

Investment Effects of Departures From Governmental Present-Value Budget Balance

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Abstract

I investigate whether departures from government borrowing constraints affect the relationship between fiscal-policy innovations and changes in the investment level. 'Break Points', or apparent departures from present-value budget balance, are then identified. Next, the investment-deficit relationship is examined prior to and following identified break points in an effort to detect potential changes in behavior. The investment-deficit relationship is quantified by examining posterior coverage bounds of impulse response functions. Britain appears to undergo such a break around 1973. Data from this country suggest that significantly more crowding out occurred following the identified breaks: in contrast, data from other comparison countries that do not appear to have experienced breaks indicate stable investment-deficit relationships.

Key words: government deficit; unit roots; structural instability; impulse response; crowding out.

JEL Classification: E62; E22.

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“Few economic issues have such far-reaching implications as excessive government budget deficits and debt.” (Thomas M. Hoenig, 1995)

I Introduction

The potential for fiscal policy to affect real variables has long been recognized. However, the possibility that a given fiscal policy innovation may have differing effects, depending on the role of the government’s overall fiscal stance, has only recently been explored. Notably Auerbach and Kotlikoff (1987) develop a model in which the short-run effects of an expansionary fiscal policy on investment are qualitatively different depending on the expected duration of the expansion. Also, Sutherland (1997) develops a model in which, given moderate levels of government debt, an expansionary fiscal policy has expansionary effects on consumption, but has contractionary effects when debt levels reach extreme levels or are deemed unsustainable. Finally, empirical support for this result comes from Giavazzi and Pagano (1990), who show that expansionary fiscal policies do not always affect real variables in a consistent manner.

This paper is an empirical investigation of whether the impact of deficit-spending innovations on investment are sensitive to the government’s overall fiscal status. Using a measure of whether a government’s budget is balanced in present-value terms, I identify two fiscal regimes: the government’s present-value budget is balanced, or it is not. I then investigate whether differences in this status translate into differences in the investment-deficit relationship, which I quantify by examining the behavior of impulse-response functions. For the case of Britain, whose government clearly appears to experience a violation of its present-value budget constraint, I find that the investment-deficit relationship is indeed related to the change in status: prior to the violation, budget-deficit innovations do not appear to crowd out investment; following the violation, crowding out occurs.

Theoretical support for the sensitivity I detect is provided by the Ricardian Equivalence Proposition. This proposition predicts that the impact of an increase in government expenditures on interest rates or investment will be identical regardless of whether the increase is funded by an increase in current taxes or by borrowing. The driving force behind this proposition is the idea that if the increase in government expenditures is financed by borrowing, individuals recognize

that the increased debt this causes must ultimately be paid off by a future tax increase; to prepare for this eventuality, individuals respond as though the tax increase was implemented immediately. Many economists dismiss the empirical relevance of the proposition due to the implausibility of the numerous assumptions that must be made in order for it to hold exactly. For example, if individuals do not expect the tax increase necessitated by a deficit expansion to occur in their lifetimes, or they value their own utility more than their descendants, the proposition breaks down. Mapping this discussion into the problem at hand, suppose individuals view future tax increases necessitated by the increased deficit expansion as far more imminent when the government's present-value budget constraint is violated than when it is not. Then individuals may well respond differently to such innovations under the two scenarios, thus generating differing real affects. Bertola and Drazen (1993) and Sutherland (1997) present theoretical models supportive of this possibility; the results obtained here lend empirical support.

The detection of possible perceived departures from government present-value budget balance is essential in this study. Tests of present-value budget balance are viewed as tests of the sustainability of the current deficit policies, and traditionally, many authors have viewed these tests as tests of whether agents can rationally expect the government to balance its budget in present-value terms. Implicit in this statement is the notion that not only do agents have rational expectations and can form present-value calculations, but also that agents are willing to entertain the possibility that the government may default on its loans. If this second possibility is excluded, present-value budget balance tests may be viewed as tests of how soon rational agents can expect the government to reverse its current deficit policies. Although the presumption that agents begin expecting the government to reverse its deficit policies may seem irrational in the face of a string of large deficits, it seems more plausible than the alternative possibility under which agents expect the government to run large deficits perpetually.

