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FISCAL MULTIPLIERS IN JAPAN

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ABSTRACT

In this paper, we estimate government purchase multipliers for Japan, following the approach used previously for a panel of OECD countries (Auerbach and Gorodnichenko, 2013). This approach allows multipliers to vary smoothly according to the state of the economy and uses real-time forecast data to purge policy innovations of their predictable components. For a sample period extending from 1960 to 2012, estimates for Japan are quite consistent with those previously estimated for the OECD as well as those estimated using a slightly different methodology for the United States (Auerbach and Gorodnichenko, 2012). However, estimates based only on more recent observations are less stable and provide weaker support for the effectiveness of government purchases at stimulating economic activity, particularly in recession, although cyclical patterns in Japan make the dating of recessions a challenge.

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1. Introduction

Since the early 1990s, Japan has faced an ongoing challenge of promoting faster economic growth, with extended periods of very low interest rates limiting the use of monetary policy and a growing debt-GDP ratio raising caution with respect to tax cuts and increases in government spending. Though the recent worldwide recession called attention to the problems of conducting monetary policy in the presence of a zero lower bound on short-term government yields, the recent literature on the subject began with a focus on the longer-standing problem in Japan (e.g., Krugman 1998, Eggertsson and Woodford 2003, and Auerbach and Obstfeld 2005). As to fiscal policy, there remains uncertainty about the role it could have played in helping Japan to emerge from its protracted period of slow growth, with at least some (notably Kuttner and Posen 2002) arguing based on fiscal multiplier estimates that fiscal policy could have been effective in Japan, had it been aggressively pursued.

In this paper, we take a new look at the potential effectiveness of Japanese fiscal policy, in the form of shocks to government purchases. Using quarterly Japanese data, we modify and augment the standard structural vector autoregression (SVAR) approach in three ways, following our recent analysis for a panel of OECD countries (Auerbach and Gorodnichenko 2013). First, we use direct projections rather than the SVAR approach to estimate multipliers, to economize on degrees of freedom and to relax the assumptions on impulse response functions imposed by the SVAR method. Second, we allow multipliers to vary by the state of the economy, distinguishing between periods of recession and expansion using a smoothly varying indicator of aggregate economic activity. Third, we attempt to control for real-time predictions of fiscal variables, to purge innovations in fiscal variables of components that were not actual shocks to policy. Our findings for the OECD, which were consistent with our earlier findings for the

United States (Auerbach and Gorodnichenko 2012), were that multipliers of government purchases are larger in recession than in expansion and that controlling for real-time predictions of government purchases tends to increase further the estimated multipliers of government spending in recession.¹

2. Methodology

We begin with a discussion of our methodology, which closely follows the approach taken in Auerbach and Gorodnichenko (2013). Our basic specification is to estimate impulse response functions (IRFs) directly by projecting a variable of interest, in this case the logarithm of real GDP (Y), on lags of variables that would typically enter a VAR, or more generally variables capturing information available in a given time period, \mathbf{X} . This single-equation approach has been advocated by Jorda (2005), Stock and Watson (2007), and others as a flexible alternative that does not impose dynamic restrictions implicitly embedded in VARs and can conveniently accommodate nonlinearities in the response function. The response of Y at horizon h is estimated from the following regression:

$$Y_{t+h} = \alpha_h + F(z_{t-1})\mathbf{\Pi}_{R,h}(L)\mathbf{X}_{t-1} + (1 - F(z_{t-1}))\mathbf{\Pi}_{E,h}(L)\mathbf{X}_{t-1} + F(z_{t-1})\Phi_{R,h}FE_{it}^G + (1 - F(z_{t-1}))\Phi_{E,h}FE_{it}^G + u_{t,h} \quad (1)$$

$$F(z_t) = \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}, \quad \gamma > 0 \quad (2)$$

where z is an indicator of the state of the economy, normalized to have zero mean and unit variance, FE_t^G is the percent shock to government spending at date t with corresponding coefficients $\Phi_{i,h}$ for two regimes, recession ($i = R$) and expansion ($i = E$) for the horizon- h estimates. The matrices $\mathbf{\Pi}_{i,h}(L)$ represent the projection coefficients in two regimes for other

¹ Although data for Japan were included in our analysis of OECD countries, we did not analyze or present results for individual countries in our prior study.

variables included as controls, and the weights assigned to each regime for a given observation based on the weighting function $F(\cdot)$ vary between 0 and 1 according to the contemporaneous state of the economy, z . Note that the lag polynomials $\Pi_{i,h}(L)$ are used to control for the history of shocks rather than to compute the dynamics. The impulse response functions for either regime come directly from the estimates of $\Phi_{i,h}$ for $h = 0, 1, 2, \dots$ and, to convert these responses into multipliers, we multiply $\Phi_{i,h}$ by the average ratio of GDP to government spending in 1960-2012, which is approximately 4.1. Unlike in the standard VAR approach, these impulse responses automatically incorporate the effects of induced future changes in government purchases. Also, because the set of regressors in (1) does not vary with the horizon h , the impulse response incorporates the average transitions of the economy from one state to another. That is, the multiplier at horizon h for a policy undertaken while in state i reflects the state that is expected to prevail h periods later.

For our initial estimates, we include the logarithm of real government purchases, G_t , in place of FE_t^G in expression (1). This makes the fiscal policy shocks the same as those that would arise from the standard VAR approach with a recursive ordering of government spending first in the VAR (see e.g. Blanchard and Perotti 2002); that is, changes in government spending are assumed to be non-responsive contemporaneously to developments in the economy. However, we found in both of our earlier papers that fiscal policy shocks so constructed were significantly correlated with real-time policy forecasts, conditional on the vector \mathbf{X}_{t-1} . Therefore, to purify our estimates of fiscal policy shocks of information available to forecasters at the time, we also used forecast errors of the real-time, professional projections for government spending. For our OECD data, real-time forecasts were available only at a semiannual frequency, which limited our

analysis to the same frequency. We face a similar issue when incorporating such forecasts for Japan, as discussed further below.

In both of our earlier papers, in constructing the weighting function $F(\cdot)$, we calibrated $\gamma = 1.5$ and based z_t on the (standardized) deviation of real GDP growth from trend (1.5 years in the case of semiannual data; seven quarters in the case of quarterly data), extracting the trend using a Hodrick-Prescott filter. To minimize the possibility of smoothing out deep contractions or prolonged expansions, we use a large value of the smoothing parameter ($\lambda = 1e9$) in the filter. In Auerbach and Gorodnichenko (2013), we also considered other plausible measures of z and found little qualitative differences in our results, primarily because the different measures of the indicator variable led to similar time patterns of weights for the two regimes.

