sup>a</sup>See note to table 1.

<sup>b</sup>Shock = (a, b) indicates a shock of size a% in period -1 and size b% in period 0, while shock = (-,-) indicates the negative version of the same shock. Shocks are calibrated to ensure  $\Delta Y_{-1} = -0.0101$  and  $\Delta Y_0 = -0.0065$  following a negative impulse. Standard errors of estimated responses are in parentheses.

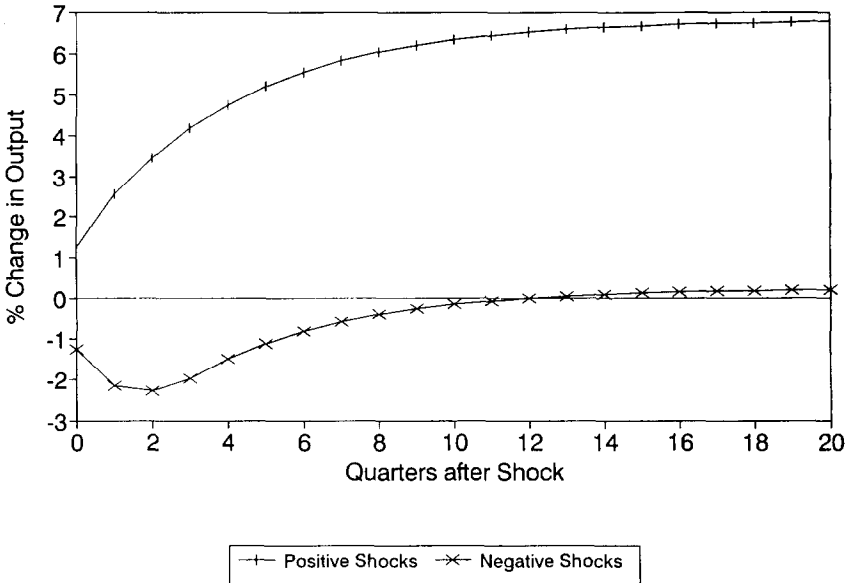


Fig. 4. Response to a recession perturbation.

Table 2 reports impulse responses associated with recessionary size shocks for each of the models (2,0,1), (2,0,2), (2,0,3), and (2,3,1). Recessionary size shocks are calibrated to match initial downturns in post-war recessions. The average growth in the initial four quarters of post-war recessions are  $-0.0101$ ,  $-0.0065$ ,  $-0.0022$ , and  $0.0063$ .<sup>6</sup> For all the models in table 1 it is impossible to choose a single shock that would generate this type of pattern. Therefore, we calibrate a pair of initial shocks that insures that the first two quarter growth rates predicted by the model exactly matches the averages of post-war recessions. The impulse responses in table 2 correspond both to a negative and a positive version of this calibrated pair of shocks. The exact sizes of the shocks are reported in table 2 and fig. 4 plots the impulse response function for the (2,0,1) model.

Two results stand out in table 2: (i) the impulse responses are highly asymmetric for all four models and (ii) there is a high degree of consistency across models. For each of the models, the effect of recessionary shocks is estimated to have a negative impact on real GNP for only 8 to 12 quarters, while positive shocks lead to a permanent increase in output of around 6%.<sup>7</sup> Furthermore, fig. 4

<sup>6</sup>These averages were calculated from the seven recessions starting in 1953:3, 1957:4, 1962:2, 1969:4, 1974:1, 1980:2, and 1981:4.

<sup>7</sup>In contrast, models (1,0,0) and (0,2,0), which do not allow for asymmetric impulse responses, imply a permanent change of around 4% following recessionary shocks.

suggests that the impact of a recession resembles the hump-shaped, trend-reverting view of business cycles emphasized by Blanchard (1981), while the impact of a positive shock to output growth resembles the permanent and amplified view emphasized by Campbell and Mankiw (1987).<sup>8</sup> Allowing for asymmetries in impulse response functions therefore offers a simple new perspective on the debate regarding the nature of output fluctuations.

In summary, the results of table 2 suggest that linear representations of real output growth may have severely biased the characterization of business cycle phenomena. In particular, we find nonlinearities to be both statistically significant and economically important. The fact that the (2,0,1), (2,0,2), (2,0,3), and (2,3,1) models provide very similar impulse responses is evidence of the robustness of our approach, since these four models can potentially have very different dynamics. In spite of these findings, in the next section we consider another class of models to provide further evidence that our results are truly robust to different specifications.

## 5. A switching regression representation

The previous investigation suggests that it is important to allow for the economy to behave differently when in recession (i.e., when  $CDR_t$  is positive) than when in expansion. One alternative to eq. (3), which also allows for asymmetries in persistence, is the switching regressions model where one regime corresponds to recessions and one to expansions.<sup>9</sup> In this section, we describe the impulse response function generated by estimating the switching regression representation given by

$$\begin{aligned} \Delta Y_t &= c_1 + \Phi_1(L)\Delta Y_{t-1} + \Theta_1(L)\varepsilon_t \quad \text{if } CDR_{t-1} = 0, \\ &= c_2 + \Phi_2(L)\Delta Y_{t-1} + \Theta_2(L)\varepsilon_t \quad \text{if } CDR_{t-1} > 0. \end{aligned} \tag{4}$$

Eq. (4) is similar in spirit to (3), but requires more parameters to nest any particular ARMA model. For example, (4) requires four additional parameters beyond that required by (3) to nest an ARMA (2,2). For easy reference, we index each parameterization of (4) by  $(p_1, q_1, p_2, q_2)$ , where  $(p_1, q_1)$  refers to the order of the ARMA( $p_1, q_1$ ) model for the expansionary regime and  $(p_2, q_2)$  refers to the order of the ARMA( $p_2, q_2$ ) model for the recessionary regime. To limit the number of models considered and to ensure comparability with our results in

<sup>8</sup> Recently, several papers have suggested that recessions may in fact stimulate growth in the long run [for an interesting discussion see DeLong (1991)]. Although our framework allows for this possibility, we find no evidence here to support it.