Over the past few years, a large body of literature has developed which is dedicated to testing the satisfaction of the present-value budget constraints. Notably, Hamilton and Flavin (1987), Trehan and Walsh (1988), Zin and Smith (1991), and Quintos (1995) have examined conditions under which the government's budget is balanced in present-value terms. These tests generally concern

the cointegration of the deficit components and/or the stationarity of the deficit as conditions for the satisfaction of present-value borrowing constraints.¹ The rejection of present-value budget balance signals the ‘drifting apart’ of expenditures and total revenues, and hence large and persistent government imbalances and therefore seems a reasonable place to search for a potential alteration of the investment-deficit relationship.

Since the advent of these types of tests, various papers have examined the government’s constraint for a wide range of countries and time periods (e.g. Trehan and Walsh (1988), Wilcox (1989), Haug (1991), Hakkio and Rush (1991), and Ahmed and Rogers (1995)). The bulk of this literature has focused on the U.S. government, but present-value budget balance results have not been conclusive for this case. For countries with larger debts (measured as a percentage of GDP), the results of such an analysis should be less ambiguous and consequently the effects of such violations may be examined.

In this essay, I identify ‘break points’, using the methods employed in the structural break literature (e.g., Zivot and Andrews (1992), Banerjee, Lumsdaine, and Stock (1992) (henceforth BLS), etc.), and at which point individuals may expect an alteration of the investment-deficit relationship (possibly because individuals might expect the government to reverse its current policies and raise future taxes which lowers the expected return to future investment). Interactions between fiscal-policy innovations and changes in investment levels are examined before and after identified breaks in order to evaluate this possibility. Britain, for whom a break point is identified in 1973, is focused on. The case of Britain is compared with Germany, Italy, and France who do not appear to undergo a ‘break’. These countries were chosen for their geographical proximity and their economic interdependence; this interdependence makes it likely that changing economic conditions affecting one of these countries may have significant effects on others. These comparisons are made in order to determine whether unobserved variables may account for the results obtained for Britain. This analysis suggests that significantly more crowding out occurred following perceived departures from present-value budget balance in Britain indicating that the investment-deficit relationship was altered. In contrast, investment-deficit relationships appear stable in the comparison countries.

The remainder of this essay is organized as follows: Section II explains the procedures which

were used in this analysis, Section III presents the data which is used and results, Section IV concludes the essay with some final remarks and possible extensions.

II Procedures

The stock of government debt b_{t+1} evolves according to the accounting identity

$$b_{t+1} = (1 + r)b_t + g_t - \tau_t \quad (1)$$

where g_t denotes government expenditures exclusive of interest payments, τ_t denotes government tax revenue, r is a constant discount rate, and $g_t + rb_t$ is interest-inclusive government expenditures. By taking expected values of (1) and recursively substituting, the present-value budget constraint faced by the government can be rewritten as

$$b_t = -E_t \sum_{j=0}^{\infty} (1 + r)^{-(j+1)} (g_{t+j} - \tau_{t+j}) + \lim_{j \rightarrow \infty} E_t (1 + r)^{-(j+1)} b_{t+j+1} \quad (2)$$

In order for (2) to actually constrain borrowing activity, the following condition must hold:

$$\lim_{j \rightarrow \infty} E_t (1 + r)^{-(j+1)} b_{t+j+1} = 0 \quad (3)$$

This precludes the possibility of a Ponzi scheme in which the government continually finances its current-period primary deficit, as well as its previous debt and interest payments on that debt, by the issuance of new debt. Present-value budget balance is satisfied when (3) holds. As Trehan and Walsh show, equations (2) and (3) impose restrictions upon the stochastic processes of the deficit components. Provided interest-inclusive government expenditures and revenues are I(1), the restrictions derived concern the cointegration of the components (specifically the stationarity of the deficit inclusive of interest payments) as conditions for present-value budget balance to be satisfied. Quintos (1995) demonstrates that the cointegration of government expenditures and revenues is only a sufficient condition for the satisfaction of the present-value borrowing constraint. Quintos

develops strong and weak conditions for the satisfaction of deficit sustainability in which the strong condition corresponds to Trehan and Walsh's conditions for present-value budget balance. As Quintos mentions however, the weaker conditions he presents have serious policy implications for the marketability of government debt. Therefore, the criterion that will be used throughout this essay to determine present-value budget balance is that developed by Trehan and Walsh and that criterion is the cointegration of the deficit components.