3. Data and Modifications of our Approach for Japan

In undertaking our analysis for Japan, we face a number of specific issues related to data and the economy. First, due to changes over time in the construction of national income accounts, it is necessary to merge series from overlapping time periods based on different conventions to obtain reasonably long quarterly series for real GDP and government purchases.² The resulting series run from 1960 through 2012. Second, unlike for the United States, we do not have any series of real-time forecasts of government purchases from Japan, but must rely on the forecasts produced elsewhere. We utilize two such sources. The first source is the OECD's Statistics and

² We are very grateful to Mr. Susumu Suzuki of ESRI for the construction of these series, which begin in 1960. For a corresponding measure of real tax receipts, we rely on data from Doi et al. (2011). We define tax receipts, intended to measure tax receipts net of transfers payments, as the sum of (1) taxes on production and imports, receivable; (2) current taxes on income, wealth, etc., receivable; (3) social contributions, receivable; and (4) capital taxes receivable; net of (5) subsidies payable; (6) net property income payable; (7) social benefits other than social transfers in kind, payable; and (8) net other current transfers payable. As these tax data are in nominal terms and not seasonally adjusted, we deflate them by the GDP deflator and then use the X-12 program in EViews to seasonally adjust them. As a check for data consistency, we also calculate real, seasonally adjusted government purchases using the Doi et al. data. For the period over which the two government purchases series overlap (beginning in 1980), the levels of the two purchases series are slightly different but their movements track each other very closely.

Projections database, from which we have the same semiannual forecasts dating from 1985 used in our earlier paper. The second source is the IMF World Economic Outlook, which since 2003 has also produced semiannual forecasts for various countries, including Japan. As the IMF forecasts are roughly one quarter out of phase with the OECD forecasts, we can merge the two series for the period since 2003 to obtain a series of quarterly forecasts of government purchases. Third, Japan has had an extended period of slow growth since 1990, which makes the construction of trends and the development of consistent indicators of expansion and recession a challenge.

Figure 1 illustrates this issue, providing time series of the probability of being in recession, based on three alternative potential indicator variables for the state of the business cycle. In all three cases, the probabilities are based on the function $F(\cdot)$ as defined in expression (2), with $\gamma = 1.5$.

The dark line in Figure 1, labeled PR(Y), is the probability series based on a measure of the output gap, equal to the percentage difference between real GDP and its HP-filtered trend. Even though this series is intended to pick up business cycle fluctuations, most of its variation occurs at a frequency much lower than is normally associated with business cycles, with the probability of recession being very low for an extended period from the late 1970s through the mid-1990s, very high in the mid-1960s and mid-2000s, and in transition from the late '60s to the mid-'70s and from the late '90s to the early '00s.

There is much more high-frequency variation in the series labeled PR(DY), which is based on the deviation of the 7-quarter centered moving average real GDP growth rate from its HP-filtered trend.³ In addition, there is a very different pattern regarding which periods have a

³ We employ a centered moving average because our objective for z is to use a coincident measure of business cycles. Using only lags of the output growth rate can give only a lagging measure of business cycles and we are

high probability of recession. For example, this measure shows two episodes with a high probability of recession in the mid-‘90s, throughout which the first series indicates a low recession probability, and a generally low probability of recession near the end of the sample period, when the first series’ probability is consistently high. Thus, unlike in our analysis of the full OECD sample, for which indicator variables based on growth rates and levels of activity produced probability series with similar patterns, the choice for Japan makes a big difference.

The third series in Figure 1, labeled PR(res), also shows probabilities based on a moving average of real GDP growth rates. However, to reflect the perspective that much of the slower growth after 1990 may have been due more to prolonged economic weakness than to a lower underlying trend, the growth rates are measured as deviations from the *pre-1990* average growth rate. Almost by construction, this series tracks PR(DY) closely during the period up to 1990, but deviates substantially thereafter, particularly during the post-2000 period, showing a long period since the mid ‘90s during which the probability of recession stays high.

Given the very different time series probabilities based on these three plausible indicators of economic weakness, we present results below based on each series.

4. Results

A. Full sample estimates

To obtain estimates based on the longest available sample period, which begins in 1960, we begin our analysis using the basic measure of shocks to real government purchases, unadjusted for the real-time forecasts that are available only beginning in 1985. For the same reason, we

wary of using variables with the wrong timing (see the discussion in Ramey (2011)). On the other hand, using future values of the output growth rate utilizes information not available to economic agents. While there is an obvious tradeoff, the cost of using future values to construct a centered moving average of output growth rate is not large. For example, when we use SPF forecasts for output growth rates instead of actual values for the U.S. data, we get similar results. Since SPF forecasts are dated by $t-1$ (or t), they do not utilize information unavailable to economic agents and hence the similarity of results suggested that the cost is likely to be small.

exclude from the vector of control variables, \mathbf{X} , the lagged values of taxes, for which our series dates only from 1980. Thus, we estimate expression (1) with \mathbf{X} consisting of (four) lagged values of the logarithms of real GDP, Y , and real government purchases, G , and condition the current value of G on these same variables to construct our government purchases policy variable.⁴ Finally, in this first pass at the data, we abstract from potentially time-varying responses and focus on the linear model.

Panel A of Figure 2 presents the resulting estimates of output impulse responses, along with 90-percent confidence bands, for a unit increase in government purchases. The results indicate a large fiscal policy multiplier, with a short-run impact just below 1.0 and values around 1.5 two to three years after the initial shock. The first line of Table 1 provides three measures that summarize these results, each with a corresponding standard error. The first measure is the maximum multiplier over 12 quarters; the second measure is the average multiplier over 12 quarters; the final measure divides the cumulative output effect by the cumulative effect on government purchases, based on estimates of equation (1) with government purchases as the dependent variable. This last number is an estimate of an average multiplier during the initial three-year window. All three measures suggest a large policy effect; the average multiplier of 2.30 is larger than those typically found for the US postwar period (as surveyed by Ramey 2011).

Figure 3 and the remaining rows in Table 1 show the impact of allowing IRFs to vary according to the state of the economy. Results differ depending on which of the three variables discussed in connection with Figure 1 is used to define the business cycle. For example, point estimates of multipliers in expansions are small but positive when the output gap is used (the

⁴ In this draft, we exclude taxes from the control vector \mathbf{X} for all specifications presented, even for shorter sample periods for which the tax variable is available. Estimated multipliers of government purchases for sample periods starting after 1980 are generally similar for specifications including and excluding taxes from the set of control variables.

middle panel on the left-hand side of Figure 3), but generally negative when growth rates are used, particularly when the growth rate is measured relative to the pre-1990 average growth rate (the bottom panel on the left-hand side of Figure 3). However, regardless of which indicator variable is used, multipliers in recessions (the right-hand side of Figure 3) are substantially larger than those in expansions, with the results for recessions and expansions generally bracketing those for the linear model shown in Figure 1. These results show up very clearly in the first two sets of columns in Table 1, showing the maximum and cumulative multipliers by regime. The estimated multipliers are larger in recessions and smaller in expansions than for the standard linear model that pools expansions and recessions.

The finding that multipliers are larger in recessions than for the linear model carries over to the average multiplier estimates in the last columns of Table 1, although the differences from the linear model are not statistically significant. The average multiplier estimates for expansions, though, vary wildly and are quite imprecisely estimated. The problem appears to arise from the estimated average values of induced government purchases being close to zero, which makes the ratio measured here very sensitive to small changes in the denominator and hence the standard errors very large. Indeed, the large positive point estimate for the last business-cycle measure, *res*, results from dividing a negative estimated average output effect by a small negative average effect on government purchases. It turns out (not shown) that the two large standard errors (for the indicator variables *DY* and *res*) vanish with the elimination of a single (different) observation.