<sup>9</sup> This type of model is also referred to as a threshold model.

Table 3  
Impulse responses for switching regression model.

Quarters	Model <sup>a</sup>					
	(1,0,1,0)	(2,0,1,0)	(2,1,1,0)	(2,2,1,0)	(1,0,1,0)	(2,2,1,0)
	(1.55, 0.84)	(1.25, 0.84)	(1.67, 0.77)	(1.38, 0.79)	(-,-)	(-,-)
	(-,-)	(-,-)	(-,-)	(-,-)	Shock size <sup>b</sup>	
1	3.12 (0.19)	2.57 (0.16)	3.17 (0.17)	2.75 (0.14)	-2.14 (0.24)	-2.99 (0.20)
2	3.85 (0.39)	3.09 (0.32)	3.17 (0.44)	2.75 (0.35)	-2.12 (0.46)	-3.32 (0.45)
4	4.36 (0.53)	4.03 (0.50)	3.90 (0.56)	3.10 (0.49)	-0.60 (0.84)	-2.66 (0.72)
8	4.50 (0.56)	4.84 (0.67)	3.72 (0.71)	3.61 (0.64)	0.94 (1.08)	-2.47 (0.77)
12	4.51 (0.56)	5.10 (0.72)	3.78 (0.71)	3.80 (0.70)	1.59 (1.16)	-2.47 (0.78)
16	4.51 (0.56)	5.19 (0.74)	3.78 (0.71)	3.89 (0.71)	1.59 (1.20)	-2.48 (0.78)
20	4.51 (0.56)	5.22 (0.75)	3.80 (0.71)	3.93 (0.71)	1.68 (1.21)	-2.49 (0.78)

<sup>a</sup>Models are indicated by  $(p_1, q_1, p_2, q_2)$  where  $p_i$  and  $q_i$  are the lag AR and MA lengths in each of the two regimes, where regime 1 corresponds to situations where  $CDR_t = 0$ . In all cases the dependent variable is the first difference of  $\ln(\text{GNP})$ .

<sup>b</sup>See note to table 2.

section 4, we examine cases where  $p_1$ ,  $q_1$ ,  $p_2$ , and  $q_2$  are each less than or equal to 3 and where  $p_1 + q_1 + p_2 + q_2$  is less than 6. This allows the total number of estimated parameters to equal 7 since in (4) the drifts are allowed to be different in each regime. Even with these restrictions, (4) still allows for a great number of models. For example, in the sole case where  $p_1 + q_1 + p_2 + q_2$  equals 5, there are a total of 56 different representations. Therefore, we report results only for the set of models with the highest likelihoods for a given number of parameters. We again call this the set of preferred models.

Table 3 presents the impulse responses for the preferred switching regression models where  $p_1 + q_1 + p_2 + q_2$  equals 2 to 5.<sup>10</sup> For each of the representations, shocks are calibrated in the same fashion as in table 2. The Akaike criterion picks out model (2,2,1,0) as the overall preferred model, while the Schwarz criterion picks out the (2,0,1,0) model. When applicable, we calculated likelihood ratio tests for the hypothesis that the parameters in the two regimes are equal. These tests were generally found to be rejected at standard significance levels.

The results of table 3 are roughly consistent with those of table 2. In all cases we observe the same asymmetry: positive shocks tend to be more persistent than negative shocks. For the (2,0,1,0) and (2,2,1,0) models, which are the models selected by the Akaike and Schwarz criteria, recessionary shocks actually end up increasing output in the long run relative to the case where no shock occurs. However, in neither of these cases is the increase statistically significant. It is also worth noting that for these two models we again find that the effect of a recessionary shock dies out after approximately 8 to 12 quarters. The specification (1,0,1,0) provides a similar characterization since the effect of a negative shock of recessionary size becomes insignificant after only 8 quarters, even though the point estimate remains negative throughout. It is only for specification (2,1,1,0) that we observe a significant permanent negative effect of a recessionary shock. Overall, the results from the switching regressions model confirm our finding that positive and negative shocks have asymmetric effects and that recessions may have only very short-lived effects on output.

## 6. Conclusion

Macroeconomic research is greatly influenced by stylized facts about business cycles. In particular, the widespread view that output fluctuations are highly persistent has encouraged research on stochastic technological change and on models of multiple equilibria rather than on monetary theories of the business

<sup>10</sup>We omit the results for the case where  $p_1 + q_1 + p_2 + q_2$  is equal to one, since such a case imposes asymmetry by forcing trivial dynamics in one regime.

cycle.<sup>11</sup> The results of this paper suggest that describing all output fluctuations as highly persistent may be incorrect and thereby may contribute to a reappraisal of some macroeconomic theories. The main finding of the paper is that the imposition of symmetry on impulse responses has likely led to misleading measures of persistence since such a methodology provides estimates of the average response of two potentially different phenomena. In particular, we find the effects of negative shocks to be mainly temporary and the effects of positive shocks to be very persistent. Our results therefore suggest that theories that explain temporary changes in output may be relevant for understanding contractions and recoveries, while theories which explain permanent changes in output may be more relevant for expansions.

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<sup>11</sup>The observation that output fluctuations are very persistent has often been taken as evidence against monetary theories of the business cycle. Romer and Romer (1989) present evidence to the contrary by indicating that monetary shocks may have persistent effects on output. However, Romer (1989) tends to undermine his own claim since his estimates of the effect of a monetary shock is insignificant after only 10 quarters [see table 3 in Romer (1989)].

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