A brief summary of the procedures used within this essay are as follows. Using the full sample, stationarity tests are performed to determine whether present-value budget balance is satisfied. Tests then attempt to discern approximately whether and/or where a departure from present-value budget balance may have occurred. Finally, impulse response functions, and corresponding posterior coverage bounds, are calculated for the split samples to determine if the investment-deficit relationship is altered in a statistically-significant sense following an identified break. The examination of impulse response functions also allows a pictorial representation of the nature of the instability. A more detailed analysis of the procedures follows.

Originally, the criterion employed to determine whether present-value budget balance is satisfied involves recursively testing for the stationarity of the deficit using critical values reported by Fuller (1976). Trehan and Walsh (1988) showed that the budget at time t is balanced in present-value terms if and only if there exists a linear combination of interest-inclusive expenditures and revenues which is stationary (in particular, the cointegrating vector between revenues and expenditures (inclusive of interest payments) should be $(1, -1)$). The deficit, d_t is this linear combination:

$$d_t = g_t + rb_t - \tau_t \tag{4}$$

My analysis involves testing whether the deficit is stationary, and the null hypothesis of nonstationarity corresponds to a present-value budget imbalance.

The time t stationarity is assessed via an Augmented Dickey-Fuller (ADF) unit-root test where the lag length which is chosen using the Akaike Information Criterion (AIC). In searching for 'breaks', unit-root tests are recursively conducted over sub-intervals $t = 1, \dots, k$ for $k = k_0, \dots, T$,

where k_0 is a startup value and T is the sample size. The Dickey-Fuller t -statistics, $t_{DF}(k/T)$, are calculated for all k , $k = k_0, \dots, T$. In an effort to determine sub-intervals in which the series appears to be stationary, any possible changes in present-value budget balance are identified by comparing the $t_{DF}(k/T)$, $k = k_0, \dots, T$, results with the critical values calculated by Fuller (1976).² The rule to determine sub-intervals of stationarity starts with the full sample, and working backwards period by period, a break in behavior is deemed to have occurred the first period the present-value budget balance conclusions are reversed. For example, if the null hypothesis of no present-value budget balance cannot be rejected for an extended period of time dating back to period t_0 , but can be rejected for the sub-interval ending with period t_{-1} , then a break is hypothesized to occur at period t_{-1} . This procedure will henceforth be referred to as the Trehan-Walsh test - recursively testing for deficit stationarity by using the traditional Dickey-Fuller critical values.

There are a number of alternative ways in which a time series can exhibit nonstationarity and the alternative possibilities could result in perceived departures from present-value budget balance. These alternatives include the existence of a deterministic trend or an one-time change in either the mean and/or trend, which if accounted for, could imply that the series is actually stationary. The Trehan-Walsh test does not explicitly consider present-value budget balance conclusions for an otherwise stationary series which has undergone a one-time change in mean or trend. Within the context of this paper, it would seem that if this sort of change occurred then it would be signaling a significant change in policy. Therefore, if an otherwise stationary deficit has undergone a one-time change in mean or trend, I would classify that series as experiencing a significant change in behavior with the ‘break’ dated when the change in mean or trend occurs.

Within the last few years, a growing body of literature has focused on the existence and assessment of structural instability which, if not accounted for, may cause a series to appear nonstationary. A number of classical statistical tests have been devised which allow endogenous determination of structural changes (*e.g.*, Banerjee, Lumsdaine, and Stock (1992), Christiano (1992), and Zivot and Andrews (1992), and more recently, Ghysels and Perron (1996), Lutkepohl and Herwartz (1996), *etc.* (a special issue of the Journal of Econometrics (1996) deals with the issue of structural change), and Bai, Lumsdaine, and Stock (1996))³ while the Bayesian counterpart has been developed by DeJong

(1996). Results are obtained from using the recursive tests similar to those developed by Banerjee, Lumsdaine, and Stock (1992) and the sequential tests of Zivot and Andrews' model C (which is very similar to the sequential tests of BLS), and these results are compared to those of the original recursive unit-root test explained above. Both of these tests compare $t_{DF}^{min} \equiv \min_{k_0 \leq k \leq t_{DF}(\frac{k}{T})}$ with calculated critical values to determine whether a break has occurred.