In summary, estimates for the full sample are quite consistent with findings from our earlier work, about the overall effectiveness of government purchases at stimulating output and the ranking of effects in recessions versus expansions. If anything, overall multiplier estimates

and those for policies adopted in recessions indicate a stronger responsiveness in Japan than elsewhere. These results, though, are based on an historical period that includes three decades prior to the weak post-1990 growth era that has puzzled and frustrated policy makers and economists; and they do not adjust policy shocks for components predictable by real-time forecasts, which we have found in our previous work to affect multiplier estimates. We now consider each of these issues.

B. Post-1985 Estimates

To get an initial sense of whether multipliers have changed over time in Japan, we consider the same models estimated above, but for a sample period beginning in 1985 rather than 1960. We choose 1985 not only because it is temporally close to the beginning of Japan's "lost decade," but also because it is the earliest date for which we have real-time forecasts; hence, starting then will allow an evaluation of the effects of including real-time forecasts to purify policy shocks.

Panel B of Figure 2 shows the IRF for the effect of government purchases on output estimated for the sample period 1985-2012 in the linear model. A comparison to the previously discussed results in Panel A of the figure shows a weakening of the multiplier, with point estimates near zero and confidence intervals including the possibility of large negative effects. Summary measures of these multipliers, in the first row of Table 2, are positive but small and statistically insignificant.

What might underlie this weakening of the estimated effects of fiscal policy? One potential explanation could be a shift in the probability of being in recession during the latter period. Given the full-sample estimates of multipliers in recession and expansion, an increased likelihood of being in an expansion could by itself reduce estimates of overall multipliers. But this hypothesis fails for two reasons. First, although the line between expansion and recession is

difficult to draw in post-1990 Japan, the notion that this represented a golden expansionary age is not plausible, even for a lower trend growth rate. Second, post-1985 estimates of regime-specific IRFs based on equation (1) also suggest a deterioration of multipliers in both recession and expansion. As illustrated in Figure 4, the IRFs are generally smaller and no longer significantly different from zero in recessions; and, while point estimates are still higher in recessions than in expansions for two of the indicator variables, the ordering is now reversed for estimates using the output gap (PR(Y)). The summary statistics in Table 2 tell the same story.

Given the broad confidence bands and our uncertainty regarding how best to distinguish between regimes, one cannot state conclusively that the responsiveness of GDP to government purchases in recessions was weaker after 1985, but the evidence is suggestive.

C. The Effect of Controlling for Real-Time Forecasts

As discussed above, fiscal policy innovations defined relative to lagged values of government purchases and GDP typically understate what was known at the time, as they are partially predictable using independent real-time forecasts. To purify innovations of predictable components, we add real-time forecasts of government purchases one period ahead, $G_{t|t-1}$, to the set of control variables used in constructing policy shocks. Our two sources of forecasts (the OECD since 1985 and the IMF since 2003) allow us to estimate this augmented specification semiannually from 1985 or quarterly from 2003. Each option involves a sharp reduction in the number of observations available. With these sample sizes, separate estimates for expansions and recessions involve very large standard errors, so we limit our analysis to the single-regime, i.e., linear model. The results for the two samples are shown in Table 3; those labeled “Actual” correspond to our standard specification, while those labeled “Forecast errors” are based on innovations based on a set of variables including real-time forecasts.

Estimates in the upper panel of Table 3 are for the same sample period as those in Table 2, but for a semiannual frequency. Values in the first line are for our standard specification, and may be compared to those in the first line of Table 2. Not surprisingly the results are similar. The introduction of real-time forecasts reduces two of the three measures of the multiplier, making the cumulative effect negative. Unfortunately, the large standard errors here leave us unable to distinguish a true effect from sampling error. Turning to the lower panel of Table 3, we see that multipliers for our basic specification are larger for the post-2003 period. Adjustment of policy innovations reduces multiplier values, but again our ability to draw inferences is limited by large standard errors.

Unlike in our previous research, using real-time forecasts to purify measured policy innovations does not increase point estimates of the size of multipliers. However, we are unable to estimate effects separately for recessions, where our earlier findings were most evident, and our very small sample sizes make it impossible to draw useful statistical inferences even based on single-regime estimation.

D. Rolling Sample Period Results

We have thus far presented results for three sample periods, beginning in 1960, 1985, and 2003. The variation of the estimated multiplier across different periods seems not to be due to changes in the composition of recession/expansion regimes, but might reflect changes in the multipliers in one or both regimes. To explore this time variation further, we estimate multipliers over rolling sample periods of ten years' duration. Given the short sample periods, we focus primarily on the linear, single-regime model, and of course cannot incorporate real-time forecasts, which we have for a quarterly frequency only since 2003.

Figure 5 presents results for this estimation procedure, with the four panels of the figure showing the evolution of the three multiplier measures considered above: maximum, average, and normalized, plus the impact (contemporaneous) multiplier. Each of the panels shows how these multipliers evolve over time, with the horizontal axis indicating endpoints of the rolling ten-year periods. All four panels show higher multipliers for the most recent sample periods, consistent with our observation for the 2003-2012 sample period examined in Table 3. We also observe a general decline in point estimates as we move from the earliest samples to those ending in the early 1990s, consistent with our findings of smaller multipliers when excluding the period 1960-84 from our sample in moving from Table 1 to Table 2 and in Figure 2-Figure 4. Confidence bands for these multipliers are wide, particularly for samples ending in the 2000s, so we cannot pin down these trends precisely; but we can reject stability. Specifically, as shown in Table 4, multipliers in 1980-1995 tended to be significantly lower than multipliers in 1962-1977 or 1998-2012.

As discussed earlier, changes over time in multiplier estimates do not seem to track shifts in the likelihood of recession; for example, low multiplier estimates in samples covering the early '90s are inconsistent with what one might expect. In principle, we can address this question directly by estimating two-regime models for these rolling sample periods. Results for such estimates, shown for one multiplier measure (the 12-quarter average) and our three business cycle indicators, are provided in Appendix Figure 1. Unfortunately, these estimates vary substantially according to which business cycle indicator is used and provide no clear picture as to the evolution over time of regime-specific multipliers. Indeed, the recent increase in multipliers suggested by the results in Figure 5 seems attributable more to behavior in expansions rather than recessions, which is a puzzling result.

The multiplier dynamics, however, may be consistent with alternative measures of slack in the economy. If the Japanese economy were expanding by absorbing people into the labor force in the 1970s and early 1980s, this might explain a declining multiplier over that period, as fewer human resources were immediately available. Then, by the time the bubble collapsed in the late 1980s – early 1990s, an overheated economy might have produced low multipliers. As the economy entered the protracted period of stagnation and increasingly more resources became available (that is, the slack increased), the multiplier started to rise again. Notably, the multiplier spiked during the Great Recession. Obviously, this conjecture needs further analysis and more data.