The initial analysis compares the period by period t statistic against the critical values calculated by Fuller (1976) to determine sub-intervals when stationarity or integration appears to exist whereas BLS and Zivot and Andrews are looking at the extreme t_{DF} to determine whether the full sample is $I(0)$ with a structural break or $I(1)$. The issue addressed by these structural break tests is slightly different than the issue with which this paper is concerned. As mentioned above, the purpose of this paper is to detect departures from stationarity whether the perceived departure is due to the series actually becoming integrated or due to structural instability in the mean or trend of the series. Although the structural break tests are not designed specifically for the issue at hand, they provide a reasonable test of robustness for the initial break test. The Trehan-Walsh test and the above two structural break tests are used in conjunction to formalize the identification of departures from present-value budget balance. This practice gives a general guideline for what follows.

The next step is an analysis of possible effects departures from present-value budget balance may have on investment. This is done via impulse response analysis. The vector autoregression (VAR) contains the government deficit, interest rates, and investment.⁴ There is a body of literature which suggests that interest rates are not related to government deficits (Evans (1987a, 1987b) and Plosser (1982, 1987)), but as Barro (1989a, p. 221) notes, ...“most macroeconomists remain confident that budget deficits raise interest rates”. Therefore, I want to allow for the possibility that deficits affect interest rates and interest rates affect investment. Furthermore, block exogeneity tests were conducted to determine whether the deficit and interest rates are block exogenous and the null of block exogeneity was rejected for all countries at the 1% significance level indicating that investment has some explanatory power for deficits and interest rates. Therefore, no restrictions are placed on the coefficients of the VAR.⁵

For countries which exhibit a break in behavior, a first VAR is estimated using pre-break data,

and a second VAR is estimated using post-break data. This splitting of the data is also done for countries not demonstrating a break in behavior. Again, this is done to help determine whether the results observed in the break countries could be attributed to some unobserved event which affects multiple countries. For countries which do not seem to exhibit a break, another VAR is estimated using the full sample of data for comparison with the relevant first- and second-half-sample responses in the respective ‘no break’ countries to examine the stability of responses in these countries.

Inferences concerning the statistical significance of differences between pre- and post-break impulse response functions are obtained using posterior analysis (*e.g.*, see Doan (1990)). Coverage bounds which contain ninety percent of the mass are derived from these posterior distributions. A strong significant difference is deemed to exist if the coverage bounds of the pre-break response do not overlap with those associated with the post-break response. The examination of the impulse response functions and their corresponding posterior coverage bounds can be thought of as a test for parameter stability. The parameters which are changing at the time of a break are the coefficients of the VAR. This analysis does not address the issue of whether these parameters begin changing a number of periods prior to a break occurring, but instead asks whether the parameters are significantly different prior to and after an identified break. Present-value budget balance is a natural place to look for the alteration of the investment-deficit relationship, but it is not necessarily the only point.

III Results

The data used in this study are obtained from International Financial Statistics CD ROM. Quarterly data on government expenditures, government revenues, and investment are deflated by nominal GDP. Deflating in this manner has a number of advantages: like the common practice of deflating by some price-level measure, price-level movements are accounted for; furthermore, the resulting measure of investment (as a percentage of output) has a nice economic interpretation. The interest rate, as measured by the Treasury bill rate where available and call rate otherwise, is

deflated by subtracting the inflation rate (measured by the growth rate of the CPI) and subtracting the growth rate of real output. The countries of interest and the sample periods for each are Britain (1957:1-1995:4), Germany (1966:1-1994:4), France (1965:1-1995:4), and Italy (1960:1-1991:3).

III.1 Break Dates

Recall, the time t present-value budget balance is determined by the Dickey-Fuller stationarity of the deficit. Estimating the ADF with the full sample of data⁶ and using a 10 percent significance level the null hypothesis of no present-value budget balance (existence of a unit root) can only be rejected for Germany. The next step is to determine if any significant changes in behavior occur. As mentioned above, recursive unit-root tests are initially used to approximate sample periods for which each deficit series appears to be $I(0)$ or $I(1)$ by comparing the t -statistics with those reported by Fuller (1976). Britain seemed to experience just such a break. The null hypothesis of no present-value budget balance cannot consistently be rejected for Britain until the sub-interval ends with 1973:1. For Germany, a unit root cannot be rejected for any sub-intervals until 1982:2 after which time the null of a unit root is rejected for the remaining sub-intervals, *i.e.*, this procedure seems to suggest that Germany may have experienced a qualitatively-opposite break than the one experienced in Britain. For France and Italy, the unit-root null hypothesis cannot be rejected for any sub-interval at the 1% significance level⁷ (the Britain break date is indicated by the vertical line in Figure 1). Upon examination of Britain's deficit process (Figure 1), and as Eltis (1988) explains, borrowing by the British government accelerated in the mid-1970's after occasional earlier surpluses. With this observation, the above hypothesis of a break being detected in the early 1970's seems reasonable. It also roughly corresponds to a period in the mid-1970's in which tighter monetary policies were being pursued in order to reduce inflation; given these policies, government debt became harder to finance because it was being monetized to a lesser extent. Germany's deficit, (Figure 2) although exhibiting a brief increase during the 1970's, seems to settle down in the early 1980's, never seeming to get too large. Prior to the early 1970's, France's deficit (Figure 3) is not large relative to the later periods, but this early period is not of sufficient duration to indicate a prolonged period of fiscal restraint; the sample in general is characterized by persistent deficits.

Finally, Italy's deficit (Figure 4) seems to exhibit an upward trend, but never exhibiting the type of significant change in behavior observed in Britain.

Using a more formal framework to search for changes in behavior, and to test the robustness of the above results, the results for Britain, France, and Italy do not change significantly from the above first-approximation results. Using the BLS method, for Britain the t_{DF}^{min} is found at 1971:4 and is significant using the BLS critical values ($t_{DF}^{min} = -5.2$), dating the break a few periods earlier than the one found above. For no other country is the t_{DF}^{min} less than the 2.5% critical value reported by BLS indicating that significant changes in government behavior do not occur in these other countries. Next, the Zivot-Andrew test is performed. For Britain, the Zivot-Andrews test picks 1975:2 ($t = -5.86$, significant at the 1% level), and once again no other country exhibits t-statistics which are significant at the 2.5% level. These tests give approximately similar results for the break date in Britain: $\approx 1971:4$ - $1975:2$, but the determination of the *exact* date is not critically important to this study. The results for Britain (break around 1973), Italy (no break), and France (no break) are consistent regardless of the criterion used, but this is not the case for Germany. Using the full sample of data for Germany, stationarity was concluded so there is not necessarily a good reason to expect that procedures which test the null hypothesis of a unit root against the alternative of trend-stationarity with a structural break would yield consistent results with initial stationarity results. It is possible that the relatively low power of the unit-root tests inhibit these tests from correctly indicating that the Germany deficit was stationary for the entire time and not just for sub-intervals ending after 1982. Therefore, it seems reasonable to consider Germany as a no-break country whose deficit always seems to be balanced in present-value terms. Complete break results are summarized in Tables 1, 2, and 3.

III.2 Impulse Response Functions

In order to understand the effects that violations of the government's borrowing constraint may have on investment, impulse response functions and their corresponding coverage bounds are examined. As stated earlier, two types of analyses are performed. First, the responses for a given country are compared (*i.e.*, responses before and after a break occurs). This is done to understand

whether any significant changes occur in a given country. Next, the behavior across countries is compared. For instance, if similar significant changes occur in Germany, Italy, and/or France as well as Britain then the cause of any changes which are found in Britain could not necessarily be attributed to a perceived departure from the borrowing constraint which is only apparently happening in Britain. If instead the changes which may or do appear in Britain do not occur in Germany, France, and/or Italy then the changes may be more plausibly attributed to the effects of a present-value budget imbalance.