5. Concluding Remarks

Our analysis for the period after 1960 suggests that fiscal policy in Japan, like other advanced countries, has the capacity to stimulate economic activity, particularly in recession. But results are less clear for more recent periods, and there is evidence of multiplier instability. Many factors limit our ability to draw strong conclusions. Specifically, analysis of fiscal multipliers is particularly challenging in Japan because of the following reasons.

First, we lack a clear measure of the business cycle for Japan. This is a difficult issue because Japan has gone through different long phases during the post-war period, beginning with “catch-up” growth after WWII, which dominated business cycles, followed by the collapse of the bubble in 1990, after which the economy stagnated for a prolonged period of time. This creates a challenge of how to separate trend and cycle. For example, is the low growth in the 2000s a new normal or is it a massive under-utilization of resources? Also, the population in Japan has been rapidly aging in recent decades and this may mean that alternative approaches should be used for construction of trends.

Second, the effects of fiscal policy may be hard to detect if monetary policy is working against it. For example, for most of the period since the mid-1990s the Bank of Japan has typically been viewed as having the position that it would raise interest rates in response to any sign of rising inflation. Thus, any fiscal stimulus that might have jump-started the economy and created inflation could have brought with it an expectation of an offsetting response by the Bank of Japan. Note that a response to fiscal policy might have evaporated without any *actual* response by the Bank of Japan – the threat may have been enough to limit the potency of fiscal stimuli.

Third, after the collapse of the bubble, there may have been other changes in the economy that hindered the ability of fiscal policy to stimulate aggregate activity. For example, Caballero et al. (2008) argue that continued allocation of credit to “zombie” firms hindered the reallocation of capital to productive uses. Thus, cyclical variation in the magnitude of fiscal multipliers may be confounded by the prolonged period of post-bubble stagnation.

Fourth, it is difficult to assemble long, consistent time series of macroeconomic variables for Japan. For example, we lack a single, consistent series for GDP for the postwar period; some variables (e.g., capacity utilization) are not available at all; and some variables have limited usefulness (e.g., the unemployment series appears to be relatively insensitive to business-cycle variation: until the 1990s, the unemployment rate was routinely between 1 and 2 percent and even in the worst of the times it did not exceed 6 percent).

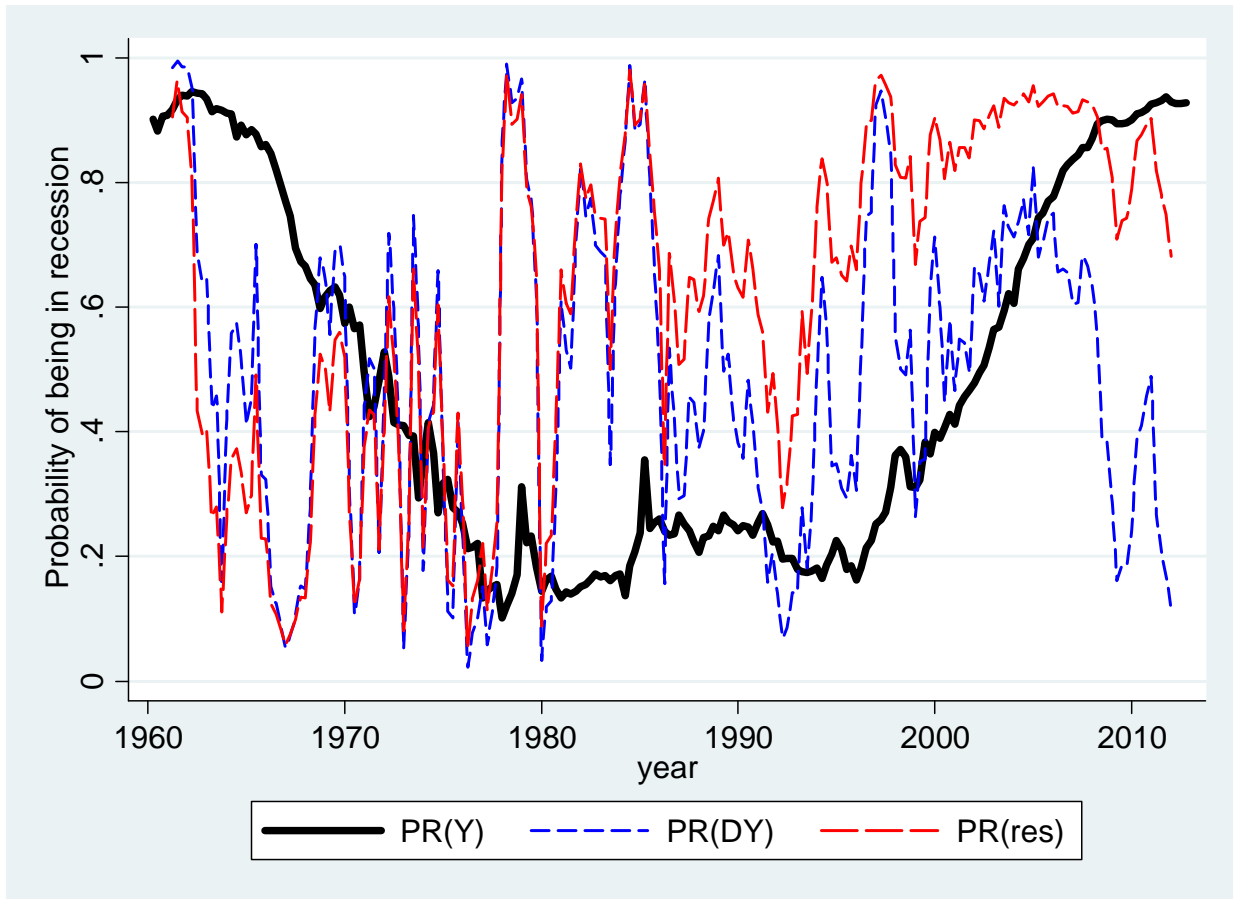
Finally, the previous literature of fiscal multipliers emphasizes the importance of “unanticipated” shocks, and thus the lack of a long time series of macroeconomic forecasts (especially for government spending) hinders our ability to produce convincing analysis.

We hope that future work will address these challenges.