Since Britain is the example of a country whose budget is initially balanced in present-value terms and then became unbalanced in present-value terms, it is useful to first detail this country's responses. The most striking result is the effect of a deficit shock on the investment response following a perceived departure from present-value budget balance; in Britain, the post-break responses are more negative than the pre-break responses, but this is not so in the 'no-break' countries. In Britain, the pre-break response does exhibit significantly positive effects for nine periods (Figure 5). This is not so for the post-break sample (Figure 6), in which there is significant crowding out for seven periods following a shock to the deficit. There is a statistically-significant difference between the pre- and post-break responses for approximately seven periods. This pattern is consistent with the hypothesis set forth earlier concerning the effect present-value budget balance has upon the investment-deficit relationship. This suggests that around the time of the break, the investment-deficit relationship is altered in a negative direction. This is supportive of the present hypothesis that as the policy becomes unsustainable the expectation of higher future taxes alters the investment-deficit relationship by making current investment less profitable. The responses of interest rates to a deficit shock (figures not shown) are never significant which supports the results of other empirical evidence cited above that suggests that government deficits have little effect on interest rates.⁸

To investigate whether these results are the outcome of some unobserved phenomenon, the data for the 'no-break' countries are split approximately in the middle of the samples⁹ and the first- and second-half samples are examined for response patterns similar to those observed in Britain. It is important to note why the samples of these 'no break' countries are initially being split instead of

examining the full sample responses. This essay is not attempting to explain what determines the responses, but instead is attempting to offer an explanation as to why the responses are changing. Therefore, the samples are split to search for consistent patterns across countries around a similar time frame. In France, there are no significant differences between the two sets of coverage bounds (Figures 7 and 8), and in fact, the responses are nearly identical between the first- and second-half responses. A similar pattern is observed in Italy; the response of investment to a deficit shock in Italy is also not significantly different between the first- and second-half samples (figures not shown). Germany seems to be a slight puzzle though. Recall, that using the Trehan-Walsh test, an argument could be made for Germany exhibiting a break which is qualitatively opposite to that observed in Britain. The deficit, in sub-intervals ending pre-1982, was not stationary, but the deficit, in sub-intervals ending post-1982, was stationary. These results were not supported by the structural break tests though, and therefore it was concluded that Germany was a ‘no-break’ country whose budget was always balanced in present-value terms. The response of investment to a deficit shock in the first-half sample is just slightly significantly negative for a few periods of the response with the mean response negative for the entire response. The second-half sample response is not statistically different from zero with the mean response positive. Comparing the second-half mean response (analogous to a point estimate) to the first-half coverage bounds is a slightly weaker form of significant difference, but if this metric is adopted then there is a significant difference between the first- and second-half response with the second-half response significantly more positive possibly because the probability of future taxes is lowered as the policies are now perceived to be sustainable. The important point is that although there may be weak significant differences in the German responses, they are qualitatively opposite to those observed in Britain. Therefore it can be concluded that the observed results in Britain do not seem to be driven by some unobservable.¹⁰

Finally, the comparison of first- and second-half responses is one method of determining whether significant changes occurred in the ‘no break’ countries. Alternatively, the comparison of the first-half-sample mean responses with the full-sample responses as well as the second-half-sample responses with the full-sample responses could be used to detect whether a consistent pattern exists

throughout the sample for ‘no break’ countries. For all of the ‘no break’ countries, no significant differences exist when the metric of significance is taken to be the overlap of coverage bounds between either the first- or second-half-sample mean responses and the full-sample responses. Even adopting the weaker measure of significance mentioned above, comparing the mean response in each of the sub-samples with the coverage bounds of the full-sample response, there only exists a two period interval in Germany in which the first-half-sample mean response lies outside of the full-sample coverage bounds. For the majority of the response though, the first-half-sample mean response lies within the full-sample coverage bounds. For Italy and France, the complete first- and second-half mean responses lie totally within the full-sample coverage bounds indicating that there is a consistent pattern of responses in these countries.