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Figure 1. State of the Business Cycle



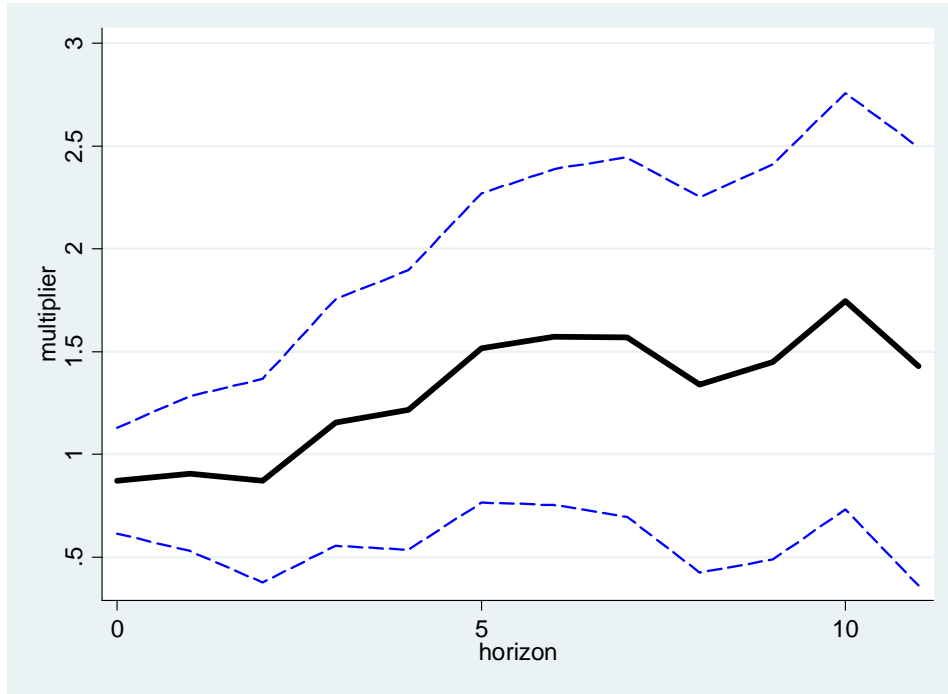
Notes: $\Pr(\text{Recession}) = \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}$, with $\gamma = 1.5$.

The state z is measured as the normalized deviation of i) the growth rate (centered moving average over 7 quarters) of output from HP-filtered trend (DY); ii) level of output from HP-filtered trend (Y); iii) the growth rate (centered moving average over 7 quarters) of output from the average growth rate of output *before* 1990 (res).

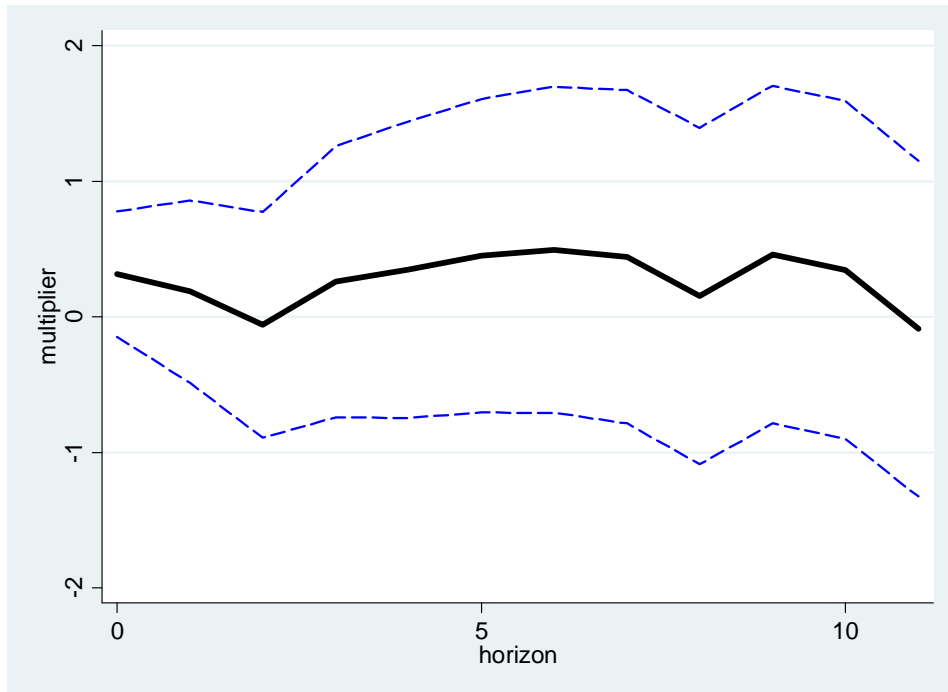
For the last measure, we use the following procedure: 1) calculate the average growth rate of output for 1960-1990; 2) calculate the deviation of the centered moving-average growth rate of output from the average calculated in step 1; and 3) normalize the deviation from step 2 to have standard deviation equal to one. (Note that we do not normalize this measure to have zero mean).