IV Conclusion

I have examined impulse response functions to determine whether violations of government borrowing constraints affect the influence of fiscal policy innovations on investment. The hypothesis I explore is that the investment-deficit relationship is altered by perceived violations of present-value budget balance. For the case of Britain, the results seem to be conclusive in that there are notable differences in the responses of investment to deficit innovations before and after the break detected in 1973: prior to 1973, a deficit did not tend to crowd out investment; afterwards, crowding out did occur. This indicates that it is not the current level of the deficit alone that affects investment: there is some interaction between current, past, and expected future government behavior that substantially alters the investment-deficit relationship.¹¹

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Table 1: Trehan-Walsh Test

$$y_t = \mu + \alpha y_{t-1} + \sum_{j=1}^n c_j \Delta y_{t-1} + \varepsilon_t$$

Country	deficit stationarity results
Britain	deficit stationary before 1973:1
Germany	deficit stationary after 1982:2
France	deficit never stationary
Italy	deficit never stationary

Table 2: BLS Test

$$y_t = \mu + \beta t + \alpha y_{t-1} + \sum_{j=1}^n c_j \Delta y_{t-1} + \varepsilon_t$$

Country	$t_{DF}^{min} \equiv \min_{k_0 \leq k \leq t_{DF}(\frac{k}{T})}$	Date
Britain	-5.2 ^a	1971:4
Germany	-3.52	1990:2
France	-4.53	1978:1
Italy	-2.04	1972:1

a = significant at the 1% level

Table 3: Zivot-Andrews Test

$$y_t = \mu + \theta DU_t + \beta t + \delta DT_t + \alpha y_{t-1} + \sum_{j=1}^n c_j \Delta y_{t-1} + \varepsilon_t$$

Country	$t_{DF}^{min} \equiv \min_{k_0 \leq k \leq t_{DF}(\frac{k}{T})}$	Date
Britain	-5.86 ^b	1975:2
Germany	-4.25	1971:1
France	-5.14 ^c	1976:2
Italy	-4.13	1979:3

where DU_t is an intercept dummy and DT_t is a slope dummy, *b* = significant at the 1% level, *c* = significant at 5% level

Endnotes

1. Quintos shows that present-value budget balance can be satisfied under weaker conditions, but explains that although present-value budget balance is satisfied these weaker conditions have ‘serious policy implications because the government will have difficulty in marketing its debt in the long run’ (Quintos (1995), p. 410).
2. The critical values are given as -3.51 (1%), -2.89 (5%), -2.58 (10%).
3. The Bai, Lumsdaine, and Stock paper explores the structural stability issue within a multivariate framework while the other papers listed are confined to a univariate analysis.
4. The nominal deficit and investment are deflated by nominal GDP and nominal interest rates are deflated by subtracting the inflation rate and the growth rate of real output. Although the real interest rates are generally determined by subtracting just the inflation rate from the nominal interest rates, this is the appropriate method of deflating when other nominal variables are deflated by a measure of prices; when nominal variables are deflated by nominal GDP, deflating the nominal interest rate entails subtracting the growth of nominal GDP (or similarly, subtracting inflation and the growth of real output).
5. Similar investment responses are obtained if zero coefficients are imposed on the interest-rate and investment lags in the deficit equation and on investment lags in the interest-rate equation.
6. In determining breaks, government expenditures and revenues were smoothed using an eight-period centered moving average to minimize the apparent seasonality which existed.
7. For France, there is an eight-period interval, from 1978:1 to 1980:1, for which a unit-root can be rejected at the 10% significance level, but for no sub-interval can a unit-root be rejected at the 1% significance level.
8. A referee has suggested that because the interest-rate response to a deficit shock is insignificant what may be driving investment is the “bunching up” of irreversible investments (Bernanke,

1883) due to the uncertainty in future taxes. This explanation is complementary to the hypothesis of this essay.

9. The France and Germany data are split at 1980:1 and the Italy data at 1975:1.
10. All other pictures are available from the author upon request.
11. I would like to thank Dave DeJong, Steve Husted, and John Duffy for their comments and guidance. I would also like to thank Carl Walsh, Neil Ericsson, Anindya Banerjee, Robin Lumsdaine, and the participants of the International Seminar at the University of Pittsburgh for their helpful suggestions. I would also like to thank anonymous referees for the suggestions and comments.