Figure 2. Impulse Response (Multiplier) in the Linear Model

Panel A: 1960-2012 sample

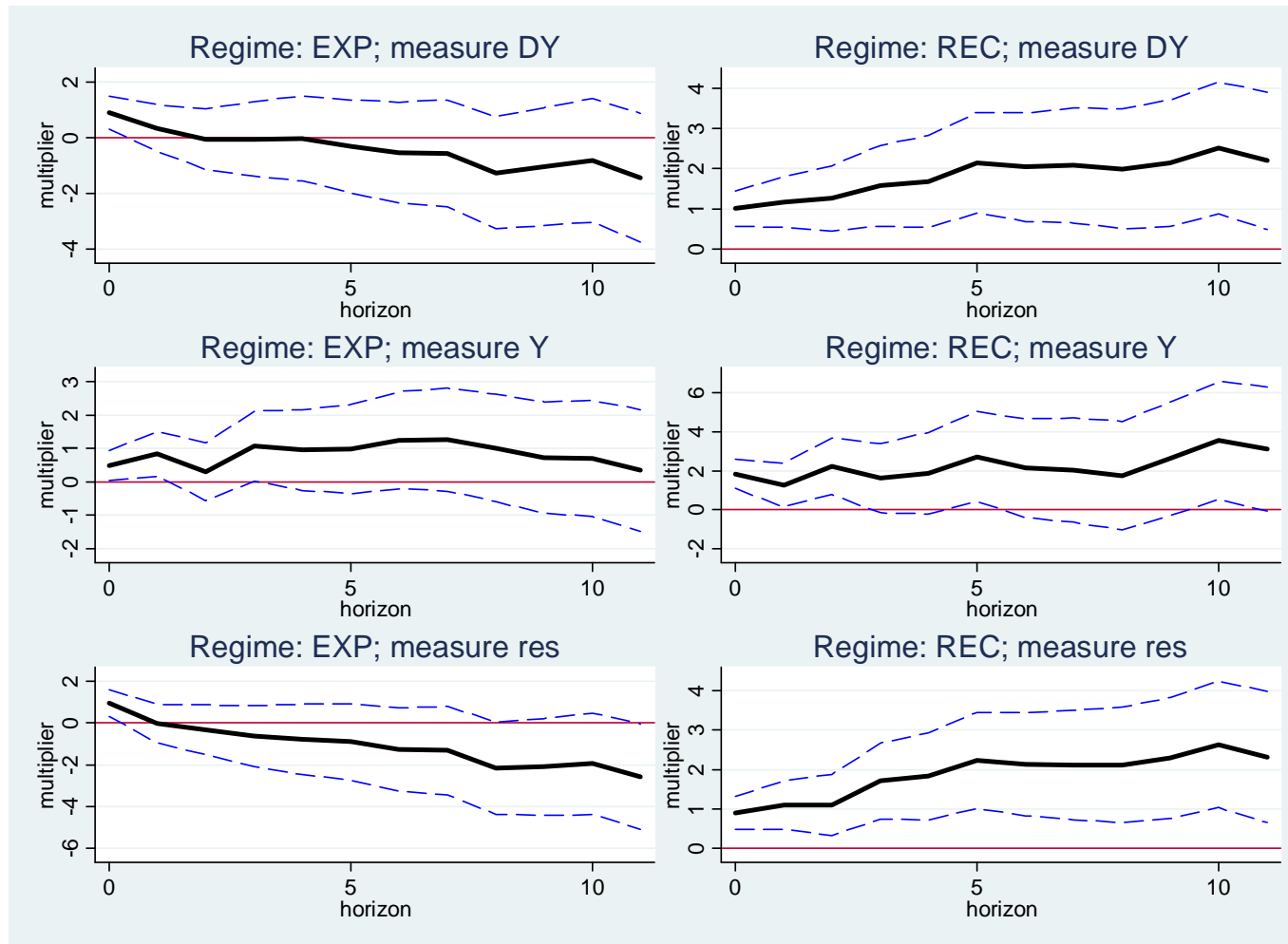


Panel B: 1985-2012 sample



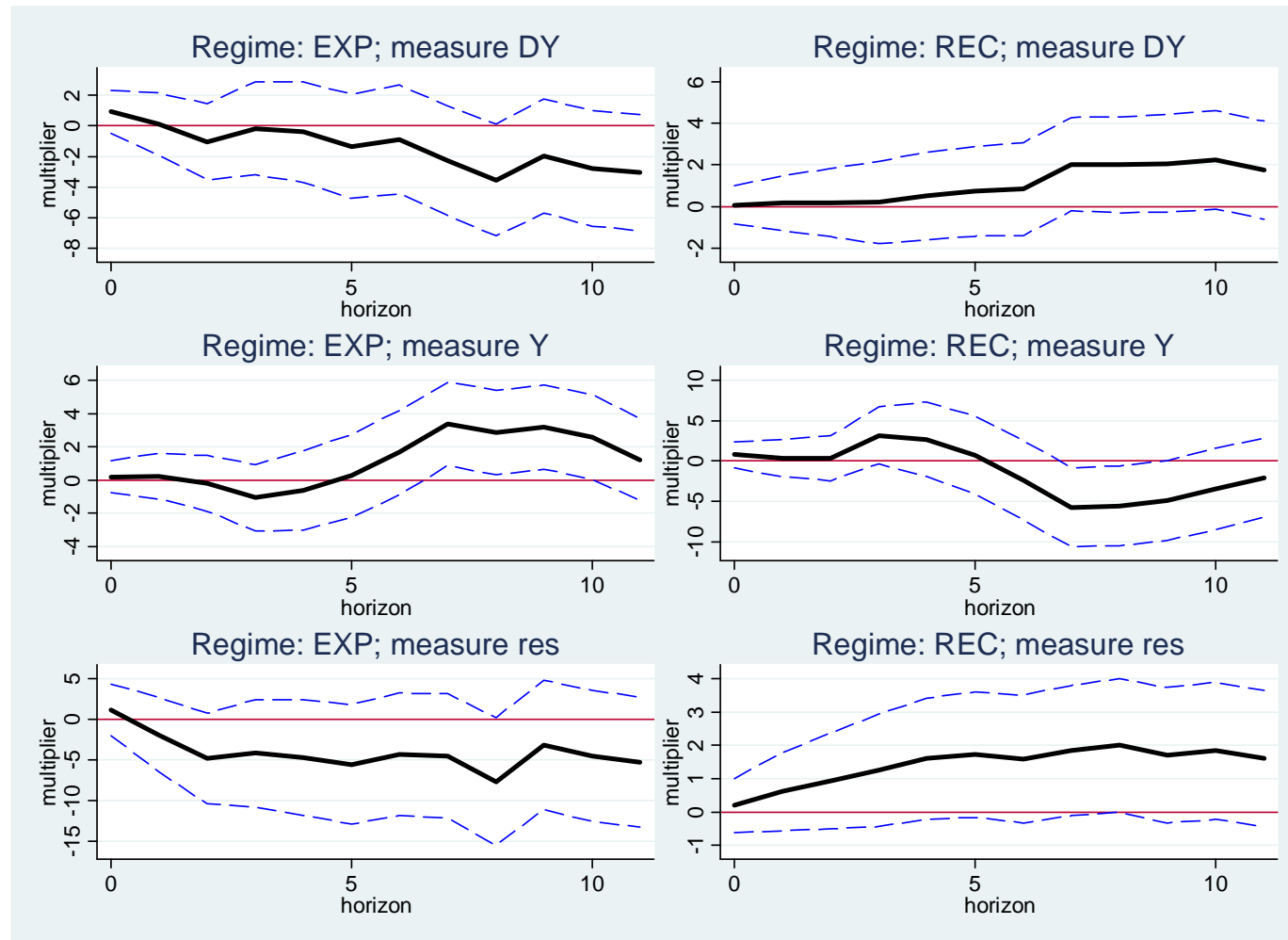
Notes: The panels show the estimated dynamics of output (solid, thick, black line) after a unit increase in the government spending. Blue, dashed lines show the 90% confidence interval. All results are based on direct projections.

Figure 3. Multiplier by Regime and Measure of the Business Cycle, 1960-2012



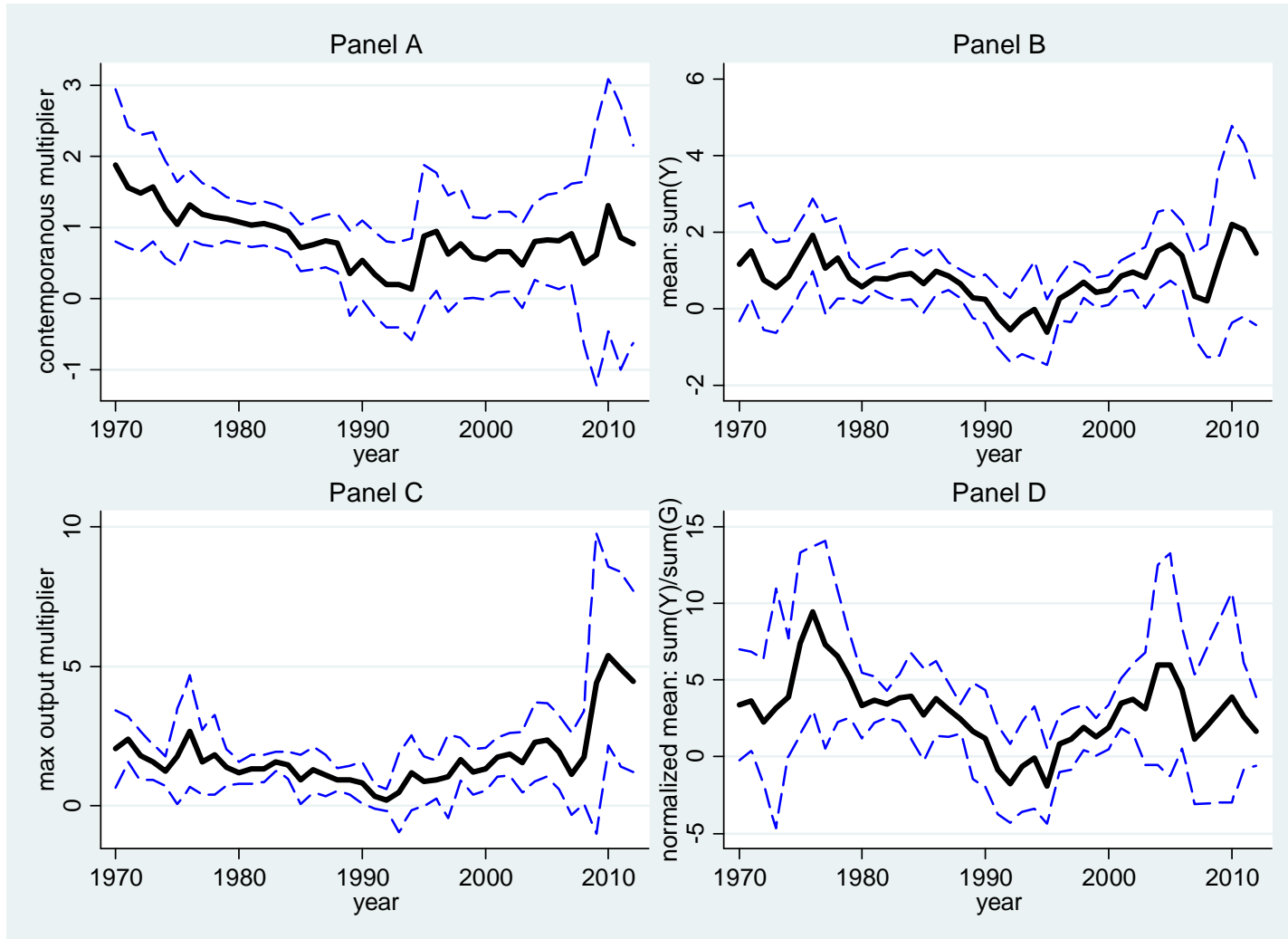
Notes: The figure plots dynamics of output multipliers after a unit shock in government spending. The black, thick, solid line is the point estimate. Blue, dashed lines indicate the 90% confidence interval. The dynamics are reported for expansions (EXP; left column) and recessions (REC; right column) and for three measures of the state of the business cycle: deviation of output growth rate (centered moving average over 7 quarters) from HP trend (DY; top row); deviation of output from HP trend (Y; middle row); deviation of output growth rate (centered moving average over 7 quarters) from the average growth rate of output before 1990 (res, bottom row). All results are based on direct projections for specification (1).

Figure 4. Multiplier by Regime and Measure of the Business Cycle, 1985-2012



Notes: The figure plots dynamics of output multipliers after a unit shock in government spending. The black, thick, solid line is the point estimate. Blue, dashed lines indicate the 90% confidence interval. The dynamics are reported for expansions (EXP; left column) and recessions (REC; right column) and for three measures of the state of the business cycle: deviation of output growth rate (centered moving average over 7 quarters) from HP trend (DY; top row); deviation of output from HP trend (Y; middle row); deviation of output growth rate (centered moving average over 7 quarters) from the average growth rate of output before 1990 (res, bottom row). All results are based on direct projections for specification (1).

Figure 5. Time Variation in Multipliers, Linear Model



Notes: Each panel shows the time series variation of output multipliers after a unit shock in government spending in the linear model. Black, thick, solid lines show point estimates. Blue, dashed lines show 90% confidence intervals. Each multiplier is estimated over 10 years. The year of a reported multiplier corresponds to the last year of the 10-year window; for example, a multiplier reported for 1990 is estimated over 1981-1990.

Table 1. Basic Estimates, 1960-2012

| State | Indicator Variable | $\max_{h=0,\dots,11} \{Y_h\}$ | | $\frac{1}{12} \sum_{h=0}^{11} Y_h$ | | $\sum_{h=0}^{11} Y_h / \sum_{h=0}^{11} G_h$ | |
|-----------|--|-------------------------------|----------------|------------------------------------|----------------|---|----------------|
| | | Point estimate | Standard error | Point estimate | Standard error | Point estimate | Standard error |
| Linear | | 1.74 | 0.65 | 1.30 | 0.41 | 2.30 | 0.67 |
| Expansion | Deviation of output growth rate (7-quarter moving average) from HP filter trend (DY) | 0.90 | 0.29 | -0.40 | 0.89 | -4.70 | 18.10 |
| Recession | | 2.51 | 0.98 | 1.81 | 0.65 | 2.73 | 1.01 |
| Expansion | Deviation of output level from HP filter trend (Y) | 1.26 | 1.11 | 0.83 | 0.85 | 2.47 | 2.25 |
| Recession | | 3.55 | 1.75 | 2.23 | 1.20 | 2.52 | 1.10 |
| Expansion | Deviation of output growth rate (7-quarter moving average) from average output growth rate before 1990 (res) | 0.95 | 0.30 | -1.09 | 1.01 | 16.31 | 50.80 |
| Recession | | 2.63 | 0.94 | 1.87 | 0.62 | 2.80 | 0.95 |

Notes: The table reports output multipliers after a unit shock in government spending in the linear and non-linear models. In the non-linear model, the multipliers are reported for expansions (EXP; left column) and recessions (REC; right column) and for three measures of the state of the business cycle: deviation of output growth rate (centered moving average over 7 quarters) from HP trend (DY); deviation of output from HP trend (Y); deviation of output growth rate (centered moving average over 7 quarters) from the average growth rate of output before 1990 (res).

Table 2. Basic Estimates, 1985-2012

| State | Indicator Variable | $\max_{h=0,\dots,11} \{Y_h\}$ | | $\frac{1}{12} \sum_{h=0}^{11} Y_h$ | | $\sum_{h=0}^{11} Y_h / \sum_{h=0}^{11} G_h$ | |
|-----------|--|-------------------------------|----------------|------------------------------------|----------------|---|----------------|
| | | Point estimate | Standard error | Point estimate | Standard error | Point estimate | Standard error |
| Linear | | 0.50 | 0.77 | 0.27 | 0.52 | 0.44 | 0.89 |
| Expansion | Deviation of output growth rate (7-quarter moving average) from HP filter trend (DY) | 0.92 | 0.64 | -1.37 | 0.91 | -5.17 | 4.71 |
| Recession | | 2.25 | 0.90 | 1.07 | 0.67 | 1.63 | 1.29 |
| Expansion | Deviation of output level from HP filter trend (Y) | 3.38 | 1.47 | 1.14 | 0.87 | 10.85 | 24.60 |
| Recession | | 3.17 | 2.76 | -1.32 | 1.25 | -0.93 | 0.81 |
| Expansion | Deviation of output growth rate (7-quarter moving average) from average output growth rate before 1990 (res) | 1.17 | 1.47 | -4.12 | 2.22 | 4.66 | 4.94 |
| Recession | | 2.00 | 0.86 | 1.41 | 0.69 | 1.84 | 1.27 |

Notes: The table reports output multipliers after a unit shock in government spending in the linear and non-linear models. In the non-linear model, the multipliers are reported for expansions (EXP; left column) and recessions (REC; right column) and for three measures of the state of the business cycle: deviation of output growth rate (centered moving average over 7 quarters) from HP trend (DY); deviation of output from HP trend (Y); deviation of output growth rate (centered moving average over 7 quarters) from the average growth rate of output before 1990 (res).

Table 3. Actual Government Spending and Forecast Errors, Linear Model

| Sample | $\max_{h=0,\dots,H} \{Y_h\}$ | | $\frac{1}{12} \sum_{h=0}^H Y_h$ | | $\sum_{h=0}^H Y_h / \sum_{h=0}^H G_h$ | |
|------------------------|------------------------------|----------------|---------------------------------|----------------|---------------------------------------|----------------|
| | Point estimate | Standard error | Point estimate | Standard error | Point estimate | Standard error |
| Semiannual (1985-2012) | | | | | | |
| Actual | 0.78 | 0.77 | 0.24 | 0.26 | 0.62 | 0.71 |
| Forecast errors | 0.79 | 0.95 | -0.34 | 0.96 | -0.23 | 0.62 |
| Quarterly (2003-2012) | | | | | | |
| Actual | 4.45 | 1.96 | 1.44 | 1.13 | 1.64 | 1.34 |
| Forecast errors | 3.73 | 2.49 | 1.13 | 1.27 | 1.06 | 1.11 |

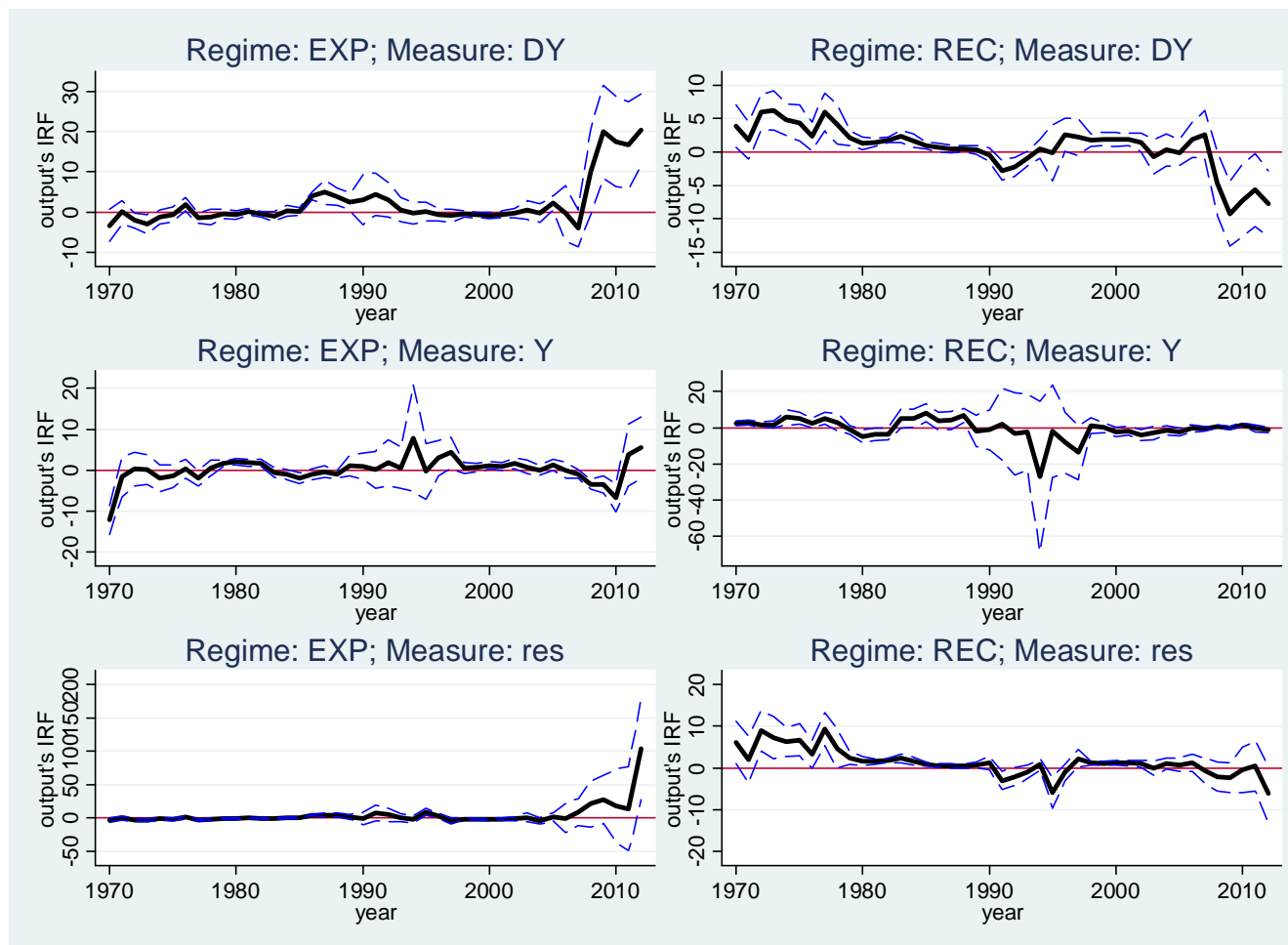
Notes: The table reports output multipliers for the linear model where government spending shocks are measured as percent forecast errors with real-time projections by the IMF and OECD included in the information set. For semiannual estimates, summations are over six semiannual periods ($H = 5$). For quarterly estimates, summations are over twelve quarters ($H = 11$).

Table 4. Tests of Equality in Rolling Sample Regressions: t-statistics

| Multiplier | 1962-1977 | 1962-1977 | 1980-1995 |
|---|------------------|------------------|------------------|
| | vs. 1980-1995 | vs. 1998-2012 | vs. 1998-2012 |
| Contemporaneous | 2.15 | 1.57 | -0.17 |
| $\frac{1}{12} \sum_{h=0}^{11} Y_h$ | 1.58 | -0.94 | -3.08 |
| $\max_{h=0, \dots, 11} \{Y_h\}$ | 1.81 | -0.84 | -2.31 |
| $\sum_{h=0}^{11} Y_h / \sum_{h=0}^{11} G_h$ | 1.44 | 0.68 | -0.62 |

Note: Statistically significant tests (at 10 percent or less) are in bold.

Appendix Figure 1. Time Variation in Multipliers by State and Business Cycle Measure. Average Multipliers $\left(\frac{1}{12} \sum_{h=0}^{11} Y_h\right)$



Notes: Each panel shows the time series variation of output multipliers after a unit shock in government spending by regime and a measure of the state of business cycle. Black, thick, solid lines show point estimates. Blue, dashed lines show 90% confidence intervals. Each multiplier is estimated over 10 years. The year of a reported multiplier corresponds to the last year of the 10-year window; for example, a multiplier reported for 1990 is estimated over 1981-1990. The dynamics are reported for expansions (EXP; left column) and recessions (REC; right column) and for three measures of the state of the business cycle: deviation of output growth rate (centered moving average over 7 quarters) from HP trend (DY; top row); deviation of output from HP trend (Y; middle row); deviation of output growth rate (centered moving average over 7 quarters) from the average growth rate of output before 1990 (res, bottom row). All results are based on direct projections for specification (1).